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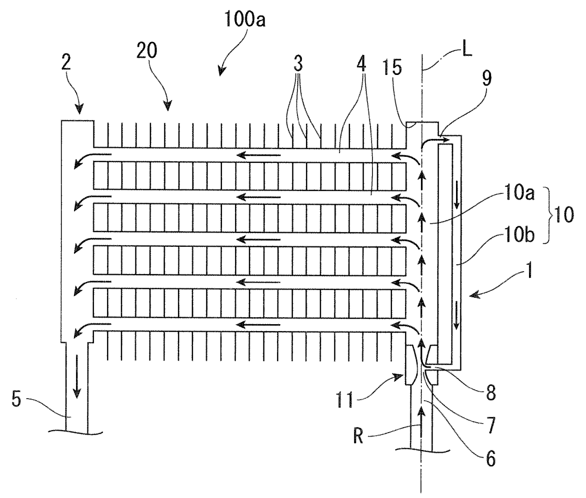
(54) HEAT EXCHANGER

(57) A heat exchanger (100a) includes a plurality of tubes (4), an entrance header (1) for distributing a refrigerant to the tubes (4), and an exit header (2) for collecting the refrigerant from the tubes (4). The entrance header (1) includes a circulating conduit (10) capable of circulating at least part of the refrigerant that has flowed into the entrance header (1), and the plurality of tubes (4) are fluidly connected to the outward channel (10a) of the circulating conduit (10). The entrance header (1) also includes an ejector 11 that uses the refrigerant flowing into the entrance header to draw and mix at least part of the refrigerant that has flowed into the entrance header and spray out the mixed refrigerant. The entrance header (1) can supply refrigerant more uniformly to the tubes (4) connected to the circulating conduit (10).

Fig. 2



EP 1 985 949 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a heat exchanger used in a freezer, refrigerator, or the like.

BACKGROUND ART

[0002] In a heat exchanger, to increase the heat exchange efficiency, it is important to distribute a heat exchange medium that has been supplied to a header uniformly to a plurality of heat exchange tubes. However, in a heat exchanger or in particular, in an evaporator, it is normal for the heat exchange medium (refrigerant) to be in a two-phase state including a gas phase and a liquid phase. This means that inside the header, the liquid phase component whose specific gravity is higher and is susceptible to the effect of gravity and the gas phase component whose specific gravity is lower and is less susceptible to the effect of gravity tend to separate, resulting in the distribution of refrigerant into the plurality of heat exchange tubes becoming non-uniform. This non-uniformity in the distribution of the heat exchange medium is especially noticeable when a heat exchanger is used in a posture where the header is vertical. For this reason, there is demand for a heat exchanger where the distribution of a heat exchange medium such as a refrigerant into tubes can be made more uniform.

[0003] To improve the non-uniformity of the distribution of refrigerant, a heat exchanger equipped with a distributor where a plurality of distribution tubes are bent in three dimensions in respectively different forms is known, such as the conventional art disclosed by Japanese Laid-Open Patent Publication No. 2004-317056. This publication discloses a heat exchanger where a plurality of distribution tubes are collectively disposed in part of an entrance header where the liquid refrigerant accumulates.

[0004] In a heat exchanger equipped with a distributor such as that disclosed in this publication, the plurality of distribution tubes need to have different forms and to be bent into complex three-dimensional forms. This means that more parts are needed and the manufacturing cost tends to be higher. In addition, since space is required to dispose the distribution tubes that are bent in three dimensions, there tends to be an increase in the size of the header and the heat exchanger.

[0005] In addition, the heat exchanger disclosed in this publication is equipped with a refrigerant distributing means that uses flat distribution tubes, the flat distribution tubes are concentrated in one part of the header, and in particular the lower part of the header where a liquid refrigerant tends to accumulate, and the liquid refrigerant is caused to flow into a heat exchanger part. With this construction, the state of the refrigerant at the entry to the plurality of flat distribution tubes is close to uniform, but since there are differences in the pressure drop between tubes due to differences in the lengths of the tubes, the distribution of refrigerant to the plurality of tubes will not necessarily become uniform. In addition, since a plurality of flat distribution tubes with curved parts are disposed in this construction, a heat exchanger with a simple construction cannot be provided.

[0006] Japanese Laid-Open Patent Publication No. 2000-249428 discloses an evaporator including an entrance header, an exit header, and a plurality of tubes that extend between both headers, with a plurality of wavy fins being provided between adjacent tubes. In this evaporator, a plurality of refrigerant sprayers are provided at the entrance to the entrance header. Each refrigerant sprayer has spray orifices. However, even if spray orifices are provided at the entrance to the entrance header as in the evaporator disclosed in this document, it will still be difficult to spray the refrigerant uniformly into the entire header, with the sprayed amount and distribution tending to be affected by the flow rate. It is also difficult to incorporate a construction, which is capable of producing a suitable distribution in accordance with the flow rate by adjusting the layout of the orifices, their orientation, and the protruding amount into the tubes, inside the header. It is also difficult to obtain a suitable distribution of refrigerant in response to fluctuations in conditions such as rises and falls in the flow rate, the orientation of the header, and the pressure inside the tubes.

SUMMRY OF THE INVENTION

[0007] A first aspect of the present invention is a heat exchanger that includes a plurality of tubes, an entrance header for distributing a heat exchange medium to the plurality of tubes, and an exit header for collecting the heat exchange medium from the plurality of tubes. The entrance header of this heat exchanger includes a circulating conduit that is capable of circulating at least part of the heat exchange medium that has flowed into the entrance header. The plurality of tubes are fluidly connected to at least part of the circulating conduit. The entrance header also includes a mechanism (pressure difference generating mechanism) that sprays the heat exchange medium in an axial direction of the circulating conduit to generate a pressure difference that forcibly circulates at least part of the heat exchange medium that has flowed into the entrance header in the circulating conduit.

[0008] According to this heat exchanger, at least part of the (existing, in-flowed) heat exchange medium that has already flowed into the entrance header (i.e., heat exchange medium already present inside the entrance header) is sprayed in the axial direction of the circulating conduit by the pressure difference generating mechanism and forcibly circulated inside the circulating conduit which is fluidly connected to the plurality of tubes. This means that the state of the heat exchange medium inside the circulating conduit of the input header can be made more uniform or close to uniform. For example, even when a two-phase heat exchange medium including a gas phase and a liquid phase has flowed into the header, it is possible to suppress separation of the heat exchange medium into a liquid phase component and a gas phase component inside the entrance header. This means that even if the entrance header is fairly long in the axial direction and a plurality of tubes are fluidly connected so as to be distributed in the axial direction of the entrance header, it will still be possible to distribute the heat exchange medium to the respective tubes in a more uniform state.

[0009] According to this heat exchanger, it may omit distributer having pipes bent in complex three dimensions. It may also omit machining that bends tubes complexly to make the distribution of the heat exchange medium more uniform. Note that the present heat exchanger does not exclude devices that have pipes and tubes laid out in three dimensions or bent by machining in three dimensions. According to the present heat exchanger, it is possible to make the phase state and amount of the heat exchange medium distributed to the tubes uniform or close to uniform using a simpler construction. This means that a heat exchanger with favorable heat exchanging efficiency can be provided at comparatively low cost.

[0010] One example of a pressure difference generating mechanism is driven by an external force such as a pump. In a cooling system or the like, the heat exchange medium that flows into the heat exchanger is reduced in pressure or expanded in advance. For a heat exchanger used in such a system, it is possible to drive the pressure difference generating mechanism using the energy of the heat exchange medium. Here, since a new driving source is not required aside from a driving source typically used in a heat exchanger, the heat exchanger is economical. That is, the pressure difference generating mechanism should preferably be driven by the heat exchange medium flowing into the entrance header. As the pressure difference generating mechanism, it is possible to use a construction such as a supercharger (a construction that resembles a supercharger) that rotates a turbine using the pressure of a driving part and forcibly draws in the heat exchange medium using a pressure difference generating part (a pressurizing part) such as a coaxial compressor.

[0011] A mechanism that draws at least part of the heat exchange medium that has already flowed into the entrance header using the heat exchange medium flowing into the entrance header and mixes and sprays out the heat exchange medium flowing into the entrance header and the heat exchange medium that has already flowed into the entrance header is preferable as the pressure difference generating mechanism. One example of this type of mechanism is an ejector, where there is a drop in pressure inside the nozzle when the heat exchange medium is sprayed out at high speed from the ejector nozzle (or orifice or throttle part). This pressure drop draws at least part of the heat exchange medium (existing heat exchange medium) that has flowed into the entrance header and mixes a heat exchange medium that is flowing into the entrance header and at least part of the heat exchange medium that has flowed into the entrance header to forcibly circulate at least part of the heat exchange medium that has flowed into the entrance header via the circulating conduit. The term "ejector" here includes a type that uses a pressure drop caused by spraying out the heat exchange medium from the nozzle to draw and mix the heat exchange medium already present in the entrance header.

[0012] At least part of the circulating conduit of the entrance header can be constructed by a double pipe or multi-hole pipe (a "multi-layer pipe" or "multi-channel pipe"). The pressure difference generating mechanism should preferably be provided at one end of the double pipe or multi-layer pipe and the respective pipes of the double pipe or multilayer pipe should preferably be fluidly connected at the other end. By doing so, it is possible to use at least part of the double pipe or multi-hole pipe as the circulating conduit.

[0013] The pressure difference generating mechanism may be provided separately from the entrance header and/or the heat exchanger. Accordingly, another aspect of the present invention is a heat exchanger that includes a plurality of tubes, an entrance header for distributing a heat exchange medium to the plurality of tubes, and an exit header for collecting the heat exchange medium from the plurality of tubes, wherein the entrance header includes a circulating conduit capable of circulating at least part of the heat exchange medium that has flowed into the entrance header, wherein the plurality of tubes are fluidly connected to at least part of the circulating conduit. Yet another aspect of the present invention is a header for distributing a heat exchange medium to a plurality of tubes. This header includes a circulating conduit capable of circulating at least part of the heat exchange medium that has flowed into the header, wherein the plurality of tubes are fluidly connected to at least part of the circulating conduit. This header may also include a pressure difference generating mechanism that is driven by the heat exchange medium flowing into the header. This pressure difference generating mechanism should preferably spray out the heat exchange medium in the axial direction of the circulating conduit from the pressure difference generating mechanism. It is also preferable for the pressure difference generating mechanism to be an ejector that uses the heat exchange medium flowing into the header to draw out and mix at least part of the (existing) heat exchange medium that has already flowed into the header and spray out the heat exchange medium into the circulating conduit.

[0014] The present invention also includes a heat exchange system that includes a heat exchanger according to the one of the aspects of the present invention and an apparatus (medium supplying system) that supplies the heat exchange medium to the heat exchanger. The meaning of the heat exchange system or system includes a cooling cycle or a freezing cycle and a freezer, refrigerator, air conditioner, storage device, showcase, or the like that includes such cycle. One of favorable systems as a cooling cycle or freezing cycle includes the heat exchanger according to one of the aspects of the present invention as an evaporator, an apparatus that pressurizes the heat exchange medium collected from the evaporator, and a condenser that cools the pressurized heat exchange medium.

[0015] The ejector also functions as an expansion means that lowers the pressure of a pressurized heat exchange medium and supplies the heat exchange medium to the evaporator. Accordingly, a heat exchanger where the entrance header includes a circulating conduit and an ejector for mixing at least part of the heat exchange medium that has already flowed into the entrance header using the heat exchange medium flowing into the entrance header and spraying the heat exchange medium into the circulating conduit is suited to a cycle and/or system that circulates a refrigerant as the heat exchange medium. In a system that includes the heat exchanger, expansion means that lowers the pressure of the pressurized heat exchange medium and supplies the heat exchange medium to the evaporator may be included or may be omitted from the medium supplying system.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

FIG. 1 schematically shows a heat exchange system including a heat exchanger.
FIG. 2 schematically shows a heat exchanger according to a first embodiment.
FIG. 3 schematically shows a heat exchanger according to a second embodiment.
FIG. 4 schematically shows part of a heat exchanger according to a third embodiment.
FIG. 5 schematically shows part of a heat exchanger according to a fourth embodiment.
FIG. 6 schematically shows a heat exchanger according to a fifth embodiment.
FIG. 7 shows an example equipped with a different type of ejector.
FIG. 8 schematically shows a heat exchanger according to a sixth embodiment.
FIG. 9 shows a cross-section of a header.
FIG. 10 is an exploded view of the construction of a header.

DETAILED EXPRESSION

[0017] FIG. 1 shows a system 50 that includes a heat exchanger. This system (heat exchange system) 50 may be an air conditioner, a freezer, or another type of system, and also includes a heat exchange cycle called a "refrigeration cycle" or "freezing cycle" and a system with such heat exchange cycle. For example, if the system 50 is an air conditioner system, the system (heat exchange system) 50 will exchange heat between a liquid heat exchange medium (hereinafter "refrigerant") R and an external flow (for example, outside air) F. The system 50 includes an evaporator 100 that cools the indoor air G by heat exchange with the refrigerant R and a condenser 200 that carries out heat exchange between the refrigerant R in a pressurized gas state and the external flow F to liquefy the refrigerant R.

[0018] Also, as a medium supplying system 55 that circulates the refrigerant R and supplies the refrigerant R to the evaporator 100, in addition to the condenser 200, the system 50 includes appliances such as a compressor 51 that pressurizes the refrigerant R, an accumulator 52 in which the refrigerant R temporarily accumulates, and an expansion valve 53 that allows the refrigerant R supplied to the evaporator 100 to expand. In this system 50, the refrigerant R inside the evaporator 100 circulates so as to flow out from a refrigerant outlet of the evaporator 100, pass through the accumulator 52, the compressor 51, the condenser 200, and the expansion valve 53 and then flow back into the evaporator 100 from the refrigerant inlet of the evaporator 100.

[0019] FIG. 2 shows a heat exchanger 100a according to a first embodiment of the present invention. This heat exchanger 100a can be used as the evaporator 100 of the system 50. The heat exchanger 100a includes an entrance header 1 that includes a refrigerant inlet 6, an exit header 2 that includes a refrigerant outlet 5, and a heat exchanging part 20. The entrance header 1 and the exit header 2 both extend in the up-down direction (vertical direction) and are disposed so as to be parallel to one another. The heat exchanging part 20 exchanges heat between the refrigerant R and the air G or the like so as to cool the air G or the like. The heat exchanging part 20 includes a plurality of tubes 4, which are disposed in parallel in the horizontal direction so as to fluidly connect the entrance header 1 and the exit header 2, and fins 3, which extend in the up-down direction so as to be perpendicular to the tubes 4.

[0020] A typical example of the tubes 4 are tubes that are circular in cross-section, but the tubes may be flat tubes that are flattened in cross-section, and may also be multi-hole tubes (multi-channeled flat tubes) where the inside of a tube is subdivided into a plurality of sections. A typical example of the fins 3 is a plurality of plate-type fins that are disposed in parallel to one another and are attached with the tubes 4 passing therethrough. The fins 3 may be corrugated fins that connect and undulate between the tubes 4 or may project outward from the tubes 4 in the form of fins or pins.

[0021] The entrance header 1 functions as a distributor for distributing the refrigerant R to the plurality of tubes 4 of the heat exchanging part 20. The exit header 2 functions so as to collect the refrigerant R from the respective tubes 4. Each tube 4 is fluidly connected to the entrance header 1 at one end and to the exit header 2 at the other end. By using flat tubes as the plurality of tubes 4, the heat exchange area provided by the tubes themselves can be increased, and by further providing the fins 3, the heat exchange area (i.e., the contact area) with the gas G or the like can be further increased, thereby improving the heat exchange efficiency. To avoid the effects of icing, frost formation, and the like, fins may not be provided or the area occupied by the fins may be reduced.

[0022] The entrance header 1 includes a circulating conduit 10, which forcibly circulates at least part of the refrigerant R that has flowed into the entrance header 1, and a pressure difference generating mechanism 11. The circulating conduit 10 includes a straight outward channel 10a and a substantially U-shaped return channel 10b that connects one end of the outward channel 10a to the other end. The outward channel 10a guides the refrigerant R from the refrigerant inlet 6 at the one end thereof to the opposite end. The return channel 10b conversely guides the refrigerant R to the refrigerant inlet 6 from the opposite end of the outward channel 10a. Accordingly, the circulating conduit 10 including the outward channel 10a and the return channel 10b can circulate at least part of the refrigerant (in-flowed or existing refrigerant) R that flows into the entrance header 1.

[0023] The pressure difference generating mechanism 11 is an ejector that includes a throttle part (throat part) 7 and a drawing part (inlet part) 8, and is provided near the refrigerant inlet 6 of the entrance header 1. The return channel 10b of the circulating conduit 10 is provided so as to fluidly connect (i) the periphery of the inner end (i.e., the upper end) 15 that is the opposite end of the entrance header 1 to the refrigerant inlet 6 and (ii) the drawing part 8 of the pressure difference generating mechanism 11. Accordingly, the pressure difference generating mechanism 11 is driven by the refrigerant (inflowing refrigerant) R flowing into the entrance header 1, with at least part of the refrigerant R that has already flowed into the entrance header 1 (i.e., existing refrigerant R) being drawn out, mixed and ejected into the outward channel 10a. In the entrance header 1 of the heat exchanger 100a, the plurality of tubes 4 are fluidly connected to the outward channel 10a that is part of the circulating conduit 10. That is, the plurality of tubes 4 are fluidly connected at substantially equal intervals between (i) a drawing channel 9 where the return channel 10b branches off in the circulating conduit 10 and (ii) the pressure difference generating mechanism 11.

[0024] In the heat exchanger 100a that is used as an evaporator in the heat exchange system 50, due to the action of the accumulator 52, the compressor 51, the expansion valve 53, and the like, a two-phase refrigerant R in which gas phase and liquid phase are mixed are supplied via the refrigerant inlet 6 to the entrance header 1 and passes the throat part 7 of the drawing part 8. When the refrigerant R flows into the entrance header 1 at high speed via the throat part 7, there is a decrease in pressure inside the throat part 7. Due to this reduction in pressure, at least part of the (existing) refrigerant R that has flowed into the entrance header 1 is drawn through the drawing part 8 via the return channel 10b. After this, the refrigerant R that is flowing into the entrance header 1 and at least part of the refrigerant R that has already flowed into the entrance header 1 are mixed, and as shown by the arrow in FIG. 2, the mixed refrigerant R is sprayed from the pressure difference generating mechanism 11 inside the entrance header 1 in the direction of the axis L of the circulating conduit 10. Next, at least part of such mixed refrigerant R returns to the drawing part 8 via the outward channel 10a and the return channel 10b and becomes the existing or in-flowed refrigerant. This means that at least part of the refrigerant R is forcibly circulated inside the header 1 and by doing so, the state of the refrigerant R can be made homogeneous, even in a pipe-shaped entrance header 1 with a long axis. That is, by applying a pressure difference so that the refrigerant R is forcibly circulated inside the header 1, a situation where the liquid phase and the gas phase become separated due to a difference in head in a static state can be prevented from the outset.

[0025] In this heat exchanger 100a, the plurality of tubes 4 are connected at substantially equal intervals in a center part of the outward channel 10a in which the refrigerant R flows upward from the bottom. Part of the refrigerant R is distributed from the entrance header 1 to the respective tubes 4 and the state of the refrigerant R distributed to the respective tubes 4 can be made uniform. Also, since the state of the refrigerant R in the outward channel 10a includes a mixture of gas phase and liquid phase in a homogenized state, the amount of refrigerant R distributed to the respective tubes 4 is also made more uniform.

[0026] The refrigerant R that is uniformly distributed to the tubes 4 in this way is subjected to heat exchange with the air G via the plurality of tubes 4 and the plurality of fins 3, is outputted to the exit header 2, and flows out into the system 50 from the refrigerant outlet 5. Accordingly, the heat exchange load of the respective tubes 4 is made uniform, resulting in a heat exchanger 100a with favorable heat exchange efficiency. In addition, there is no need to provide a plurality of distribution pipes bent into different shapes in two or three dimensions in order to uniformly distribute the refrigerant into the respective tubes, and it is therefore possible to provide a heat exchanger with a simple and compact construction and favorable heat exchange efficiency at comparatively low cost. Since it is also possible to produce the respective tubes 4 with the same shape, it is possible to avoid the generation of differences in pressure drop between the respective tubes 4, which also improves the heat exchange efficiency.

[0027] Also, according to the heat exchanger 100a, it is possible to prevent separation into phases due to a head difference in the entrance header 1. This means that the orientation (layout) of the entrance header 1 of the heat exchanger 100a becomes freer. The heat exchanger 100a may be used in a posture where the entrance header 1 is disposed horizontally and may be used in a posture where the entrance header 1 is disposed vertically. In addition, when the heat exchanger 100a is used with the entrance header 1 disposed vertically, the refrigerant R may flow in from the bottom of the entrance header 1 or may flow in from the top of the entrance header 1. In addition, aside from these postures, it is possible to use the heat exchanger 100a in a variety of postures including cases where the entrance header 1 is disposed diagonally, with it being possible to uniformly distribute the refrigerant R to the plurality of tubes 4 when the heat exchanger 100a is used in such postures.

[0028] In addition, since it is easy to miniaturize the heat exchanger 100a, a cooling system 50 that is equipped with the heat exchanger 100a can use a compact arrangement. In addition, since the heat exchanger 100a uses the pressure difference generating mechanism 11 that utilizes an ejector effect, it is not necessary to use a driving means that is typically used in a heat exchanger, for example, a driving means aside from the compressor 51. The heat exchanger is therefore economical. In addition, by assigning part of the pressure loss due to the expansion valve 53 to the ejector 11 that is a pressure difference generating mechanism, it is possible to improve the heat exchange efficiency without negatively affecting the economy of the system 50. Also, if there is sufficient expansion (i.e., pressure loss) due to the ejector 11, it is possible to omit the expansion valve 53.

[0029] FIG. 3 shows a heat exchanger 100b according to a second embodiment of the present invention. This heat exchanger 100b can also be used as the evaporator 100 of the heat exchange system 50 described above. In the heat exchanger 100b, a plurality of tubes 4 are connected at substantially equal intervals to the return channel 10b of the circulating conduit 10 of the entrance header 1. In the circulating conduit 10 in which at least part of the in-flowed refrigerant R is forcibly circulated, the state of the refrigerant R becomes substantially uniformly mixed phase in not only the outward channel 10a but also the return channel 10b. Accordingly, it is possible to distribute the refrigerant R substantially uniformly to the respective tubes 4 when the tubes 4 are fluidly connected to the return channel 10b. In addition, at a position that is somewhat distant from the throat part 7, for example, at the return channel 10b, the phase state of the refrigerant R mixed by suction tends to be more stable or uniform than at a position immediately after the throat part 7 of the ejector 11. In the heat exchanger 100b, since the tubes 4 are fluidly connected to the return channel 10b, the ejector 11 that includes the throat part 7 and the tubes 4 are separated. Accordingly, it is possible to distribute the refrigerant R with more stabilized phase state to the tubes 4.

[0030] FIG. 4 shows a heat exchanger 100c according to a third embodiment of the present invention. This heat exchanger 100c can also be used as the evaporator 100 of the heat exchange system 50 described above. In the heat exchanger 100c, the entrance header 1 includes a U-shaped tube that includes two straight parts, with such straight parts being fluidly connected at the open end of the U shape by the drawing channel 9. The entrance header 1 includes a circulating conduit (circulating pathway) 10 and both the outward channel 10a and the return channel 10b of the circulating conduit 10 are fluidly connected to the plurality of tubes 4. Accordingly, it is possible to supply the refrigerant R in a substantially uniform state to the plurality of tubes 4 that are aligned in two columns along the outward channel 10a and the return channel 10b. According to the heat exchanger 100c, it is possible to further increase the heat exchange efficiency of the heat exchanging part 20 without changing the surface area (projected area) of the heat exchanging part 20 on a plane.

[0031] FIG. 5 shows a heat exchanger 100d according to a fourth embodiment of the present invention. This heat exchanger 100d includes two heat exchangers 20a and 20b and can be used as the evaporator 100 of the heat exchange system 50 described above. This heat exchanger 100d is provided with an entrance header 1 that is shared by or common to the heat exchangers 20a and 20b, the plurality of tubes 4 of one of the heat exchangers (the heat exchanging part 20a) are connected to the outward channel 10a of the circulating conduit 10 of the header 1, and the plurality of tubes 4 of the other heat exchanger (the heat exchanging part 20b) are connected to the return channel 10b. The refrigerant R can be equally distributed to the tubes 4 of a plurality of heat exchanger parts 20a and 20b using a single entrance header 1. Here, the number of heat exchanger parts that can be connected to a single entrance header may be three or higher.

[0032] FIG. 6 shows a heat exchanger 100e according to a fifth embodiment of the present invention. This heat exchanger 100e can also be used as the evaporator 100 of the heat exchange system 50 described above. The entrance header 1 of this heat exchanger 100e includes a double pipe 12 and the pressure difference generating mechanism (ejector) 11 is provided at the bottom end of the double pipe 12. An inner pipe 12a and the outer pipe 12b of the double pipe 12 are fluidly connected to one another at the upper end of the double pipe 12. In this entrance header 1, the ejector 11 is installed so as to eject the refrigerant R in the axial direction of the inner pipe 12a located on the inside of the double pipe 12. Accordingly, the inner pipe 12a of the double pipe 12 constructs the outward channel and the outer pipe 12b forms the return channel, with the circulating conduit 10 being constructed of these channels. The plurality of tubes 4 are fluidly connected to the outer pipe 12 that is the return channel. In this heat exchanger 100a, since the circulating conduit 10 is included in the inside of a single pipe, it is possible to provide a heat exchanger that is even more compact and has a simple external appearance. The circulating conduit 10 integrating like a single pipe is not limited to a double pipe and it is possible to use a multi-channel pipe (a multi-hole pipe) where a suitable number of partitions are provided on the inside of the pipe.

[0033] FIG. 7 shows a different example of the pressure difference generating mechanism 11. The pressure difference generating mechanism 11 in the respective embodiments described above is an ejector where the drawing part 8 is provided at the throttle or throat part 7 of a venturi tube. On the other hand, the pressure difference generating mechanism 11 shown in FIG. 7 is an atomizer-type ejector. The pressure difference generating mechanism 11 includes a suction nozzle 17 provided on the refrigerant inlet 6 of the header 1 for producing a pressure difference and lowering the pressure by the refrigerant flowing in to draw the existing or in-flowed refrigerant R that has flowed into the header 1 and to spray the refrigerant R mixed of in-flowing and in-flowed in the axial direction of the circulating conduit. A suction hole 18 for drawing the existing refrigerant R that has already flowed into the header 1 from the return channel 10b is provided in the periphery of the suction nozzle 17 of the outward channel 10a. Due to the pressure drop caused by the refrigerant R flowing in and spraying out from the suction nozzle 17, the refrigerant R that has flowed into the header 1 is drawn into the outward channel 10a and is going out with the sprayed one in the axial direction of the outward channel 10a. The refrigerant R is forcibly circulated in the circulating conduit 10 that constructs the entrance header 1 by the pressure difference generating mechanism 11.

[0034] FIG. 8, FIG. 9, and FIG. 10 show the construction of a heat exchanger 100f, focusing on the periphery of the entrance header 1, according to a sixth embodiment of the present invention. This heat exchanger 100f can also be used as the evaporator 100 of the heat exchange system 50 described above. The entrance header 1 of the heat exchanger 100f includes a double pipe 12 that includes an inner pipe 12a and an outer pipe 12b, with the inner pipe 12a and the outer pipe 12b being fluidly connected at the top part of the header 1. In more detail, the outer pipe 12b is composed of two members 13a and 13b that are semicircular in cross-section and are formed by extrusion and machining. A plurality of flat tubes 14 are attached to the inside (exchanger side) member 13b and these flat tubes 14 are connected to an exit header (not shown). The inner pipe 12a is constructed by attaching a member 15 that is semicircular in cross section to the outside member 13a. Both ends of the two members 13a and 13b that construct the outer pipe 12b are covered by caps 16. The nozzle 17 is attached to the bottom end of the inner pipe 12a and sprays the refrigerant R flowing into the header 1 inside the inner pipe 12a. This nozzle 17 forms the pressure difference generating mechanism 11, and due to the spray force of the refrigerant R sprayed out from the bottom toward the top of the inner pipe 12a, the existing refrigerant R (that has already flowed in) is drawn into the inner pipe 12a from the outer pipe 12b via the gap 18 at the bottom of the inner pipe 12a.

[0035] In this heat exchanger 100f, the header 1 is equipped with the circulating conduit 10 that includes the inner pipe 12a and the outer pipe 12b and is connected to the tubes 14, and the refrigerant R is forcibly circulated in the circulating conduit 10. It is possible to provide a heat exchanger with high heat exchange efficiency where the state of the refrigerant R inside the header 1 can be made more uniform.

[0036] Although examples of heat exchangers that are used in a posture where the headers are disposed vertically are described above in the first to sixth embodiments, it is also possible to use the heat exchangers in a posture where the headers are disposed horizontally.

[0037] Also, although the first to sixth embodiments described above include a circulating means equipped with a pressure difference generating mechanism driven by the heat exchange medium that flows into the header and a circulating conduit for circulating at least part of the heat exchange medium that has flowed into the header, the circulating means is not limited to this. Any type of circulating means to forcibly circulate part of the existing or in-flowed heat exchange medium (i.e., refrigerant) that has flowed into the header is applicable.

[0038] A pressure difference generating mechanism equipped with an ejector nozzle (orifice/throttle part) is a favorable example of the present invention, and by providing such mechanism in the periphery of the refrigerant inlet of the header, it is possible to draw and mix at least part of the refrigerant that has flowed into the entrance header using the refrigerant that is flowing into the entrance header and spray out the refrigerant that has been mixed into the header. Accordingly, this is suited to a cycle where the inner pressure of the heat exchanger is set low and the refrigerant is circulated as described above, and to a system that includes such cycle.

[0039] One of other examples of a pressure difference generating mechanism driven by refrigerant that has flowed into the header is a supercharger that rotates a turbine using the pressure of a driving part and forcibly draws the heat exchange medium using a pressure difference generating part (a pressurizing part) such as a coaxial compressor. In a construction that resembles a supercharger, the driving part and the pressure difference generating part (pressurizing part) are separated and are mechanically connected. In addition, it is possible to use a pressure difference generating mechanism such as a pump that is driven by a separate driving force. That is, the pressure difference generating mechanism may be a mechanism that pumps the refrigerant circulating inside the entrance header without mixing such refrigerant with the refrigerant flowing into the entrance header. Since a pressure difference generating mechanism like a pump forcibly circulates the existing refrigerant inside the entrance header by pressurizing the existing refrigerant, such pressure difference generating mechanism does not need to be provided near the refrigerant inlet of the header. This type of pressure difference generating mechanism may be provided midway in the circulating conduit, for example, in a conduit, out of the outward channel and the return channel, that is not connected to the header, in a connecting path that connects such for such channels, or the like. It is also possible to use a mechanism that can detachably attach the pressure difference generating mechanism to the circulating conduit of the header.

[0040] In addition, by additionally providing conduits that function as the outward channel and the return channel and a suitable pressure difference generating mechanism in a header of a type where refrigerant is not circulated, it is possible to construct a heat exchanger or a heat exchange system that is similar to the embodiments of the present invention.

[0041] Although examples of heat exchangers where the heat exchanger part is equipped with plate-type fins have been described in the above embodiments, the shape of the fins is not limited to plate-like shapes. Also, the heat exchanger part only needs to be able to carry out heat exchange between the refrigerant (heat exchange medium) and an external flow such as air, and the form and construction of the heat exchanger part are not limited to the examples above.

[0042] Also, the system according to the present invention is not limited to air conditioning and applicable to apparatuses and systems that include any out of a variety of heat exchanging functions, such as a radiator, various types of cooling apparatuses, and various types of freezers.

Claims

1. A heat exchanger comprising:

a plurality of tubes;
an entrance header for distributing a heat exchange medium to the plurality of tubes; and
an exit header for collecting the heat exchange medium from the plurality of tubes,
wherein the entrance header includes:
a circulating conduit that is capable of circulating at least part of the heat exchange medium that has flowed into the entrance header, the plurality of tubes being fluidly connected to at least part of the circulating conduit; and
a pressure difference generating mechanism that sprays the heat exchange medium in an axial direction of the circulating conduit to forcibly circulate at least part of the heat exchange medium that has flowed into the entrance header in the circulating conduit.

2. The heat exchanger according to claim 1, wherein the pressure difference generating mechanism is driven by the heat exchange medium flowing into the entrance header.

3. The heat exchanger according to claim 1, wherein the pressure difference generating mechanism is a mechanism for drawing, mixing, and spraying out at least part of the heat exchange medium that has flowed into the entrance header using the heat exchange medium flowing into the entrance header.

4. The heat exchanger according to claim 1, wherein the entrance header includes a double pipe or multi-layer pipe that constructs at least part of the circulating conduit, the pressure difference generating mechanism is provided at one end of the double pipe or multilayer pipe, and the respective pipes of the double pipe or multilayer pipe are fluidly connected at the other end.

5. A system comprising:

a heat exchanger according to claim 1; and
a medium supplying system that supplies the heat exchange medium to the heat exchanger.

6. A system according to claim 5, wherein the medium supplying system includes an apparatus that pressurizes the heat exchange medium collected from the heat exchanger and a condenser that cools the pressurized heat exchange medium.

7. A heat exchanger comprising:

a plurality of tubes;
an entrance header for distributing a heat exchange medium to the plurality of tubes; and
an exit header for collecting the heat exchange medium from the plurality of tubes,
wherein the entrance header includes a circulating conduit capable of circulating at least part of the heat exchange medium that has flowed into the entrance header, the plurality of tubes being fluidly connected to at least part of the circulating conduit.

8. A heat exchanger comprising:

a plurality of tubes;
an entrance header for distributing a heat exchange medium to the plurality of tubes; and
an exit header for collecting the heat exchange medium from the plurality of tubes,
wherein the entrance header includes:
a circulating conduit capable of circulating at least part of the heat exchange medium that has flowed into the entrance header, the plurality of tubes being fluidly connected to at least part of the circulating conduit; and
an ejector that draws and mixes at least part of

the heat exchange medium that has flowed into the entrance header using the heat exchange medium flowing into the entrance header and sprays out the heat exchange medium into the circulating conduit.

9. A heat exchange system comprising:

a heat exchanger according to claim 8; and
a medium supplying system that supplies the heat exchange medium to the heat exchanger as an evaporator,
wherein the medium supplying system includes an apparatus that pressurizes the heat exchange medium collected from the evaporator and a condenser that cools the pressurized heat exchange medium.

10. A header for distributing a heat exchange medium to a plurality of tubes, wherein the header includes a circulating conduit capable of circulating at least part of the heat exchange medium that has flowed into the header, wherein the plurality of tubes are fluidly connected to at least part of the circulating conduit.

11. The header according to claim 10, further comprising a mechanism that uses the heat exchange medium flowing into the header to produce a pressure difference for spraying out the heat exchange medium, which includes at least part of the heat exchange medium that has flowed into the header, in the axial direction of the circulating conduit.

12. The header according to claim 10, further comprising an ejector that uses the heat exchange medium flowing into the header to draw and mix at least part of the heat exchange medium that has flowed into the header and spray out the heat exchange medium into the circulating conduit.

Fig. 1

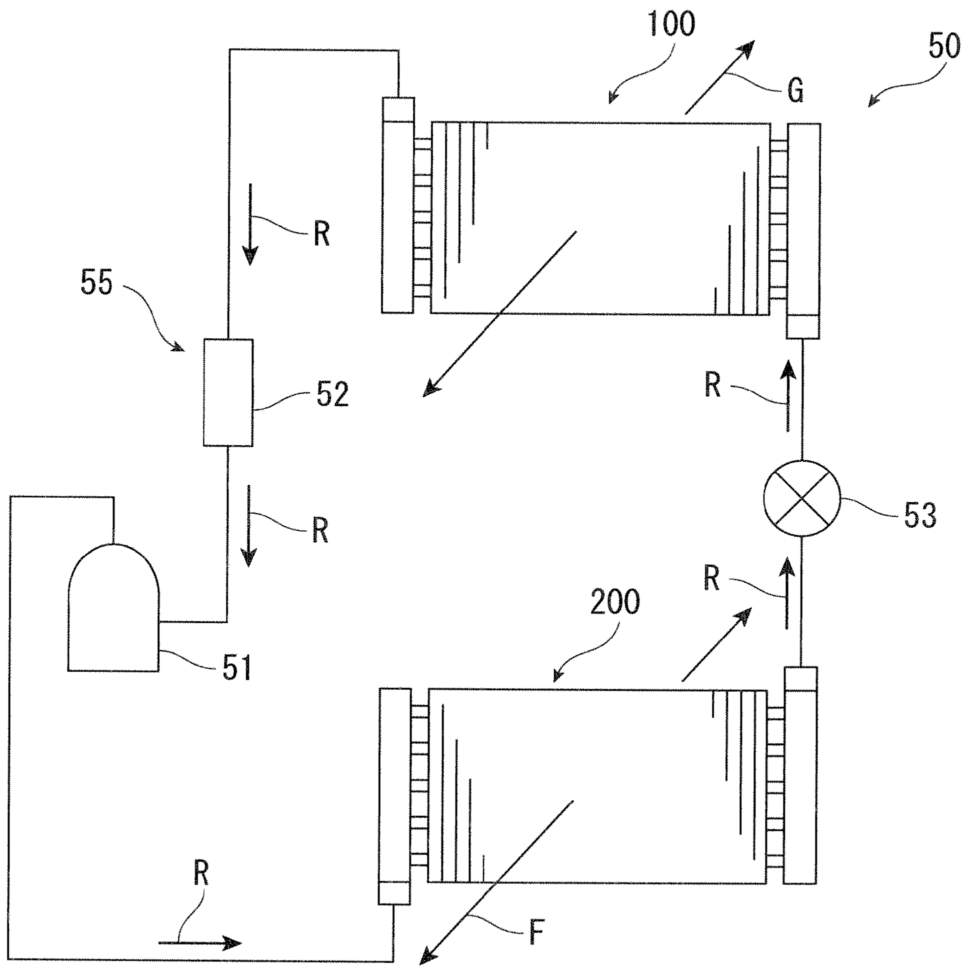


Fig. 2

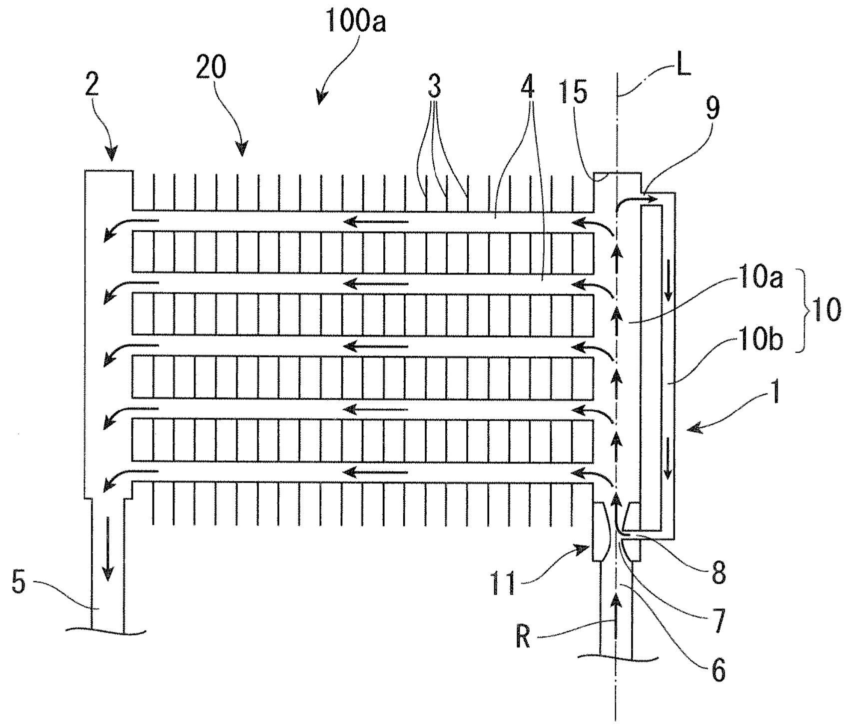

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Fig. 3

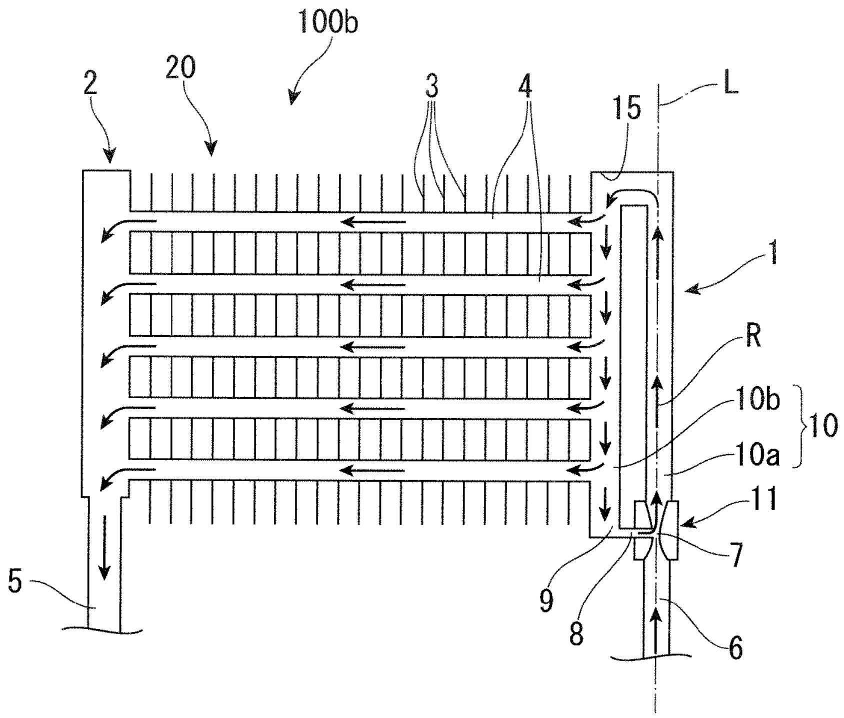
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Fig. 4

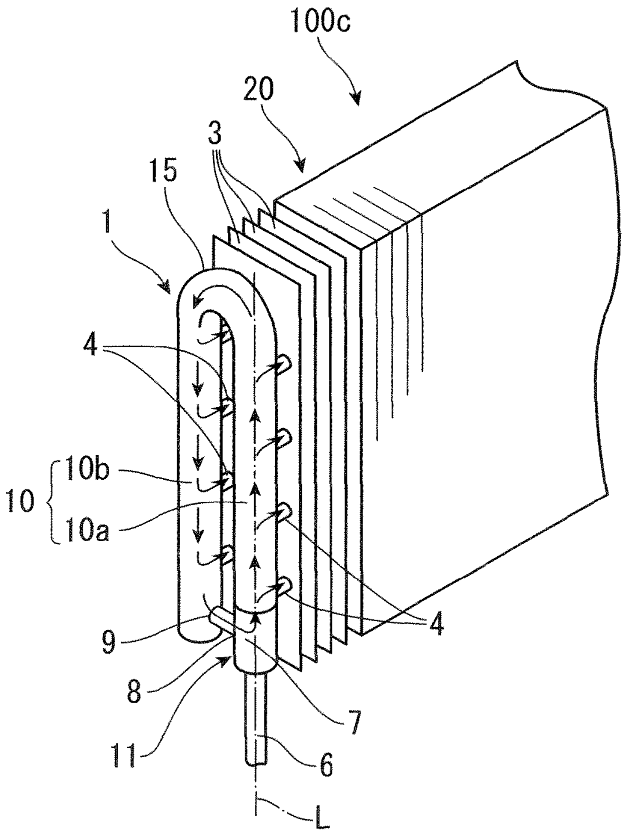
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Fig. 5

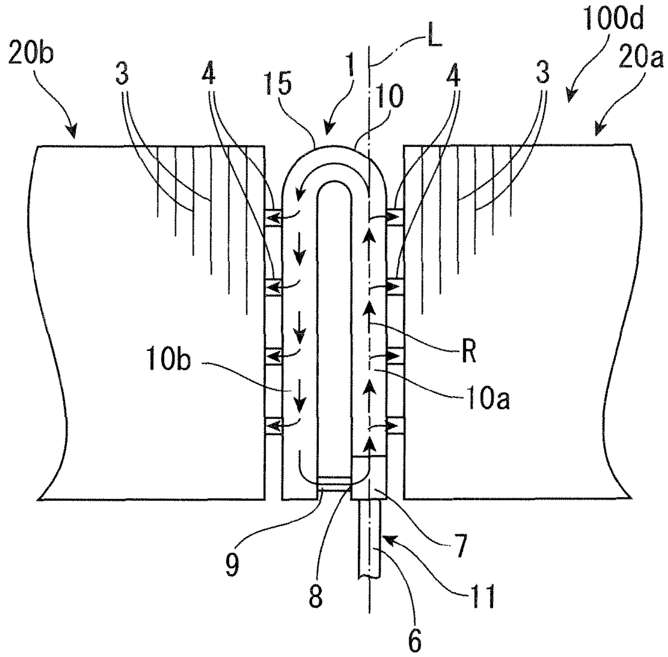
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Fig. 6

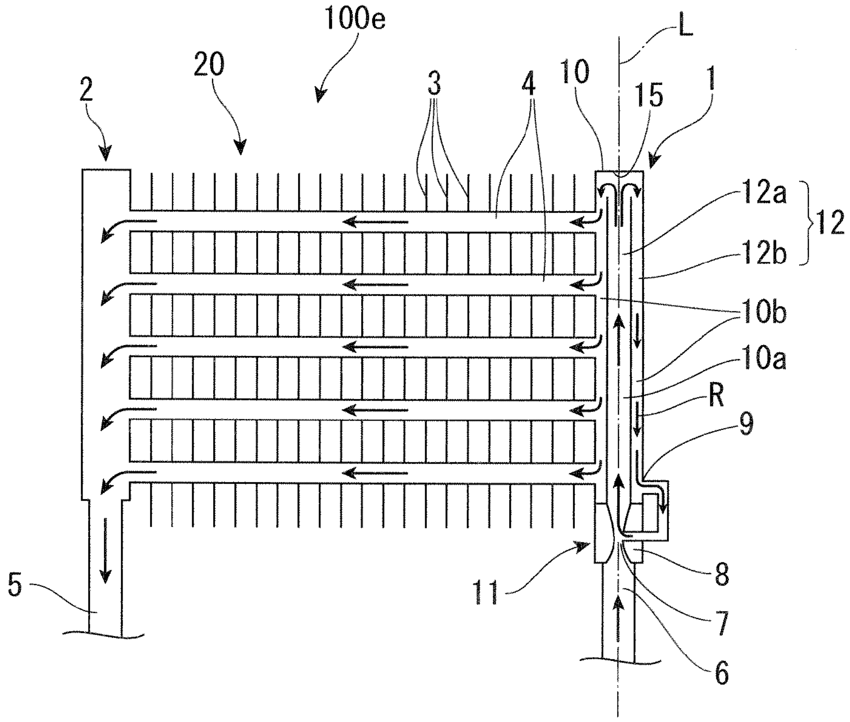
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Fig. 7

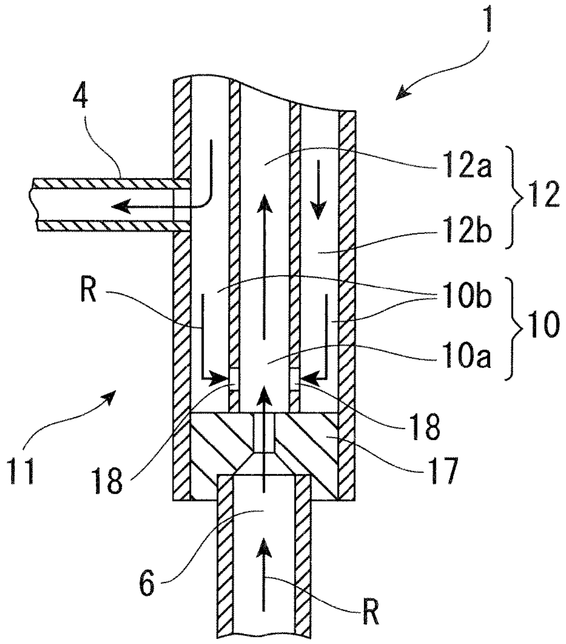
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Fig. 8

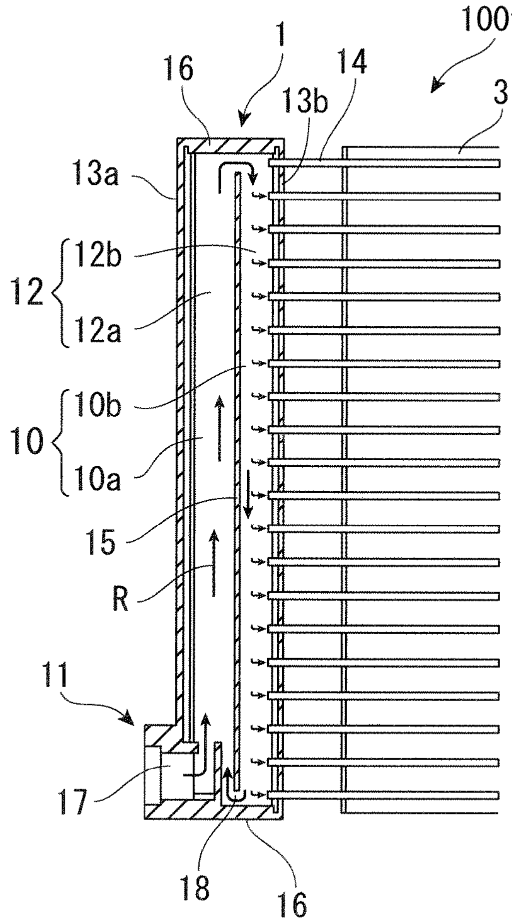
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Fig. 9

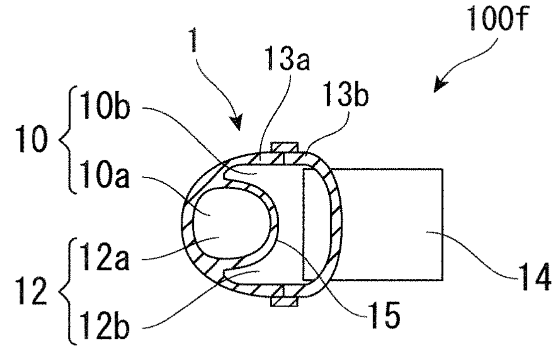
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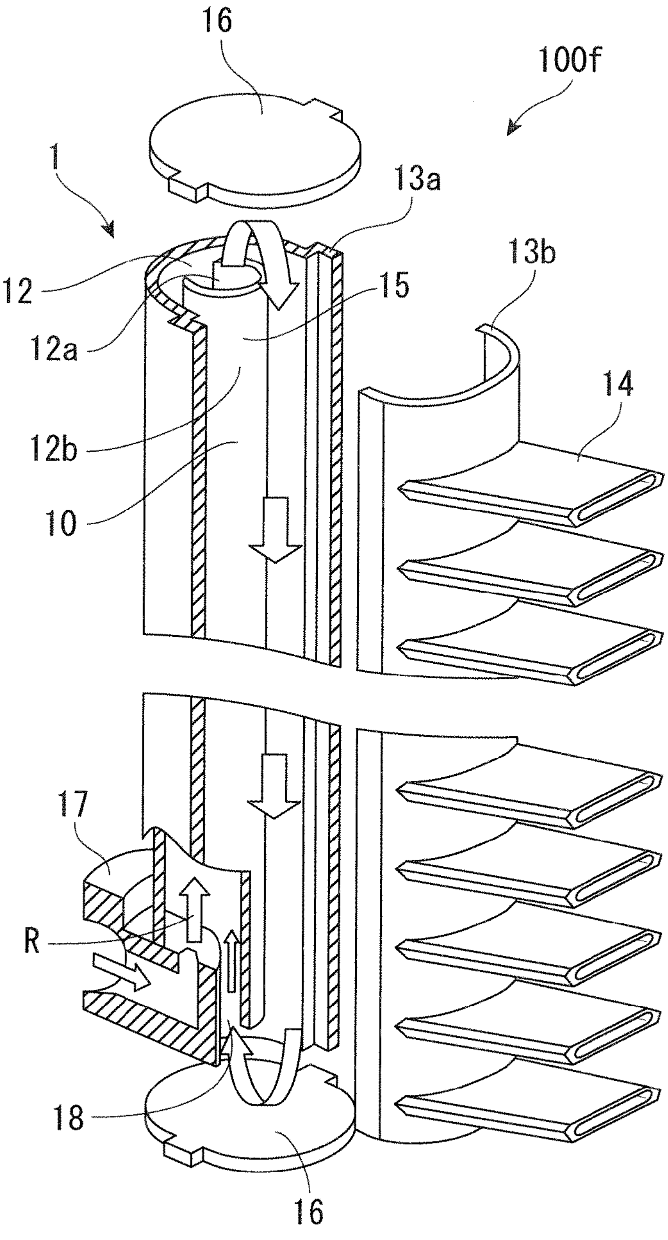
Fig. 10



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/052760

A. CLASSIFICATION OF SUBJECT MATTER
F25B39/02(2006.01)i, *F25B1/00*(2006.01)i, *F25B41/00*(2006.01)i

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)
F25B39/02, F25B1/00, F25B41/00

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2007
Kokai Jitsuyo Shinan Koho	1971-2007	Toroku Jitsuyo Shinan Koho	1994-2007

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.
Y	JP 2004-317056 A (Denso Corp.), 11 November, 2004 (11.11.04), Fig. 2 (Family: none)	1-12
Y	JP 11-337293 A (Showa Aluminum Corp.), 10 December, 1999 (10.12.99), Par. Nos. [0014] to [0017]; Fig. 1 (Family: none)	1-12
Y	JP 9-10817 A (Kawasaki Steel Corp.), 14 January, 1997 (14.01.97), Fig. 5 (Family: none)	4

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
02 April, 2007 (02.04.07)	10 April, 2007 (10.04.07)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/052760

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 5-84508 A (Kawasaki Steel Corp.), 06 April, 1993 (06.04.93), Fig. 2 (Family: none)	4
Y	JP 6-137695 A (Nippondenso Co., Ltd.), 20 May, 1994 (20.05.94), Figs. 6, 7 (Family: none)	8,9,12
A	JP 2005-308384 A (Denso Corp.), 04 November, 2005 (04.11.05), Fig. 3	1-12

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REFERENCES CITED IN THE DESCRIPTION

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- JP 2004317056 A **[0003]**
- JP 2000249428 A **[0006]**