(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 452 814 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 158(3) EPC

(43) Date of publication:
01.09.2004 Bulletin 2004/36

(21) Application number: **02802694.6**

(22) Date of filing: **30.08.2002**

(51) Int Cl.⁷: **F28D 1/053**, F28F 9/18

(86) International application number:
PCT/JP2002/008846

(87) International publication number:
WO 2003/040640 (15.05.2003 Gazette 2003/20)

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR IE IT LI LU MC NL PT SE SK TR

(30) Priority: **08.11.2001 JP 2001343077**

(71) Applicant: **Zexel Valeo Climate Control Corporation**
Ohsato-gun, Saitama 360-0193 (JP)

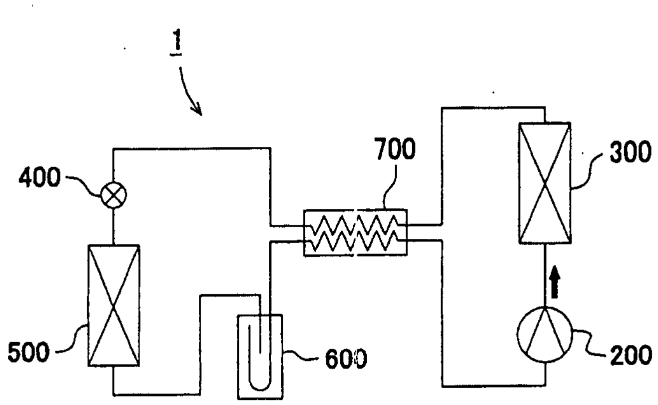
(72) Inventor: **TAKANO, Akihiko,**
Zexel Valeo Climate Control Corp
Oossato-gun, Saitama 360-0193 (JP)

(74) Representative: **HOFFMANN - EITLE**
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

(54) HEAT EXCHANGER AND TUBE FOR HEAT EXCHANGER

(57) A heat exchanger and its tubes, wherein the heat exchanger includes a core 300a, having a lamination of flat tubes 301 for flowing a refrigerant and corrugated fins 302, and tanks 310 having slots for insertion of the ends of tubes, the core is configured to have the flat surfaces of the tubes in parallel with the airflow direction, and the tubes have their ends 301a twisted in the width direction by 90° with respect to the airflow direction. A heat exchanger for a supercritical refrigeration cycle has tanks 310a, 310c displaced in a direction orthogonal to the airflow direction on one side of plural cores 300a, 300b which are overlaid in the airflow direction, and an inlet 320 and an outlet 330 for the refrigerant are oriented toward the windward side or the downwind side of the airflow direction.

FIG.1



EP 1 452 814 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a heat exchanger, which is provided with a core comprising flat tubes for flowing a refrigerant and corrugated fins, and tanks with slots for insertion of the ends of the tubes, and carries out heat exchange by flowing air to the core and transferring heat to the core.

BACKGROUND ART

[0002] A heat exchanger such as a radiator or an evaporator to be used for a refrigeration cycle is known that a core is comprised of plural flat tubes and plural corrugated fins, stacked alternately and the ends of the tubes are inserted into pipe-shape tanks. The flat surfaces of the tubes are configured to be parallel with an airflow direction. The refrigerant is introduced inside from the tank, flowed through the tubes while carrying out heat exchange with heat transferred to the core and discharged outside from the tank.

[0003] As the refrigerant for the refrigeration cycle, a fluorocarbon refrigerant including a substitute fluorocarbon has been used extensively but it now tends to be replaced with CO_2 considering the global environment in these years. A refrigeration cycle using CO_2 as the refrigerant has a very high inside pressure as compared with the refrigeration cycle using a fluorocarbon refrigerant, and particularly a pressure on a high-pressure side exceeds the critical point of the refrigerant depending on use conditions such as a temperature. The critical point is a limit on the high-pressure side (namely, a limit on a high-temperature side) in a state in which a gas phase and a liquid phase coexist and a terminal point at one end of a vapor pressure curve. A pressure, a temperature and a density at the critical point become a critical pressure, a critical temperature and a critical density, respectively. Especially, in a radiator which is a high-temperature heat source of the refrigeration cycle, the refrigerant does not condense when the pressure exceeds the critical point of the refrigerant.

[0004] As to the heat exchanger for the refrigeration cycle, improvements of heat exchange efficiency of the refrigerant, miniaturization, weight reduction, facilitation of manufacturing and saving of mounting space are important objects. Especially, a supercritical refrigeration cycle having a pressure on the high-pressure side exceeding the critical point of the refrigerant requires very high compressive strength as compared with the refrigeration cycle using the refrigerant of fluorocarbons, and the heat exchanger used therefor is required to secure pressure resistance and rationalized furthermore.

[0005] For example, the heat exchanger for the supercritical refrigeration cycle needs to reduce the tubes and the tanks in volume and to increase the wall thickness in order to secure the pressure resistance. Here, when the tanks are made thick, there is a disadvantage that the width of the tubes to be inserted into the tanks must be made extremely small with respect to the outer diameter of the tanks. In other words, the tank having a large thickness has a large difference between the outer diameter and the inner diameter, and has disadvantages that the width of the tube to the outer diameter of the tank is extremely small to insert the ends of the tube having a prescribed width along the longitudinal direction, resulting in unsatisfactory width of the core with respect to mounting space of the heat exchanger.

[0006] The present invention has been achieved under the circumstances described above and an object of the present invention is to provides a heat exchanger configured more rationally.

DISCLOSURE OF THE INVENTION

[0007] The invention described in Claim 1 of the application relates to flat tubes which are used for a heat exchanger to carry out heat exchange of a refrigerant and to flow the refrigerant, wherein the heat exchanger is provided with a core, which has the tubes and corrugated fins laminated, and tanks provided with slots for insertion of the ends of the tubes, and carries out the heat exchange of the refrigerant by flowing air to the core and transferring heat to the core, the core is configured to have the flat surfaces of the tubes in parallel with the airflow direction, and the tubes have the width direction of their ends twisted by 90° with respect to the airflow direction. with the tubes for the heat exchanger of the invention, a heat exchanger configured rationally can be obtained.

[0008] Specifically, according to the present invention, there is an advantage that the width of the tubes can be determined appropriately because it is not restrained by the inner diameter of the tanks. Further, because the flat surfaces of the tubes do not face the passage of the refrigerant within the tanks, a situation where a high flow passage resistance is produced in the refrigerant passage can be avoided, and a pressure loss can be reduced. Besides, when the twist angle of the tube ends in the width direction is 90°, the slots are formed along the longitudinal direction of the tanks, and there is an advantage that they can be formed with ease. Specifically, in the case where the twist angle of the tube ends in the width direction is less than 90° and the slots are formed in a slanting direction to the longitudinal direction of the tanks, the fabrication of the tanks involves some difficulties, but according to the present invention such a disadvantage can be avoided. Further, the tubes can be assembled with ease in comparison with the case that the slots are formed in a slanting direction.

[0009] The invention described in Claim 2 of the application is the heat exchanger tubes according to Claim 1, wherein the heat exchanger is used for a refrigeration cycle which circulates the refrigerant, and the refrigeration cycle has a pressure on a high pressure side exceeding the critical point of the refrigerant.

[0010] The heat exchanger tubes of the invention have the width direction of the ends to be inserted into the slots of the tanks twisted by 90 , and this configuration is very effective for the heat exchanger for a supercritical refrigeration cycle having a relatively small tank volume. In other words, the tubes have achieved a very remarkable effect as tubes used for the heat exchanger for the supercritical refrigeration cycle.

[0011] The invention described in Claim 3 of the application is a heat exchanger which is provided with a core having lamination of flat tubes for flowing a refrigerant and corrugated fins, and tanks provided with slots for insertion of the ends of the tubes, and carries out heat exchange of the refrigerant by flowing air to the core and transferring heat to the core, wherein the core is configured to have the flat surfaces of the tubes in parallel with the airflow direction, and the tubes have the width direction of their ends twisted by 90° with respect to the airflow direction. By configuring as above, a heat exchanger configured rationally can be obtained.

[0012] Specifically, according to the present invention, there is an advantage that the tube width can be determined appropriately because it is not restrained by the inner diameter of the tank. Because the flat surfaces of the tubes do not face the refrigerant passage in the tanks, a situation where a high flow passage resistance is produced in the refrigerant passage can be avoided, and a pressure loss can be reduced. Besides, when the twist angle of the tube ends in the width direction is 90 , the slots are formed along the longitudinal direction of the tank, and there is also an advantage that the fabrication is facilitated. Specifically, in the case where the twist angle of the tube ends in the width direction is less than 90° and the slots are formed in a slanting direction with respect to the longitudinal direction of the tanks, the fabrication of the tanks involves some difficulties, but according to the present invention, such a disadvantage can be avoided. Further, the tubes can be assembled with ease in comparison with the case that the slots are formed in a slanting direction.

[0013] The invention described in Claim 4 of the present application is the heat exchanger according to Claim 3, wherein the tanks have an inner diameter smaller than the width of the tubes . By configuring as above, a heat exchanger configured more rationally is obtained.

[0014] Specifically, according to the present invention, it is possible to adopt tubes having a width larger than the inner diameter of the tanks, and there is an advantage in securing pressure resistance performance and heat exchange performance.

[0015] The invention described in Claim 5 of the present application is the heat exchanger according to Claim 3 or 4, wherein the plural slots are arranged in a row along the longitudinal direction of the tanks, and the tubes are determined to have a width smaller than the intervals (namely, the laminated intervals) between the arranged tubes. By configuring as above, a heat exchanger configured more rationally is obtained.

[0016] Specifically, when the tube width is determined to be smaller than the intervals of the arranged tubes, the tubes do not interfere with each other even when the tube ends twisted by 90° are inserted into the slots.

[0017] The invention described in Claim 6 of the present application is the heat exchanger according to Claim 5, wherein it is assumed that the interval between the arranged tubes is P and the width of the tubes is T, then they have relationships P=(6 to 12) mm and T=P · (0.95 to 0.80). By setting the relationships of the arranged tube interval P and the tube width T as above, the heat exchanger is configured more rationally.

[0018] Specifically, the above described relationship means that when the arranged tube interval P is in a range of 6 mm to 12 mm, (T/P) is smaller than 0.95 and larger than 0.8, indicating numerically a rational fixation of the line of merits and demerits between the fact that the heat exchange efficiency lowers as the arranged tube interval P increases relatively and the fact that the strength of tank decreases because the interval between the slots decreases as the interval P decreases.

[0019] The invention described in Claim 7 of the present application is the heat exchanger according to any of Claims 3 to 6, wherein the heat exchanger comprises a plurality of cores overlaid in the airflow direction. By configuring as above, the heat exchanger configured more rationally is obtained.

[0020] Specifically, the heat exchange efficiency can be improved further by overlaying the plurality of cores, and the heat exchanger mounting space can be used more effectively.

[0021] The invention described in Claim 8 of the present application is the heat exchanger according to Claim 7, wherein the cores include a first core and a second core which are overlaid in the airflow direction, the tanks include a first tank into which one end of each of the tubes of the first core is inserted, a second tank into which the other end of each of the tubes of the first core and one end of each of the tubes of the second core are inserted, and a third tank into which the other end of each of the tubes of the second core is inserted, and an inlet for the refrigerant is formed on the first tank, and an outlet for the refrigerant is formed on the third tank. By configuring as above, a heat exchanger configured more rationally can be obtained.

[0022] Specifically, the present invention is a counterflow type heat exchanger, in which the first core and the second core are overlaid in the airflow direction and the refrigerants in the first core and the second core are flowed in opposite directions, and has an advantage of improving the heat exchange efficiency of the refrigerant. Besides, when the ends of the tubes of the first core and the ends of the tubes of the second core are inserted into the second tank, the configuration for connection of the first core and the second core can be simplified, and the productivity can be improved. It is also advantageous in view of saving the mounting space of the heat exchanger.

[0023] The invention described in Claim 9 of the present application is the heat exchanger according to Claim 8, wherein the first tank and the third tank are displaced in a direction orthogonal to the airflow direction, and the inlet and the outlet are oriented toward the windward side or the downwind side of the airflow direction. By configuring as above, a heat exchanger configured more rationally can be obtained.

[0024] Specifically, the first tank and the third tank are displaced in a direction orthogonal to the airflow direction, thereby to determine the diameters of the first tank and the third tank to a prescribed size and to prevent them from mutually interfering. Such a structure is quite effective for a heat exchanger for a supercritical refrigeration cycle having a large difference between the outer and inner diameters of the tanks. By displacing the first tank and the third tank as described above, the inlet of the first tank and the outlet of the third tank can be oriented toward the windward side or the downwind side of the airflow direction, and the piping structure in the layout of the refrigeration cycle can be simplified.

[0025] The invention described in Claim 10 of the present application is the heat exchanger according to any of Claims 3 to 9, wherein the fins are determined to have a width larger than that of the tubes.

[0026] Specifically, the heat exchange performance can be improved by adopting the fins having a width larger than the width of the fins. To laminate the tubes and the fins, the fins are somewhat deformed, but since the tubes are held by the fins, such displacement can be prevented. Accordingly, there is also an advantage that their assembling property is improved.

[0027] The invention described in Claim 11 of the application is the heat exchanger according to any of Claims 3 to 10, wherein the tanks are cylindrical and configured by assembling a first member which is semitubular (namely, an incomplete cylinder partly cut away), a second member on which the slots are arranged in a row and a closing member for closing its ends.

[0028] Specifically, the tank is formed to have a cylindrical shape by assembling the semitubular first member and the second member having the slots arranged in a row and closing the ends with the closing member. By configuring as above, the tank is configured rationally.

[0029] The invention described in Claim 12 of the present application is the heat exchanger according to Claim 11, wherein the tanks, each is configured by assembling the first member, a plurality of the second members, a spacer for connecting the plurality of second members and the closing member.

[0030] Specifically, in the case where plural rows of slots are formed on a single tank, the spacer may be used to mutually connect the plurality of second members.

[0031] The invention described in Claim 13 of the present application is the heat exchanger according to Claim 11 or 12, wherein the closing member is provided with fitting portions for fitting the second member.

[0032] Specifically, the closing member and the second member can be assembled more accurately and securely by fitting the second member to the fitting portions of the closing member.

[0033] The invention described in Claim 14 of the present application is the heat exchanger according to any of Claims 11 to 13, wherein the first member is provided with caulking parts, and the first member and the second member are fixed by caulking the caulking parts.

[0034] Specifically, when the caulking parts are caulked to fix the first member and the second member, they can be assembled more accurately and securely.

[0035] The invention described in Claim 15 of the present application is the heat exchanger according to Claim 14, wherein the caulking parts are caulked to fix the first member, the second member and the closing member.

[0036] Specifically, the closing member can also be fixed together with the first member and the second member by the caulking parts. By configuring as above, the first member, the second member and the closing member can be assembled efficiently.

[0037] The invention described in Claim 16 of the present application is the heat exchanger according to any of Claims 11 to 15, wherein the ends of the tubes are inserted into the slots, then the first member and the second member are assembled.

[0038] Specifically, the tubes and the tanks are assembled by inserting the ends of the tubes into the slots of the second member and assembling the second member and the first member.

[0039] The invention described in claim 17 of the present application is the heat exchanger according to any of Claims 11 to 15, wherein the first member and the second member are assembled, then the ends of the tubes are inserted into the slots.

[0040] Specifically, the tubes and the tanks are assembled by assembling the first member and the second member and inserting the ends of the tubes into the slots of the second member.

[0041] The invention described in Claim 18 of the present application is the heat exchanger according to any of Claims 3 to 17, wherein the ends of the tubes are bent with respect to the longitudinal direction of the tubes.

[0042] Specifically, by bending the ends of the tubes with respect to the longitudinal direction of the tubes, there is an advantage of improving the flexibility of designing the layout of the tanks and the tubes. For example, in the case where the plurality of cores are overlaid in the airflow direction, the interval between the cores can be determined to be small by adopting the above configuration. In other words, the total thickness of the cores can be made small regardless of the tank shapes.

[0043] The invention described in Claim 19 of the present application is the heat exchanger according to Claim 18, wherein the ends of the tubes are bent before they are inserted into the slots.

[0044] Specifically, the ends the tubes are previously bent to a prescribed angle with respect to the longitudinal direction of the tubes and the bent ends are inserted into the slots. By configuring as above, the tubes and the tanks can be assembled efficiently.

[0045] The invention according to Claim 20 of the present application is the heat exchanger according to Claim 18, wherein the ends of the tubes are bent after they are inserted into the slots.

[0046] Specifically, the ends of the tubes before bending are inserted into the slots and bent to a prescribed angle. By configuring as above, the tubes and the tanks can be assembled efficiently.

[0047] The invention described in Claim 21 of the present application is the heat exchanger according to any of Claims 3 to 20, wherein the heat exchanger is used for a refrigeration cycle which circulates the refrigerant, and the refrigeration cycle has a pressure on a high-pressure side exceeding the critical point of the refrigerant. The heat exchanger of the present invention uses the tubes having the ends to be inserted into the slots of the tanks twisted by 90° in the width direction, and such a structure is very effective for the heat exchanger for the supercritical refrigeration cycle having a relatively small tank volume. Specifically, the heat exchanger has achieved a very remarkable effect as a heat exchanger for the supercritical refrigeration cycle.

[0048] The invention described in claim 22 of the present application is a heat exchanger for a refrigeration cycle having a pressure on a high-pressure side exceeding the critical point of a refrigerant, which is provided with a core comprised of lamination of flat tubes for flowing the refrigerant and corrugated fins, and tanks on which slots for insertion of the ends of the tubes are formed, and carries out heat exchange of the refrigerant by flowing air to the core and transferring heat to the core, wherein the core includes a first core and a second core overlaid in the airflow direction; and an inlet for the refrigerant is disposed on the tank into which the ends of the tubes of the first core are inserted on one sides of both of the first core and the second core, an outlet for the refrigerant is disposed on the tank into which the ends of the tubes of the second core are inserted, the tanks are displaced in a direction orthogonal to the airflow direction, and the inlet and the outlet are oriented toward the windward side or the downwind side of the airflow direction. By configuring as above, a heat exchanger configured rationally can be obtained.

[0049] Specifically, with the present invention the two tanks on one side of the first core and of the second core are displaced in the direction orthogonal to the airflow direction, thereby to determine the diameters of the individual tanks to a prescribed size and also to prevent them from mutually interfering. Such a structure is very effective for the heat exchanger for the supercritical refrigeration cycle having a large difference between the outer and inner diameters of the tanks. By displacing the tanks as described above, the inlet and the outlet of the individual tanks can be oriented toward the windward side or the downwind side of the airflow direction, and the piping structure in the layout of the refrigeration cycle can be simplified.

BRIEF DESCRIPTION OF THE INVENTION

[0050]

Fig. 1 is an explanatory diagram showing a supercritical refrigeration cycle according to an embodiment of the present invention;
Fig. 2 is an explanatory diagram showing the front of a radiator according to the embodiment of the invention;
Fig. 3 is an exploded perspective diagram showing the essential portions of the radiator according to the embodiment of the invention;
Fig. 4(a) is an explanatory diagram showing the top of a tube and Fig. 4(b) is an explanatory diagram showing the front of the tube according to the embodiment of the invention;
Fig. 5 is an explanatory diagram showing a sectional view of the tube according to the embodiment of the invention;
Fig. 6 is an explanatory diagram showing a sectional view of the essential portion of a tank according to the embodiment of the invention;
Fig. 7 is an explanatory diagram showing the radiator according to an embodiment of the invention;
Fig. 8 is an explanatory diagram showing the radiator according to an embodiment of the invention;
Fig. 9 is an explanatory diagram showing the front of the radiator according to the embodiment of the invention;
Fig. 10 is an explanatory diagram showing the top of the radiator according to the embodiment of the invention;
Fig. 11 (a) is an explanatory diagram showing the top of the tube, and Fig. 11(b) is an explanatory diagram showing the front of the tube according to an embodiment of the invention;
Fig. 12(a) is an explanatory diagram showing a sectional view of a first tank and Fig. 12(b) is an explanatory diagram showing the front of the first tank according to the embodiment of the invention;
Fig. 13 (a) is an explanatory diagram showing a sectional view of a second tank and Fig. 13(b) is an explanatory diagram showing the front of the second tank according to the embodiment of the invention;
Fig. 14 is an explanatory diagram showing a sectional view of the essential portion of the second tank according to the embodiment of the invention;
Fig. 15 is an explanatory diagram showing a sec-

tional view of the essential portion of the second tank according to an embodiment of the invention;

Fig. 16 is an explanatory diagram showing a sectional view of the essential portion of the second tank according to an embodiment of the invention;

Fig. 17 is an explanatory diagram showing the top of the radiator according to an embodiment of the invention;

Fig. 18 is an explanatory diagram showing the top of the radiator according to the embodiment of the invention;

Fig. 19 is an explanatory diagram showing a sectional view of the essential portion of the first tank according to an embodiment of the invention;

Fig. 20 is an exploded explanatory diagram showing a sectional view of the essential portion of the first tank according to the embodiment of the invention;

Fig. 21 is an exploded explanatory diagram showing a sectional view of the essential portion of the first tank according to the embodiment of the invention;

Fig. 22 is an explanatory diagram showing a closing member according to the embodiment of the invention;

Fig. 23 is an explanatory diagram showing an end of the first tank according to the embodiment of the invention;

Fig. 24 is an explanatory diagram showing a vertical section of the first tank according to the embodiment of the invention;

Fig. 25 is an explanatory diagram showing a sectional view of the essential portion of the second tank according to an embodiment of the invention;

Fig. 26 is an explanatory diagram showing a sectional view of the essential portion of the second tank according to an embodiment of the invention;

Fig. 27 is an explanatory diagram showing a sectional view of the essential portion of the second tank according to an embodiment of the invention;

Fig. 28 is an explanatory diagram showing a closing member according to the embodiment of the invention;

Fig. 29 is an explanatory diagram showing an end of the second tank according to the embodiment of the invention;

Fig. 30 is an explanatory diagram showing the top of the radiator according to an embodiment of the invention;

Fig. 31 is an explanatory diagram showing the radiator according to an embodiment of the invention; and

Fig. 32 is an explanatory diagram showing the top of the radiator according to the embodiment of the invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0051] Embodiments of the present invention will be described in detail with reference to the accompanying drawings. The refrigeration cycle 1 shown in Fig. 1 is a refrigeration cycle for air conditioning of a car room to be mounted on a vehicle and comprises a compressor 200 for compressing a refrigerant, a radiator 300 for cooing the refrigerant compressed by the compressor 200, an expansion valve 400 for expanding the refrigerant cooled by the radiator 300 by decompressing, an evaporator 500 for evaporating the refrigerant decompressed by the expansion valve 400, an accumulator 600 for separating the refrigerant from the evaporator 500 into a gas phase and a liquid phase and sending the gas layer refrigerant to the compressor 200, and an inner heat exchanger 700 for heat exchanging a high-pressure refrigerant and a low-pressure refrigerant to improve a cycle efficiency. As the refrigerant, CO_2 is used, and the pressure of the supercritical refrigeration cycle 1 on the high pressure side exceeds the critical point of the refrigerant depending on use conditions such as a temperature. An arrow mark in Fig. 1 indicates a circulation direction of the refrigerant.

[0052] As shown in Fig. 2 and Fig. 3, the radiator 300 to be the heat exchanger of this embodiment is provided with a core 300a which is formed of flat tubes 301 and corrugated fins 302 having louvers being laminated alternately, and tanks 310 into which ends 301a of the tubes 301 are inserted, and configured so that the refrigerant flowing through the tubes 301 performs heat exchange with the heat transferred to the core 300a. A side plate 303 is disposed as a reinforcing member on the top and bottom of the core 300a, and both ends of each side plate 303 are supported by the individual tanks 310. The individual tanks 310 are formed of a member having a cylindrical shape with its both ends closed with a closing member 312.

[0053] One of the tanks 310 is provided with an inlet 320 for introducing the refrigerant, and the other tank 310 is provided with an outlet 330 for discharging the refrigerant. The inlet 320 and the outlet 330 are configured by forming holes in prescribed positions of the tank 310 and joints for connecting outside pipes are provided in the holes.

[0054] The refrigerant is introduced into one of the tanks 310 through the inlet 320, flowed through the tubes 301 while heat exchanging with the heat transferred to the core 300a and discharged outside through the outlet 330 of the other tank 310.

[0055] In this embodiment, CO_2 is used as the refrigerant, and the radiator 300 requires very high compressive strength. Therefore, the tanks 310 are provided with prescribed compressive strength by increasing their thickness and decreasing their volume. Especially, the tanks 310 have an inner diameter smaller than the width of the tubes 301.

[0056] Each of the tubes 301 has one of the ends

301a inserted into one of the tanks 310 and the other end 301a inserted into the other tank 310. The individual tanks 310 are provided with a row of plural slots 311 along their longitudinal directions for insertion of the ends 301a of the tubes 301.

[0057] The radiator 300 is manufactured by integrally assembling the tubes 301, the fins 320, the tanks 310, the inlet 320 and the outlet 330 and brazing the assembly in a furnace. For brazing, a brazing material and flux are previously applied to the required parts of the individual members.

[0058] The core 300a of this embodiment is configured to have the flat surfaces of the tubes 301 in parallel with an airflow direction. Further, the tubes 301 of this embodiment have both ends 301a twisted in the width direction by 90° with respect to the airflow direction. In this embodiment, the tanks 310 are erected in the vertical direction, and both ends 301a of the tubes 301 are configured to have the flat surfaces directed in the vertical direction. Fig. 4 (a) shows the top of the tube 301, and Fig. 4(b) shows the front of the tube 301. Fig. 5 shows a sectional view of the tube 301. The tube 301 shown in these drawings is an extruded tube of an aluminum alloy having plural passages 301b. In this embodiment, the ends 301a of the tube 301 are fabricated by cutting an extruded tube to a prescribed length, holding the ends 301a of the tube 301 and their neighborhood with a pair of jigs, and relatively moving the individual jigs.

[0059] Thus, when the ends 301a of the tube 301 are twisted by 90° and inserted into the slots 311 of the tanks 310, the flat surfaces of the tube 301 do not face the passage of the refrigerant in the tanks 310, so that a high flow passage resistance is not produced in the passage of the refrigerant. Therefore, a pressure loss can be made small. There is also an advantage that the flexibility of arranging the inlet 320 and the outlet 330 is improved. In other words, the inlet 320 and the outlet 330 are somewhat projected into the tanks 310 but their fitting angles can be determined appropriately. For example, as shown in Fig. 6, the fitting angles of the inlet 320 and the outlet 330 can be diagonally set with respect to the insertion direction of the tube 301. The leading ends of the inlet 320 and the outlet 330 inserted into the tanks are tapered.

[0060] In this embodiment, it is determined that the tubes 301 have a width T smaller than an arrangement interval P of the tubes 301, and the arrangement interval P and the width T establish the relationships P=(6 to 12) mm and T=P· (0.95 to 0.80). The slots have a width äT slightly larger than the width T of the tubes. By configuring as described above, the heat exchange efficiency of the refrigerant and the strength of the tanks 310 can be secured adequately.

[0061] In this embodiment, the fins 302 are determined to have a width slightly larger than that of the tubes 301. In other words, the adoption of the fins 302 having a width larger than that of the tubes 301 increases a heat exchange area and improves heat exchange performance. Considering some deformation of the fines 302 when the tubes 301 and the fins 302 are laminated, their displacement can be prevented because the tubes 301 are held by the fins 302. Thus, the assembling property is improved.

[0062] Then, a second embodiment of the invention will be described with reference to Fig. 7. As shown in Fig. 7, the radiator 300 of this embodiment is configured by overlaying a first core 300a and a second core 300b in an airflow direction. The tank 310 is disposed on both ends of the first core 300a and the second core 300b. And, on one side of the first core 300a and of the second core 300b, the inlet 320 for the refrigerant is disposed on the tank 310 into which the ends 301a of the tubes 301 of the first core 300a are inserted, and the outlet 330 for the refrigerant is disposed on the tank 310 into which the ends 301a of the tubes 301 of the second core 300b are inserted. On the other side of the first core 300a and of the second core 300b, the tank 310 into which the ends 301a of the tubes 301 of the first core 300a are inserted and the tank 310 into which the ends 301a of the tubes 301 of the second core 300b are inserted are communicated. The refrigerant successively passes through the first core 300a and the second core 300b. In other words, the radiator 300 of this embodiment is a counterflow type heat exchanger in which the refrigerants in the first core 300a and the second core 300b flow in opposite directions.

[0063] Thus, the overlaying of the plural cores 300a, 300b in the airflow direction allows further improvement of the heat exchange efficiency.

[0064] Next, a third embodiment of the invention will be described. As shown in Fig. 8 to Fig. 10, the radiator 300 as the heat exchanger of this embodiment is provided with the first core 300a and the second core 300b which are comprised of lamination of the flat tubes 301 for flowing the refrigerant and the corrugated fins 302, a first tank 310a, a second tank 310b and a third tank 310c each having a pipe shape into which the ends 301a of the tubes 301 are inserted, the inlet 320 which is disposed on the first tank 310a and has a pipe shape for the refrigerant and the outlet 330 which is disposed on the third tank 310c and has a pipe shape for the refrigerant. The refrigerant sent from the compressor 200 enters the inlet 320, and the refrigerant discharged from the outlet 330 is sent to the expansion valve 400. In Fig. 8 to Fig. 10, arrows indicate the flowing directions of the refrigerant in the radiator 300, and the outline arrows indicate the airflow direction to the first core 300a and the second core 300b.

[0065] One end 301a of each of the tubes 301 of the first core 300a is inserted into the first tank 310a. The other end 301a of each of the tubes 301 of the first core 300a and one end 301a of each of the tubes 301 of the second core 300b are inserted into the second tank 310b. The other end 301a of each of the tubes 301 of the second core 300b is inserted into the third tank 310c.

[0066] And, air flows to the first core 300a and the second core 300b by a fan (not shown), and the refrigerant carries out heat exchange with the heat transferred to the first core 300a and the second core 300b. The first core 300a and the second core 300b are overlaid in the airflow direction, the flat surfaces of the tubes 301 are configured to be parallel to the airflow direction, and airflow is directed from the side of the second core 300b. In other words, the radiator 300 of this embodiment is a counterflow type heat exchanger which flows the refrigerants in the first core 300a and the second core 300b in opposite directions.

[0067] As shown in Fig. 11, the tube 301 of this embodiment is also an extruded tube of the same aluminum alloy as in the previous embodiment. And, its both ends 301a are twisted in a width direction by 90° with respect to the airflow direction. The ends 301a of the tube 301 are fabricated by cutting the extruded tube to a prescribed length, holding the ends 301a and its neighborhood by a pair of jigs, and relatively moving the jigs.

[0068] As shown in Fig. 12, the first tank 310a is an extruded pipe or a drawn pipe, which is provided with plural slots 311 for insertion of the ends 301a of the individual tubes 301 in the longitudinal direction. The slots 311 are formed by pressing or cutting in a row in the longitudinal direction of the first tank 310a. The third tank 310c is configured of the same member as the first tank 310a. A hole for connection of the inlet 320 is formed in a required portion of the first tank 310a, and a hole for connection of the outlet 330 is formed in a required portion of the third tank 310c.

[0069] As shown in Fig. 13, the second tank 310b is also an extruded pipe or a drawn pipe which has plural slots 311 for insertion of the ends 301a of the individual tubes 301 in the longitudinal direction. The slots 311 are formed as two rows in the longitudinal direction of the second tank 310b. In other words, one of the two rows corresponds to the tubes 301 of the first core 300a, and the other row corresponds to the tubes 301 of the second core 300b. Besides, the second tank 310b has a relatively large cross-sectional area and a large wall thickness as compared with the first tank 310a and the third tank 310c.

[0070] As shown in Fig. 14 or Fig. 15, the ends 301a of the tubes 301 to be inserted into the second tank 310 are bent by a prescribed angle with respect to the longitudinal direction of the tubes 301 and inserted into the second tank 310b toward its center. The tubes 301 shown in Fig. 14 have the ends 301a twisted to determine the angles, and the tubes 301 shown in Fig. 15 have the ends 301a twisted and then bent to a prescribed angle. The ends 301a of the tubes 301 are bent before they are inserted into the slots 311. By configuring as above, the refrigerant is made save to flow smoothly. Or, as shown in Fig. 16, when it is configured to insert the ends 301a of the tubes 301 of the first core 300a and the second core 300b in parallel to the second tank 310b, their assembling property can be improved.

[0071] And, the radiator 300 is manufactured by integrally assembling the tubes 301, the fins 320, the first tank 310a, the second tank 310b, the third tank 310c, the inlet 320 and the outlet 330, and brazing the assembly in a furnace. For brazing, a brazing material and flux are previously applied to required portions of the individual members.

[0072] Thus, the radiator 300 of this embodiment secures the required pressure tightness depending on the refrigerant which becomes in a supercritical state, has rationalized the improvement of heat exchange efficiency of the refrigerant, miniaturization, weight reduction, facilitation of manufacturing and saving of a mounting space, and can be used quite suitably as the heat exchanger for the supercritical refrigeration cycle 1 mounted on a vehicle.

[0073] Next, a fourth embodiment of the invention will be described with reference to Fig. 17 and Fig. 18. As shown in Fig. 17, the radiator 300 of this embodiment is disposed on the windward of a radiator 800 of a vehicle, the positions of the first tank 310a and the third tank 310c are displaced in a direction orthogonal to the airflow direction on one side of the first core 300a and of the second core 300b, and the inlet 320 and the outlet 330 are directed toward the downwind side of the airflow direction. The tubes 301 of the first core 300a are determined to be somewhat shorter than the tubes 301 of the second core 300b. The other structure is the same as the previous embodiment.

[0074] According to this embodiment, the radiator 300 can be configured more rationally, and the piping structure in the layout of the refrigeration cycle 1 of a vehicle can be simplified. Especially, the inlet 320 and the outlet 330 in the pipe form for flowing a high-pressure refrigerant and piping to be connected to the inlet 302 and the outlet 330 become thick and are very disadvantageous in view of bending. However, according to this embodiment there is an advantage that their shape can be made very simple and can contribute to a saving in power for their fabrication.

[0075] As shown in Fig. 18, when the positional relationship between the first tank 310a and the third tank 310c is reversed, the inlet 320 and the outlet 330 can be directed to the windward side of the airflow direction. In this case, the tubes 301 of the second core 300b are determined to be somewhat shorter than the tubes 301 of the first core 300a.

[0076] Then, a fifth embodiment of the invention will be described with reference to Fig. 19 to Fig. 24. As shown in Fig. 19 and Fig. 24, the first tank 310a or the third tank 310c of this embodiment is cylindrical, and a first member 313 which is semi-tubular and a second member 314 on which slots 311 are arranged in a row, and a closing member 312 for closing the end are assembled. The first member 313 has a section in a shape which is nearly letter C or U.

[0077] The first member 313 is provided with caulking parts 313a, and the first member 313, the second member 314 and the closing member 312 are fixed by caulking the caulking parts 313a. The tube 301 and the first tank 310a or the third tank 310c are assembled by first assembling the first member 313, the second member 314 and the closing member 312 and inserting the end 301a of the tube 301 into the slot 311 (see Fig. 20). Or, after the end 301a of the tube 301 is inserted into the slot 311, the first member 313, the second member 314 and the closing member 312 are assembled (see Fig. 21).

[0078] The closing member 312 is a plate having a prescribed shape so as to be held on the inner circumference of the first member 313 and to which an end of the second member 314 is pressed. The other basic structure is the same as in the above-described embodiment.

[0079] According to this embodiment, the tanks can be configured more rationally.

[0080] A sixth embodiment of the invention will be described with reference to Fig. 25. The second tank 310b of this embodiment is also configured in the same way as the first tank 310a or the third tank 310c of the fifth embodiment by assembling the first member 313 which is semi-tubular, the second member 314 on which the slots 311 are arranged in a row and the closing member 312 for closing its end. Especially, the second member 314 is provided with the slots 311 arranged in two rows. One end 301a of each of the tubes 301 of the first core 300a is inserted into one row of slots 311, and one end 301a of each of the tubes 301 of the second core 300b is inserted into the other row. The other basic structure is the same as in the above-described embodiment.

[0081] Thus, the second tank 310b may also be configured by using the second member 314 having plural rows of slots.

[0082] Next, a seventh embodiment of the invention will be described with reference to Fig. 26. The second tank 310b of this embodiment is comprised of plural second members 314 and a spacer 315 for mutually connecting the plural second members. And, one end 301a of each of the tubes 301 of the first core 300a is inserted into a row of slots 311 formed in one of the second members 314, and the one end 301 of each of the tubes 301 of the second core 300b is inserted into a row of slots 311 formed in the other second member 314. The other basic structure is the same as in the previous embodiment.

[0083] Thus, to form plural rows of slots in a single tank, the plural second members 314 are mutually connected with the spacer 315, and the connected body may be assembled with the first member 313.

[0084] Next, an eighth embodiment of the invention will be described with reference to Fig. 27 to Fig. 29. The ends 301a of the tubes 301 are inserted into the second tank 310b of this embodiment toward its center, and the ends 301a of the tubes 301 are bent by a prescribed angle with respect to the longitudinal direction of the tubes 301.

[0085] As the spacer 315 for connecting the plural second members 314, a tapered one for connecting the individual second members 314 at a prescribed angle is used, and the slots 311 in one of the second members 314 and the slots 311 in the other second member 314 are directed to different directions.

[0086] In this embodiment, the closing member 312 is provided with notched fitting portions 312a for fitting the ends of the second members 314, and the plural second members 314 are connected via the spacer 315 and disposed with the ends fitted to the closing member 312. The first member 313 is provided with shoulders 313b for positioning the closing member 312. And, an end face of the spacer 315 is pressed to the closing member 312. The other basic structure is the same as in the previous embodiment.

[0087] Thus, it is possible to configure so to connect the individual second members 314 at a prescribed angle. Further, by fitting the second members 314 to the fitting portions 312a of the closing member 312, the closing member 312 and the second member 314 can be assembled more accurately and securely.

[0088] Next, a ninth embodiment of the invention will be described with reference to Fig. 30. The radiator 300 shown in Fig. 30 is comprised of the first core 300a and the second core 300b whose both ends are provided with the tank 310. In the drawing, 340 denotes a communication part for mutually communicating the prescribed tanks 310.

[0089] The ends 301a of the tubes 301 of this embodiment are inserted into the slots and thereafter bent by a prescribed angle. In other words, the ends 301a of the tubes 301 twisted to be parallel to the longitudinal direction of the tubes 301 are inserted into the slots 311 of the tanks 310 and bent by forcibly moving the individual tanks 310 with a jig or the like. As shown in the drawing, the ends 301a of the tubes 301 are bent so to have a small interval between the first core 300a and the second core 300b. Thus, a total thickness of the first core 300a and the second core 300b becomes thin. The communication part 340 is attached after the ends 301a of the tubes 301 are bent.

[0090] Thus, the ends 301a of the tubes 301 may also be bent after inserting into the slots.

[0091] Next, a tenth embodiment of the invention will be described with reference to Fig. 31 and Fig. 32. As shown in the drawings, the radiator 300 of this embodiment is a crossflow type heat exchanger which is determined to flow the refrigerants parallel in the first core 300a and the second core 300b. One end 301a of each of the tubes 301 of the first core 300a and the second core 300b is inserted into the tank 310 having the inlet 320, and the other end 301a of each of the tubes 301 of the first core 300a and the second core 300b is inserted into the other tank 310 having the outlet 330.

[0092] The refrigerant is introduced into one of the tanks 310 through the inlet 320, flowed through the tubes 301 of the first core 300a or the second core 300b and discharged outside through the outlet 330 of the other tank 310. The other basic structure is the same as in the previous embodiment.

[0093] Thus, the structure of this embodiment, wherein the ends 301a of the tubes 301 are twisted in the width direction by 90° with respect to the airflow direction, can be applied to various types of heat exchangers such as a counterflow type heat exchanger and a crossflow type heat exchanger.

INDUSTRIAL APPLICABILITY

[0094] The present invention relates to a heat exchanger and tubes thereof generally used for a refrigeration cycle of air conditioners for automobiles, home use, etc., and particularly suitable for a refrigeration cycle which uses, for example, CO_2 as the refrigerant and has the pressure in a radiator exceeding the critical point of the refrigerant.

Claims

1. Flat tubes which are used for a heat exchanger to carry out heat exchange of a refrigerant and to flow the refrigerant,
wherein:

    the heat exchanger is provided with a core, which has the tubes and corrugated fins laminated, and tanks provided with slots for insertion of the ends of the tubes, and carries out the heat exchange of the refrigerant by flowing air to the core and transferring heat to the core,
    the core is configured to have the flat surfaces of the tubes in parallel with the airflow direction, and
    the tubes have the width direction of their ends twisted by 90° with respect to the airflow direction.

2. The heat exchanger tubes according to Claim 1, wherein the heat exchanger is used for a refrigeration cycle which circulates the refrigerant, and the refrigeration cycle has a pressure on a high pressure side exceeding the critical point of the refrigerant.

3. A heat exchanger which is provided with a core having lamination of flat tubes for flowing a refrigerant and corrugated fins, and tanks provided with slots for insertion of the ends of the tubes, and carries out heat exchange of the refrigerant by flowing air to the core and transferring heat to the core, wherein:

    the core is configured to have the flat surfaces of the tubes in parallel with the airflow direction, and
    the tubes have the width direction of their ends twisted by 90° with respect to the airflow direction.

4. The heat exchanger according to Claim 3, wherein the tanks have an inner diameter smaller than the width of the tubes.

5. The heat exchanger according to Claim 3 or 4, wherein the plural slots are arranged in a row along the longitudinal direction of the tanks, and the tubes are determined to have a width smaller than intervals between the arranged tubes.

6. The heat exchanger according to Claim 5, wherein it is assumed that the interval between the arranged tubes is P and the width of the tubes is T, then they have relationships P=(6 to 12) mm and T=P · (0.95 to 0.80).

7. The heat exchanger according to any of Claims 3 to 6, wherein the heat exchanger comprises a plurality of cores overlaid in the airflow direction.

8. The heat exchanger according to Claim 7, wherein:

    the cores include a first core and a second core which are overlaid in the airflow direction,
    the tanks include a first tank into which one end of each of the tubes of the first core is inserted, a second tank into which the other end of each of the tubes of the first core and one end of each of the tubes of the second core are inserted, and a third tank into which the other end of each of the tubes of the second core is inserted, and an inlet for the refrigerant is formed on the first tank, and an outlet for the refrigerant is formed on the third tank.

9. The heat exchanger according to Claim 8, wherein the first tank and the third tank are displaced in a direction orthogonal to the airflow direction, and the inlet and the outlet are oriented toward the windward side or the downwind side of the airflow direction.

10. The heat exchanger according to any of Claims 3 to 9, wherein the fins are determined to have a width larger than that of the tubes.

11. The heat exchanger according to any of Claims 3 to 10, wherein the tanks are cylindrical and configured by assembling a first member which is semitubular, a second member on which the slots are arranged in a row and a closing member for closing its ends.

12. The heat exchanger according to Claim 11, wherein the tanks each is configured by assembling the first member, a plurality of the second members, a spacer for connecting the plurality of second members and the closing member.

13. The heat exchanger according to Claim 11 or 12, wherein the closing member is provided with fitting portions for fitting the second member.

14. The heat exchanger according to any of Claims 11 to 13, wherein the first member is provided with caulking parts, and the first member and the second member are fixed by caulking the caulking parts.

15. The heat exchanger according to Claim 14, wherein the caulking parts are caulked to fix the first member, the second member and the closing member.

16. The heat exchanger according to any of Claims 11 to 15, wherein the ends of the tubes are inserted into the slots, then the first member and the second member are assembled.

17. The heat exchanger according to any of Claims 11 to 15, wherein the first member and the second member are assembled, then the ends of the tubes are inserted into the slots.

18. The heat exchanger according to any of Claims 3 to 17, wherein the ends of the tubes are bent with respect to the longitudinal direction of the tubes.

19. The heat exchanger according to Claim 18, wherein the ends of the tubes are bent before they are inserted into the slots.

20. The heat exchanger according to Claim 18, wherein the ends of the tubes are bent after they are inserted into the slots.

21. The heat exchanger according to any of Claims 3 to 20, wherein the heat exchanger is used for a refrigeration cycle which circulates the refrigerant, and the refrigeration cycle has a pressure on a high-pressure side exceeding the critical point of the refrigerant.

22. A heat exchanger for a refrigeration cycle having a pressure on a high-pressure side exceeding the critical point of a refrigerant, which is provided with a core comprised of lamination of flat tubes for flowing the refrigerant and corrugated fins, and tanks on which slots for insertion of the ends of the tubes are formed, and carries out heat exchange of the refrigerant by flowing air to the core and transferring heat to the core, wherein:

the core includes a first core and a second core overlaid in the airflow direction; and

an inlet for the refrigerant is disposed on the tank into which the ends of the tubes of the first core are inserted on one side of both of the first core and the second core, an outlet for the refrigerant is disposed on the tank into which the ends of the tubes of the second core are inserted, the tanks are displaced in a direction orthogonal to the airflow direction, and the inlet and the outlet are oriented toward the windward side or the downwind side of the airflow direction.

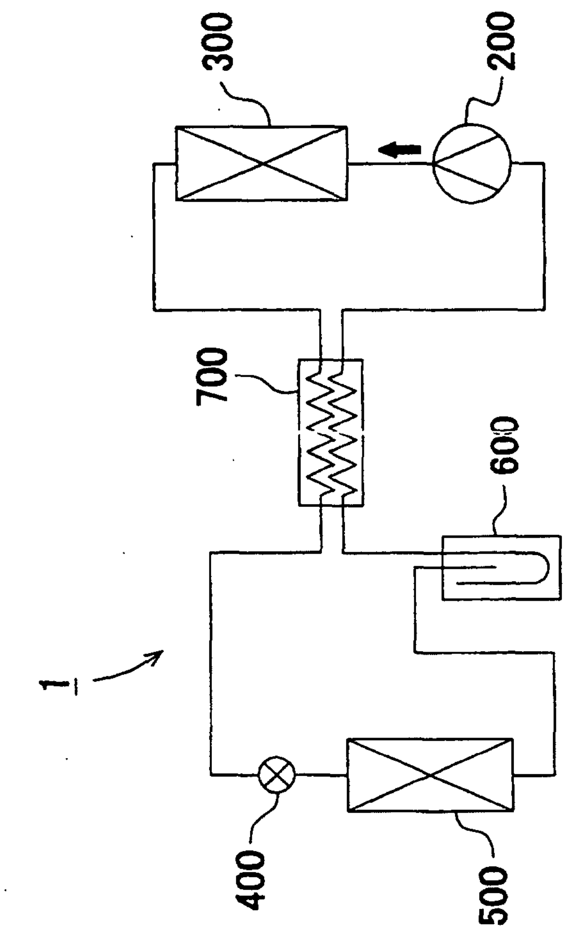
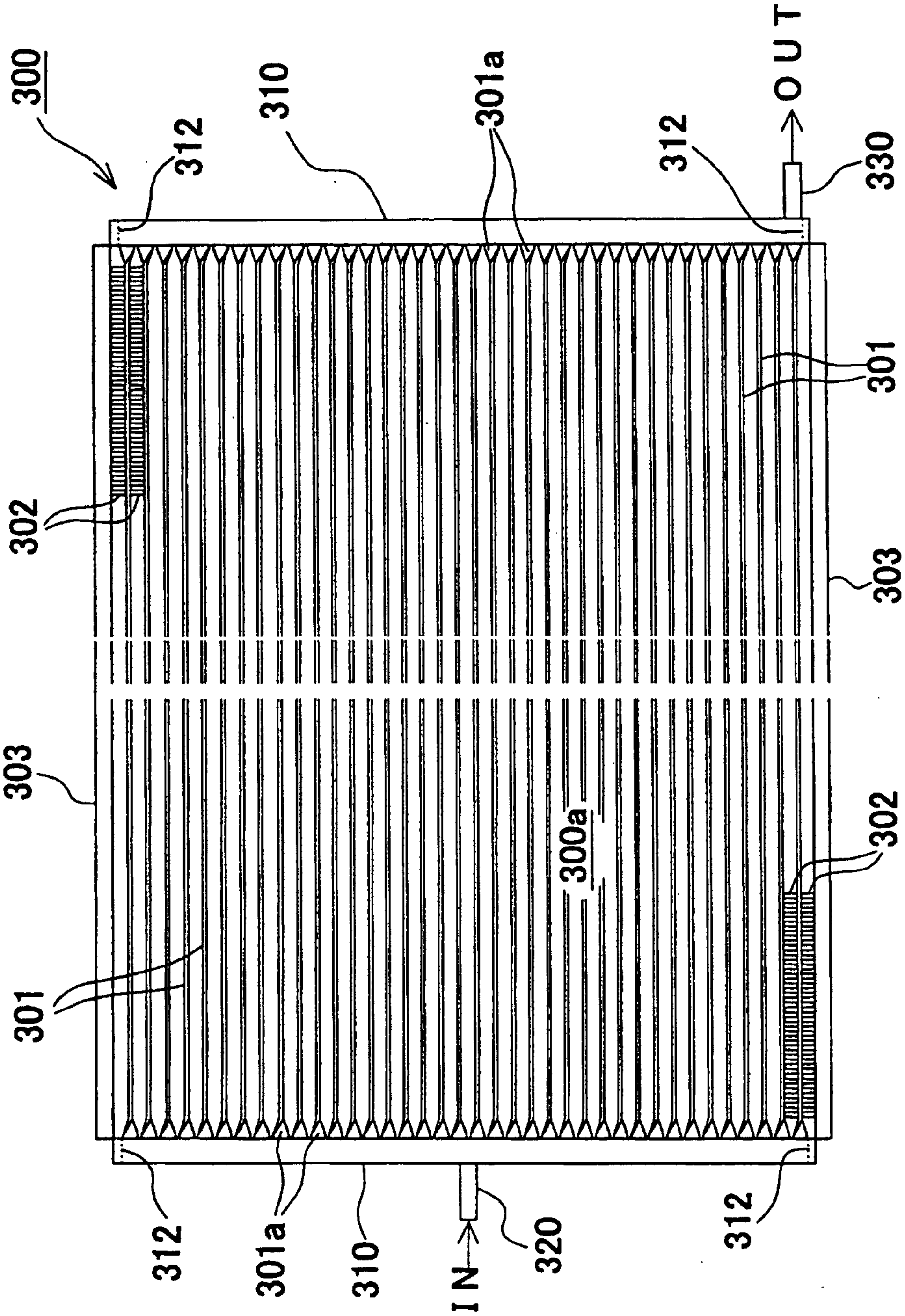


FIG.1

FIG.2


300
312
310
301a
312
OUT
330
301
302
303
303
300a
302
301
312
301a
310
IN
320
312

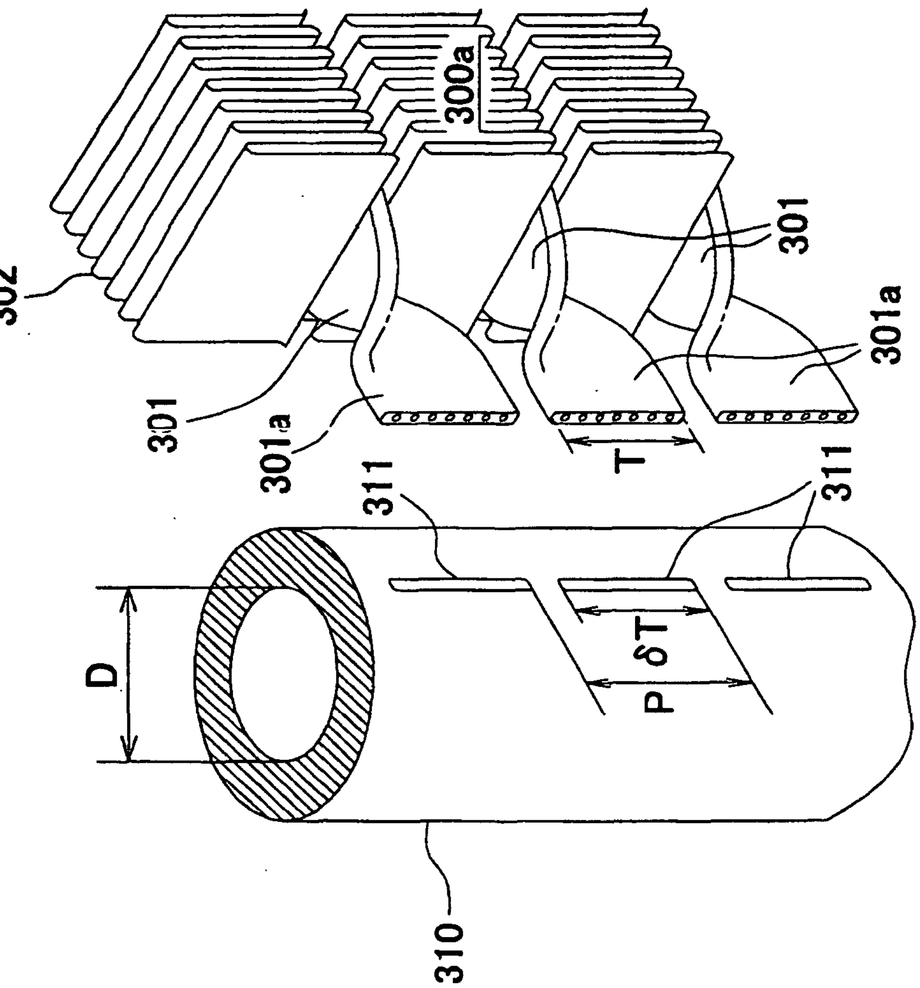


FIG.3

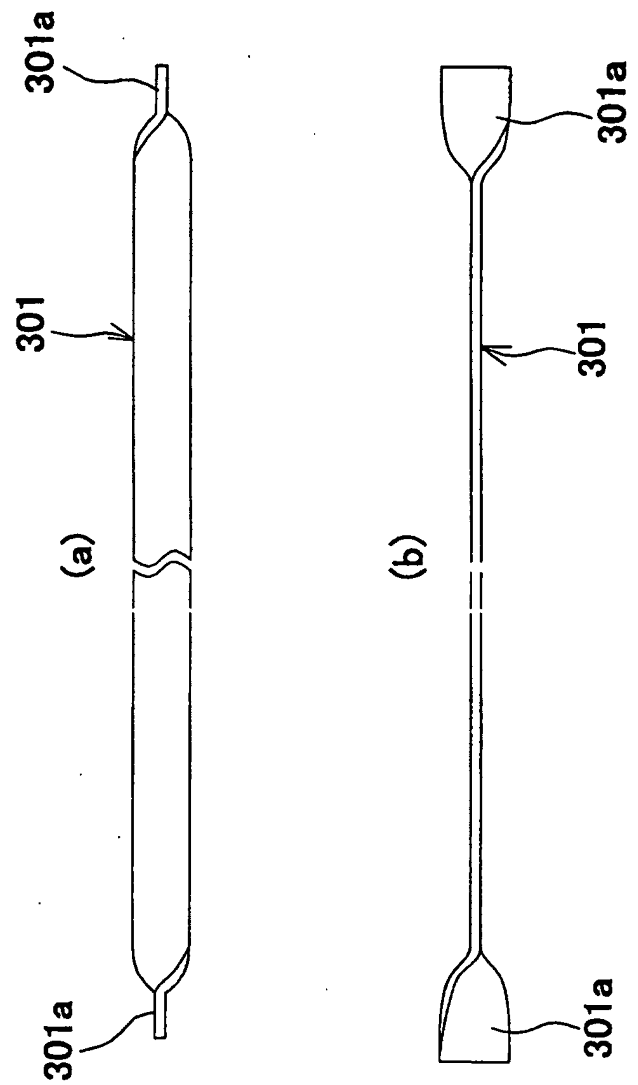


FIG.4

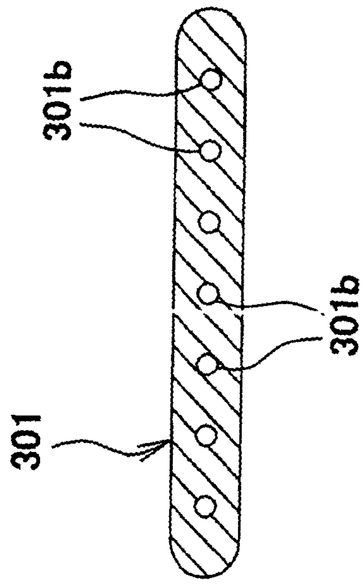


FIG.5

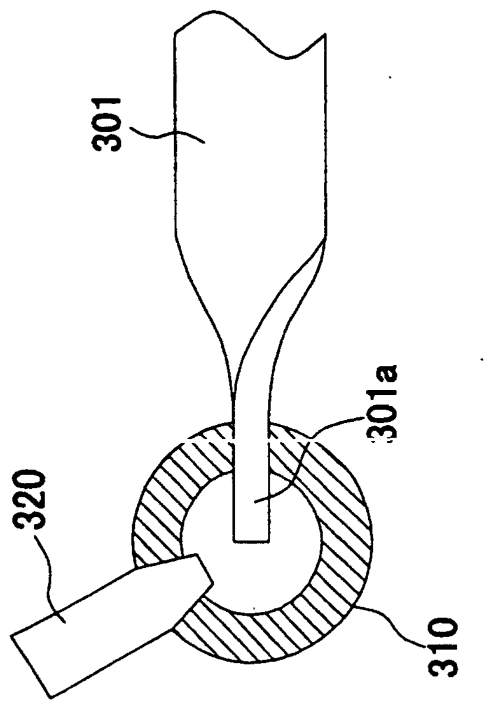


FIG.6

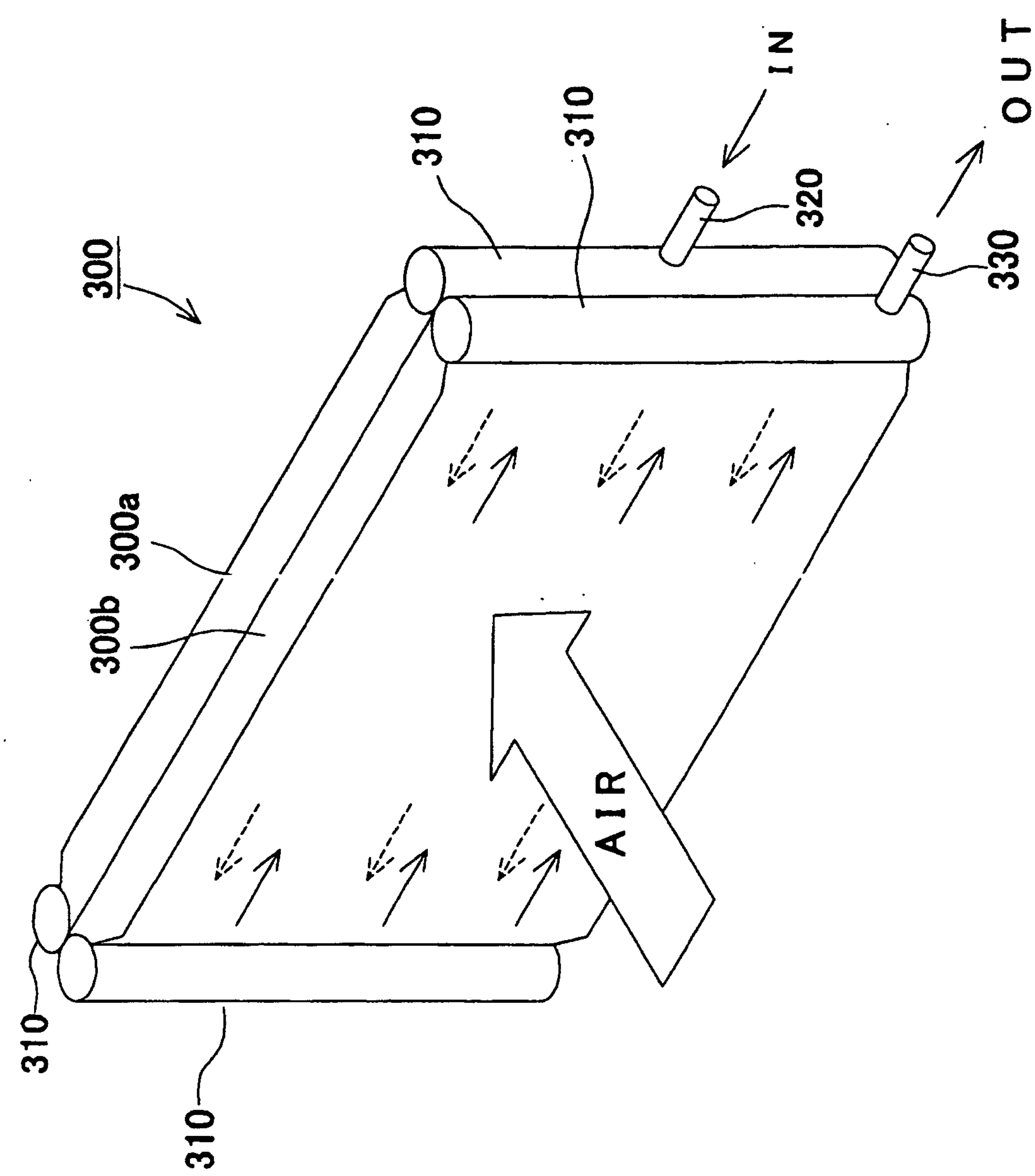


FIG.7

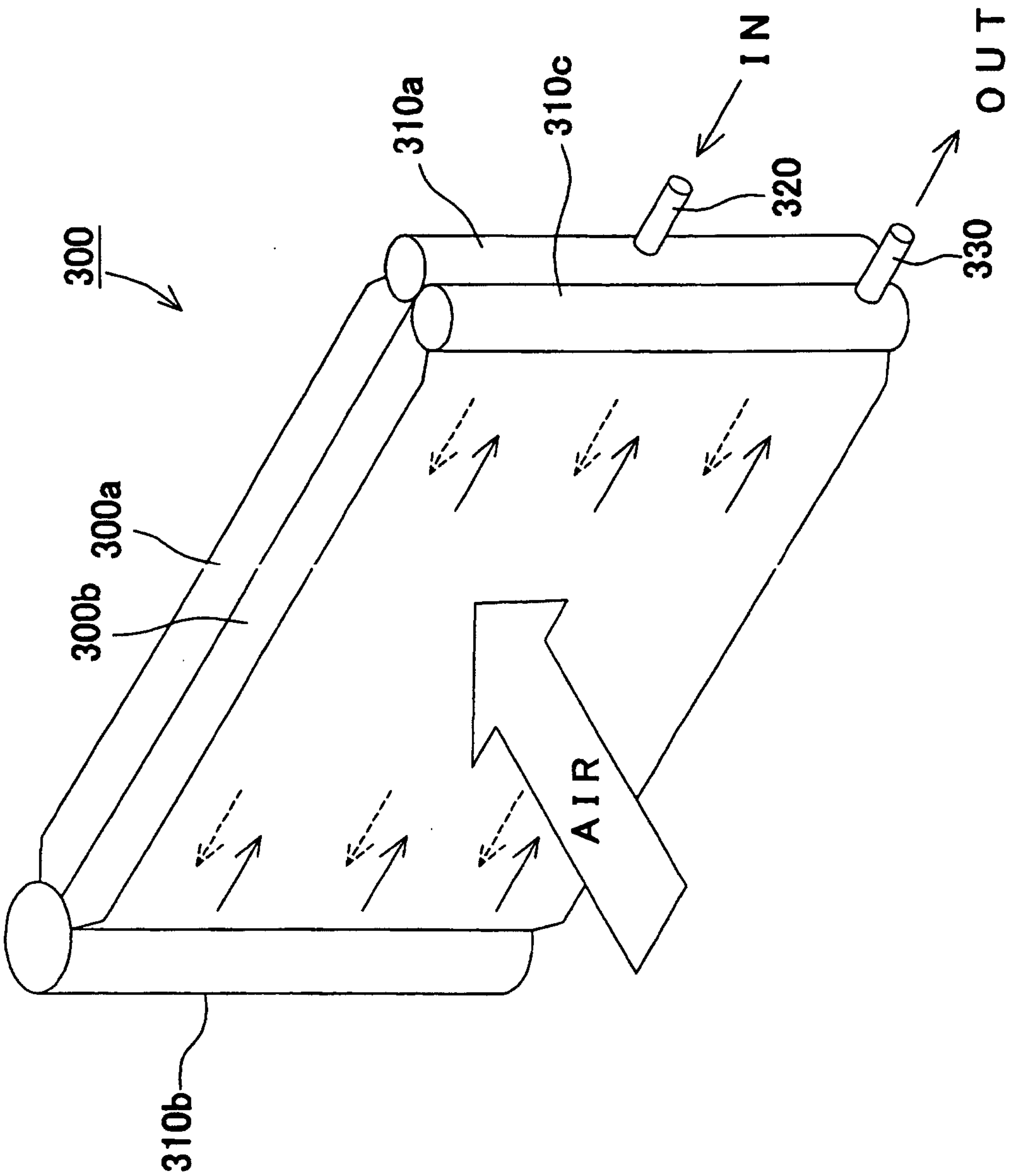


FIG.8

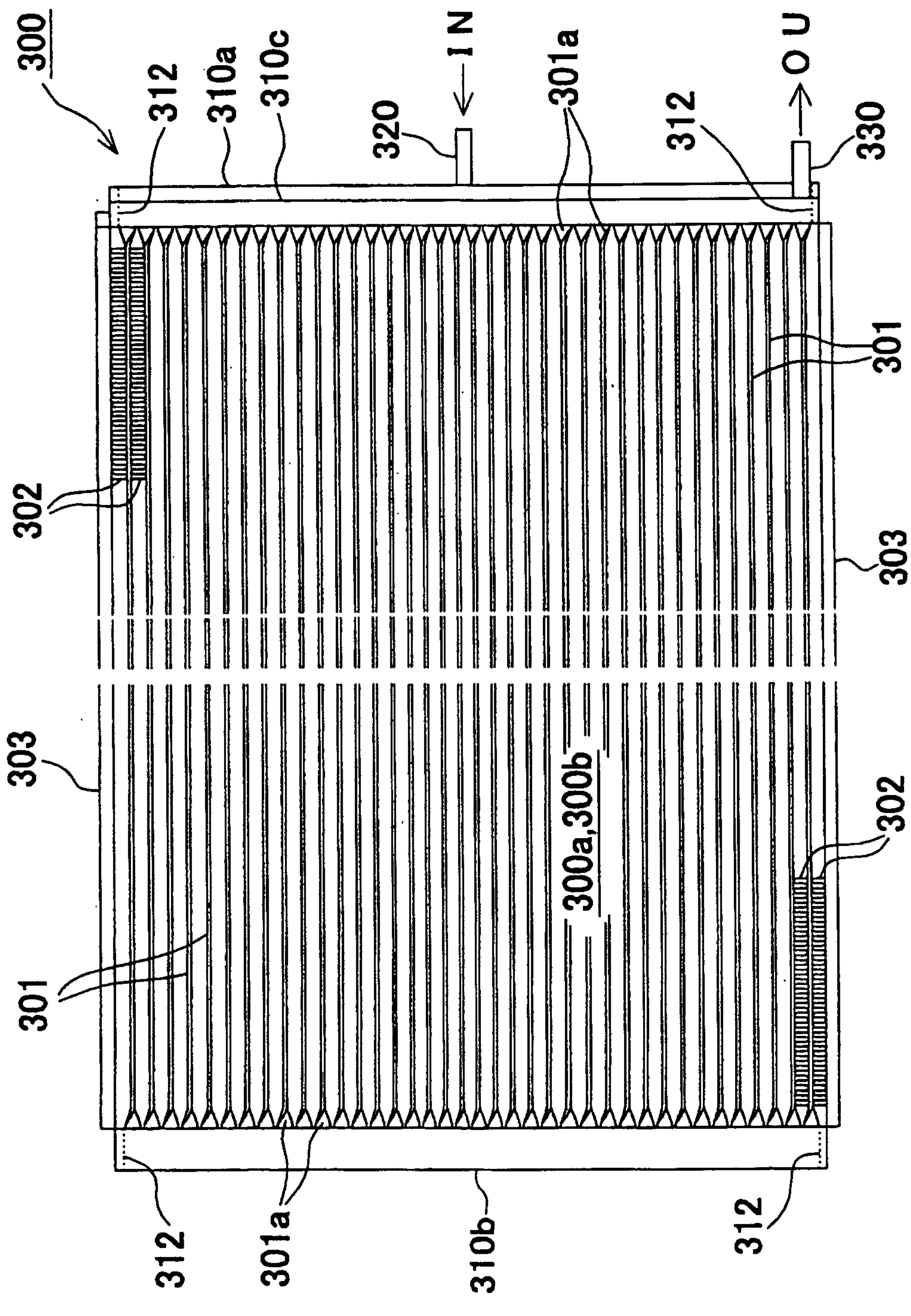

300
312
310a
310c
320
IN
301a
312
OUT
330
301
302
303
300a,300b
310b

FIG.9

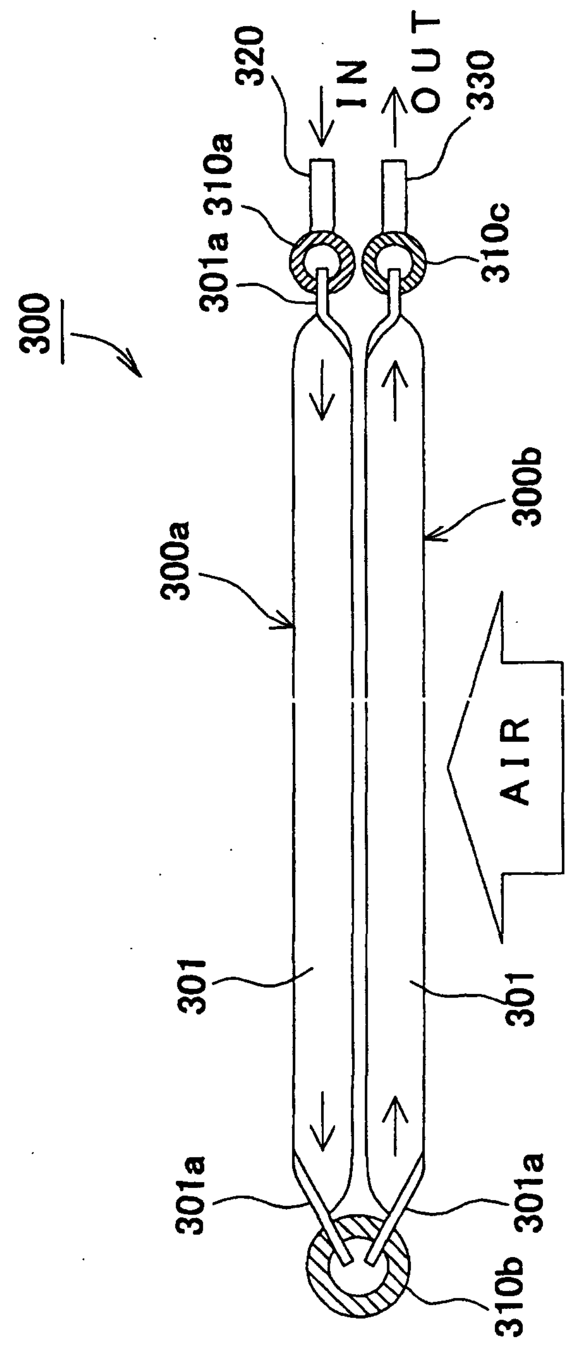

300
300a
300b
301
301
301a
301a
301a
310a
310b
310c
320
330
IN
OUT
AIR

FIG.10

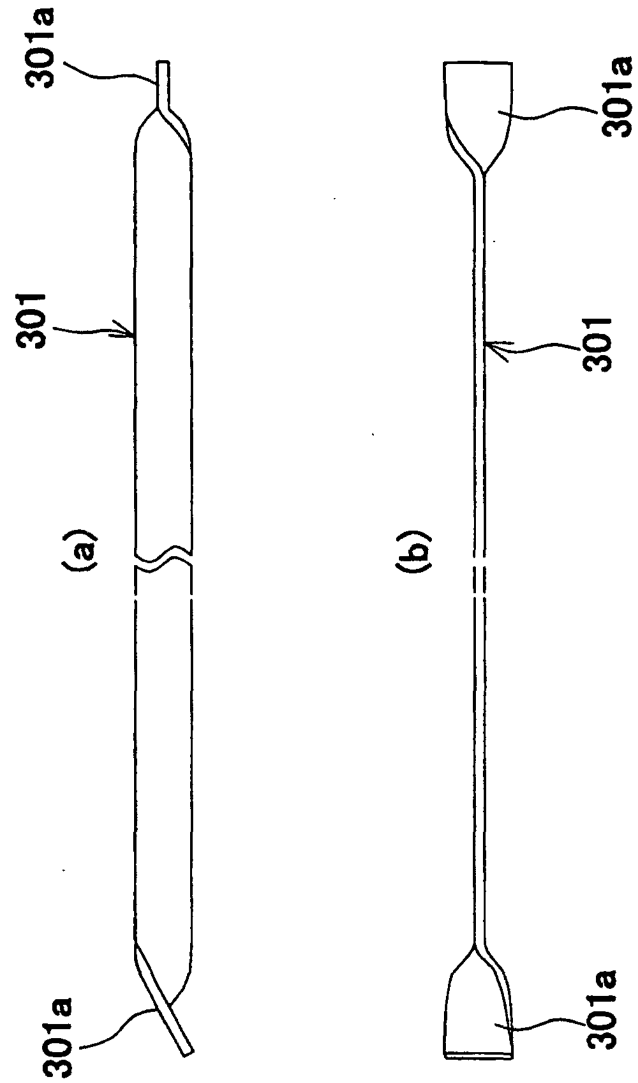


FIG.11

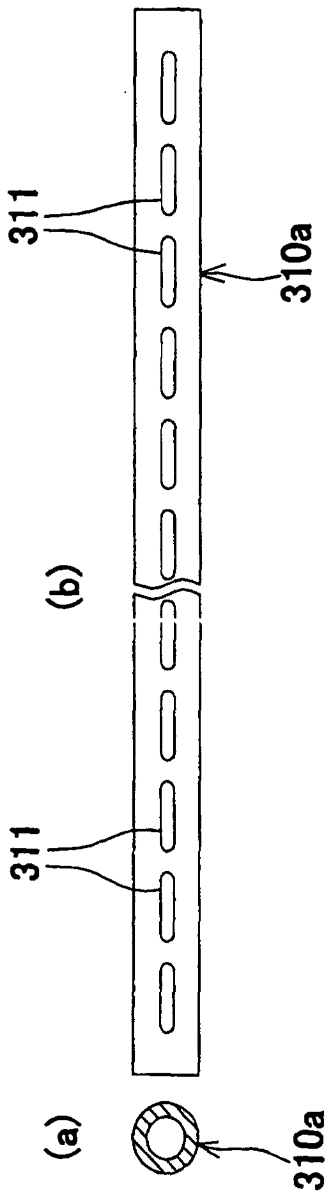


FIG.12

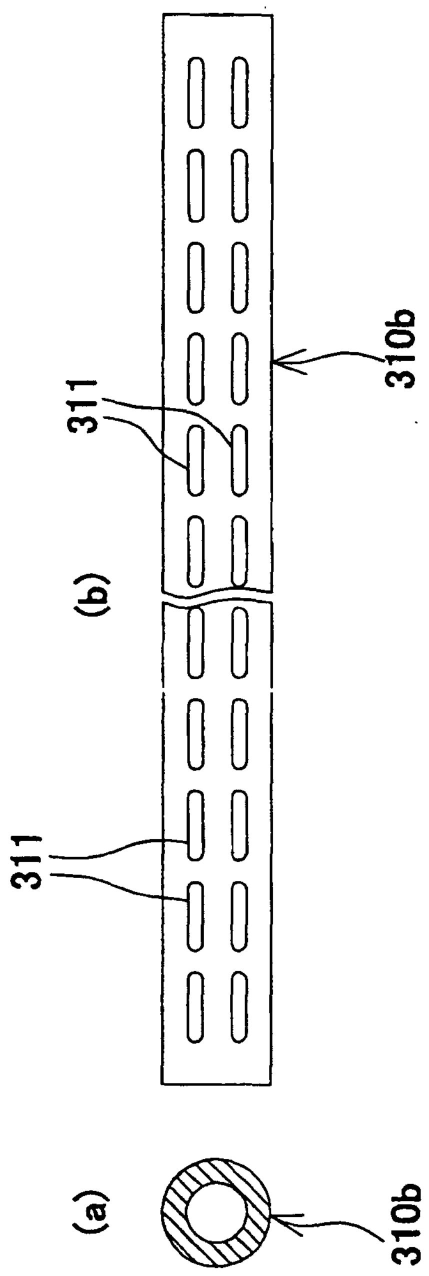


FIG.13

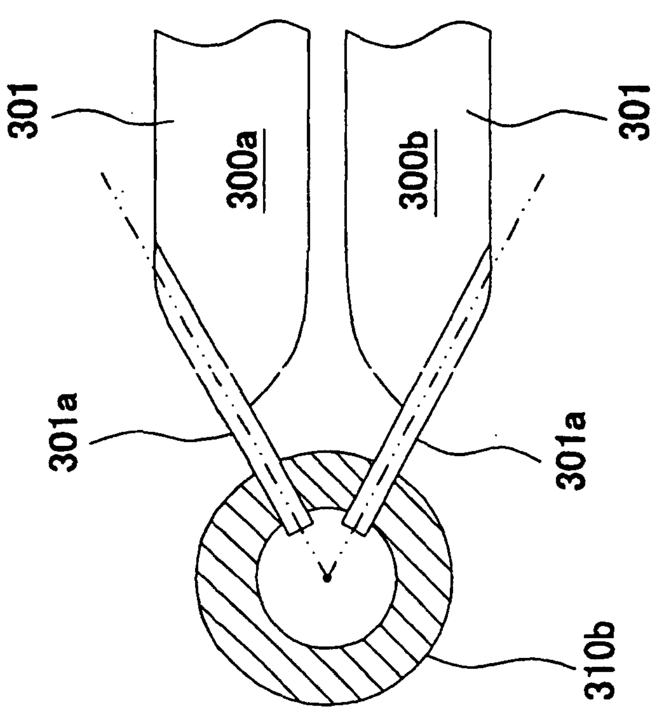
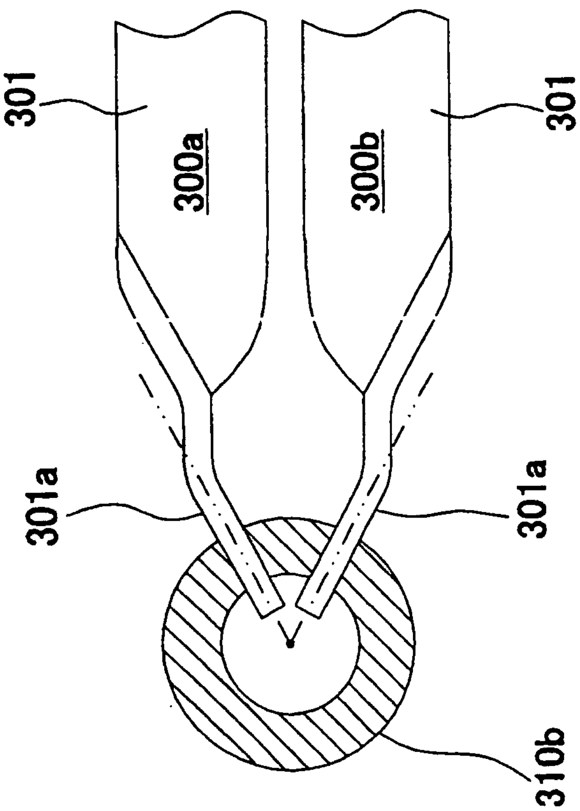


FIG.14

FIG.15



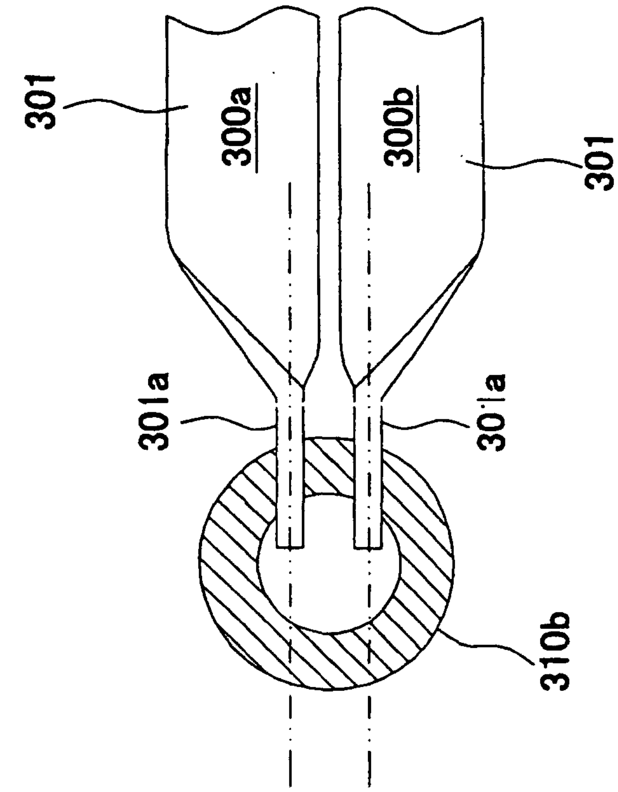


FIG.16

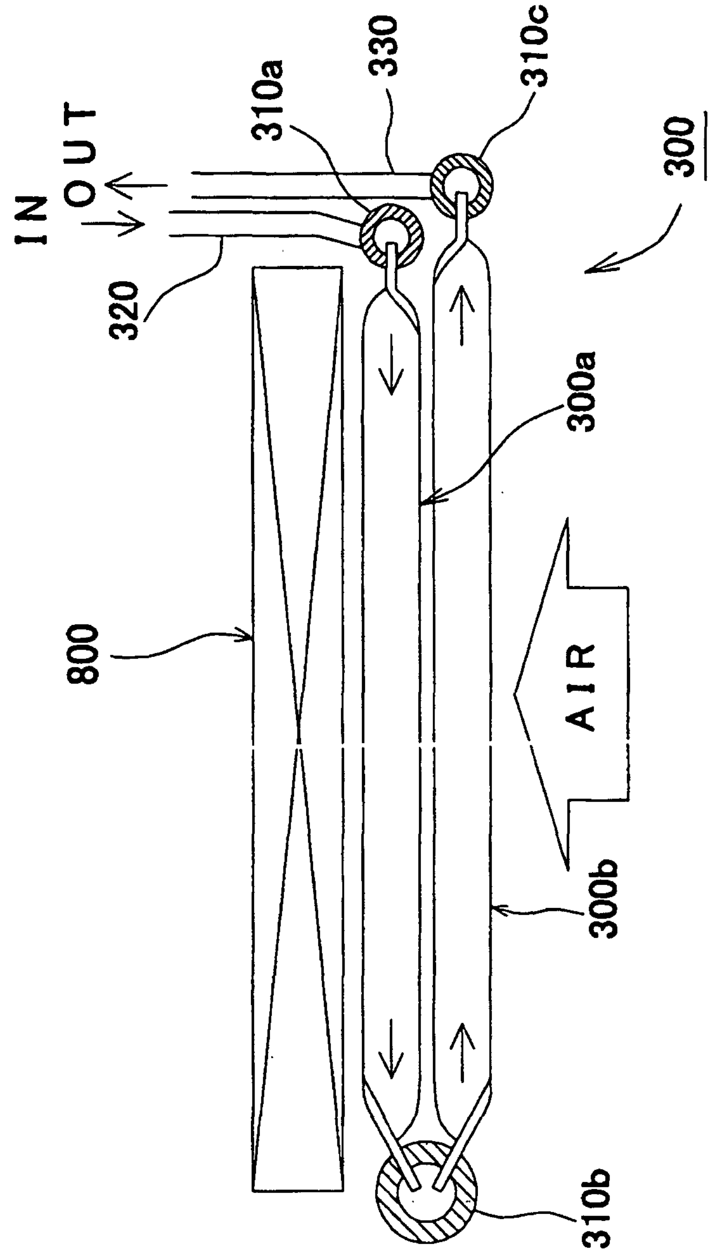


FIG.17

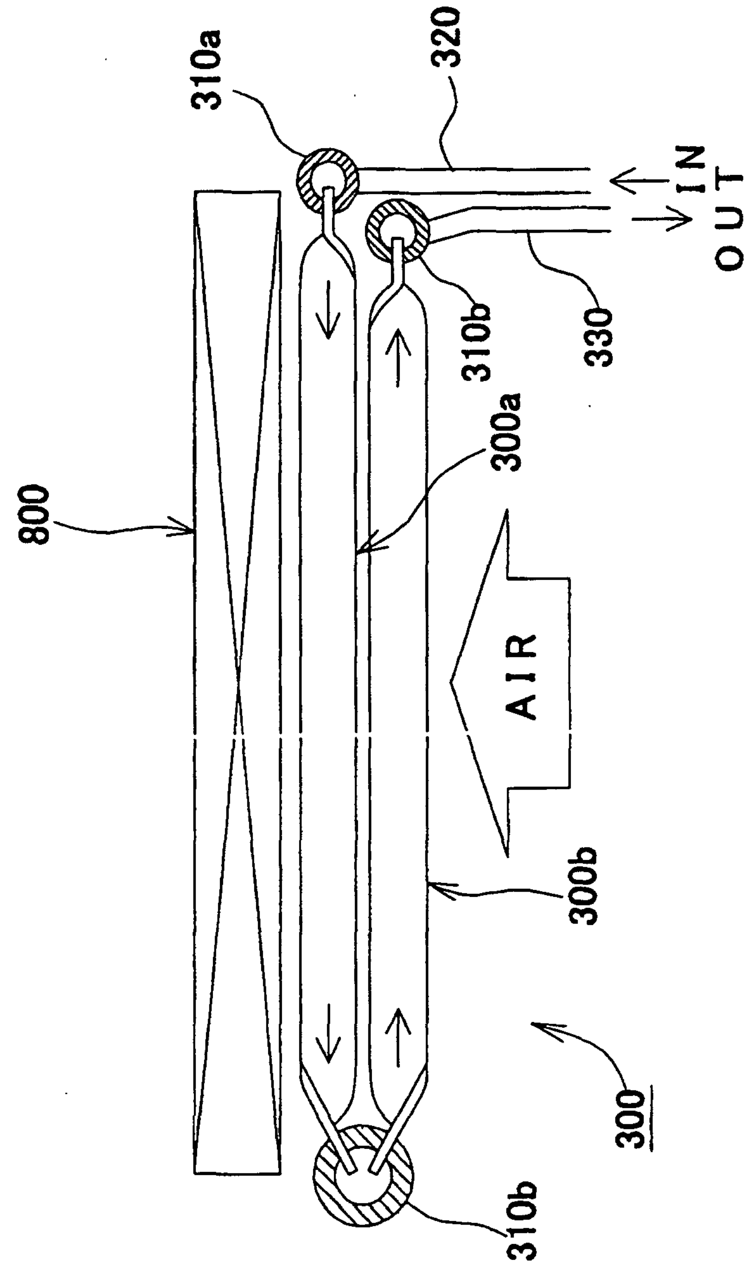


FIG.18

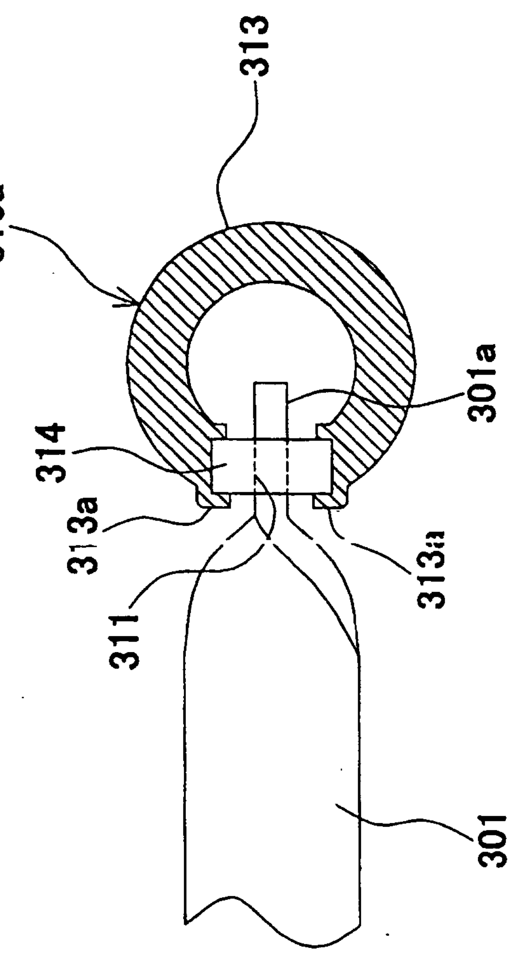


FIG.19

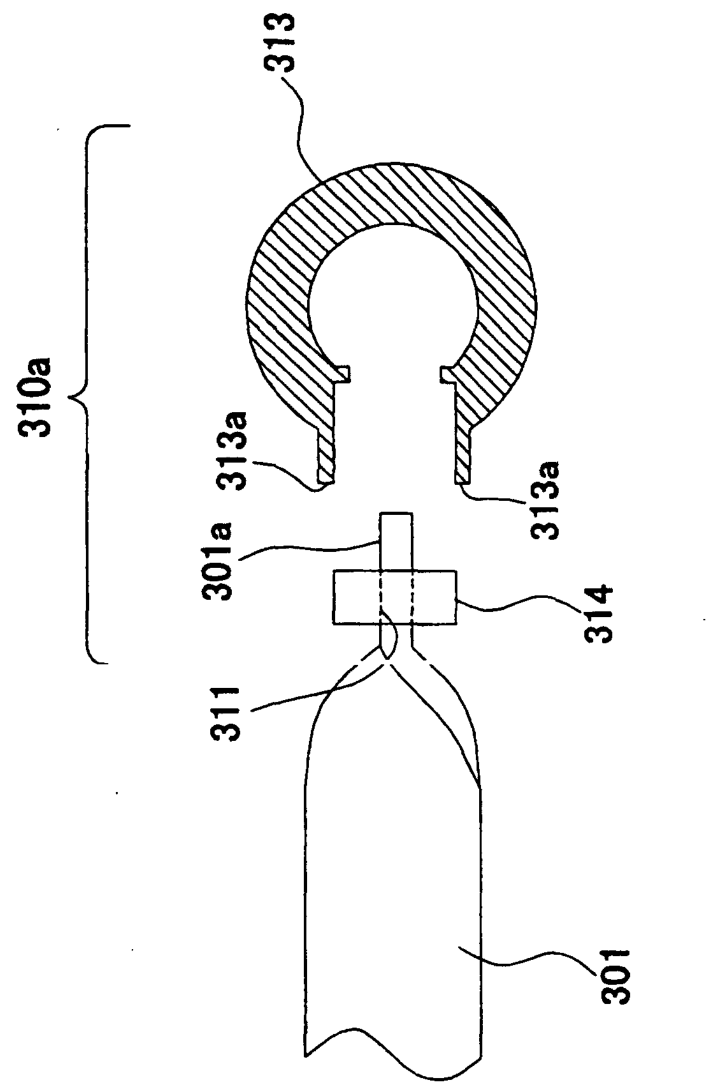


FIG.20

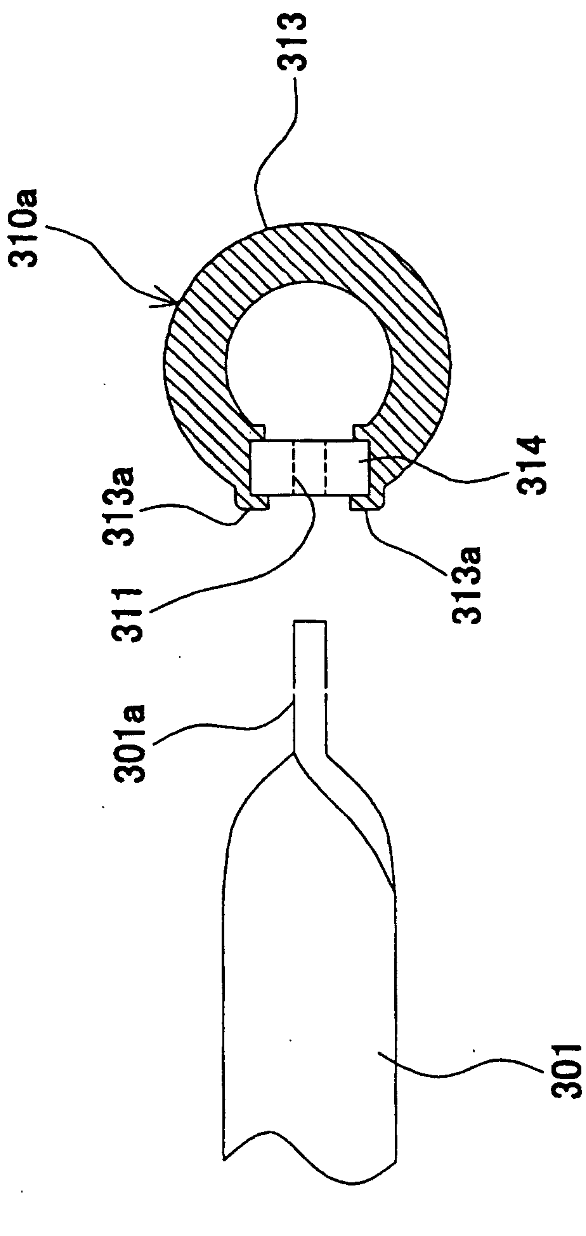


FIG.21

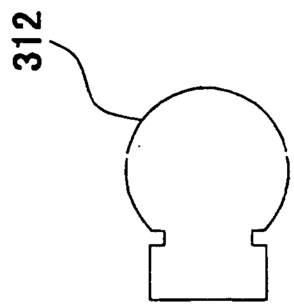


FIG.22

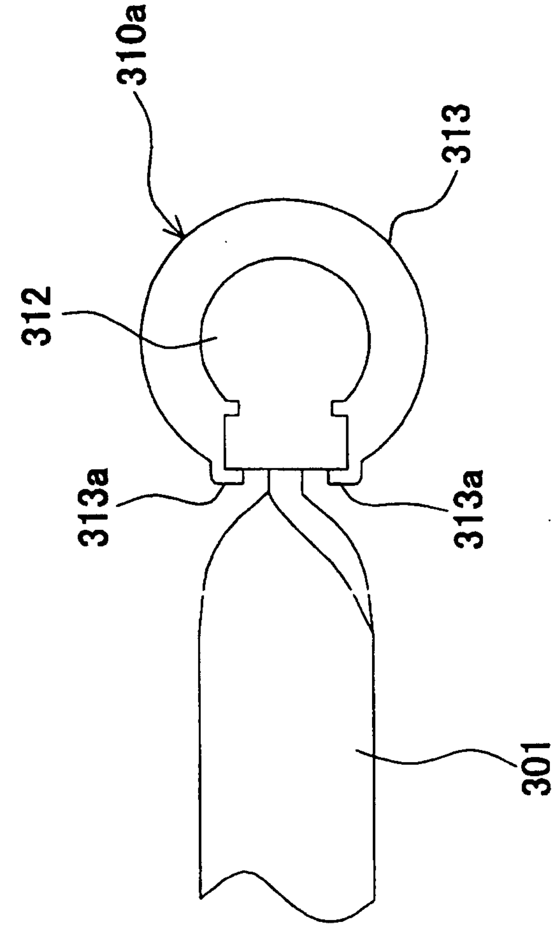


FIG.23

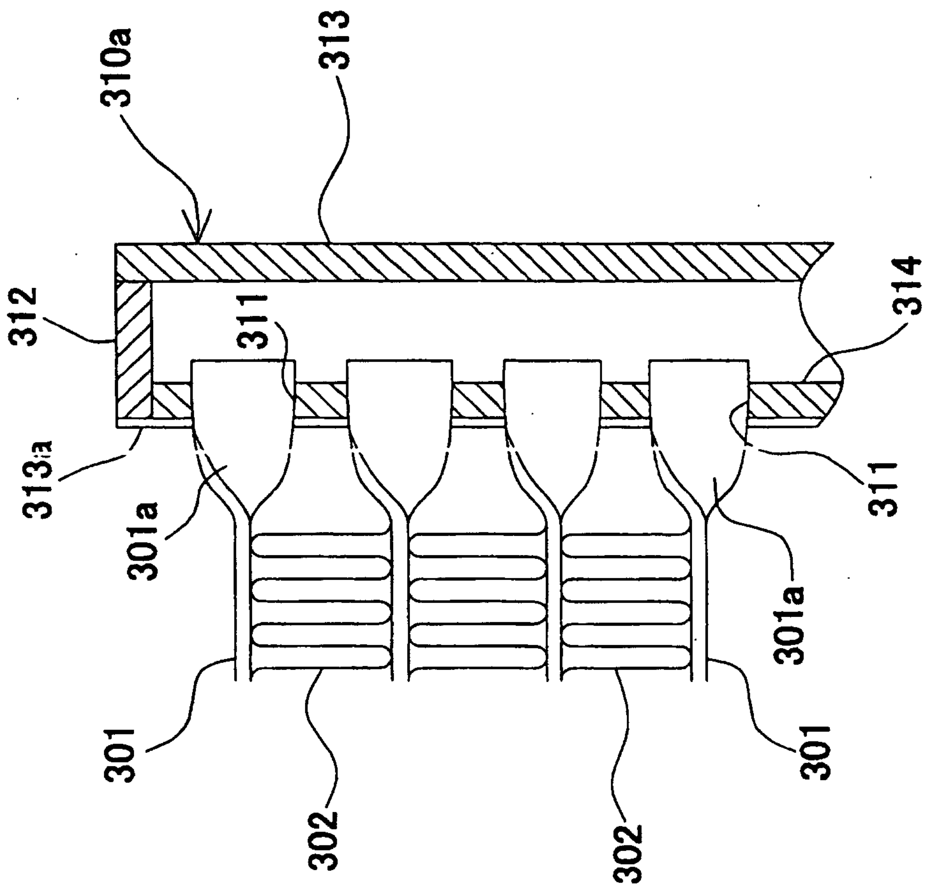
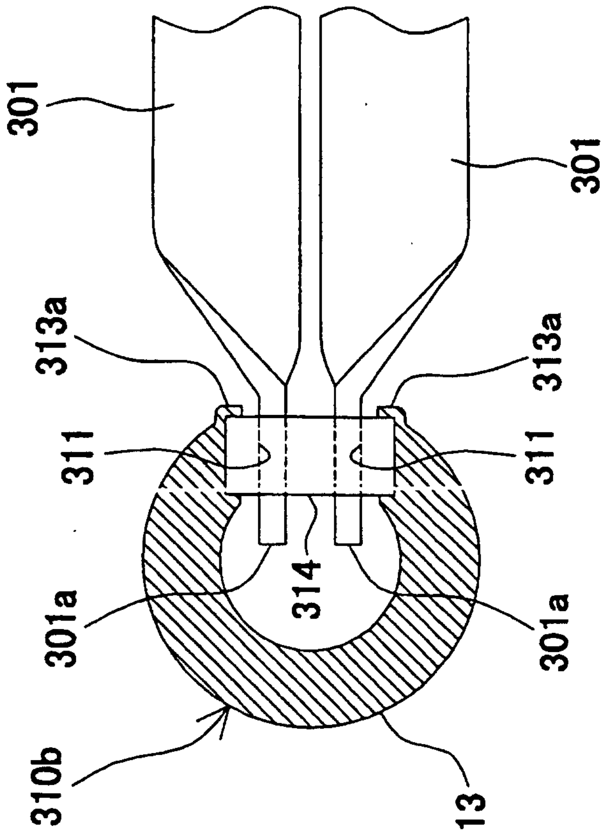


FIG.24

FIG.25



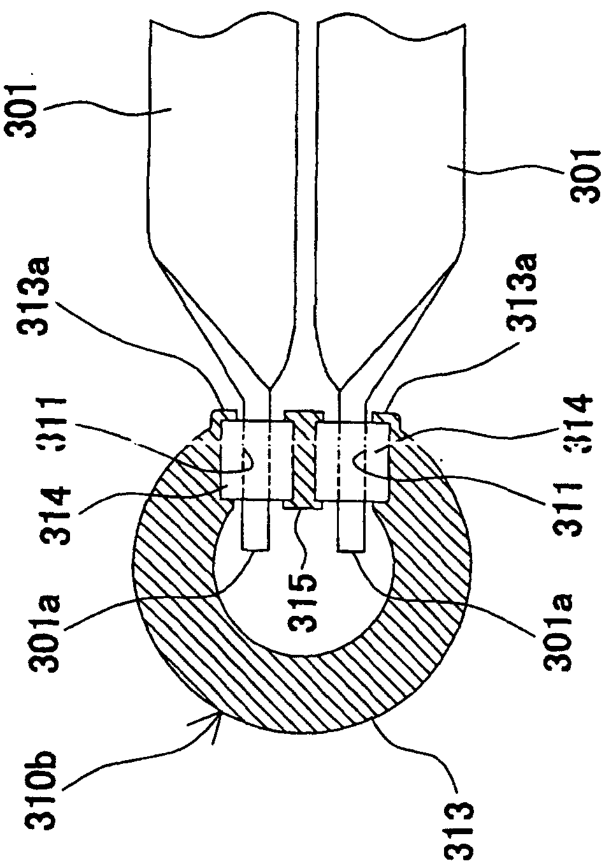


FIG.26

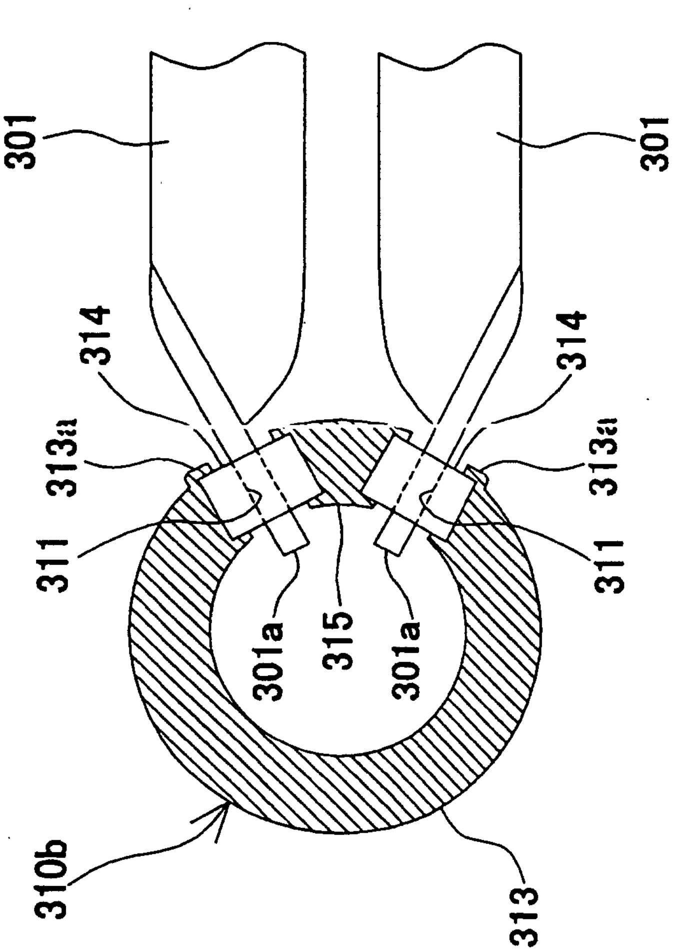


FIG.27

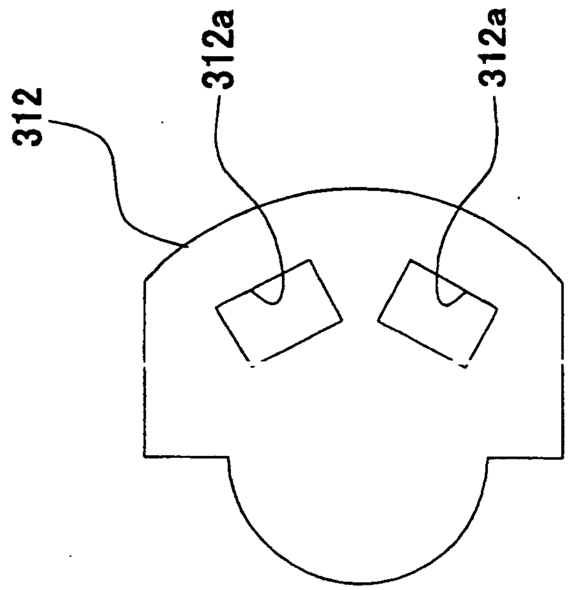


FIG.28

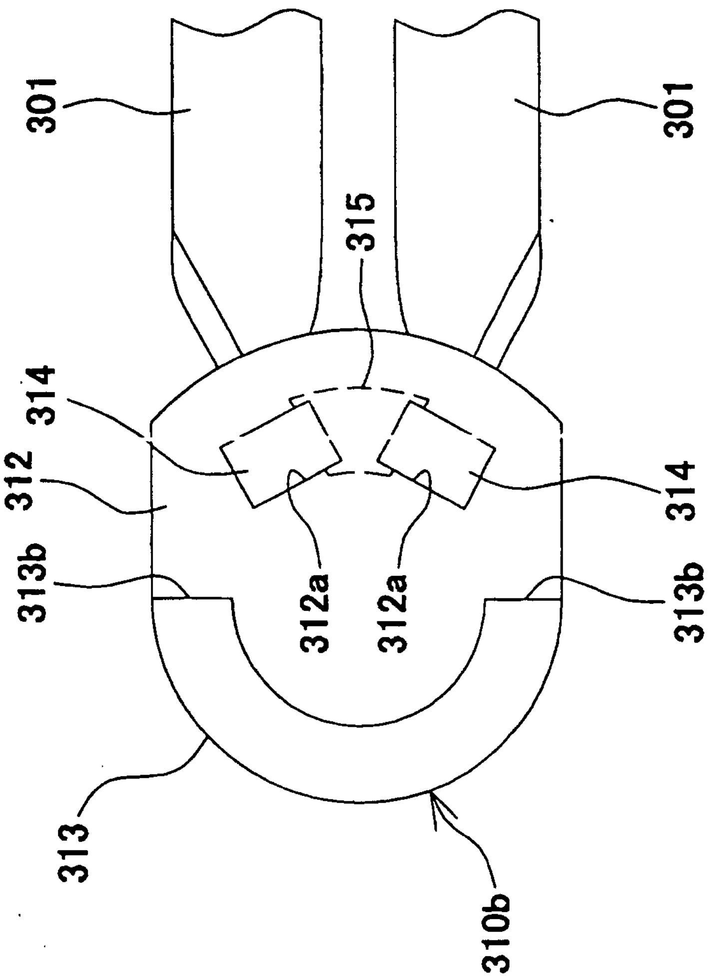


FIG.29

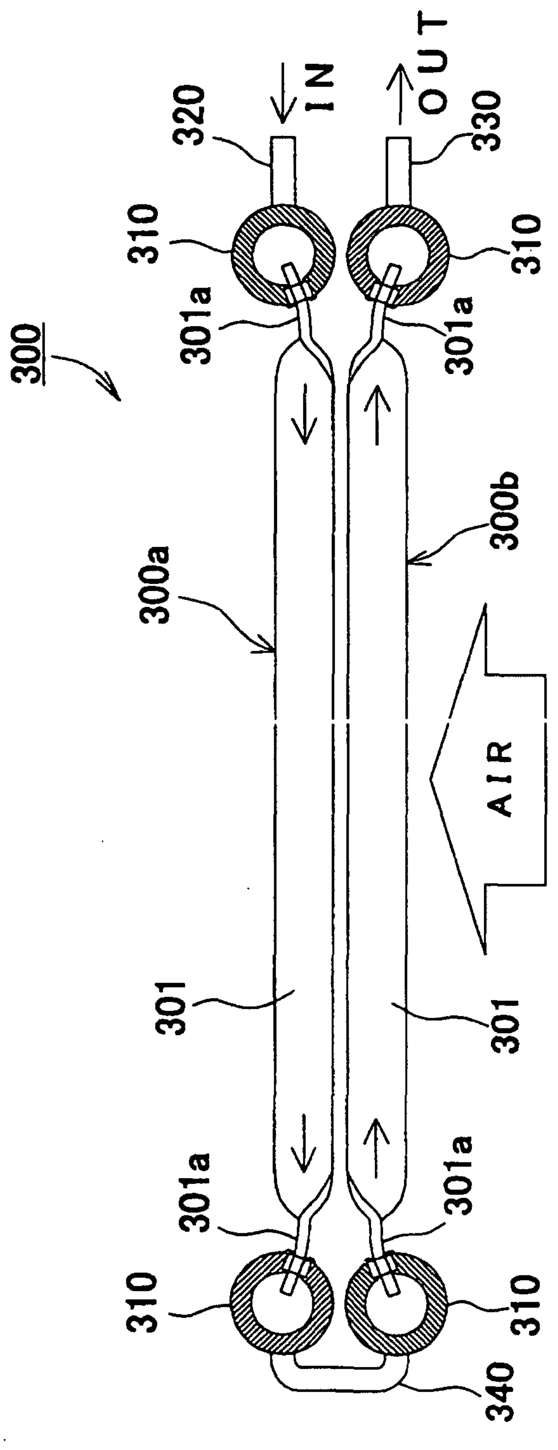

300
300a
300b
301
301
301a
301a
301a
301a
310
310
310
310
320
330
340
IN
OUT
AIR

FIG.30

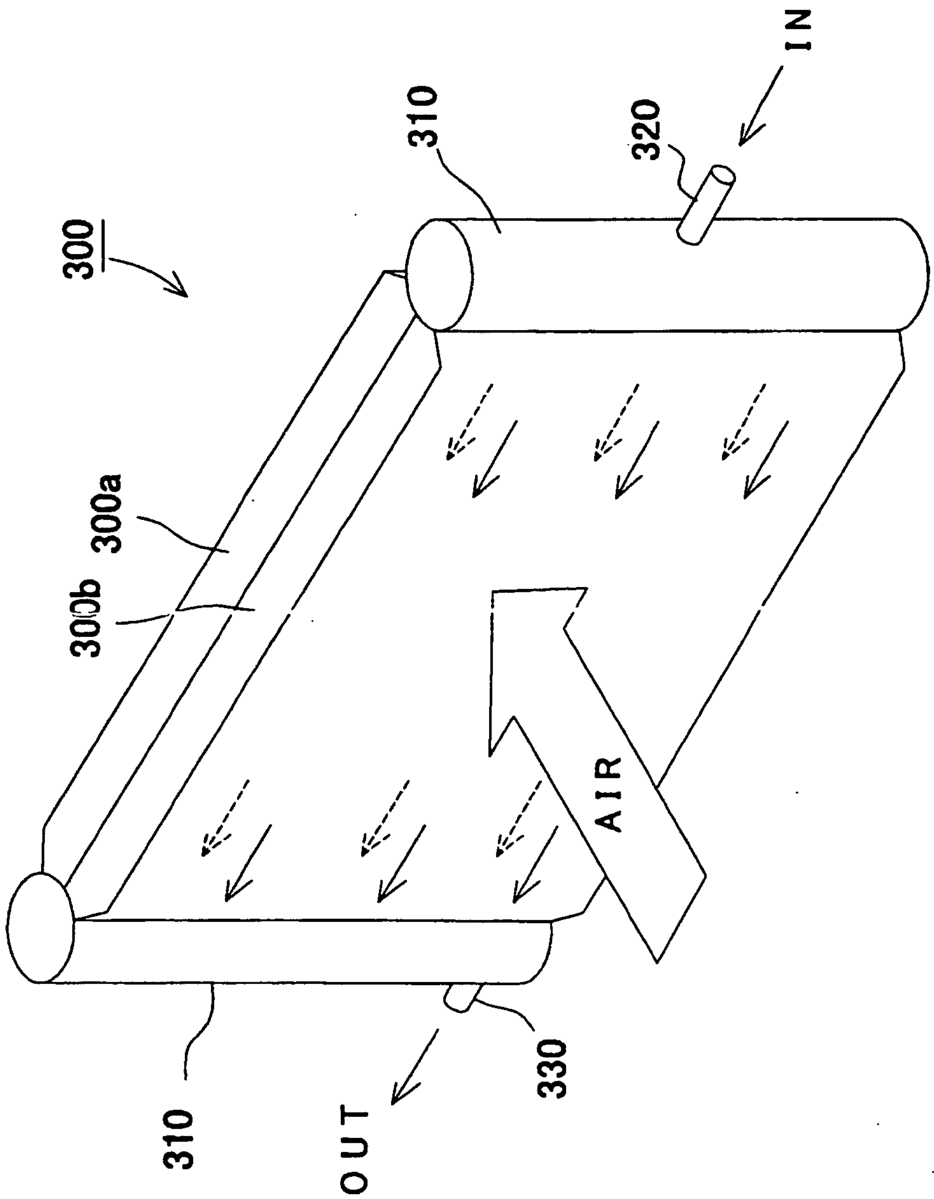


FIG.31

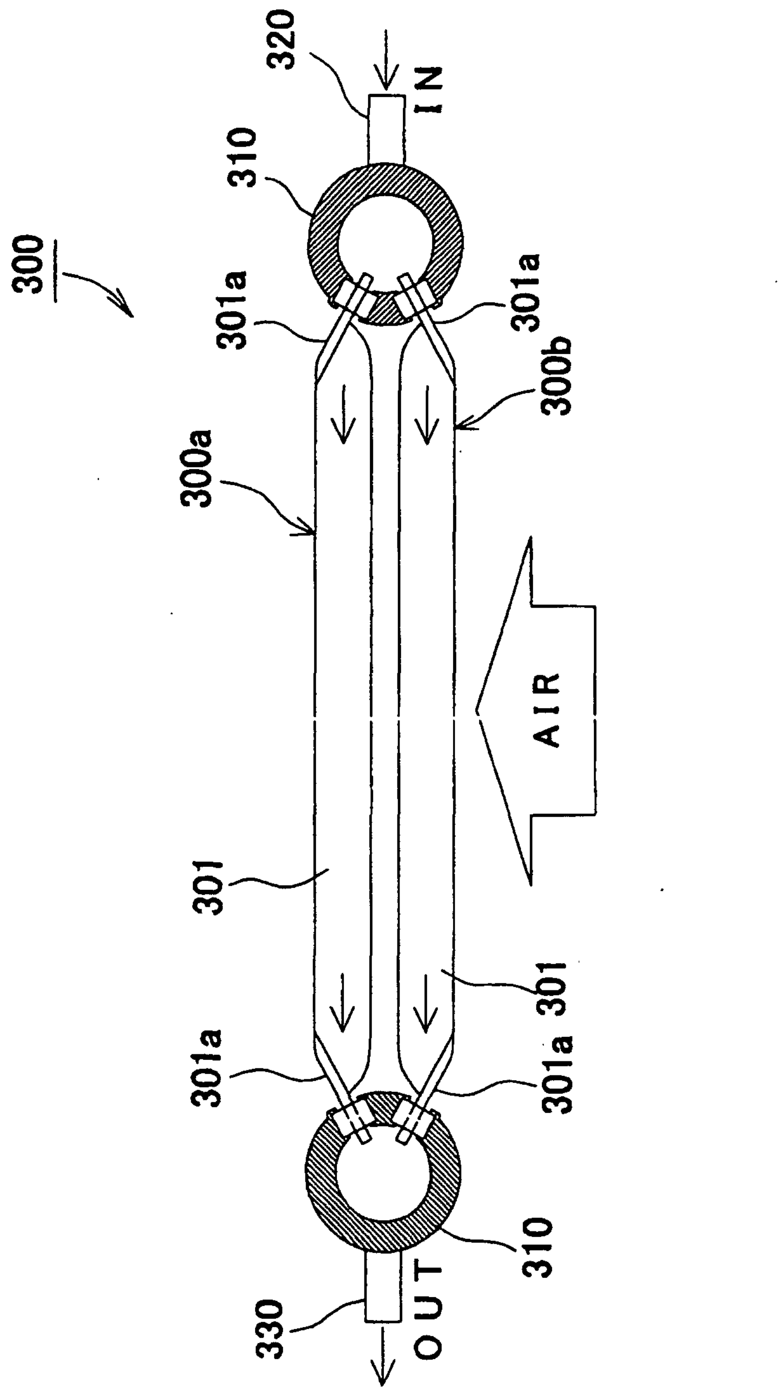

300
320
IN
310
301a
301a
300b
300a
AIR
301
301
301a
301a
310
330
OUT

FIG.32

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP02/08846

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] F28D1/053, F28F9/18

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] F28D1/053, F28F9/18

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Toroku Jitsuyo Shinan Koho	1994-2002
Kokai Jitsuyo Shinan Koho	1971-2002	Jitsuyo Shinan Toroku Koho	1996-2002

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	WO 00/06964 A (Ford-Werke AG), 10 February, 2000 (10.02.00), All pages & EP 1042641 A	1,3-6 2,7-22
Y	JP 10-288476 A (Sanden Corp.), 27 October, 1998 (27.10.98), All pages (Family: none)	2,21,22
Y	JP 2001-174191 A (Kabushiki Kaisha Zexel Vareo Kuraimeto Control), 29 June, 2001 (29.06.01), All pages (Family: none)	7-22

[X] Further documents are listed in the continuation of Box C.   [ ] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search 03 December, 2002 (03.12.02)	Date of mailing of the international search report 17 December, 2002 (17.12.02)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP02/08846

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 4-187991 A (Showa Aluminum Kabushiki Kaisha), 06 July, 1992 (06.07.92), All pages (Family: none)	10-22
Y	EP 0414433 A (Showa Aluminum Kabushiki Kaisha), 07 February, 1991 (07.02.91), All pages & JP 3-084395 A	9-22

Form PCT/ISA/210 (continuation of second sheet) (July 1998)