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(54) HEAT EXCHANGER

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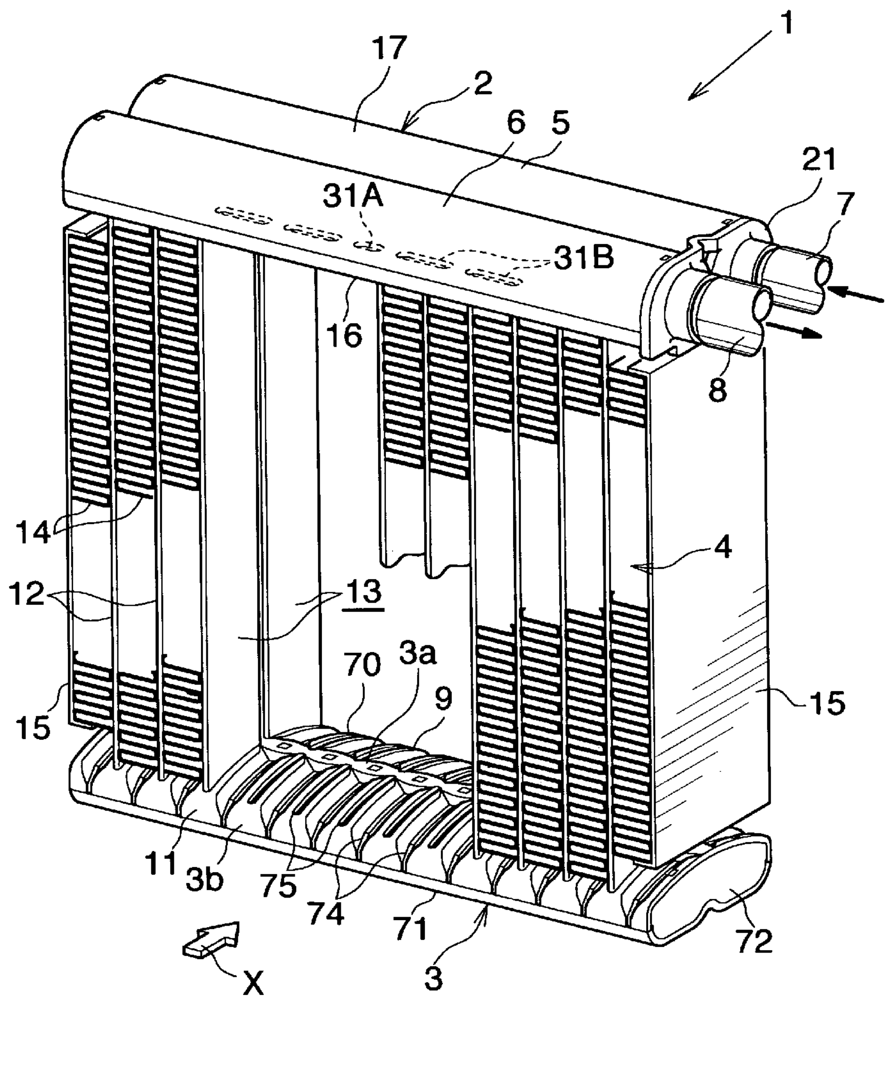
(57) **ABSTRACT**

A heat exchanger used as an evaporator includes a refrigerant inlet header section and a refrigerant outlet header section. The refrigerant inlet and outlet header sections each include a header section body having opened opposite ends and two caps closing opposite end openings of the header section body. The header section body of the refrigerant inlet header section and the header section body of the refrigerant outlet header section are integral with each other. The caps are fitted into the corresponding opposite end openings of the header section bodies. Projections formed at peripheral portions of the caps are fitted into corresponding mating holes formed in tubular walls of the header section bodies. In this condition, the caps are joined to the header section bodies. This heat exchanger allows relatively easy practice of the work of preventing detachment of caps in manufacture thereof.



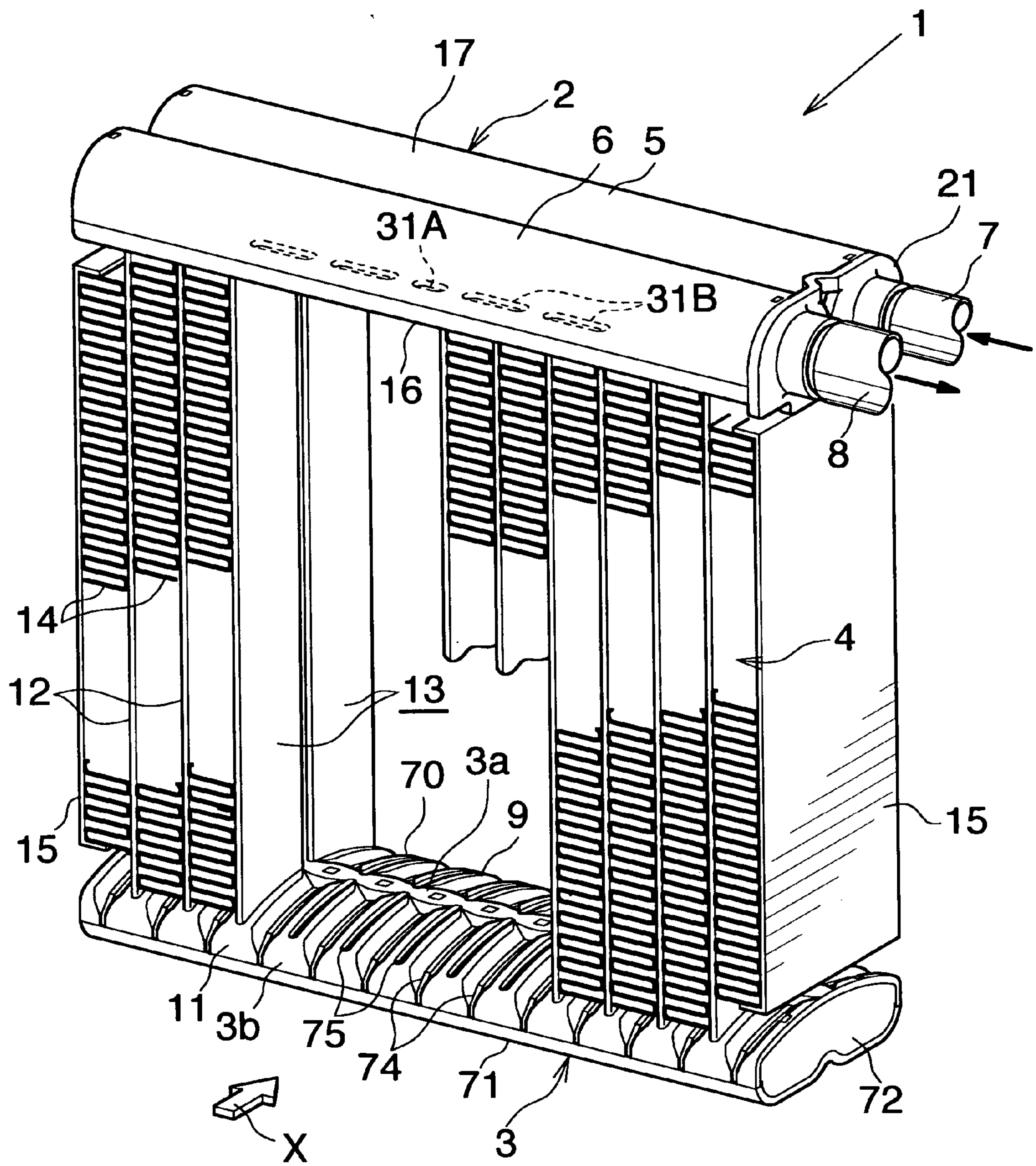


Fig.1

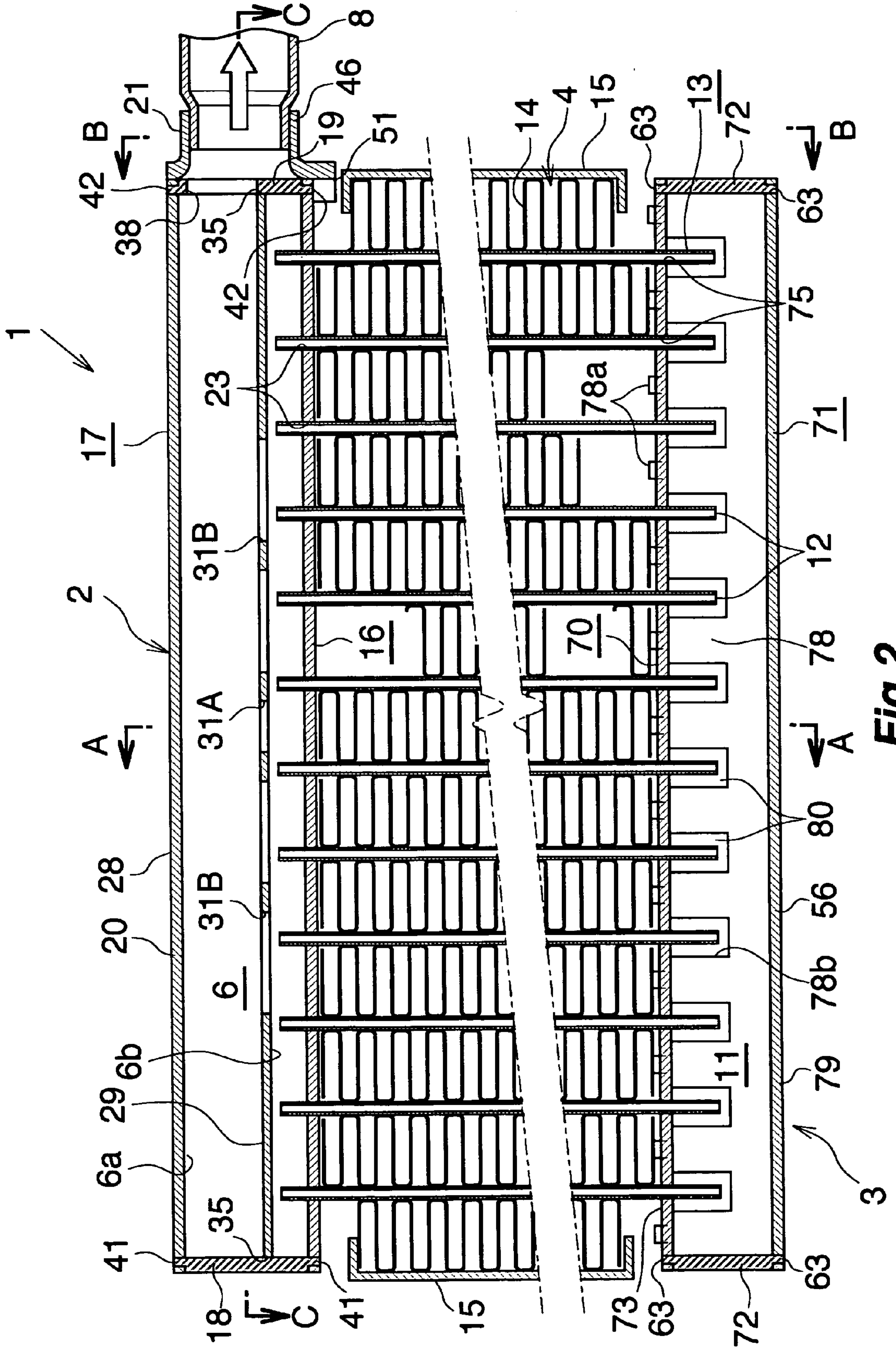

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Fig.2

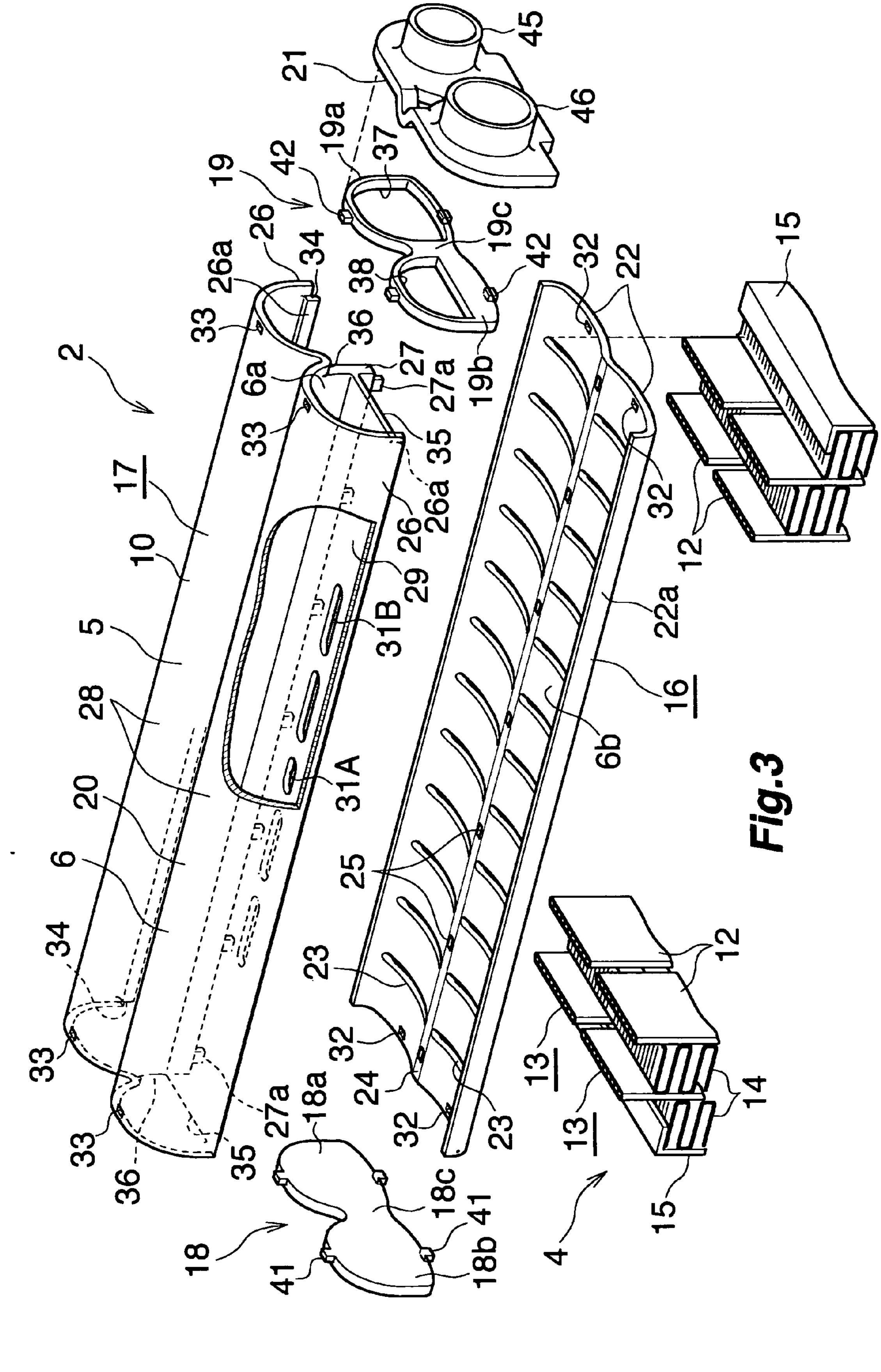
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Fig.3

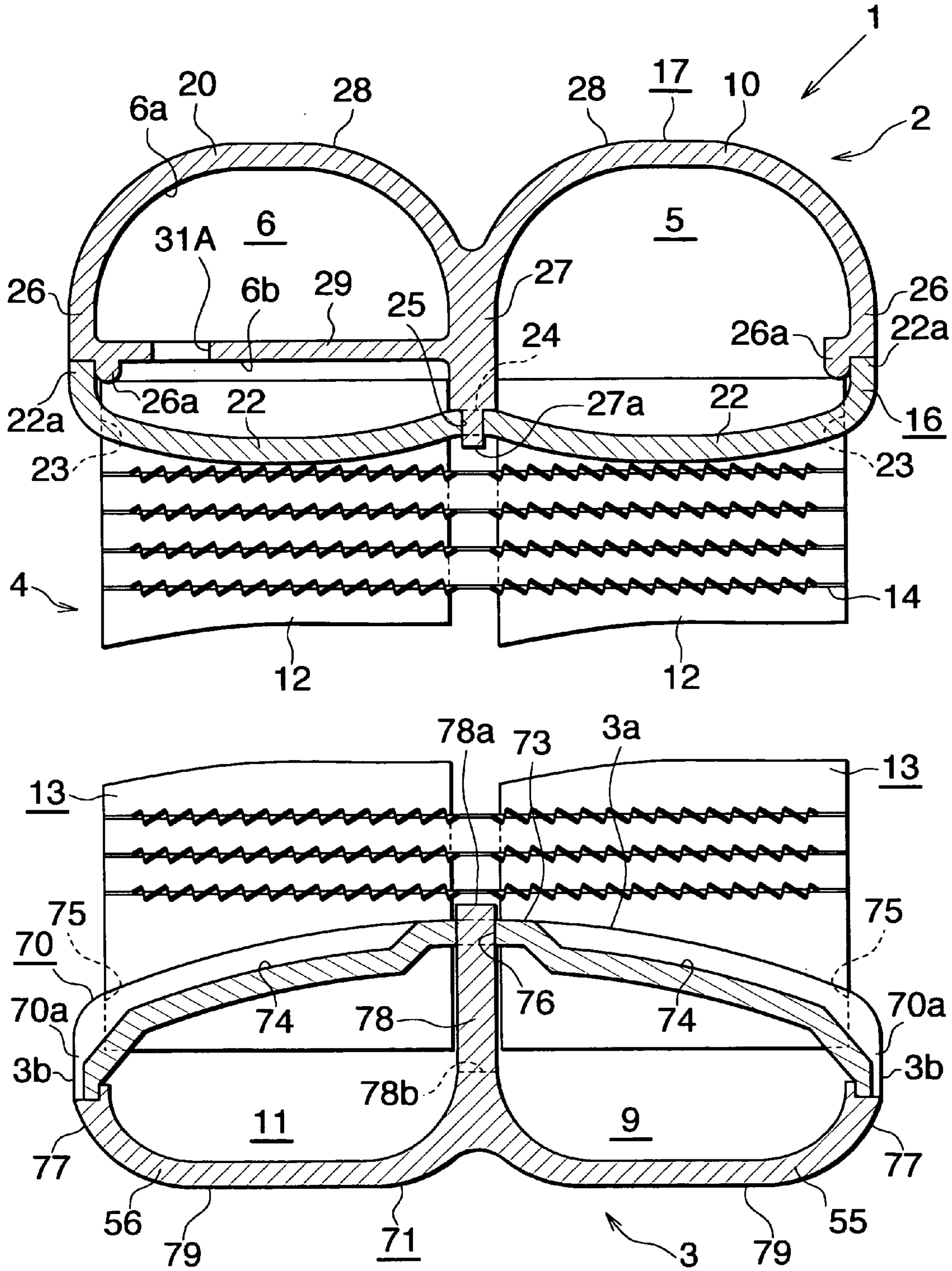
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Fig.4

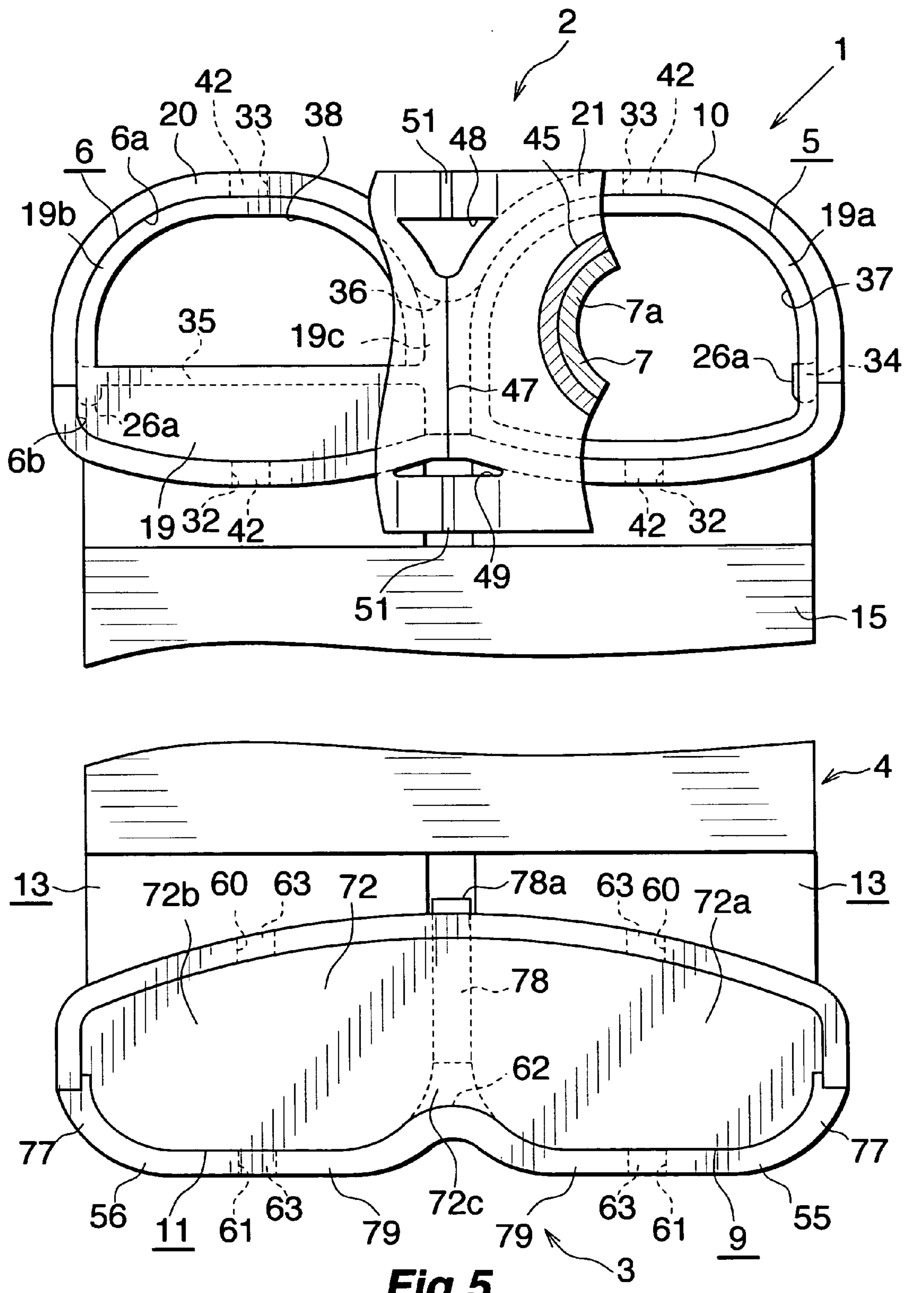

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Fig.5

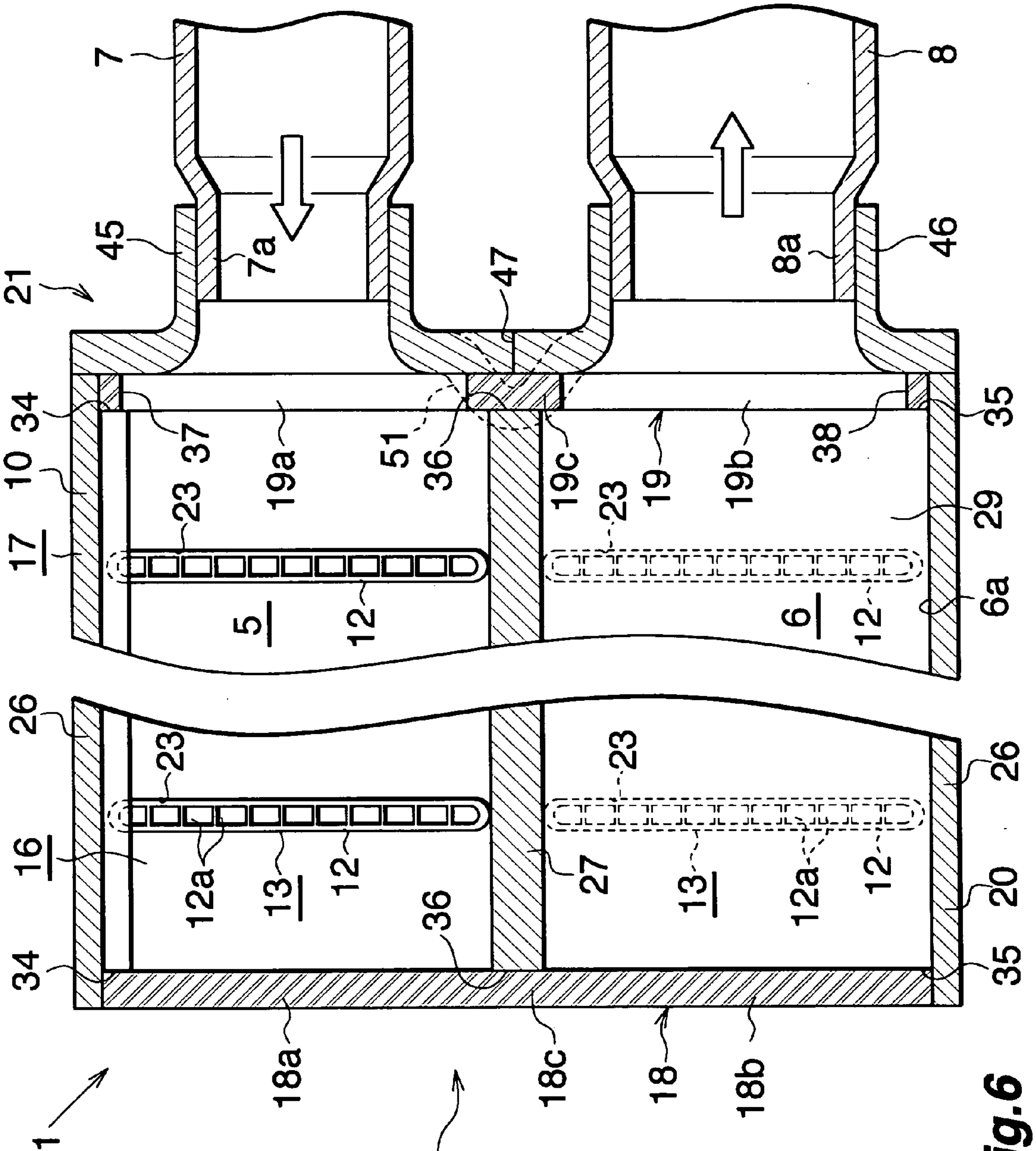
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Fig.6

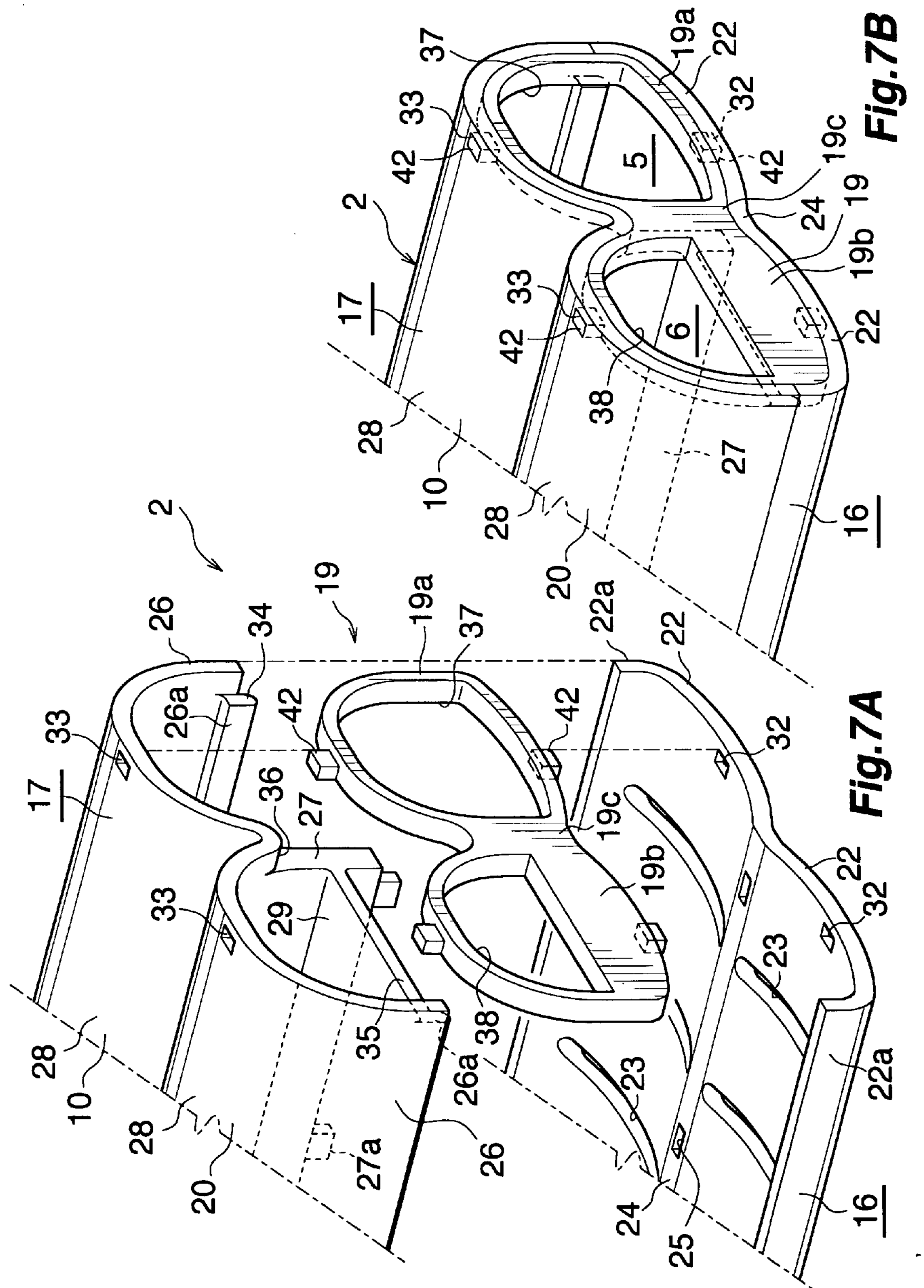
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Fig.7A

Fig.7B

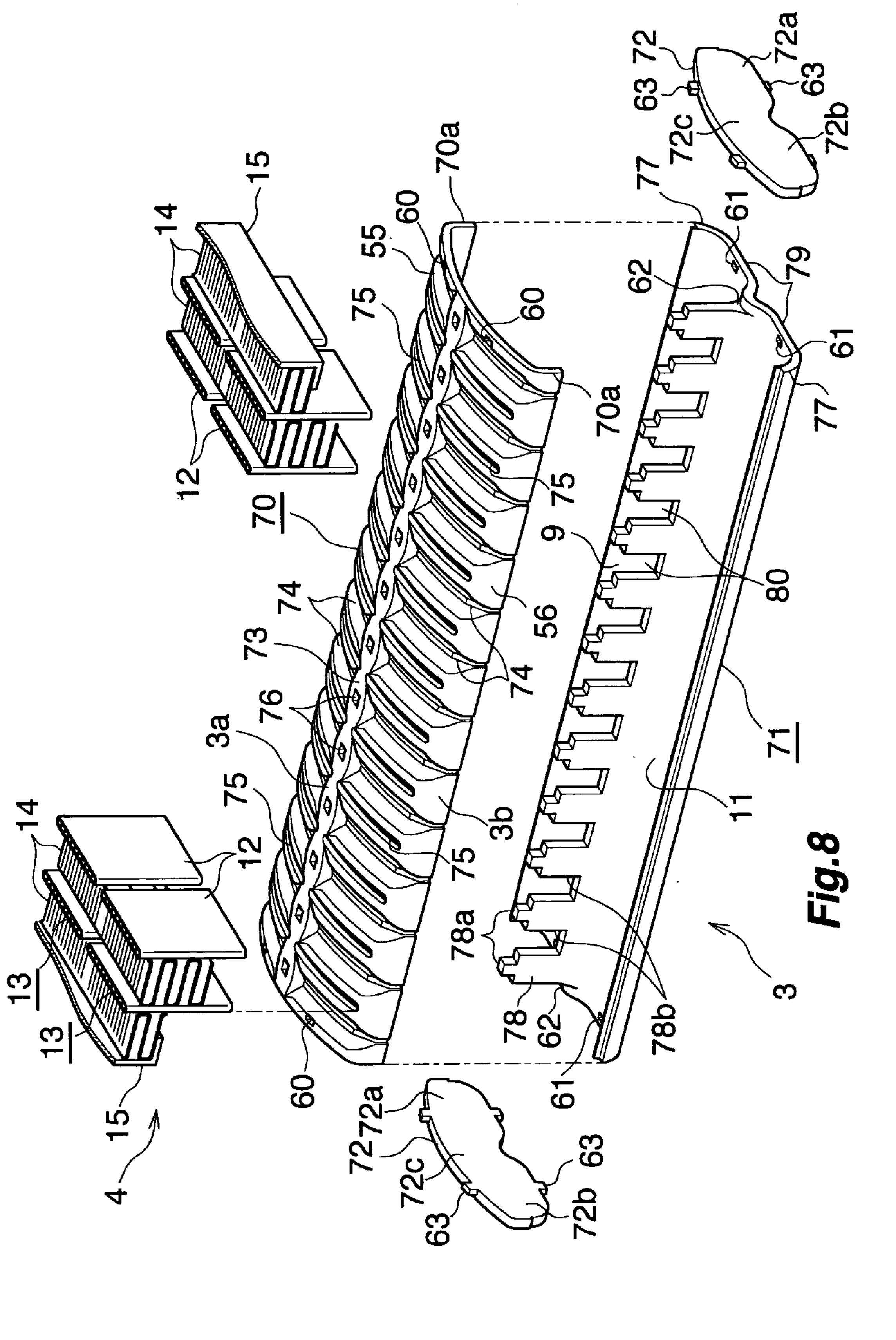
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Fig.8

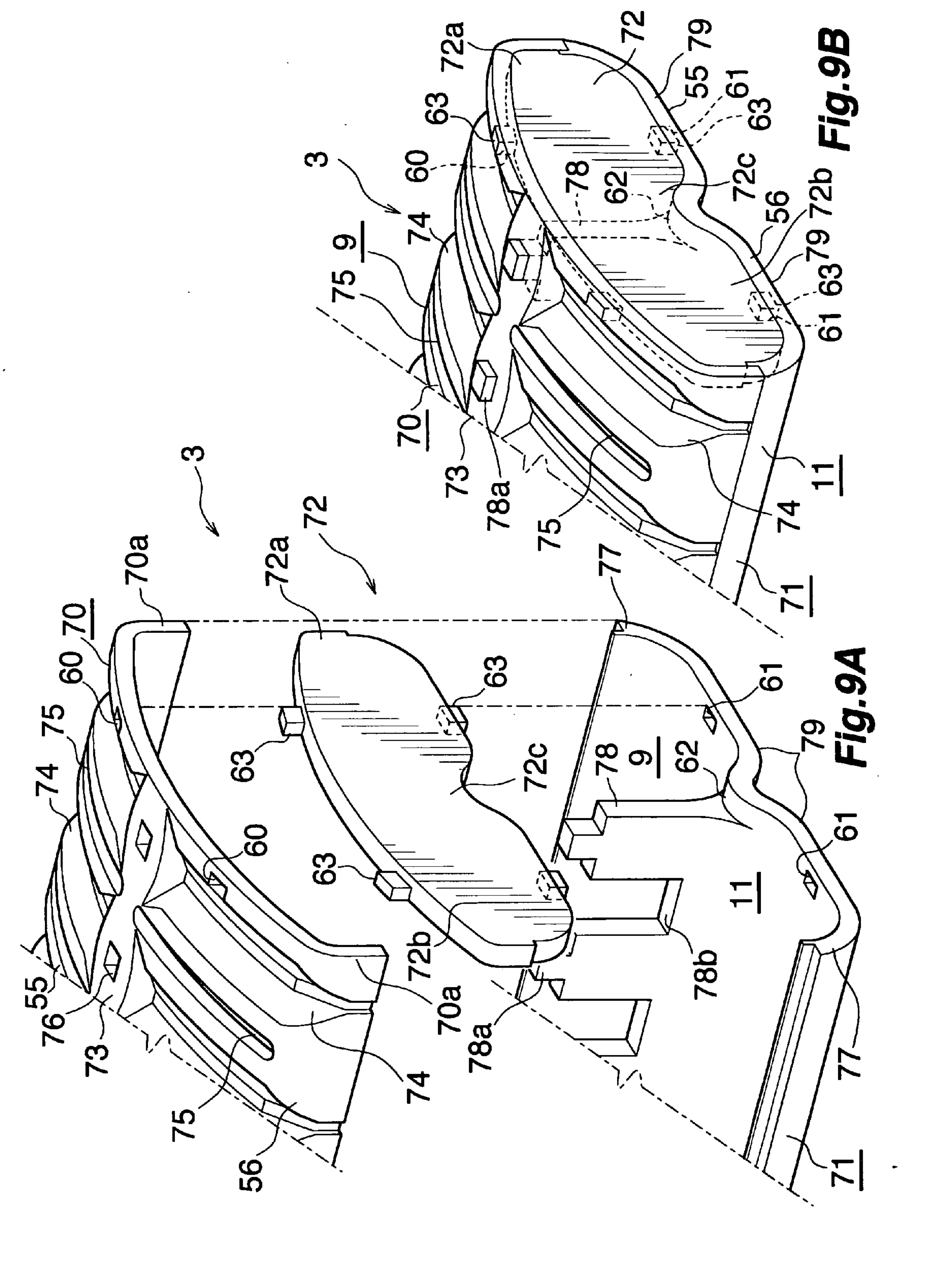

Fig.9A

Fig.9B

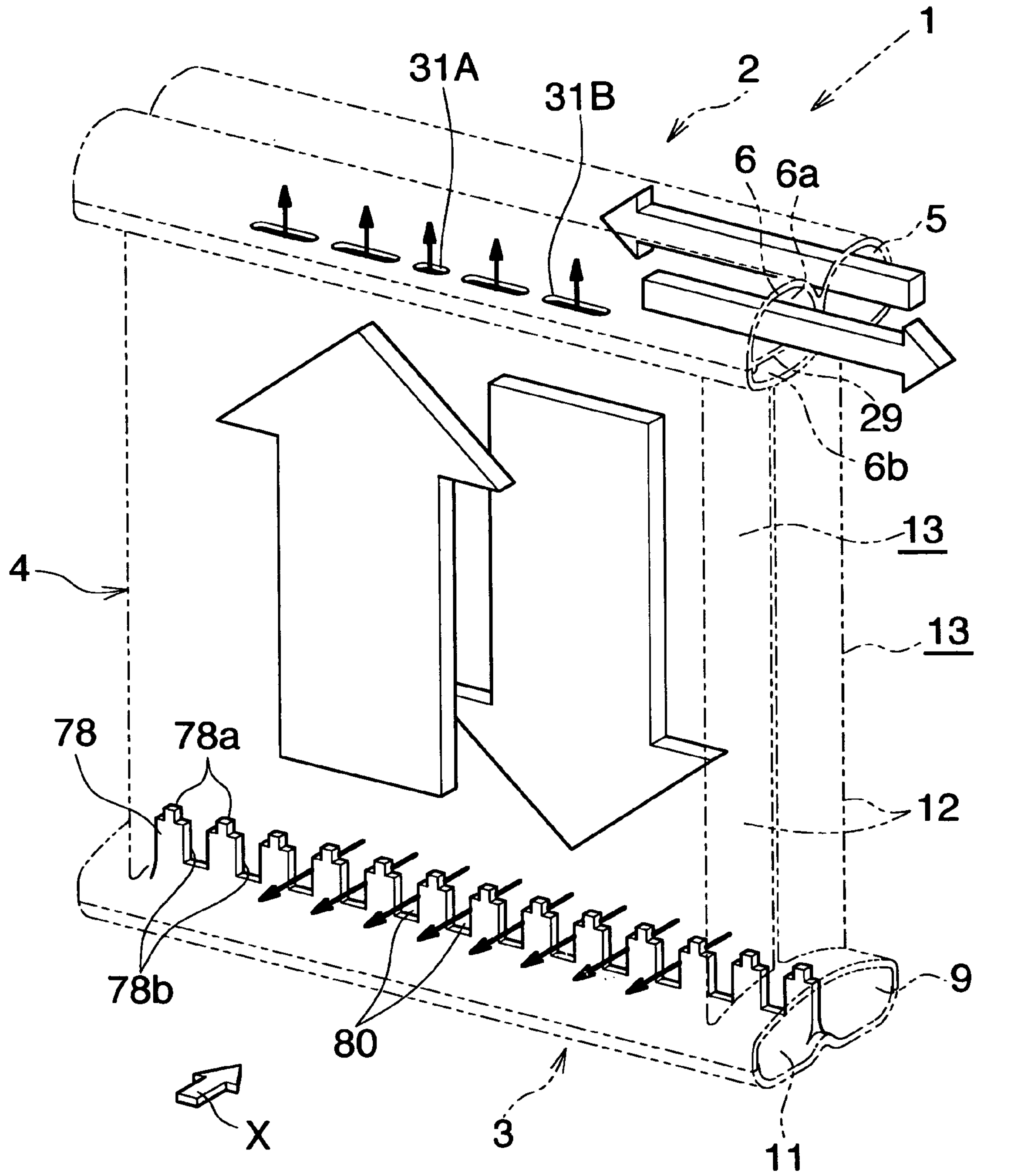

Fig.10

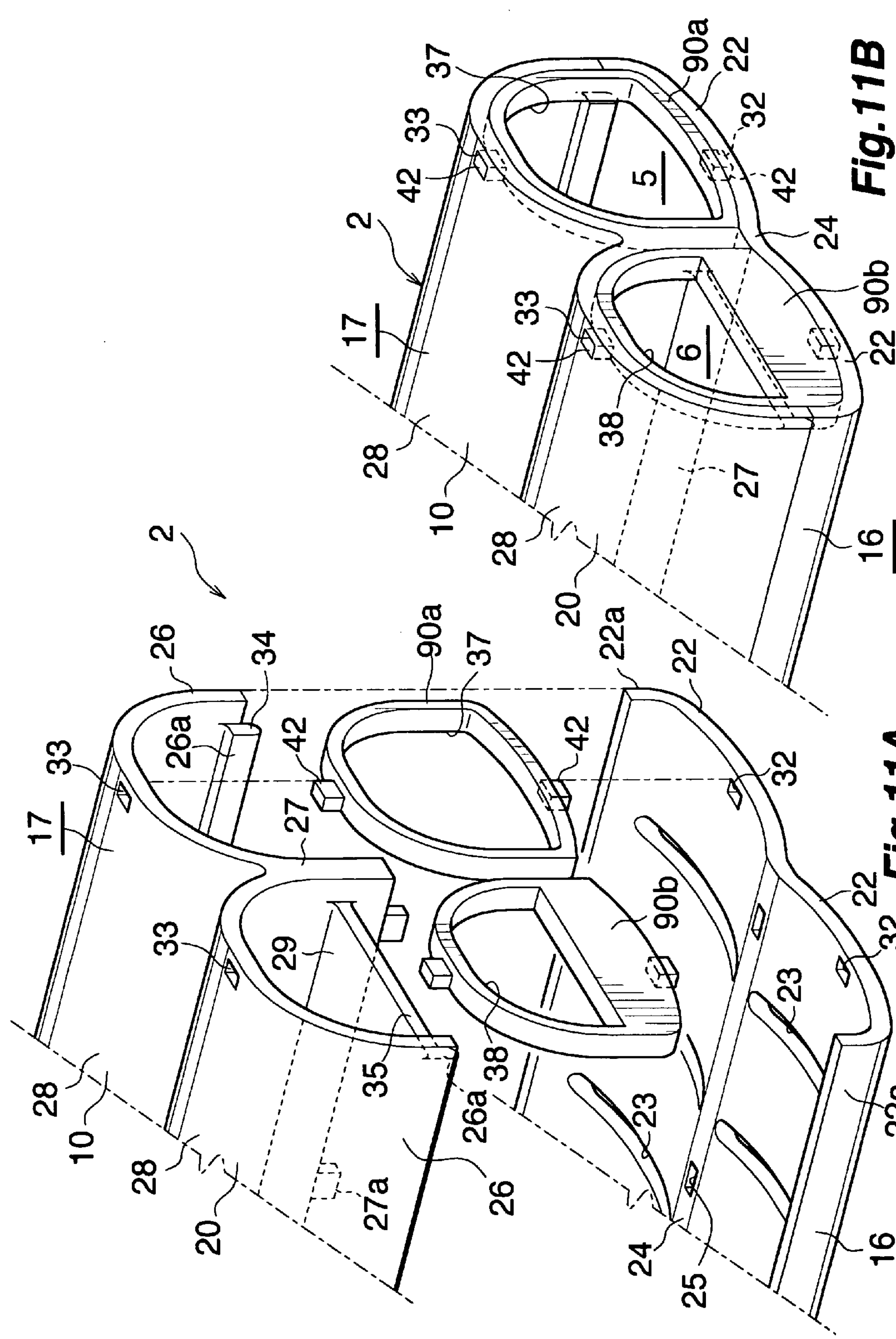

Fig.11A

Fig.11B

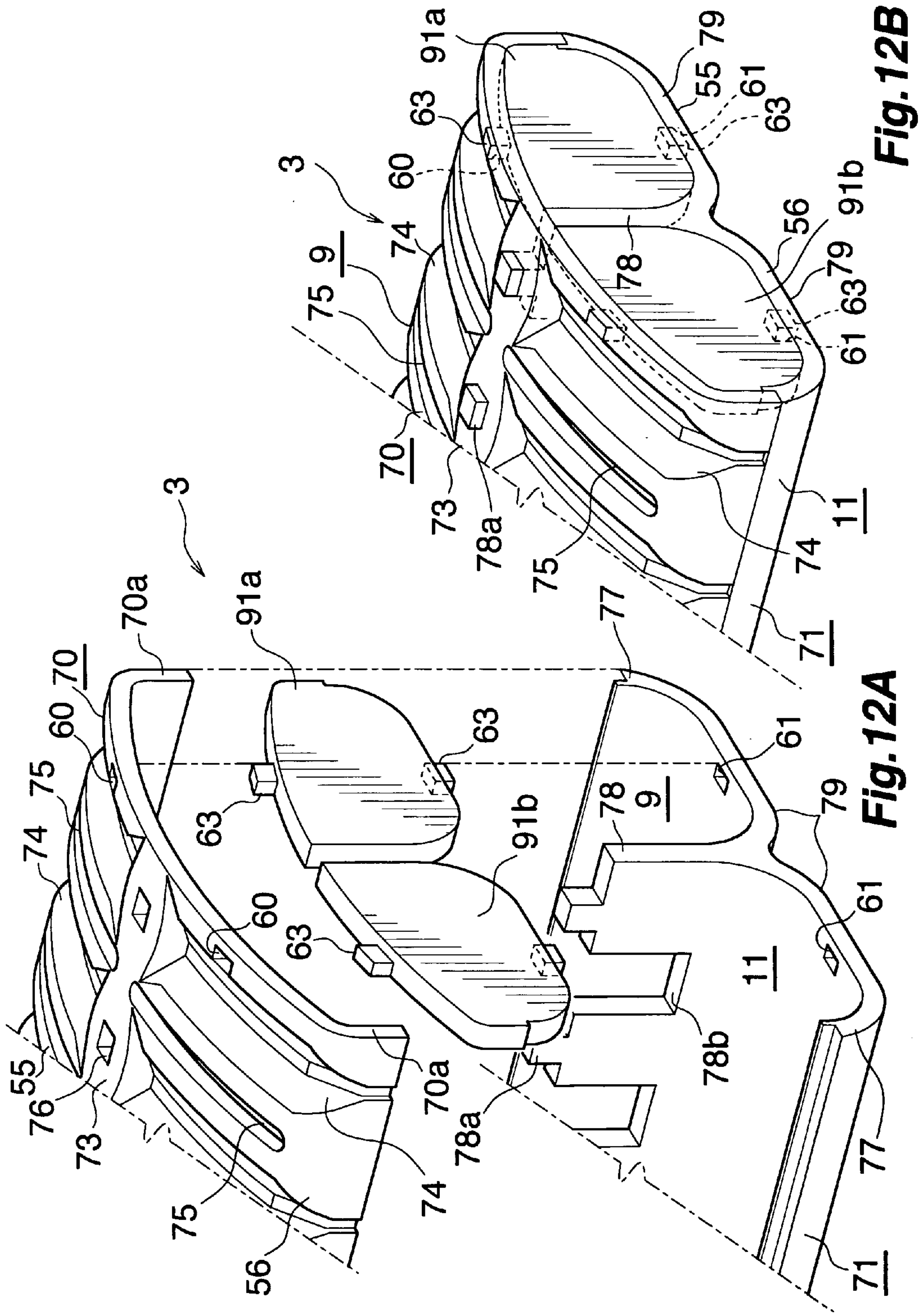

Fig.12A

Fig.12B

HEAT EXCHANGER

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a heat exchanger preferably used as an evaporator of a car air conditioner, which is a refrigeration cycle to be mounted on, for example, an automobile.

[0002] Herein and in the appended claims, the left-hand and right-hand sides of FIG. 2 will be referred to as "left" and "right," respectively.

[0003] Conventionally, a so-called laminated evaporator has been widely employed as an evaporator for use in a car air conditioner. In the laminated evaporator, a plurality of flat, hollow members, each of which includes a pair of depressed plates facing each other and brazed to each other at their peripheral edge portions, are arranged in parallel, and corrugate fins are each disposed between and brazed to the adjacent flat, hollow members.

[0004] However, in recent years, evaporators have been demanded to further reduce size and weight and to exhibit higher performance. The present applicant proposed a heat exchanger for use in an evaporator which fulfills those requirements (refer to Japanese Patent Application Laid-Open (Kokai) No. 2005-164226). The proposed heat exchanger includes a heat exchange core section, a first header section, a second header section, a third header section, and a fourth header section. The heat exchange core section includes a plurality of rows of heat exchange tube groups arranged in an air flow direction, each heat exchange tube group consisting of a plurality of heat exchange tubes arranged in a left-right direction at predetermined intervals, and a plurality of fins disposed between and joined to the adjacent heat exchange tubes. The first header section is disposed on a first-end side of the heat exchange tubes, and the heat exchange tubes of at least a single heat exchange tube group are connected thereto. The second header section is disposed on the first-end side of the heat exchange tubes and upstream of the first header section with-respect to the air flow direction, and the heat exchange tubes of the remaining heat exchange tube group(s) are connected thereto. The third header section is disposed on a second-end side of the heat exchange tubes, and the heat exchange tubes connected to the first header section are connected thereto. The fourth header section is disposed on the second-end side of the heat exchange tubes, and the heat exchange tubes connected to the second header section are connected thereto. Each of the first to fourth header sections includes a hollow header section body whose opposite ends are open, and two caps closing corresponding opposite end openings of the header section body. The header section body of the first header section and the header section body of the second header section are integral with each other, and the header section body of the third header section and the header section body of the fourth header section are integral with each other. The two caps which close the openings on one side of the header section bodies of the first header section and the second header section are integrated with each other to form a closing member, and the two caps which close the openings on the other side of the header section bodies of the first header section and the second header section are integrated with each other to form a closing member. The two caps which close the openings on one side of the header section bodies of the third header section and the fourth header section are integrated with each other to form a closing member, and the two caps which close the openings on the other side of the header section bodies of the third header section and the fourth header section are integrated with each other to form a closing member.

[0005] The heat exchanger disclosed in the above publication is manufactured through steps of assembling and provisionally joining the respective constituent members, and brazing all the constituent members together. Specifically, this heat exchanger is manufactured through steps of arranging the heat exchange tubes, the corrugate fins, and the header section bodies in an assembled condition; provisionally joining the constituent members, while the closing members each being composed of two caps integrated with each other are fitted to opposite end portions of the header section bodies of the first and second header sections and to opposite end portions of the third and fourth header sections; and simultaneously brazing the heat exchange tubes and the corrugate fins together, the heat exchange tubes and the header section bodies together, and the header section bodies and the caps together.

[0006] However, in some cases, in manufacture of the heat exchanger disclosed in the above publication, provisionally fixing the closing members; i.e., the caps, to the header section bodies in such a manner that the caps are not detached may become troublesome.

SUMMARY OF THE INVENTION

[0007] An object of the present invention is to solve the above problem and to provide a heat exchanger which allows relatively easy practice of the work of preventing detachment of caps in manufacture thereof.

[0008] To achieve the above object, the present invention comprises the following modes.

[0009] 1) A heat exchanger comprising two header sections spaced apart from each other and a plurality of heat exchange tubes extending between the two header sections and arranged at predetermined intervals in a longitudinal direction of the two header sections with opposite end portions thereof connected to the two header sections, the two header sections each comprising a hollow header section body having opened opposite ends, and two caps closing opposite end openings of the header section body wherein the caps are fitted into the corresponding opposite end openings of the header section bodies; a projection is formed at a peripheral portion of each of the caps; a mating hole into which the projection of the cap is fitted is formed in a tubular wall of each of the header section bodies; and while the projections of the caps are fitted into the corresponding mating holes of the header section bodies, the caps are joined to the header section bodies.

[0010] 2) A heat exchanger according to par. 1), wherein the header section bodies each comprise a first member which forms a portion of the header section body on a side toward the heat exchange tubes and to which the heat exchange tubes are connected, and a second member which forms the remaining portion of the header section body and is joined to the first member, and the mating holes into which the corresponding projections of the caps are fitted are formed in the first and second members.

[0011] 3) A heat exchanger comprising:

[0012] a heat exchange core section comprising:

[0013] a plurality of rows of heat exchange tube groups arranged in an air flow direction, each heat exchange tube group consisting of a plurality of heat exchange tubes arranged in a left-right direction at predetermined intervals; and

[0014] a plurality of fins disposed between and joined to the adjacent heat exchange tubes;

[0015] a first header section which is disposed on a first-end side of the heat exchange tubes and to which the heat exchange tubes of at least a single heat exchange tube group are connected;

[0016] a second header section which is disposed on the first-end side of the heat exchange tubes and upstream of the first header section with respect to the air flow direction and to which the heat exchange tubes of the remaining heat exchange tube group(s) are connected;

[0017] a third header section which is disposed on a second-end side of the heat exchange tubes and to which the heat exchange tubes connected to the first header section are connected; and

[0018] a fourth header section which is disposed on the second-end side of the heat exchange tubes and to which the heat exchange tubes connected to the second header section are connected;

[0019] the first to fourth header sections each comprising a hollow header section body having opened opposite ends, and two caps closing opposite end openings of the header section body,

[0020] the header section body of the first header section and the header section body of the second header section being integral with each other, and the header section body of the third header section and the header section body of the fourth header section being integral with each other,

[0021] wherein the caps are fitted into the corresponding opposite end openings of the header section bodies; a projection is formed at a peripheral portion of each of the caps; a mating hole into which the projection of the cap is fitted is formed in a tubular wall of each of the header section bodies; and while the projections of the caps are fitted into the corresponding mating holes of the header section bodies, the caps are joined to the header section bodies.

[0022] 4) A heat exchanger according to par. 3), wherein the header section body of the first header section and the header section body of the second header section are formed by a first member which forms portions of the header section bodies on a side toward the heat exchange tubes and to which the heat exchange tubes are connected, and a second member which forms the remaining portions of the header section bodies and is joined to the first member, and

[0023] the mating holes into which the corresponding projections of the caps are fitted are formed in the first and second members.

[0024] 5) A heat exchanger according to par. 4), wherein the two caps which close one end opening of the header section body of the first header section and one end opening of the header section body of the second header section, respectively, are integral with each other, and the two caps which close the other end opening of the header section body of the first header section and the other end opening of the header section body of the second header section, respectively, are integral with each other.

[0025] 6) A heat exchanger according to par. 3), wherein the header section body of the third header section and the header section body of the fourth header section are formed by a first member which forms portions of the header section bodies on a side toward the heat exchange tubes and to which the heat exchange tubes are connected, and a second member which forms the remaining portions of the header section bodies and is joined to the first member, and

[0026] the mating holes into which the corresponding projections of the caps are fitted are formed in the first and second members.

[0027] 7) A heat exchanger according to par. 6), wherein the two caps which close one end opening of the header section body of the third header section and one end opening of the header section body of the fourth header section, respectively, are integral with each other, and the two caps which close the other end opening of the header section body of the third header section and the other end opening of the header section body of the fourth header section, respectively, are integral with each other.

[0028] 8) A heat exchanger according to par. 3), wherein a refrigerant inlet is formed on the cap which closes one end opening of the header section body of the first header section; a refrigerant outlet is formed on the cap which closes one end opening of the header section body of the second header section located on the same side as the refrigerant inlet; and the third header section and the fourth header section communicate with each other.

[0029] The above-mentioned heat exchanger is preferably used as an evaporator in a refrigeration cycle having a compressor, a refrigerant cooler, and an evaporator. This refrigeration cycle is mounted on a vehicle in the form of, for example, an air conditioner.

[0030] In the heat exchanger of par. 1), the caps are fitted into the corresponding opposite end openings of the header section bodies; a projection is formed at a peripheral portion of each of the caps; a mating hole into which the projection of the cap is fitted is formed in a tubular wall of each of the header section bodies; and while the projections of the caps are fitted into the corresponding mating holes of the header section bodies, the caps are joined to the header section bodies. Thus, in manufacture of the heat exchanger, by practicing a relatively easy work of fitting the projections of the caps into the corresponding mating holes of the header section bodies, detachment of the caps from the header section bodies can be reliably prevented. Also, since the caps are fitted into the corresponding opposite end openings of the header section bodies, projection of peripheral portions of the caps to the exterior of the header section bodies can be prevented.

[0031] The heat exchanger of par. 2) allows the projections of the caps to be fitted into the corresponding mating holes when the first and second members are assembled together to form individual header section bodies. Thus, the work of attaching the caps to the header section bodies is facilitated.

[0032] In the heat exchanger of par. 3), the caps are fitted into the corresponding opposite end openings of the header section bodies; a projection is formed at a peripheral portion of each of the caps; a mating hole into which the projection of the cap is fitted is formed in a tubular wall of each of the header section bodies; and while the projections of the caps are fitted into the corresponding mating holes of the header section bodies, the caps are joined to the header section bodies. Thus, in manufacture of the heat exchanger, by practicing a relatively easy work of fitting the projections of the caps into the corresponding mating holes of the header section bodies, detachment of the caps from the header section bodies can be reliably prevented. Also, since the caps are fitted into the corresponding opposite end openings of the header section bodies, projection of peripheral portions of the caps to the exterior of the header section bodies can be prevented.

[0033] The heat exchanger of par. 4) allows the projections of the caps to be fitted into the corresponding mating holes when the first and second members are assembled together to form the header section bodies of the first and second header sections. Thus, the work of attaching the caps to the header section bodies is facilitated.

[0034] The heat exchanger of par. 5) implements a reduction in the number of components. In manufacture of the heat exchanger, the work of assembling together the first and second members, which form the header section bodies of the first and second header sections, and the caps, which close the opposite end openings of the two header section bodies, is facilitated.

[0035] The heat exchanger of par. 6) allows the projections of the caps to be fitted into the corresponding mating holes when the first and second members are assembled together to form the header section bodies of the third and fourth header sections. Thus, the work of attaching the caps to the header section bodies is facilitated.

[0036] The heat exchanger of par. 7) implements a reduction in the number of components. In manufacture of the heat exchanger, the work of assembling together the first and second members, which form the header section bodies of the third and fourth header sections, and the caps, which close the opposite end openings of the two header section bodies, is facilitated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0037] FIG. **1** is a partially cut-away perspective view showing the overall configuration of an evaporator of Embodiment 1 to which a heat exchanger according to the present invention is applied;

[0038] FIG. **2** is a fragmentary view in vertical section showing the evaporator of FIG. **1** with its intermediate portion omitted;

[0039] FIG. **3** is an exploded perspective view of a refrigerant inlet/outlet tank of the evaporator of FIG. **1**;

[0040] FIG. **4** is an enlarged fragmentary view in section taken along line A-A of FIG. **2**;

[0041] FIG. **5** is an enlarged fragmentary view in section taken along line B-B of FIG. **2**;

[0042] FIG. **6** is an enlarged fragmentary view in section taken along line C-C of FIG. **2**;

[0043] FIG. **7**A is an exploded perspective view showing, on an enlarged scale, a portion of the refrigerant inlet/outlet tank of the evaporator of FIG. **1**;

[0044] FIG. **7**B is a perspective view showing, on an enlarged scale, a portion of the refrigerant inlet/outlet tank of the evaporator of FIG. **1**;

[0045] FIG. **8** is an exploded perspective view of a refrigerant turn tank of the evaporator of FIG. **1**;

[0046] FIG. **9**A is an exploded perspective view showing, on an enlarged scale, a portion of the refrigerant turn tank of the evaporator of FIG. **1**;

[0047] FIG. **9**B is a perspective view showing, on an enlarged scale, a portion of the refrigerant turn tank of the evaporator of FIG. **1**;

[0048] FIG. **10** is a diagram showing the flow of a refrigerant in the evaporator of FIG. **1**;

[0049] FIG. **11**A is an exploded perspective view showing, on an enlarged scale, a portion of a refrigerant inlet/outlet tank of an evaporator of Embodiment 2 to which a heat exchanger according to the present invention is applied;

[0050] FIG. **11**B is a perspective view showing, on an enlarged scale, a portion of the refrigerant inlet/outlet tank of the evaporator of Embodiment 2;

[0051] FIG. **12**A is an exploded perspective view showing, on an enlarged scale, a portion of a refrigerant turn tank of the evaporator of Embodiment 2; and

[0052] FIG. **12**B is a perspective view showing, on an enlarged scale, a portion of the refrigerant turn tank of the evaporator of Embodiment 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0053] Embodiments of the present invention will next be described in detail with reference to the drawings. In the drawings, like sections or components throughout the several views are denoted by like reference numerals, and repeated description thereof is omitted.

[0054] Herein, the term “aluminum” encompasses aluminum alloys in addition to pure aluminum. Also, the downstream side (a direction represented by arrow X in FIG. **1**; the right side of FIG. **4**) of an air flow through air passing clearances between adjacent heat exchange tubes will be referred to as,the “front,” and the opposite side as the “rear.” The upper and lower sides of FIG. **1** will be referred to as “upper” and “lower,” respectively.

Embodiment 1:

[0055] The present embodiment is shown in FIGS. **1** to **10**.

[0056] FIGS. **1** and **2** show the overall configuration of an evaporator for a car air conditioner to which the present invention is applied. FIGS. **3** to **9** show the configuration of essential portions of the evaporator. FIG. **10** shows how a refrigerant flows in the evaporator.

[0057] In FIGS. **1** and **2**, the evaporator **1**, which is used in a car air conditioner using a chlorofluorocarbon-based refrigerant, includes a refrigerant inlet/outlet tank **2** made of aluminum and a refrigerant turn tank **3** made of aluminum, the tanks **2** and **3** being vertically spaced apart from each other, and further includes a heat exchange core section **4** provided between the tanks **2** and **3**.

[**0058**] The refrigerant inlet/outlet tank **2** includes a refrigerant inlet header section **5** (first header section) located on a side toward the front (downstream side with respect to the air flow direction) and a refrigerant outlet header section **6** (second header section) located on a side toward the rear (upstream side with respect to the air flow direction). The refrigerant inlet header section **5** and the refrigerant outlet header section **6** are integral with each other via a connection means, which will be described later. A refrigerant inlet pipe **7** made of aluminum is connected to the refrigerant inlet header section **5** of the refrigerant inlet/outlet tank **2**. A refrigerant outlet pipe **8** made of aluminum is connected to the refrigerant outlet header section **6**. The refrigerant turn tank **3** includes a refrigerant inflow header section **9** (third header section) located on the side toward the front and a refrigerant outflow header section **11** (fourth header section) located on the side toward the rear. The refrigerant inflow header section **9** and the refrigerant outflow header section **11** are integral with each other via a connection means, which will be described later.

[**0059**] The heat exchange core section **4** is configured such that heat exchange tube groups **13** are arranged in a plurality of; herein, two, rows in the front-rear direction, each heat exchange tube group **13** consisting of a plurality of heat exchange tubes **12** arranged in parallel at predetermined intervals in the left-right direction. Corrugate fins **14** are disposed within corresponding air-passing clearances between the adjacent heat exchange tubes **12** of the heat exchange tube groups **13** and on the outer sides of the leftmost and rightmost heat exchange tubes **12** of the heat exchange tube groups **13**, and are brazed to the corresponding heat exchange tubes **12**. Side plates **15** made of aluminum are disposed on the outer sides of the leftmost and rightmost corrugate fins **14**, and are brazed to the corresponding corrugate fins **14**. The upper and lower ends of the heat exchange tubes **12** of the front heat exchange tube group **13** are connected to the refrigerant inlet header section **5** and the refrigerant inflow header section **9**, respectively. The upper and lower ends of the heat exchange tubes **12** of the rear heat exchange tube group **13** are connected to the refrigerant outlet header section **6** and the refrigerant outflow header section **11**, respectively.

[**0060**] As shown in FIGS. **3** to **7**, the refrigerant inlet/outlet tank **2** includes a plate-like first member **16** which is formed from an aluminum brazing sheet having a brazing material layer on each of opposite sides thereof and to which the heat exchange tubes **12** are connected, and a second member **17** which is formed from a bare aluminum extrudate and covers the upper side of the first member **16**.

[**0061**] The first member **16** has front and rear curved portions **22**, whose central regions each have an arcuate cross section projecting downward and having a small curvature. Rectangular mating holes **32** into which projections **41** and **42** of caps **18***a*, **18***b*, **19***a*, and **19***b*, which will be described later, are formed at left and right end portions of the curved portions **22**. A plurality of tube insertion holes **23**, which are elongated in the front-rear direction, are formed in the curved portions **22** at predetermined intervals in the left-right direction. The tube insertion holes **23** of the front curved portion **22** and those of the rear curved portion **22** are identical in position in the left-right direction. A rising wall **22***a* is formed integrally with each of the front edge of the front curved portion **22** and the rear edge of the rear curved portion **22**, over the entire length of the front and rear edges. A flat portion **24** is formed between the two curved portions **22** of the first member **16** and-serves as means for connecting together the refrigerant inlet header section **5** and the refrigerant outlet header section **6**. A plurality of through holes **25** are formed in the flat portion **24** at predetermined intervals in the left-right direction.

[**0062**] The second member **17** has a cross section resembling the letter m, which opens downward, and includes front and rear walls **26** extending in the left-right direction; a vertical, intermediate wall **27** provided at a central region thereof between the front and rear walls **26**, extending in the left-right direction, and serving as means for connecting together the refrigerant inlet header section **5** and the refrigerant outlet header section **6**; and two generally arcuate connection walls **28** projecting upward and integrally connecting the upper end of the intermediate wall **27** and the upper ends of the front and rear walls **26**. Engagement portions **26***a* to be engaged with the corresponding rising walls **22***a* of the front and rear curved portions **22** of the first member **16** are formed at corresponding lower end portions of the front and rear walls **26**. The lower end of the intermediate wall **27** projects downward beyond the lower ends of the front and rear walls **26**. A plurality of projections **27***a* are integrally formed on the lower end face of the intermediate wall **27** at predetermined intervals in the left-right direction in such a manner as to project downward, and are fitted into corresponding through holes **25** of the first member **16**. The projections **27***a* are formed by cutting off predetermined portions of the intermediate wall **27**. A flow-dividing resistance plate **29** (dividing means) for dividing the interior of the refrigerant outlet header section **6** into an upper space **6***a* and an lower space **6***b*, integrally connects the engagement portion **26***a* of the rear wall **26** of the second member **17** and a lower end portion of the intermediate wall **27** over the entire length thereof. A plurality of refrigerant passage holes **31**A and **31**B in a through-hole form and elongated in the left-right direction are formed in a rear region, excluding left and right end portions thereof, of the flow-dividing resistance plate **29** at predetermined intervals in the left-right direction. Rectangular mating holes **33** into which the projections **41** and **42** of the caps **18***a*, **18***b*, **19***a*, and **19***b*, which will be described later, are formed at left and right end portions of top portions of the connection walls **28**.

[**0063**] The front curved portion **22** and the flat portion **24** of the first member **16**, and the front wall **26**, the intermediate wall **27**, and the front connection wall **28** of the second member **17** form a hollow header section body **10**, whose left and right ends are opened, of the refrigerant inlet header section **5**. The rear curved portion **22** and the flat portion **24** of the first member **16**, and the rear wall **26**, the intermediate wall **27**, and the rear connection wall **28** of the second member **17** form a hollow header section body **20**, whose left and right ends are opened, of the refrigerant outlet header section **6**. The header section bodies **10** and **20** are integral with each other via connection means composed of the flat portion **24** and the intermediate wall **27**.

[**0064**] As shown in FIG. **7**, left and right end portions of the engagement portion **26***a* of the front wall **26** of the second member **17**, which partially forms the header section body **10**, are each cut out by a length equal to a wall thickness of the front caps **18***a* and **19***a* of closing members **18** and **19**, which will be described later, so as to allow the front caps **18***a* and **19***a* to be fitted into the left and right end openings, respectively, of the header section body **10**. Reference numeral **34** denotes thus-formed cutouts. Similarly, left and right end portions of the engagement portion **26***a* of the rear wall **26** of the second member **17**, which partially forms the header section body **20**, and left and right end portions of the flow-dividing resistance plate **29** are each cut out by a length equal to a wall thickness of the rear caps **18***b* and **19***b* of the closing members **18** and **19**, which will be described later, so as to allow the rear caps **18***b* and **19***b* to be fitted into the left and right end openings, respectively, of the header section body **20**. Reference numeral **35** denotes thus-formed cutouts. Furthermore, left and right end portions of the intermediate wall **27** are each cut out by a length equal to a wall thickness of connection portions **18***c* and **19***c* of the closing members **18** and **19**, which will be described later, so as to allow the connection portions **18***c* and **19***c* to be fitted to the intermediate wall **27**. Reference numeral **36** denotes thus-formed cutouts.

[**0065**] The left end openings of the header section bodies **10** and **20** are closed by the plate-like left closing member **18** which is formed from an aluminum brazing sheet having a brazing material layer on each of opposite sides thereof. The right end openings of the header section bodies **10** and **20** are closed by the plate-like right closing member **19** which is formed from an aluminum brazing sheet having a brazing material layer on each of opposite sides thereof. A plate-like pipe joint member **21** made of aluminum and elongated in the front-rear direction is brazed to the outer surface of the right closing member **19**.

[**0066**] The left closing member **18** is configured such that the front cap **18***a* to be fitted into the left end opening of the header section body **10** of the refrigerant inlet header section **5** for closing the left end opening, and the rear cap **18***b* to be fitted into the left end opening of the header section body **20** of the refrigerant outlet header section **6** for closing the left end opening are integral with each other via the connection portion **18***c*. The connection portion **18***c* is fitted to the cutout portion **36** formed at a left end portion of the intermediate wall **27** of the second member **17**. The front and rear caps **18***a* and **18***b* and the connection portion **18***c* have the same wall thickness. The projections **41** are formed on the front and rear caps **18**a and **18***b* and are fitted into the corresponding mating holes **32** and **33** formed in tubular walls of the header section bodies **10** and **20**; i.e., in left end portions of the first and second members **16** and **17**.

[**0067**] The right closing member **19** has the same outline as that of the left closing member **18** and is configured such that the front cap **19***a* to be fitted into the right end opening of the header section body **10** of the refrigerant inlet header section **5** for closing the right end opening, and the rear cap **19***b* to be fitted into the right end opening of the header section body **20** of the refrigerant outlet header section **6** for closing the right end opening are integral with each other via the connection portion **19***c*. The connection portion **19***c* is fitted to the cutout portion **36** formed at a right end portion of the intermediate wall **27** of the second member **17**. The front and rear caps **19***a* and **19***b* and the connection portion **19***c* have the same wall thickness. A refrigerant inlet **37** for establishing communication between the interior and the exterior of the refrigerant inlet header section **5** is formed in the front cap **19***a*. A refrigerant outlet **38** for establishing communication between the upper space **6***a* and the exterior of the refrigerant outlet header section **6** is formed in the rear cap **19***b*. The projections **42** are formed on the front and rear caps **19***a* and **19***b* and are fitted into the corresponding mating holes **32** and **33** formed in tubular walls of the header section bodies **10** and **20**; i.e., in right end portions of the first and second members **16** and **17**.

[**0068**] The pipe joint member **21** has an integrally formed short, cylindrical refrigerant inflow port **45** communicating with the refrigerant inlet **37** of the front cap **19***a* of the right closing member **19**, and an integrally formed short, cylindrical refrigerant outflow port **46** communicating with the refrigerant outlet **38** of the rear cap **19***b*. A diameter-reduced portion **7***a* formed at one end portion of the refrigerant inlet pipe **7** is inserted into and brazed to the refrigerant inflow port **45** of the pipe joint member **21**. Similarly, a diameter-reduced portion **8***a* formed at one end portion of the refrigerant outlet pipe **8** is inserted into and brazed to the refrigerant outflow port **46** of the pipe joint member **21**. A slit **47** extending in the vertical direction is formed on the pipe joint member **21** between the refrigerant inflow port **45** and the refrigerant outflow port **46**. Through holes **48** and **49** are formed at the upper and lower ends of the slit **47**, respectively, such that the through holes **48** and **49** are connected with the slit **47**. Further, a portion of the pipe joint member **21** located above the upper through hole **48** and a portion of the pipe joint member **21** located under the lower through hole **49** are bent such that these portions project leftward to thereby from bent portions **51**. These upper and lower bent portions **51** come into engagement with the refrigerant inlet header section **5** and the refrigerant outlet header section **6** at a location therebetween; i.e., the central portions of the first and second members **16** and **17** with respect to the front-rear direction.

[**0069**] The first and second members **16** and **17** of the refrigerant inlet/outlet tank **2**, the closing members **18** and **19**, and the pipe joint member **21** are brazed together as follows. In assembly of the first and second members **16** and **17**, the projections **27***a* of the second member **17** are inserted into the corresponding through holes **25** of the first member **16**, followed by crimping. As a result, upper end portions of the front and rear rising walls **22***a* of the first member **16** come into engagement with the engagement portions **26***a* at the lower end portions of the front and rear walls **26** of the second member **17**. In the thus-established condition, the first and second members **16** and **17** are brazed together by utilization of the brazing material layers of the first member **16**. In attachment of the closing members **18** and **19**, the front caps **18***a* and **19***a* are fitted into the left and right end openings, respectively, of the header section body **10**; the rear caps **18***b* and **19***b* are fitted into the left and right end openings, respectively, of the header section body **20**; the connection portions **18***c* and **19***c* are fitted to the corresponding cutout portions **36** of the intermediate wall **27**; and the projections **41** and **42** of the caps **18***a*, **18***b*, **19***a*, and **19***b* are fitted into the corresponding mating holes **32** and **33**. In the thus-established condition, the closing members **18** and **19** are brazed to the first and second members **16** and **17** by utilization of the brazing material layers thereof. The pipe joint member **21** is brazed to the right closing member **19** by utilization of the brazing material layer of the right closing member **19** in the condition that the upper bent portion **51** is in engagement with the central portion of the second member **17** with respect to the front-rear direction, and the lower bent portion **51** is in engagement with the central portion of the first member **16** with respect to the front-rear direction.

[**0070**] The refrigerant inlet/outlet tank **2** is thus formed. A portion of the refrigerant inlet/outlet tank **2** located forward of the flat portion **24** of the first member **16** and the intermediate wall **27** of the second member **17** serves as the refrigerant inlet header section **5**. A portion of the refrigerant inlet/outlet tank **2** located backward of the flat portion **24** of the first member **16** and the intermediate wall **27** of the second member **17** serves as the refrigerant outlet header section **6**. The refrigerant inlet header section **5** and the refrigerant outlet header section **6** are integrated with each other. The flow-dividing resistance plate **29** divides the refrigerant outlet header section **6** into the upper and lower spaces **6***a* and **6***b*. The spaces **6***a* and **6***b* communicate with each other through the refrigerant passage holes **31**A and **31**B.

[**0071**] As shown in FIGS. **4**, **5**, **8**, and **9**, the refrigerant turn tank **3** includes a plate-like first member **70** which is formed from an aluminum brazing sheet having a brazing material layer on each of opposite sides thereof and to which heat exchange tubes **12** are connected, and a second member **71** which is formed from a bare aluminum extrudate and covers the lower side of the first member **70**.

[**0072**] A top face **3***a* of the refrigerant turn tank **3** has such an arcuate transverse cross section that a central portion thereof with respect to the front-rear direction serves as a top portion **73** and that the height gradually decreases from the top portion **73** toward the front and rear sides. A plurality of grooves **74** are formed on front and rear portions of the refrigerant turn tank **3** at predetermined intervals along the left-right direction such that they extend from the front and rear sides of the top portion **73** of the top face **3***a* to front and rear side surfaces **3***b*.

[**0073**] The first member **70** has an arcuate transverse cross section such that a central portion thereof with respect to the front-rear direction projects upward. Downwardly extending walls **70***a* are formed integrally with front and rear edges of the first member **70** over the entire length thereof. The upper surface of the first member **70** serves as the top face **3***a* of the refrigerant turn tank **3**. The outer surfaces of the downwardly extending walls **70***a* serve as the front and rear side surfaces **3***b* of the refrigerant turn tank **3**. A plurality of the grooves **74** are formed at predetermined intervals in the left-right direction on the front and rear portions of the first member **70** in such a manner as to extend from the top portion **73** located at the center with respect to the front-rear direction to the lower ends of the downwardly extending walls **70***a*. Tube insertion holes **75** elongated in the front-rear direction are formed in the first member **70** excepting the top portion **73**; i.e., in front and rear portions of the first member **70**, such that the tube insertion holes **75** are located between the adjacent grooves **74**. The front tube insertion holes **75** and the rear tube insertion holes **75** are identical in position in the left-right direction. A plurality of through holes **76** are formed in the top portion **73** of the first member **70** at predetermined intervals in the left-right direction. Rectangular mating holes **60** are formed in left and right end portions of the first member **70** on the front and rear sides of the top portion **73**. Projections **63** of the caps **72***a* and **72***b*, which will be described later, are fitted into the corresponding mating holes **60**.

[**0074**] The second member **71** has a transverse cross section-resembling the letter w, which opens upward, and includes front and rear walls **77** curved upward and toward the outside with respect to the front-rear direction and extending in the left-right direction; a vertical intermediate wall **78** provided at a central portion of the second member **71** between the front and rear walls **77**, extending in the left-right direction, and serving as connection means for connecting together the refrigerant inflow header section **9** and the refrigerant outflow header section **11**; and two connection walls **79** integrally connecting the lower ends of the front and rear walls **77** and the lower end of the intermediate wall **78**. The upper end of the intermediate wall **78** projects upward beyond the upper ends of the front and rear walls **77**. A plurality of projections **78***a* projecting upward and to be fitted into the corresponding through holes **76** of the first member **70** are formed integrally with the upper end of the intermediate wall **78** at predetermined intervals in the left-right direction. Refrigerant passage cutouts **78***b* are formed between the adjacent projections **78***a* of the intermediate wall **78** in such a manner as to extend from its upper edges. The projections **78***a* and the cutouts **78***b* are formed by cutting out predetermined portions of the intermediate wall **78**. Left and right end portions of the intermediate wall **78** are each cut out by a length equal to a wall thickness of connection portions **72***c* of closing members **72**, which will be described later, so as to allow the connection portions **72***c* to be fitted to the intermediate wall **78**. Reference numeral **62** denotes thus-formed cutouts. Rectangular mating holes **61** are formed at left and right end portions of the connection walls **79**. The projections **63** of the caps **72***a* and **72***b*, which will be described later, are fitted into the corresponding mating holes **61**.

[**0075**] A front half portion of the first member **70**, the front wall **77** of the second member **71**, the intermediate wall **78**, and the front connection wall **79** form a header section body **55**, whose left and right ends are opened, of the refrigerant inflow header section **9**. A rear half portion of the first member **70**, a rear wall **77** of the second member **71**, the intermediate wall **78**, and the rear connection wall **79** form a header section body **56**, whose left and right ends are opened, of the refrigerant outflow header section **11**. The header section bodies **55** and **56** are integral with each other via connection means composed of the top portion **73** and the intermediate wall **78**.

[**0076**] The opposite end openings of the header section bodies **55** and **56** are closed by the plate-like closing members **72** formed from an aluminum brazing sheet having a brazing material layer on each of opposite sides thereof. The closing members **72** are each configured such that the front cap **72***a* to be fitted into the left/right end opening of the header section body **55** of the refrigerant inflow header section **9** for closing the left/right end opening, and the rear cap **72***b* to be fitted into the left/right end opening of the header section body **56** of the refrigerant outflow header section **11** for closing the left/right end opening are integral with each other via the connection portion **72***c*. The connection portion **72***c* is fitted to the cutout portion **62** formed at a left/right end portion of the intermediate wall **78** of the second member **71**. The front and rear caps **72***a* and **72***b* and the connection portion **72***c* have the same wall thickness. The projections **63** are formed on the front and rear caps **72***a* and **72***b* and are fitted into the corresponding mating holes **60** and **61** formed in tubular walls of the header section bodies **55** and **56**; i.e., in left/right end portions of the first and second members **70** and **71**.

[**0077**] The first and second members **70** and **71** of the refrigerant return tank **3** and the two closing members **72** are brazed together as follows. In assembly of the first and second members **70** and **71**, the projections **78***a* of the second member **71** are inserted into the corresponding through holes **76**, followed by crimping. As a result, lower end portions of the front and rear downwardly extending walls **70***a* of the first member **70** are fitted to corresponding upper end portions of the front and rear walls **77** of the second member **71**. In the thus-established condition, the first and second members **70** and **71** are brazed together by utilization of the brazing material layers of the first member **70**. In attachment of the two closing members **72**, the front caps **72***a* are fitted into the left and right end openings of the header section body **55**; the rear caps **72***b* are fitted into the left and right end openings of the header section body **56**; the connection portions **72***c* are fitted to the corresponding cutout portions **62**; and the projections **63** of the front and rear caps **72***a* and **72***b* are fitted into the corresponding mating holes **60** and **61**. In the thus-established condition, the two closing members **72** are brazed to the first and second members **70** and **71** by utilization of the brazing material layers thereof. The upper end openings of the cutouts **78***b* of the intermediate wall **78** of the second member **71** are closed by the first member **70** to thereby form refrigerant passage holes **80**.

[**0078**] The refrigerant turn tank **3** is thus formed. A portion of the refrigerant turn tank **3** located forward of the intermediate wall **78** of the second member **71** serves as the refrigerant inflow header section **9**. A portion of the refrigerant turn tank **3** located backward of the intermediate wall **78** serves as the refrigerant outflow header section **11**. The refrigerant inflow header section **9** and the refrigerant outflow header section **11** communicate with each other via the refrigerant passage holes **80**.

[**0079**] Each of the heat exchange tubes **12** which constitute the front and rear heat exchange tube groups **13** of the heat exchange core section **4** is formed from an aluminum extrudate and assumes a flat form having a wide width in the front-rear direction. In the heat exchange tube **12**, a plurality of refrigerant channels **12***a* extending in the longitudinal direction thereof are formed in parallel therein (see FIG. **6**). Upper end portions of the heat exchange tubes **12** are inserted into the corresponding tube insertion holes **23** of the first member **16** of the refrigerant inlet/outlet tank **2** and brazed to the first member **16** by utilization of the brazing material layers of the first member **16**. Lower end portions of the heat exchange tubes **12** are inserted into the corresponding tube insertion holes **75** of the first member **70** of the refrigerant turn tank **3** and brazed to the first member **70** by utilization of the brazing material layers of the first member **70**.

[**0080**] Preferably, the thickness of the heat exchange tube **12** as measured in the left-right direction; i.e., a tube height, is 0.75 mm to 1.5 mm; the width of the heat exchange tube **12** as measured in the front-rear direction is 12 mm to 18 mm; the wall thickness of the heat exchange tube **12** is 0.175 mm to 0.275 mm; the thickness of a intermediate wall separating the refrigerant channels from each other is 0.175 mm to 0.275 mm; the pitch of the intermediate walls is 0.5 mm to 3.0 mm; and the front and rear end walls each have a radius of curvature of 0.35 mm to 0.75 mm as measured on the outer surface thereof.

[**0081**] In place of use of the heat exchange tube **12** formed from an aluminum extrudate, a heat exchange tube to be used may be formed such that an inner fin is inserted into a seam welded pipe of aluminum so as to form a plurality of refrigerant channels therein. Alternatively, a heat exchange tube to be used may be formed as follows. An aluminum brazing sheet having a brazing material layer on one side thereof is subjected to a rolling process performed on the side where the brazing material is present, so as to form a plate that includes two flat-wall-forming portions connected together via a connection portion; side-wall-forming portions, which are formed, in a bulging condition, integrally with the corresponding flat-wall-forming portions at their side edges located in opposition to the connection portion; and a plurality of partition-wall-forming portions, which are formed integrally with the flat-wall-forming portions in such a manner as to project from the flat-wall-forming portions and to be arranged at predetermined intervals in the width direction of the flat-wall-forming portions. The thus-prepared plate is bent at the connection portion into a hairpin form such that the side-wall-forming portions abut each other, followed by brazing. The partition-wall-forming portions become intermediate walls.

[**0082**] Each of the corrugated fins **14** is made in a wavy form from an aluminum brazing sheet having a brazing material layer over opposite surfaces thereof. The corrugate fin **14** includes wave crest portions, wave trough portions, and connection portions each connecting together the wave crest portion and the wave trough portion. A plurality of louvers are formed at the connection portions in such a manner as to be juxtaposed in the front-rear direction. The front and rear heat exchange tube groups **13** share the corrugate fin **14**. The width of the corrugate fin **14** as measured in the front-rear direction is approximately equal to the span between the front edges of the heat exchange tubes **12** of the front heat exchange group **13** and the rear edges of the rear heat exchange tubes **12** of the rear heat exchange tube group **13**. The fin height of the corrugate fin **14** means a direct distance between the wave crest portion and the wave through portion, and is preferably 7.0 mm to 10.0 mm. The fin pitch of the corrugate fin **14** means half the distance between the centers in the vertical direction of adjacent wave crest portions or wave through portions, and is preferably 1.3 mm to 1.8 mm. Instead of a single corrugate fin being shared between the front and rear heat exchange tube groups **13**, a corrugate fin may be disposed between the adjacent heat exchange tubes **12** of each of the front and rear heat exchange tube groups **13**.

[**0083**] In manufacture of the evaporator **1**, constituent members thereof excluding the refrigerant inlet pipe **7** and the refrigerant outlet pipe **8** are assembled and provisionally fixed together, and then all the constituent members are brazed together. In assembly of the first and second members **16** and **17** of the refrigerant inlet/outlet tank **2**, the closing members **18** and **19** are disposed between the first and second members **16** and **17** such that the projections **41** and

42 of the front and rear caps **18***a,* **18***b,* **19***a,* and **19***b* are fitted into the corresponding mating holes **32** and **33**. In assembly of the first and second members **70** and **71** of the refrigerant turn tank **3**, the two closing members **72** are disposed between the first and second members **70** and **71** such that the projections **63** of the front and rear caps **72***a* and **72***b* are fitted into the corresponding mating holes **60** and **61**. This prevents detachment of the closing members **18**, **19**, and **72**; i.e., detachment of the front and rear caps **18***a,* **18***b,* **19***a,* **19***b,* **72***a*, and **72***b*, which could otherwise result during brazing.

[**0084**] The evaporator **1**, together with a compressor, a condenser (refrigerant cooler), and an expansion valve (pressure-reducing device), constitutes a refrigeration cycle which uses a chlorofluorocarbon-based refrigerant. This refrigeration cycle is installed in a vehicle, such as an automobile, as a car air conditioner.

[**0085**] In the evaporator **1** described above, as shown in FIG. **10**, a two-phase refrigerant of vapor-liquid phase having passed through a compressor, a condenser, and an expansion valve (pressure-reducing device) enters the refrigerant inlet header section **5** from the refrigerant inlet pipe **7** through the refrigerant inflow port **45** of the pipe joint member **21** and the refrigerant inlet **37** of the right closing member **19**. Then, the refrigerant dividedly flows into the refrigerant channels **12***a* of all the heat exchange tubes **12** of the front heat exchange tube group **13**.

[**0086**] The refrigerant having entered the refrigerant channels **12***a* of all the heat exchange tubes **12** flows downward through the refrigerant channels **12***a* and enters the refrigerant inflow header section **9** of the refrigerant turn tank **3**. The refrigerant having entered the refrigerant inflow header section **9** passes through the refrigerant passage holes **85** of the intermediate wall **78** and enters the refrigerant outflow header section **11**.

[**0087**] The refrigerant having entered the refrigerant outflow header section **11** dividedly flows into the refrigerant cannels **12***a* of all the heat exchange tubes **12** of the rear heat exchange tube group **13**; flows upward, in opposition to the previous flow direction, through the refrigerant channels **12***a;* and enters the lower space **6***b* of the refrigerant outlet header section **6**. Since the flow-dividing resistance plate **29** imparts resistance to the flow of the refrigerant, the divided flow from the refrigerant outflow header section **11** to all the heat exchange tubes **12** of the rear heat exchange tube group **13** becomes uniform, and the divided flow from the refrigerant inlet header section **5** to all the heat exchange tubes **12** of the front heat exchange tube group **13** becomes uniform to a greater extent. As a result, the refrigerant flow rate becomes uniform among all the heat exchange tubes **12** of the two heat exchange tube groups **13**.

[**0088**] Then, the refrigerant passes through the refrigerant passage holes **31**A and **31**B of the flow-dividing resistance plate **29** and enters the upper space **6***a* of the refrigerant outlet header section **6**. Subsequently, the refrigerant flows out to the refrigerant outlet pipe **8** through the refrigerant outlet **38** of the right closing member **19** and the refrigerant outflow port **46** of the pipe joint member **21**. While flowing through the refrigerant channels **12***a* of the heat exchange tubes **12** of the front heat exchange tube group **13** and through the refrigerant channels **12***a* of the heat exchange tubes **12** of the rear heat exchange tube group **13**, the refrigerant is subjected to heat exchange with the air flowing through the air-passing clearances in the direction of arrow X shown in FIGS. **1** and **10** flows out from the evaporator **1** in a vapor phase.

[**0089**] During the heat exchange, condensed water is generated on the surface of the corrugate fins **14**. The condensed water flows downward onto the top face **3***a* of the refrigerant turn tank **3**. Then, the condensed water, by the capillary effect, enters the grooves **74**; flows through the grooves **74**; and drops downward below the refrigerant turn tank **3** from front and rear end portions of the grooves **74**. This mechanism prevents freezing of condensed water which could otherwise result from stagnation of condensed water in a large amount in the region between the top face **3***a* of the refrigerant turn tank **3** and the lower ends of the corrugate fins **14**. As a result, a drop in performance of the evaporator **1** is prevented.

Embodiment 2:

[**0090**] The present embodiment is shown in FIGS. **11** and **12**.

[**0091**] In FIG. **11**, mutually independent plate-like caps **90***a* and **90***b* respectively close the right end opening of the header section body **10** of the refrigerant inlet header section **5** of the refrigerant inlet/outlet tank **2** and the right end opening of the header section body **20** of the refrigerant outlet header section **6** of the refrigerant inlet/outlet tank **2**. The caps **90***a* and **90***b* are each formed from an aluminum brazing sheet having a brazing material layer on each of opposite sides thereof and are fitted into the right end openings of the header section bodies **10** and **20**, respectively. The refrigerant inlet **37** for establishing communication between the interior and the exterior of the refrigerant inlet header section **5** is formed in the front cap **90***a*. The refrigerant outlet **38** for establishing communication between the upper space **6***a* and the exterior of the refrigerant outlet header section **6** is formed in the rear cap **90***b*. The projections **42** are formed on the caps **90***a* and **90***b* and are fitted into the corresponding mating holes **32** and **33** formed in tubular walls of the header section bodies **10** and **20**; i.e., in right end portions of the first and second members **16** and **17**. That is, the caps **90***a* and **90***b* are configured similarly to the front cap **19***a* and the rear cap **19***b,* which result from eliminating the connection portion **19***c* from the right closing member **19** of Embodiment 1. Since a connection portion is absent between the caps **90***a* and **90***b,* a cutout portion is not formed at a right end portion of the intermediate wall **27** of the second member **17** of the refrigerant inlet/outlet tank **2**.

[**0092**] Although unillustrated, mutually independent two plate-like caps respectively close the left end opening of the header section body **10** of the refrigerant inlet header section **5** of the refrigerant inlet/outlet tank **2** and the left end opening of the header section body **20** of the refrigerant outlet header section **6** of the refrigerant inlet/outlet tank **2**. The two caps are each formed from an aluminum brazing sheet having a brazing material layer on each of opposite sides thereof and are fitted into the left end openings of the header section bodies **10** and **20**, respectively. Projections are formed on the two caps and are fitted into the corresponding mating holes **32** and **33** formed in tubular walls of the header section bodies **10** and **20**; i.e., in left end portions of the first and second members **16** and **17**. That is, the two caps are configured similarly to the front cap **18***a* and the rear cap **18***b*, which result from eliminating the connection portion **18***c* from the left closing member **18** of Embodiment 1. Since a connection portion is absent between the two caps, a cutout portion is not formed at a left end portion of the intermediate wall **27** of the second member **17** of the refrigerant inlet/outlet tank **2**.

[**0093**] These caps **90***a* and **90***b* and unillustrated caps are brazed to the first and second members **16** and **17** by utilization of the brazing material layers thereof in the following condition: the front cap **90***a* and the unillustrated front cap are fitted into the corresponding opposite end openings of the header section body **10**; the rear cap **90***b* and the unillustrated rear cap are fitted into the corresponding opposite end openings of the header section body **20**; and the projections **42** of the caps **90***a* and **90***b* and the unillustrated caps are fitted into the corresponding mating holes **32** and **33**.

[**0094**] In FIG. **12**, mutually independent plate-like caps **91***a* and **91***b* respectively close the right end opening of the header section body **55** of the refrigerant inflow header section **9** of the refrigerant turn tank **3** and the right end opening of the header section body **56** of the refrigerant outflow header section **11** of the refrigerant turn tank **3**. The caps **91***a* and **91***b* are each formed from an aluminum brazing sheet having a brazing material layer on each of opposite sides thereof and are fitted into the right end openings of the header section bodies **55** and **56**, respectively. The projections **63** are formed on the caps **91***a* and **91***b* and are fitted into the corresponding mating holes **60** and **61** formed in tubular walls of the header section bodies **55** and **56**; i.e., in right end portions of the first and second members **70** and **71**. That is, the caps **91***a* and **91***b* are configured similarly to the front cap **72***a* and the rear cap **72***b*, which result from eliminating the connection portion **72***c* from the right closing member **72** of Embodiment 1. Since a connection portion is absent between the caps **91***a* and **91***b*, a cutout portion is not formed at a right end portion of the intermediate wall **78** of the second member **17** of the refrigerant turn tank **3**.

[**0095**] Although unillustrated, the mutually independent plate-like caps **91***a* and **91***b* respectively close the left end opening of the header section body **55** of the refrigerant inflow header section **9** of the refrigerant turn tank **3** and the left end opening of the header section body **56** of the refrigerant outflow header section **11** of the refrigerant turn tank **3**. The caps **91***a* and **91***b* are each formed from an aluminum brazing sheet having a brazing material layer on each of opposite sides thereof and are fitted into the left end openings of the header section bodies **55** and **56**, respectively. The projections **63** are formed on the caps **91***a* and **91***b* and are fitted into the corresponding mating holes **60** and **61** formed in tubular walls of the header section bodies **55** and **56**; i.e., in left end portions of the first and second members **70** and **71**. That is, the caps **91***a* and **91***b* are configured similarly to the front cap **72***a* and the rear cap **72***b*, which result from eliminating the connection portion **72***c* from the left closing member **72** of Embodiment 1. Since a connection portion is absent between the caps **91***a* and **91***b*, a cutout portion is not formed at a left end portion of the intermediate wall **78** of the second member **71** of the refrigerant turn tank **3**.

[**0096**] These caps **91***a* and **91***b* are brazed to the first and second members **70** and **71** by utilization of the brazing material layers thereof in the following condition: the front caps **91***a* are fitted into the corresponding opposite end openings of the header section body **55**; the rear caps **91***b* are fitted into the corresponding opposite end openings of the header section body **56**; and the projections **63** of the caps **91***a* and **91***b* are fitted into the corresponding mating holes **60** and **61**.

[**0097**] Other configurational features are similar to those of the evaporator **1** of Embodiment 1.

[**0098**] In the above-described two embodiments, the mating holes **32**, **33**, **60**, and **61**, which are formed in the tubular walls of the header section bodies **10**, **20**, **55**, and **56**; i.e., in the first and second members **16**, **17**, **70**, and **71** and into which the projections **41**, **42**, and **63** are fitted, are through holes. However, the present invention is not limited thereto. The mating holes **32**, **33**, **60**, and **61** may be closed-bottomed holes.

[**0099**] In the above-described two embodiments, a single heat exchange tube group **13** is provided between the refrigerant inlet header section **5** and the refrigerant inflow header section **9** of the tanks **2** and **3**, respectively, and a single heat exchange tube group **13** is provided between the refrigerant outlet header section **6** and the refrigerant outflow header section **11** of the tanks **2** and **3**, respectively. However, the present invention is not limited thereto. For example, the following configuration may be employed: one or more heat exchange groups **13** are provided between the refrigerant inlet header section **5** and the refrigerant inflow header section **9** of the tanks **2** and **3**, respectively; and one or more heat exchange groups **13** are provided between the refrigerant outlet header section **6** and the refrigerant outflow header section **11** of the tanks **2** and **3**, respectively. Also, the refrigerant turn tank may be located above the refrigerant inlet/outlet tank.

[**0100**] The above two embodiments are described while mentioning the heat exchanger applied to an evaporator of a car air conditioner which uses a chlorofluorocarbon-based refrigerant. However, the present invention is not limited thereto. The heat exchanger of the present invention may be used as an evaporator of a car air conditioner used in a vehicle, for example, an automobile, the car air conditioner including a compressor, a gas cooler (refrigerant cooler), an intermediate heat exchanger, an expansion valve (pressure-reducing device), and an evaporator and using a CO_2 refrigerant.

[**0101**] In the above-described two embodiments, in order to enhance drainage performance, the refrigerant turn tank **3** has the grooves **74** formed in regions between the adjacent heat exchange tubes **12**. However, the present invention is not limited thereto. Grooves for enhancing drainage performance may be formed at positions corresponding to the heat exchange tubes **12**. In this case, in a region of the refrigerant turn tank **3** extending from the top face **3***a* to the front and rear side surfaces **3***b*, grooves for enhancing drainage performance are formed to extend from the outer ends of the tube insertion holes **75** with respect to the front-rear direction.

What is claimed is:

1. A heat exchanger comprising two header sections spaced apart from each other and a plurality of heat exchange tubes extending between the two header sections and arranged at predetermined intervals in a longitudinal direction of the two header sections with opposite end portions thereof connected to the two header sections, the two header sections each comprising a hollow header section body having opened opposite ends, and two caps closing opposite end openings of the header section body,

wherein the caps are fitted into the corresponding opposite end openings of the header section bodies; a projection is formed at a peripheral portion of each of the caps; a mating hole into which the projection of the cap is fitted is formed in a tubular wall of each of the header section bodies; and while the projections of the caps are fitted into the corresponding mating holes of the header section bodies, the caps are joined to the header section bodies.

2. A heat exchanger according to claim 1, wherein the header section bodies each comprise a first member which forms a portion of the header section body on a side toward the heat exchange tubes and to which the heat exchange tubes are connected, and a second member which forms the remaining portion of the header section body and is joined to the first member, and

the mating holes into which the corresponding projections of the caps are fitted are formed in the first and second members.

3. A heat exchanger comprising:

a heat exchange core section comprising:

a plurality of rows of heat exchange tube groups arranged in an air flow direction, each heat exchange tube group consisting of a plurality of heat exchange tubes arranged in a left-right direction at predetermined intervals; and

a plurality of fins disposed between and joined to the adjacent heat exchange tubes;

a first header section which is disposed on a first-end side of the heat exchange tubes and to which the heat exchange tubes of at least a single heat exchange tube group are connected;

a second header section which is disposed on the first-end side of the heat exchange tubes and upstream of the first header section with respect to the air flow direction and to which the heat exchange tubes of the remaining heat exchange tube group(s) are connected;

a third header section which is disposed on a second-end side of the heat exchange tubes and to which the heat exchange tubes connected to the first header section are connected; and

a fourth header section which is disposed on the second-end side of the heat exchange tubes and to which the heat exchange tubes connected to the second header section are connected;

the first to fourth header sections each comprising a hollow header section body having opened opposite ends, and two caps closing opposite end openings of the header section body,

the header section body of the first header section and the header section body of the second header section being integral with each other, and the header section body of the third header section and the header section body of the fourth header section being integral with each other,

wherein the caps are fitted into the corresponding opposite end openings of the header section bodies; a projection is formed at a peripheral portion of each of the caps; a mating hole into which the projection of the cap is fitted is formed in a tubular wall of each of the header section bodies; and while the projections of the caps are fitted into the corresponding mating holes of the header section bodies, the caps are joined to the header section bodies.

4. A heat exchanger according to claim 3, wherein the header section body of the first header section and the header section body of the second header section are formed by a first member which forms portions of the header section bodies on a side toward the heat exchange tubes and to which the heat exchange tubes are connected, and a second member which forms the remaining portions of the header section bodies and is joined to the first member, and

the mating holes into which the corresponding projections of the caps are fitted are formed in the first and second members.

5. A heat exchanger according to claim 4, wherein the two caps which close one end opening of the header section body of the first header section and one end opening of the header section body of the second header section, respectively, are integral with each other, and the two caps which close the other end opening of the header section body of the first header section and the other end opening of the header section body of the second header section, respectively, are integral with each other.

6. A heat exchanger according to claim 3, wherein the header section body of the third header section and the header section body of the fourth header section are formed by a first member which forms portions of the header section bodies on a side toward the heat exchange tubes and to which the heat exchange tubes are connected, and a second member which forms the remaining portions of the header section bodies and is joined to the first member, and

the mating holes into which the corresponding projections of the caps are fitted are formed in the first and second members.

7. A heat exchanger according to claim 6, wherein the two caps which close one end opening of the header section body of the third header section and one end opening of the header section body of the fourth header section, respectively, are integral with each other, and the two caps which close the other end opening of the header section body of the third header section and the other end opening of the header section body of the fourth header section, respectively, are integral with each other.

8. A heat exchanger according to claim 3, wherein a refrigerant inlet is formed on the cap which closes one end opening of the header section body of the first header section; a refrigerant outlet is formed on the cap which closes one end opening of the header section body of the second header section located on the same side as the refrigerant inlet; and the third header section and the fourth header section communicate with each other.

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