A distributor able to evenly supply influent two-phase refrigerant flowing in by various flow states to different pipes with an extremely small pressure loss, that is, a distributor of a gas-liquid two-phase fluid distributing a gas-liquid two-phase fluid flowing in from an inlet pipe into a plurality of distribution pipes, provided with a cylindrical vessel with a cylindrical upper part, an inlet pipe connected in a tangential direction with respect to a circular cross section of the upper portion of the cylindrical vessel, and distribution pipes connected to a lower portion of the cylindrical vessel.

**ABSTRACT**

DISTRIBUTOR OF A GAS-LIQUID TWO PHASE FLUID

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Fig. 1

(a) TWO PHASE REFRIGERANT

(b) TWO PHASE REFRIGERANT

Fig. 2
DISTRIBUTOR OF A GAS-LIQUID TWO PHASE FLUID

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention
[0002] The present invention relates to a distributor provided in a refrigerant circuit of an air conditioning system or the like and distributing a two-phase refrigerant to a plurality of heat exchangers and the like, more particularly relates to structure uniformly dividing a two-phase refrigerant of a uniform mixing ratio.

[0003] 2. Description of the Related Art
[0004] In the past, as shown in FIG. 4, there has been proposed a refrigeration cycle 100 connecting a refrigerant compressor 102, refrigerant condenser 103, ejector 104, first refrigerant evaporator 113 of an indoor heat exchanger 105, and a gas-liquid separator 106 successively in a ring by refrigerant piping 107 and connecting a liquid phase refrigerant side of the gas-liquid separator 106 and a suction part 108 of the ejector 104 by bypass piping 109 provided with a second refrigerant evaporator 114 of the indoor heat exchanger 105 (Japanese Patent No. 3265649).

[0005] Here, the ejector 4, as shown in FIG. 5, is attached to the side surface of the indoor heat exchanger 105. The ejector 4, as shown in FIG. 6, ejects a liquid phase refrigerant condensed and liquefied by the refrigerant condenser 103, whereby the gas phase refrigerant is sucked in by the suction part 108, the liquid phase refrigerant and gas phase refrigerant are mixed and raised in pressure in a diffuser 111, then the refrigerant of the gas-liquid two-phase state (below, referred to as “two-phase refrigerant”) is sent via a distributor 112 to a first refrigerant evaporator 113. The distributor 112, as shown in FIGS. 1 and 2, is a pipe evenly distributing the refrigerant of the gas-liquid two-phase state flowing out from the ejector 104 to the plurality of tubes of the first refrigerant evaporator 113.

[0006] The role of the distributor 112 is to evenly supply two-phase refrigerant flowing in by various flow states (slag flow, mist flow, annular flow, and the like) to the pipes. However, the refrigerant ejected by the nozzle 110 flows affected by the gas-liquid ratio and flow rate. Refrigerant with a large liquid phase runs through the lower distribution pipe 112a due to the effect of gravity, while refrigerant with a large gas phase runs through the upper distribution pipe 112b. Due to this, the distributor 112 cannot completely fulfill its role.

[0007] Further, pressure loss occurs downstream of the ejector, the pressure boosting effect by the ejector is diminished. Consequently, pressure loss downstream of the ejector should be avoided as much as possible. Despite this, since the refrigerant directly flows from the diffuser 111 to the distribution pipe 112, it changes to a direction in which the channel cross-sectional area is greatly reduced. Due to this throttling effect, pressure loss occurs. Note that, as widely known, in an expansion valve cycle, compared with the ejector cycle, the amount of pressure loss at the distributor portion is adjusted by the amount of throttling of the expansion valve, so the effect of the pressure loss is small.

[0008] On the other hand, as distributors of two-phase refrigerants, there are the ones disclosed in Japanese Patent Publication (A) No. 6-201225 and No. 5-340648, but these had energy loss since they lifted the liquid upward for transport after gas-liquid separation. Further, these required a downstream side circular upper surface having a diameter larger than the diameter of the swirl part and gently inclined conical surface for holding the liquid film, so became extremely large impractical vessels. Both were imperfect for performing their functions.

SUMMARY OF THE INVENTION

[0009] An object of the present invention is to provide a distributor that can evenly supply two-phase refrigerant flowing in by various flow states to the pipes without pressure loss.

[0010] The present invention provides a distributor of a gas-liquid two-phase fluid according to the claims as a means of achieving the object.

[0011] According to a first aspect of the invention, there is provided a distributor of a gas-liquid two-phase fluid provided with a cylindrical vessel with a cylindrical upper part, an inlet pipe connected in a tangential direction with respect to a circular cross section of the upper portion of the cylindrical vessel, and distribution pipes connected to a lower portion of the cylindrical vessel.

[0012] Since the inlet pipe is connected in a tangential direction with respect to the circular cross section of the cylindrical vessel, the two-phase fluid is separated into a gas phase and a liquid phase in the cylindrical vessel irrespective of the form of the inlet flow by a known centrifugal separation action. The liquid phase forms a thin liquid film at the inner surface of the cylindrical vessel and drips down by gravity and forms a uniform liquid film thickness along with the action of the refrigerant swirl flow. The liquid film formed in the uniform thickness flows downward while swirling and reaches the plurality of distribution pipes arranged at the lower portion of the cylindrical vessel. In the distribution pipes, the liquid film formed in the uniform thickness and the gas phase refrigerant flow in, so a two-phase fluid comprised of a gas and liquid evenly mixed is formed and flows. Further, the two-phase fluid moves inside the vessel by gravity, so the energy loss (pressure loss) is extremely small.

[0013] According to a second aspect of the invention, the distributor of a gas-liquid two-phase fluid is one where the lower portion of the cylindrical vessel is formed into a reverse conical shape. The two-phase fluid forms a swirl flow along the inner surface of the vessel and flows toward the lower part of the vessel by gravity. At this time, the liquid film on the reverse conical surface occurring due to the centrifugal separation action is subjected to an upward force component due to the reverse conical surface with respect to this centrifugal force, so the dropping speed is eased. Further, due to the reverse conical surface, the angular speed or rises, the centrifugal force mro2 becomes larger, and the centrifugal separation action is promoted (since the peripheral speed is substantially fixed, by the amount by which the radius r becomes smaller). Because of this, the liquid film of a more uniform thickness drops down while swirling on the reverse conical surface.

[0014] According to a third aspect of the invention, there is provided a distributor of the first aspect wherein said inlet pipe is curved just before being connected to said cylindrical vessel. This curved portion has the function of causing a centrifugal separation action, so the cylindrical vessel generating the centrifugal separation action can be made smaller.
According to a fourth aspect of the invention, there is provided a refrigeration cycle provided with any of the above distributors downstream of an ejector.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and features of the present invention will become clearer from the following description of the preferred embodiments given with reference to the attached drawings, wherein:

FIG. 1 shows a first embodiment of a distributor according to the present invention by schematic views,

FIG. 2 shows a first embodiment of a distributor according to the present invention by a schematic view,

FIG. 3 shows a first embodiment of a distributor according to the present invention by a schematic view,

FIG. 4 shows a conventional refrigeration cycle provided with an ejector.

FIG. 5 is the perspective view of an indoor heat exchanger forming part of the cycle of FIG. 4, and

FIG. 6 shows an ejector and distributor forming parts of the cycle of FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention will be described in detail below while referring to the attached figures.

First Embodiment

FIG. 1 shows a first embodiment of a distributor according to the present invention by schematic views. FIG. 1(a) shows a top view of the distributor, while FIG. 1(b) shows a side cross-sectional view of the distributor. In FIG. 1, reference numeral 10 is a distributor of the first embodiment, 1 is a cylindrical vessel, 2 is an inlet pipe, and 3 are distribution pipes.

The inlet pipe 2 is connected in a tangential direction with respect to the circular cross-section of the upper portion of the cylindrical vessel 1. At the lower portion of the cylindrical vessel 1, a plurality of distribution pipes 3 are connected at positions separated by equal angles in the peripheral direction and extend outward radially. That is, the plurality of distribution pipes 3 are connected to the cylindrical vessel 1 so that the intervals between them become equal distances.

Further, the gas phase two-phase refrigerant (for example, having a ratio of the liquid phase to the gas phase of approximately 0.3 vol%) flows from the inlet pipe 2 into the cylindrical vessel 1 from a tangential direction at the peripheral part and separates into gas and liquid by the centrifugal force acting on this in the process of swirling inside the cylindrical vessel 1. The heavy liquid collects at the peripheral side, while the light gas collects at the center. The gas becomes a uniform pressure and flows from an outlet 3a to the distribution pipes 3 in the process of moving while swirling.

On the other hand, the liquid swirls along the inner surface of the cylindrical wall 1a and free falls by gravity, swirls, and forms a liquid film. As it proceeds, the thickness of the liquid film becomes a uniform thickness over the entire circumference due to the action of the surface tension and flows into the distribution pipes 3. Note that when the volume ratio of the liquid phase is 0.3 vol %, the liquid film thickness is approximately 0.1 mm. The liquid free falls, so can move downward with no energy loss.

In this way, near the distribution pipes 3, the liquid becomes a film of a uniform thickness over the entire circumference and the gas becomes a uniform pressure over the entire circumference when flowing into the distribution pipes 3. Therefore so the gas phase two-phase refrigerant can be evenly dispensed. Conversely, if making the intervals of the mounting positions of the distribution pipes 3 unequal, it is possible to change the ratio of distribution to the distribution pipes 3.

Second Embodiment

FIG. 2 shows the side cross-section of a second embodiment of the distributor according to the present invention by a schematic view. The top view is the same as FIG. 1(a), so is omitted. The distributor of the second embodiment differs from the first embodiment in only the cylindrical vessel. Therefore, parts substantially the same as the parts of the first embodiment are assigned the same reference notations and explanations are omitted.

In FIG. 2, reference numeral 20 is the distributor of the second embodiment, while 21 is a vessel with a cylindrical upper portion 21b and an inverted conical lower portion 21c (below referred to as "the upper portion cylindrical vessel")

The two-phase refrigerant forms a swirl flow along the inner surface 21a of the vessel 21 and flows toward the bottom of the vessel 21. At that time, the liquid film on the reverse conical surface generated by the centrifugal separation action is subjected to an upward force component by the reverse conical surface 21c with respect to this centrifugal force, so the dropping speed is eased. Further, due to the reverse conical surface, the angular speed so rises and the centrifugal separation action is promoted. Because of this, the liquid film of a more uniform thickness drops down while swirling on the reverse conical surface.

Note that the diameter D2 of the circular cross-section near the cut apex of the cone (that is, near the distribution pipe connection portion) is preferably larger than the inlet pipe inside diameter D1. This is to avoid a pressure loss by the throttling effect. Further, the tilt angle of the cone can be set to an optimal value by parameters such as the flow rate at the vessel inlet, dryness of the refrigerant, D1, D2, and the like.

In this way, near the distribution pipes 3, the liquid forms a film of a more uniform thickness over the entire circumference, while the gas becomes a uniform pressure over the entire circumference when flowing into the distribution pipes 3. Therefore so the gas phase two-phase refrigerant can be evenly dispensed.

Third Embodiment

FIG. 3 shows a top view of a third embodiment of a distributor according to the present invention by schematic view. The side cross-sectional view is the same as FIG. 1(b), so is omitted. The distributor of the third embodiment differs from the first embodiment in only the inlet pipe is different. Therefore, parts substantially the same as the parts of the first embodiment are assigned the same reference notations and explanations are omitted.

In FIG. 2, reference numeral 30 is the distributor of the third embodiment, while 32 is the inlet pipe. The inlet
pipe 32 has a curved portion 32a that curves just before being connected to the cylindrical vessel 1. This curve portion 32a has the function of generating a centrifugal separation action, so it becomes possible to make cylindrical vessel 1 smaller by that amount.

While the invention has been described with reference to specific embodiments chosen for purpose of illustration, it should be apparent that numerous modifications could be made thereto by those skilled in the art without departing from the basic concept and scope of the invention.

1. A distributor of a gas-liquid two-phase fluid distributing a gas-liquid two-phase fluid flowing in from an inlet pipe into a plurality of distribution pipes, provided with a cylindrical vessel with a cylindrical upper part, an inlet pipe connected in a tangential direction with respect to a circular cross section of the upper portion of the cylindrical vessel, and distribution pipes connected to a lower portion of the cylindrical vessel.

2. A distributor according to claim 1 wherein the lower portion of the cylindrical vessel is formed into a reverse conical shape.

3. A distributor according to claim 1 wherein said inlet pipe is curved just before being connected to said cylindrical vessel.

4. A refrigeration cycle provided with a distributor according to claim 1 downstream of an ejector.