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(54) FLOODED EVAPORATOR

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Description

Technical field

[0001] The present invention relates to a flooded evaporator as defined in the preamble of claim 1 further increased in heat transfer performance of flooded evaporators commonly adopted in refrigerating machines, etc. for their superior heat transfer performance and improved in function of separating refrigerant mist in refrigerant vapor volatilized an the evaporator. Such a flooded evaporator is known for instance from JP-62-162868.

Background art

[0002] A flooded evaporator is an evaporator in which tubes for allowing a medium to be cooled(water for refrigerated air conditioning, for example) to flow are arranged in refrigerant liquid flooded therein to allow heat exchange between the refrigerant liquid and the medium to be cooled so that the medium is cooled by giving heat to the refrigerant liquid to allow it to evaporate. The heat exchange is performed effectively because heat transfer from liquid through the tube wall is superior.

[0003] Refrigerant vapor to be introduced into a compressor located downstream of the evaporator must be got rid of refrigerant mist included the refrigerant volatilized in the evaporator. As a large part in the flooded evaporator is filled with refrigerant liquid, generally an accumulator for separating refrigerant liquid(mist) from the refrigerant which is volatized in the evaporator and is in a state of mixture of refrigerant liquid and refrigerant vapor, is provided so that the mixture introduced from the evaporator is separated into liquid and vapor, and the vapor is sucked into the compressor and the liquid is returned to the evaporator.

[0004] In Japanese Laid-Open Patent Application No. H8-233407 (patent literature 1) is disclosed a flooded evaporator, in which heat transfer between a refrigerant liquid and medium to be cooled is increased through utilizing disturbance effect by allowing bubbles developed in the refrigerant liquid to positively contact the tubes arranged in a shell filled with the refrigerant liquid, and at the same time refrigerant mist is prevented from being flown out from the evaporator thereby preventing liquid flow-back (flow of liquid state refrigerant into the compressor).

[0005] FIG.8 shows the flooded evaporator disclosed in the patent literature 1. The flooded evaporator comprises a horizontal type cylindrical shell 01 and a plurality of cooling tubes 02 arranged in the shell 01. The cooling tubes are arranged such that lower tubes constitute a means 03 for increasing development of bubbles in the refrigerant liquid and upper tubes constitute a means 04 for decreasing flowing out of refrigerant liquid(mist).

The bubble increasing effect of the means 03 and liquid flow-out decreasing effect of the means 04 are obtained by such an arrangement of the cooling tubes 02 that a group of inlet side cooling tubes 02a is located in the upper part of the refrigerant liquid in the shell 01, a group of inlet side tubes 02b into which the medium to be cooled flowed through the inlet side tubes 02a is introduced is located in lower part of the refrigerant liquid in the shell 01, and groups of outlet side tubes 02c and 02d are located in the intermediate range between the inlet side tubes 02a and 02b.

[0006] A refrigerant liquid inlet port 05 and a refrigerant vapor outlet port 06 are provided on the bottom and top of the shell 01 respectively in the middle in longitudinal direction of the shell 01. Low pressure refrigerant liquid 'a' experienced compression, condensation, and expansion is introduced into the shell 01 from the inlet port 05, and low pressure refrigerant vapor 's' evaporated in the shell 01 flows out from the outlet port 06 to be returned to the compressor. A flow splitting plate 07 having a number of apertures is provided below the lowest tubes 02d in the shell 01. The refrigerant liquid introduced from the inlet port 05 provided at the center part of the shell 01 is spread in longitudinal direction of the shell 01 so that the refrigerant liquid flow is distributed evenly in the longitudinal direction.

With the construction, the medium to be cooled 'b' of relatively high temperature flowing in the inlet side tubes 02a exchanges heat with the refrigerant liquid in the upper part of the refrigerant liquid in the shell 01, so vaporization of the refrigerant liquid is enhanced near the surface of the refrigerant liquid 'a' in the shell and the amount of refrigerant mist floating on the surface of the refrigerant liquid is reduced. Therefore, liquid flow-back, i.e. sucking of refrigerant mist by the compressor is prevented. As the tubes 02b and 02c in which the medium to be cooled of relatively low in temperature flows are located above the tubes 02d in which the medium to be cooled of still relatively high in temperature flows and bubbles develop still relatively actively, heat transfer through the tubes 02b and 02c is increased by virtue of bubbles developed around the periphery of the tubes 02b moving upward by the disturbance effect of the bubbles in spite of low temperature of the medium to be cooled flowing in the intermediate tubes 02b and 02c. In this way, heat transfer through the walls of the tubes 02 is totally increased.

[0007] In the patent literature 2 is disclosed a double tube type flooded evaporator for an absorption refrigerating machine is disclosed with which carry-over of refrigerant mist by refrigerant vapor is prevented with compact construction. FIG.9a is a longitudinal sectional view and FIG.9b is a cross-sectional view of the evaporator. In the drawings, the double tube type flooded evaporator 011 is composed of a horizontal outer tube 013 and a horizontal inner tube 014. The medium to be cooled 'b' flows inside space 017 of the inner tube 014, and a refrigerant liquid room 016 where refrigerant liquid a' is flooded is formed between the outer tube 013 and inner tube 014. The inner tube 014 is located in the outer tube 013 such that the inner tube 014 is positioned nearer to one of the inside wall of the outer tube 013. A partition

plate 015 is provided in a space 16A larger in width between the outer tube 013 and inner tube 014 to divide the space 16A into an outer tube side space and an inner tube side space. Refrigerant vapor 's' evaporated in the evaporator 011 moves up in the inner tube side space between the outer periphery of the inner tube 014 and the partition plate 015 and refrigerant liquid 'a' moves down in the outer tube side space between the inner periphery of the outer tube 013 and the partition plate 015, so refrigerant vapor 'S' and refrigerant liquid 'a' flow in counter directions without interfering with each other. Therefore, mixing of refrigerant liquid 'a' with refrigerant vapor 's' by agitation is prevented, and occurrence of carrying over of refrigerant mist by refrigerant vapor to the compressor can be prevented.

[0008] In a space 016B lower in width between the inner tube and outer tube, a stable upward flows of refrigerant vapor 's' occur and water concentration in the refrigerant liquid 'a' is reduced there due to development of refrigerant vapor 'S'. Increase in water concentration in refrigerant liquid is suppressed by taking out the refrigerant liquid increased in water concentration in the space 016B through a refrigerant extraction opening 020. Evaporation temperature of refrigerant liquid 'a' rises with increased water concentration in refrigerant liquid. When boiling point of refrigerant liquid rises, temperature difference between the temperature of the medium to be cooled and that of refrigerant liquid 'a' becomes small, the amount of heat exchange in the evaporator decreases, and desired low temperature of the medium to be cooled can not be obtained. For this reason, increase in water concentration in refrigerant liquid is suppressed by taking out the refrigerant liquid increased in water concentration in the space 16B from the refrigerant extraction opening 020.

[0009] Evaporation occurs in the refrigerant liquid flooded in the refrigerant liquid room 016 by receiving heat from the medium to be cooled 'b' flowing in the inner tube 014 and concentration of water in refrigerant liquid increases particularly in the space 016B and evaporation temperature rises with increased concentration of water in refrigerant as mentioned above. By providing an inlet 022 for introducing the medium to be cooled 'b' into the inside space 017 of the inner tube 014 at an end(right side end in FIG.9A) thereof and an outlet 023 at the other end(left side end), providing an inlet 019 for introducing refrigerant liquid into the refrigerant liquid room 016 at the bottom of the outer tube 013 near said outlet 023 provided to the inner tube, and providing the refrigerant extraction opening 020 on the outer tube 013 at a position near said inlet 022 provided to the inner tube, the medium to be cooled and refrigerant liquid flow countercurrently each other. Therefore, evaporation temperature of refrigerant 'a' is lower near the refrigerant inlet 019, and the medium to be cooled 'b' cooled effectively flows out from the outlet 023.

As mentioned above, according to the patent literature 2, concentration of water in the refrigerant liquid is suppressed and effect of cooling the medium to be cooled is improved.

Patent Literature 1: Japanese Laid-Open Patent Application No. H8-233407

Patent Literature 2: Japanese Laid-Open Patent Application No. 2003-336934

Problems to be solved by the invention

[0010] However, according to the flooded evaporator disclosed in the patent literature 1, effect of increasing heat transfer is limited naturally, since the cooling tubes 02 are surrounded with gas, which reduces heat transfer as compared with a case the tubes are surrounded with liquid.

Further, according to the invention of the patent literature 1, evaporation of refrigerant liquid is enhanced near the level of the refrigerant liquid by allowing heat exchange between the medium to be cooled of relatively high temperature flowing in the inlet side tubes 02a among the cooling tubes 02 and the refrigerant liquid in the upper part of refrigerant liquid flooded in the shell, thereby reducing the amount of refrigerant mist floating on the surface of the refrigerant liquid and preventing occurrence of liquid flow-back to the compressor. However, effect of preventing the liquid flow-back by the means like this is also limited and reliable separation of refrigerant mist is not exactly expected, and in case when the medium to be cooled has leaked and mixed with the refrigerant liquid, the mixed medium to be cooled can not be removed from the refrigerant liquid.

[0011] The flooded evaporator of the patent literature 2 is composed such that stable upward flows of refrigerant vapor 's' surround the outer periphery of the inner tube 014 in which the medium to be cooled flows. Therefore, as the inner tube is surrounded with refrigerant vapor, heat transfer between the refrigerant liquid 'a' and the medium to be cooled 'b' through the wall of the inner tube is deteriorated and effect of the heat transfer is limited naturally as is in the art of the patent literature 1.

Further, an upward flow of refrigerant vapor 's' is formed in the space between the partition plate 015 and inner tube 014, and a downward flow of refrigerant liquid is formed in the space between the partition plate 015 and outer tube 013, so refrigerant vapor 'S' and refrigerant liquid 'a' flow in counter directions without interfering with each other. Therefore, mixing of refrigerant liquid 'a' with refrigerant vapor 's' by agitation is prevented, and occurrence of carrying over of refrigerant mist by refrigerant vapor to the compressor can be prevented. However, effect of suppressing the carrying over of refrigerant mist is limited naturally by the art like this, and exact separation of refrigerant mist is not expected. Further, there remains a problem that in case when the medium to be cooled has leaked and mixed with the refrigerant liquid, the mixed medium to be cooled can not be removed from the refrigerant liquid as is in the art of the patent literature 1.

Means for solving the problems

[0012] The present invention was made in light of the problem mentioned above, an object of the invention is to provide a flooded evaporator which is able to remove floating mist above the surface of refrigerant liquid more exactly resulting in that the refrigerant mist is prevented from being sucked into the compressor without increasing the size of the evaporator.
Another object of the invention is to improve heat transfer between the medium to be cooled and refrigerant liquid and effectively cool the medium to be cooled.

[0013] To attain the objects, the present invention proposes a flooded evaporator having a container that forms a heat exchanging section in which a heat exchanger is accommodated, the heat exchanger comprising cooling tubes in which a medium to be cooled flows and heat exchange is performed between the medium to be cooled and refrigerant liquid filled in the heat exchanging section to vaporize the refrigerant, wherein a tubular housing is formed to extend upward from the container, an inner tube communicating to the heat exchanger to guide refrigerant vapor generated in the heat exchanger upward is provided, a loose cover is attached on top of the inner tube with a clearance retained between the loose cover and the top of the inner tube, the loose cover having downward extending parts with a clearance retained between the downward extending parts of the loose cover and the inner tube so that refrigerant vapor flowed up and impinged against the loose cover is deflected downward, and a demister is provided in the tubular housing in its upper part so that a space for separating refrigerant mist in upward-flowing refrigerant vapor through allowing the mist to fall downward by gravitational attraction is secured between the loose cover and the demister, and further area of the clearance between the downward extending parts of the loose cover and the inner tube is formed to be smaller than area of a clearance between the downward extending parts of the loose cover and the inner surface of the tubular housing.

[0014] The flooded evaporator of the invention is composed of a heat exchanging section where heat exchange is performed between the medium to be cooled and refrigerant liquid and a vapor-liquid separating section formed above the heat exchanging section. In the heat exchanging section is accommodated a heat exchanger comprises cooling tubes immersed in refrigerant liquid filled in the heat exchanging section, and the refrigerant liquid is evaporated by receiving heat from the medium to be cooled flowing in the cooling tubes.
The evaporated refrigerant vapor flows up through the inner tube communicating to the heat exchanger and impinges against the loose cover at the top of the inner tube, thereby reversed in its flow direction to downward direction passing through the clearance between the loose cover and the top of the inner tube and through the clearance between the downward extending parts of the loose cover and the inner tube.

[0015] The loose cover has parts extending downward continuing to the ceiling part like a cross section of an umbrella, semi oval, chevron, or flat shape, any shape is suitable as long as the flow direction of the refrigerant vapor is reversed downward.
The loose cover may be supported by supporting pillars or supporting plates provided at the top end part of the inner tube so that a clearance is retained between the loose cover and the top end of the inner tube.
The loose cover is formed such that area A of the clearance between the inside periphery of the downwardly extending parts of the loose cover and the outer periphery of the inner tube is smaller than area B of the clearance between the outer periphery of the downwardly extending parts of the loose cover and the inside periphery of the tubular housing (A < B), so velocity Va of refrigerant vapor containing refrigerant mist flowing through the area A is larger than velocity Vb of that flowing through the area B. Therefore, the refrigerant mist contained in the refrigerant vapor is prevented from flowing upward directly together with the refrigerant vapor after the refrigerant vapor containing refrigerant mist flows out passing through the area B, and when the refrigerant vapor containing refrigerant mist is reversed in its flow direction to flow downward a part of the mist is separated from the refrigerant vapor and falls down due to gravitational attraction aided by downward velocity thereof to return to the heat exchanging section.

[0016] Refrigerant vapor containing refrigerant mist flowed out from the area B then flows up in the space above the loose cover, and a part of refrigerant mist contained in the upward-flowing refrigerant vapor falls down in the course of flowing up in the space due to gravitational attraction, and then the rest of refrigerant mist remaining in the refrigerant vapor is removed in the demister. Refrigerant vapor get rid of refrigerant mist is supplied to a device such as a compressor located downstream of the demister.

[0017] The heat exchanger is preferably covered with a cover plate such that an upper part of the cover plate where the inner tube is provided is opened to allow communication of the heat exchanger to the inner tube, lower part is open to the heat exchanging section of the container, and circulation paths are formed between both sides of the cover plate and the inner surface of the container so that refrigerant liquid circulates flowing down the circulation paths, entering the heat exchanger from the opening in the lower part of the cover plate, flowing up in the heat exchanger, and separated refrigerant mist fallen down to the heat exchanging section of the container again flows down the paths as liquid refrigerant.
It is preferable that the heat exchanger is comprised of a number of heat transfer plates arranged parallel to each other at certain spacing and a number of tubes crossing the heat transfer plate, in which tubes flows the medium to be cooled.
It is also preferable that the container for accommodating the heat exchanger and the heat exchanger has a circular

cross section respectively, and the heat exchanger is placed in the container offset a little downward.
Further, it is preferable that at least two of the tubular housing are provided to the container forming the heat exchanging section to erect parallel to each other in longitudinal direction of the container.

Effect of the invention

[0018] According to the flooded evaporator of the invention, the heat exchanger having a number of cooling tubes in which the medium to be cooled flows is immersed in refrigerant liquid in the container to form the heat exchanging section, good heat transfer performance between the medium to be cooled and refrigerant filled in the heat exchanging section specific to a flooded evaporator can be obtained, and mist separation is performed in three steps. The first step is that refrigerant vapor generated in the heat exchanging section and containing refrigerant mist is introduced to the inner tube to flow up in the inner tube, this fluid impinges against the loose cover provided at the top of the inner tube with a clearance retained between the loose cover and the top end of the inner tube to be deflected there to flow downward, the loose cover being formed such that area A of the clearance between the inside periphery of the downwardly extending parts of the loose cover and the outer periphery of the inner tube is smaller than area B of the clearance between the outer periphery of the downwardly extending parts of the loose cover and the inside periphery of the tubular housing(A<B) so that the refrigerant mist contained in the refrigerant vapor is prevented from flowing upward directly together with the refrigerant vapor after the refrigerant vapor containing refrigerant mist flows out passing through the area B and a part of the mist is separated from the refrigerant vapor and falls down due to gravitational attraction aided by downward velocity thereof to return to the heat exchanging section. The second step is that refrigerant mist remaining in the refrigerant vapor is separated in the course of flowing upward in the space above the loose cover due to gravitational attraction. The third step is that the rest of refrigerant mist is removed in the demister. Therefore, refrigerant mist can be exactly separated from refrigerant vapor, as a result liquid flow-back to a device such as a compressor located downstream of the evaporator can be prevented.

[0019] As the flooded evaporator of the invention is composed of a heat exchanging section and a vapor-liquid separating section provided integral with the heat exchanging section to rise upward, the evaporator does not become large sized, space saving is attained, and can be composed to be hermetically-closed easily by composing as welded construction, it can be applied to an ammonia refrigeration system.

[0020] By composing the flooded evaporator preferably such that the heat exchanger is preferably covered with a cover plate such that an upper part of the cover plate where the inner tube is provided is opened to allow communication of the heat exchanger to the inner tube, lower part is open to the heat exchanging section of the container, and circulation paths are formed between both sides of the cover plate and the inner surface of the container so that refrigerant liquid circulates flowing down the circulation paths, entering the heat exchanger from the opening in the lower part of the cover plate, flowing up in the heat exchanger, and separated refrigerant mist fallen down to the heat exchanging section of the container again flows down the paths as liquid refrigerant, refrigerant liquid filled in the container can flow through the circulation paths which are formed between both sides of the cover plate of the heat exchanger and the container and extending to the lower opening from where the refrigerant liquid enter the heat exchanger, heat exchanging between the medium to be cooled and refrigerant liquid can be performed repeatedly, and heat transfer efficiency is further increased.

[0021] By composing the flooded evaporator preferably such that the container for accommodating the heat exchanger and the heat exchanger has a circular cross section respectively and the heat exchanger is placed in the container offset a little downward, wide area for guiding refrigerant liquid to the circulation paths formed between both sides of the cover plate of the heat exchanger and container can be secured in the upper part of each of the paths at the entrance of refrigerant liquid into the circulation paths. Therefore, circulation of refrigerant liquid through the heat exchanger is enhanced and heat transfer between the medium to be cooled and refrigerant liquid is improved.

[0022] Further, by forming the container for filling refrigerant and the heat exchanger accommodated in the container to have a circular cross section respectively, the volume of the heat exchanger can be increased to a maximum relative to the amount of refrigerant filled in the container, as a result, utilization efficiency of refrigerant is increased. Therefore, the amount of refrigerant liquid retained in the container can be reduced to a minimum and maximum evaporation performance can be attained with minimum amount of refrigerant liquid retained in the container.

[0023] By composing the flooded evaporator preferably such that the heat exchanger is comprised of a number of heat transfer plates arranged parallel to each other at certain spacing and a number of tubes crossing the heat transfer plate, in which tubes the medium to be cooled flows, efficiency of heat transfer between the medium to be cooled and refrigerant liquid can be increased further.

[0024] The flooded evaporator may be composed such that at least two of the tubular housing are provided to the container forming the heat exchanging section to erect parallel to each other in longitudinal direction of the container. With this composition, capacity of vaporizing refrigerant liquid can be increased considerably with a single unit of evaporator as compared with a flooded evaporator unit with a single tubular housing.

Brief description of the drawings

[0025]

FIG. 1 is an elevational view in section of a first embodiment of the flooded evaporator according to the invention.
FIG. 2 is a sectional side elevation of the flooded evaporator of the first embodiment.
FIG.3 is a plan view of the flooded evaporator of the first embodiment.
FIG. 4 is a perspective view of showing an umbrella-like loose cover in the flooded evaporator of the first embodiment.
FIG.5 is a side elavation partly in section of a second embodiment of the flooded evaporator according to the invention.
FIG. 6 is an elavational view partly in section of the flooded evaporator of the second embodiment.
FIG.7 is a plan view of the flooded evaporator of the second embodiment.
FIG.8 a cross sectional view of a conventional flooded evaporator.
FIG.9A is an elevational view in section of another conventional flooded evaporator.
FIG.9B is a cross sectional view of the flooded evaporator of FIG.9A.

Explanation of reference numerals

[0026]

1	Horizontal cylindrical container
2	Heat exchanger
3	tubular housing
4	Cover
6	Cover plate
7	inlet pipe
8	outlet pipe
11	Lower opening
12	inner tube
13	Umbrella-like loose cover
14	Downward extending parts
15	Apertures
16	Demister
17	Space
18	Outlet pipe
19	Supply pipe
20	Circulation paths

Best Mode for carrying out the Invention

[0027] Preferred embodiments of the present invention will now be detailed with reference to the accompanying drawings. It is intended, however, that unless particularly specified, dimensions, materials, relative positions and so forth of the constituent parts in the embodiments shall be interpreted as illustrative only not as limitative of the scope of the present invention.

[The first embodiment]

[0028] Referring to FIGS.1-3, reference numeral 1 is a horizontal cylindrical container in which a heat exchanger 2 is accommodated. Reference numeral 3 is a tubular housing extending upward from the cylindrical container 1 which composes a refrigerant mist separating section. The tubular housing 3 is closed at the top thereof by a cover 4.

[0029] The heat transfer plates 5 are arranged parallel to each other at certain spacing and the upper part of the heat exchanger 2 including the upper part of the heat transfer plates 5 is covered with a cover plate 6. Reference numeral 7 is an inlet pipe for introducing a medium to be cooled 'b' and reference numeral 8 is an outlet pipe through which the medium cooled in the heat exchanger 2 flows out from the heat exchanger 2. The inlet pipe 7 and outlet pipe 8 are connected with heat exchanging tubes (not shown in the drawings, intersections of cross-hatched lines indicating centers of the heat exchanging tubes) arranged in staggered fashion crossing the heat transfer plates 5, thereby increasing heat transfer between the refrigerant 'a' filled in the cylindrical container 1 and medium to be cooled 'b' flowing through the heat exchanging tubes not shown in the drawings.

[0030] The heat exchanger 2 is composed such that both ends of the heat transfer plates are covered with end plates 9 and 10 respectively, and the sides and top parts thereof are covered with the cover plate 6 except the lower part thereof where the cover plate 6 does not cover the heat exchanger to form a lower opening 11. In FIG.1, reference symbol h indicates the width of the lower opening 11. An inner tube 12 of rectangular cross section is provided to the cover plate 6 to erect upright as shown in FIG.4. The inside space of the inner tube 12 is communicated with the inner space of the heat exchanger 2 via an opening(not shown in the drawings) formed in the cover plate 6 where the inner tube is provided.
The heat exchanger 2 is formed to have a cylindrical periphery so that it is accommodated in the cylindrical container 1 with conformity in shape therewith and placed therein in a state offset a little downward, thereby circulation paths 20 reducing downwardly being formed between both sides of the cover plate 6 of the heat exchanger 2 and inner periphery of the cylindrical container 1.

[0031] An umbrella-like loose cover 13 is provided on top of the inner tube 12. The loose cover 13 has a pair of downward extending parts 14 as shown in FIG.4 so that a pair of apertures 15 is formed between the both sides of the inner tube 12 and the downward extending parts 14 of the loose cover 13.
A demister 16 composed of steel wire, etc. forming a microporous layer is provided in an upper part of the tubular housing 3, and between the demister 16 and the loose cover 13 is secured a space 17 to enhance separation of refrigerant mist from refrigerant vapor utilizing

the property of refrigerant mist of falling down due to attraction of gravity.

An outlet pipe 18 is provided above the demister 16 to allow the refrigerant vapor 's' got rid of refrigerant mist to flow out to be introduced to devices located downstream such as a compressor, etc. At the bottom of the cylindrical container 1 is provided a supply pipe 19 for supplying refrigerant 'a' to the heat exchanger 2.

[0032] Refrigerant liquid 'a' is supplied to the cylindrical container 1 via the supply pipe 19, a medium to be cooled 'b' is supplied to the heat exchanger 2 via the inlet pipe 7, and heat exchange occurs between the refrigerant 'a' and medium to be cooled 'b'. Flow paths of the medium to be cooled is arranged in the heat exchanger 2 in staggered fashion crossing the heat transfer plates 5 in order to increase the heat transfer. Refrigerant liquid 'a' is evaporated by receiving heat from the medium to be cooled, and the evaporated refrigerant vapor moves up in the refrigerant liquid and flows through the inner tube 12 to reach the pair of apertures 15.

The refrigerant vapor 's' flowed up the inner tube 12 impinges against the umbrella-like loose cover 13 to change flow direction to flow downward to pass through the apertures 15, then its flow direction is again changed to flow upward passing through the clearance between the outer periphery of the loose cover 13 and the inner periphery of the cylindrical container 3.

[0033] As area A of the apertures 15 is determined to be smaller than area B of the clearance between the loose cover 13 and the inner periphery of the cylindrical container 3, flow velocity Va of refrigerant vapor passing through the apertures 15 is larger than flow velocity Vb of refrigerant vapor passing through the clearance between the loose cover 13 and cylindrical container 3. Therefore, refrigerant mist contained in the refrigerant vapor flowed through the apertures 15 is prevented from flowing upward, and a part of the refrigerant mist flows down separating from the refrigerant vapor which flow up through the space 17 inside the tubular housing 3.

[0034] A part of remaining refrigerant mist is separated from the refrigerant vapor 's' flowing up through the space 17 to fall down due to attraction of gravity exerting on the refrigerant mist. The refrigerant vapor 's' passes through the demister 16 where the rest of refrigerant mist is caught by impingement against the steel wires in the demister 16, and refrigerant vapor got rid of refrigerant mist is introduced to devices located downstream such as a compressor, etc.

[0035] In the horizontal cylindrical container 1, the circulation paths 20 reduced in its width downwardly are formed by the offset positioning of the heat exchanger 2, and refrigerant liquid 'a' in the upper part of the cylindrical container 1 can flow down the circulation paths 20 smoothly owing to negative pressure in the heat exchanger 2 generated by the upward flow of refrigerant vapor evaporated in the heat exchanger 2. In this way, circulation flow of refrigerant liquid that the refrigerant liquid flowed down in the circulation paths 20 enters the heat exchanger 2 from the lower opening 11 to flow up through the heat exchanger 2 and refrigerant liquid returned to the heat exchanging section as refrigerant mist flows down the circulation path 20, is formed easily, as a result heat transfer between the refrigerant liquid 'a' and medium to be cooled 'b' is enhanced.

[0036] According to the first embodiment, heat exchange between the refrigerant liquid 'a' and medium to be cooled 'b' is enhanced by forming circulation paths 20 in the horizontal cylindrical container 1, and the cylindrical container 1 can be reduced in size by which the amount of the refrigerant liquid contained in the cylindrical container 1 can be decreased to a requisite minimum by forming the heat exchanger 2 to have a cylindrical periphery so that it is accommodated in the cylindrical container 1 with conformity in shape therewith and placed therein in a state offset a little downward to form narrow circulation paths 20 between both sides of the heat exchanger 2 and inner periphery of the cylindrical container 1.

[0037] Further, as the area A of the apertures 15 is smaller than the area B between the outer periphery of the loose cover 13 and the inner surface of the tubular housing 3, the refrigerant vapor 's' vaporized in the heat exchanger 2 and flowed up in the tubular housing 12 impinged against the loose cover is reversed in its flow direction to flow down through the apertures 15 at the flow velocity of Va and then the refrigerant vapor 's' is again reversed in its flow direction to flow up through the clearance of area B at the flow velocity of Vb which is smaller than Va. Therefore, the refrigerant vapor 's' is prevented from being directly brought upward by the upward-flowing refrigerant vapor, a part of the refrigerant mist is separated from the refrigerant vapor to fall downward, and further a part of refrigerant mist contained in the upward-flowing refrigerant vapor falls down in the course of flowing up in the space 17 due to gravitational attraction, and furthermore the rest of refrigerant mist remaining in the refrigerant vapor is removed in the demister almost completely.

[0038] Further, the evaporator of the invention is comprised of the heat exchanging section accommodating the heat exchanger 2 and vapor-liquid separating section (the tubular housing 3) extending upward from the heat exchanging section, so the evaporator can be relatively small sized and space saving can be attained. As the evaporator can be composed to be hermetically-closed, it can be applied to an ammonia refrigeration system.

[The second embodiment]

[0039] Next, a second embodiment of the invention will be explained with reference to FIGS.5-7. The second embodiment is an example of a case the flooded evaporator of the invention is applied to an ammonia refrigerating machine. In FIGS.5-7, constituents the same as those of FIGS.1-3 are indicated by the same reference numerals and symbols. Reference numerals 7 and 8 in FIGS.5-7

are inlet pipes and outlet pipes for introducing and letting out the medium to be cooled and cooled medium into and from the heat exchanger 2 respectively. Unlike the first embodiment, in the second embodiment the inlet pipes 7 and outlet pipes 8 are provided at both ends of the horizontal cylindrical container 1 respectively. The outlet pipe 18 is connected to the upper part of each of two tubular housings 3 so that refrigerant vapor from each of the tubular housings 3 flows together therethrough. Reference numeral 21 is a support member for supporting the supply pipe 19 for introducing ammonia refrigerant 'a' into the cylindrical container 1, 22 is a base member for supporting the cylindrical container 1 and tubular housing 3 of the flooded evaporator.

[0040] The second embodiment is different from the first embodiment in a point that two tubular housings 3 are provided to rise parallel on the horizontal cylindrical container 1. The lower part of the cover plate 6 is open to form the lower opening 11 as is in the first embodiment, and the heat exchanger having a cylindrical periphery is placed in the cylindrical container 1 in a state offset a little downward as is in the first embodiment. In each of the two tubular housings 3 is provided the inner tube 12 and the umbrella-like loose cover 13 having a pair of downward extending parts 14 such that a pair of apertures 15 is formed between the both sides of the inner tube 12 and the downward extending parts 14 of the loose cover 13, and such that the area A of the apertures 15 is smaller than the area B of the clearance between the loose cover 13 and the inner periphery of the cylindrical container 3 as is in the first embodiment.

[0041] With the second embodiment, action and effect the same as the first embodiment can be attained and in addition capacity of vaporizing refrigerant liquid can be increased considerably with a single unit of evaporator by providing two tubular housings to a single horizontal cylindrical container.

Industrial Applicability

[0042] Heat exchange performance between a refrigerant liquid and a medium to be cooled is improved resulting in increased thermal efficiency of a refrigerating machine by adopting the flooded evaporator of the invention, which comprises a horizontal cylindrical container, a tubular housing provided with refrigerant mist separating section formed integral with the cylindrical container to erect therefrom, and a heat exchanger accommodated in the cylindrical container such that circulation paths are formed between both sides of the cover plate of the heat exchanger and the cylindrical container to allow the refrigerant liquid flooded in the cylindrical container to flow in the heat exchanger repeatedly.

[0043] In the refrigerant mist separating section, exact and highly efficient separation of refrigerant mist is made possible by performing mist separation in three steps including precipitation of the mist utilizing gravitational attraction and catching of refrigerant mist by impingement. Further, the amount of refrigerant liquid filled in the horizontal cylindrical container can be decreased and it is made possible to allow the refrigerant liquid of relatively small amount to achieve highly effective cooling performance.

As the evaporator can be composed to be hermetically-closed, it can be applied to an ammonia refrigeration system.

Claims

1. A flooded evaporator having a container (1) that forms a heat exchanging section in which a heat exchanger (2) is accommodated, the heat exchanger comprising cooling tubes in which a medium to be cooled flows and heat exchange is performed between the medium to be cooled and refrigerant liquid filled in the heat exchanging section to vaporize the refrigerant,
   wherein a tubular housing (3) is formed to extend upward from the container (1), an inner tube (12) communicating to the heat exchanger to guide refrigerant vapor generated in the heat exchanger upward is provided, a loose cover (13) is attached on top of the inner tube with a clearance retained between the loose cover (13) and the top of the inner tube (12), the loose cover (13) having downward extending parts with a clearance retained between the downward extending parts of the loose cover (13) and the inner tube (12) so that refrigerant vapor flowed up and impinged against the loose cover (13) is deflected downward, and a demister (16) is provided in the tubular housing (3) in its upper part so that a space for separating refrigerant mist in upward-flowing refrigerant vapor through allowing the mist to fall downward by gravitational attraction is secured between the loose cover and the demister (16) , and **characterised in that** the area of the clearance between the downward extending parts of the loose cover (13) and the inner tube (12) is smaller than area of a clearance between the downward extending parts of the loose cover (13) and the inner surface of the tubular housing (3).

2. A flooded evaporator according to claim 1, wherein the heat exchanger is covered with a cover plate such that an upper part of the cover plate where the inner tube (12) is provided is opened to allow communication of the heat exchanger (2) to the inner tube (12), lower part is open to the heat exchanging section of the container (1), and circulation paths are formed between both sides of the cover plate and the inner surface of the container (1) so that refrigerant liquid circulates flowing down the circulation paths, entering the heat exchanger (2) from the opening in the lower part of the cover plate, flowing up in the heat exchanger (2), and separated refrig-

erant mist fallen down to the heat exchanging section of the container (1) again flows down the paths as liquid refrigerant.

3. A flooded evaporator according to claim 1, wherein the heat exchanger (2) is comprised of a number of heat transfer plates arranged parallel to each other at certain spacing and a number of tubes crossing the heat transfer plates, in which tubes flows the medium to be cooled.

4. A flooded evaporator according to claim 2, wherein the container (1) for accommodating the heat exchanger (2) and the heat exchanger have a circular cross section respectively, and the heat exchanger (2) is placed in the container offset a little downward.

5. A flooded evaporator according to claim 1, wherein at least two of the tubular housings (3) are provided to the container forming the heat exchanging section to erect parallel to each other in longitudinal direction of the container.

Patentansprüche

1. Gefluteter Verdampfer mit einem Behälter (1), der eine Wärmeaustauschsektion bildet, in der ein Wärmetauscher (2) untergebracht ist, wobei der Wärmetauscher Kühlrohre enthält, in denen ein zu kühlendes Medium strömt und ein Wärmeaustausch zwischen dem zu kühlenden Medium und einer in der Wärmeaustauschsektion eingefüllten Kältemittelflüssigkeit stattfindet, um das Kältemittel zu verdampfen,
wobei ein vom Behälter (1) nach oben verlaufendes rohrförmiges Gehäuse (3) gebildet ist, ein mit dem Wärmetauscher verbundenes Innenrohr (12) vorgesehen ist, um den in dem Wärmetauscher erzeugten Kühlmitteldampf nach oben zu leiten, ein loser Dekkel (13) auf der Spitze des Innenrohres mit einem zwischen dem losen Deckel (13) und der Spitze des Innenrohres (12) gehaltenen Abstand befestigt ist, wobei der lose Deckel (13) nach unten verlaufende Abschnitte mit einem zwischen den nach unten verlaufenden Abschnitten des losen Deckels (13) und dem Innenrohr (12) gehaltenen Abstand aufweist, so dass der nach oben strömende und gegen den losen Deckel (13) treffende Kühlmitteldampf nach unten abgelenkt wird, und ein Demister (16) im unteren Abschnitt des rohrförmigen Gehäuses (3) so vorgesehen ist, dass ein Raum zum Abscheiden von Kühlmittelnebel im aufwärts strömenden Kühlmitteldampf zwischen dem losen Deckel und dem Demister (16) sichergestellt ist, indem es ermöglicht, dass der Nebel durch die Schwerkraftanziehung nach unten fällt,
dadurch gekennzeichnet, dass
der Bereich des Abstands zwischen den nach unten verlaufenden Abschnitten des losen Deckels (13) und dem Innenrohr (12) kleiner ist als der zwischen den nach unten verlaufenden Abschnitten des losen Deckels (13) und der Innenfläche des rohrförmigen Gehäuses (3).

2. Gefluteter Verdampfer nach Anspruch 1, wobei der Wärmetauscher mit einer Abdeckplatte so abgedeckt ist, dass ein oberer Abschnitt der Abdeckplatte dort, wo das Innenrohr (12) vorgesehen ist, geöffnet ist, um eine Verbindung des Wärmetauschers (2) mit dem Innenrohr (12) zu ermöglichen, ein unterer Abschnitt zur Wärmeaustauschsektion des Behälters (1) offen ist und Zirkulationswege zwischen beiden Seiten der Abdeckplatte und der Innenfläche des Behälters (1) so gebildet sind, dass die Kühlmittelflüssigkeit zirkuliert, die Zirkulationswege herabströmt, in den Wärmetauscher (2) von der Öffnung im unteren Abschnitt der Abdeckplatte eintritt, im Wärmetauscher (2) nach oben strömt und der abgeschiedene, nach unten in die Wärmeaustauschsektion des Behälters (1) fallende, Kühlmittelnebel erneut die Wege als Kühlmittelflüssigkeit herabströmt.

3. Gefluteter Verdampfer nach Anspruch 1, wobei der Wärmetauscher (2) eine Anzahl von Wärmeaustauschplatten, die unter bestimmten Abständen parallel zueinander angeordnet sind, und eine Anzahl von die Wärmeaustauschplatten kreuzenden Rohren, in denen das zu kühlende Medium fließt, umfasst.

4. Gefluteter Verdampfer nach Anspruch 2, wobei der Behälter (1) zum Unterbringen des Wärmetauschers (2), beziehungsweise der Wärmetauscher einen Kreisquerschnitt hat, und der Wärmetauscher (2) im Behälter ein wenig nach unten versetzt platziert ist.

5. Gefluteter Verdampfer nach Anspruch 1, wobei mindestens zwei der rohrförmigen Gehäuse (3) an dem die Wärmeaustauschsektion bildenden Behälter vorgesehen sind, die parallel zueinander in Längsrichtung des Behälters aufrecht angeordnet sind.

Revendications

1. Évaporateur noyé possédant un récipient (1) qui forme une section d'échange de chaleur dans laquelle est logé un échangeur de chaleur (2), l'échangeur de chaleur comprenant des tubes de refroidissement dans lesquels s'écoule un milieu qui doit être refroidi et un échange de chaleur étant mis en oeuvre entre le milieu à refroidir et le liquide frigorigène qui remplit la section d'échange de chaleur pour vaporiser le fluide frigorigène,
dans lequel est formé un logement tubulaire (3) pour

s'étendre vers le haut à partir du récipient (1), un tube interne (12) mis en communication avec l'échangeur de chaleur étant prévu pour guider vers le haut la vapeur du fluide frigorigène générée dans l'échangeur de chaleur, un revêtement décollé (13) étant fixé au sommet du tube interne tout en maintenant un espace libre entre le revêtement décollé (13) et le sommet du tube interne (12), le revêtement décollé (13) possédant des parties s'étendant vers le bas tout en maintenant un espace libre entre les parties s'étendant vers le bas du revêtement décollé (13) et le tube interne (12), si bien que la vapeur du fluide frigorigène s'écoulant vers le haut et venant heurter le revêtement décollé (13) est déviée vers le bas, et un dévésiculeur (16) étant prévu dans le logement tubulaire (3) dans la partie supérieure de ce dernier, si bien que l'on garantit un espace pour séparer le brouillard du fluide frigorigène dans la vapeur du fluide frigorigène s'écoulant vers le haut en permettant au brouillard de retomber vers le bas via la force gravitationnelle, entre le revêtement décollé et le dévésiculeur (16), et **caractérisé en ce que** l'étendue de l'espace libre entre les parties s'étendant vers le bas du revêtement décollé (13) et le tube interne (12) est inférieure à l'étendue de l'espace libre entre les parties s'étendant vers le bas du revêtement décollé (13) et la surface interne du logement tubulaire (3).

2. Évaporateur noyé selon la revendication 1, dans lequel l'échangeur de chaleur est recouvert d'une plaque de recouvrement de telle sorte que la partie supérieure de la plaque de recouvrement dans laquelle on prévoit le tube interne (12) est ouverte pour permettre une communication entre l'échangeur de chaleur (2) et le tube interne (12), la partie inférieure est ouverte sur la section d'échange de chaleur du récipient (1) et des voies de circulation sont formés entre les deux côtés de la plaque de recouvrement et la surface interne du récipient (1) de telle sorte que le liquide de frigorigène circule en s'écoulant vers le bas le long des voies de circulation, pénètre dans l'échangeur de chaleur (2) à partir de l'ouverture pratiquée dans la partie inférieure de la plaque de recouvrement, s'écoule vers le haut dans l'échangeur de chaleur (2), et le brouillard d'un réfrigérant séparé qui est retombé en direction de la section d'échange de chaleur du récipient (1) s'écoule à nouveau vers le bas le long des voies pour faire office de frigorigène liquide.

3. Évaporateur noyé selon la revendication 1, dans lequel l'échangeur de chaleur (1) comprend plusieurs plaques de transfert de chaleur montées parallèlement les unes aux autres en maintenant un certain intervalle et plusieurs tubes traversant les plaques de transfert de chaleur, tubes dans lesquels s'écoule le milieu à refroidir.

4. Évaporateur noyé selon la revendication 2, dans lequel le récipient (1) dans lequel doit venir se loger l'échangeur de chaleur (2) et l'échangeur de chaleur possèdent une section transversale circulaire respectivement, et l'échangeur de chaleur (2) est placé dans le récipient en étant légèrement décalé vers le bas.

5. Évaporateur noyé selon la revendication 1, dans lequel au moins deux des logements tubulaires (3) sont prévus dans le récipient formant la section d'échange de chaleur pour se dresser parallèlement l'une à l'autre dans la direction longitudinale du récipient.

FIG. 1

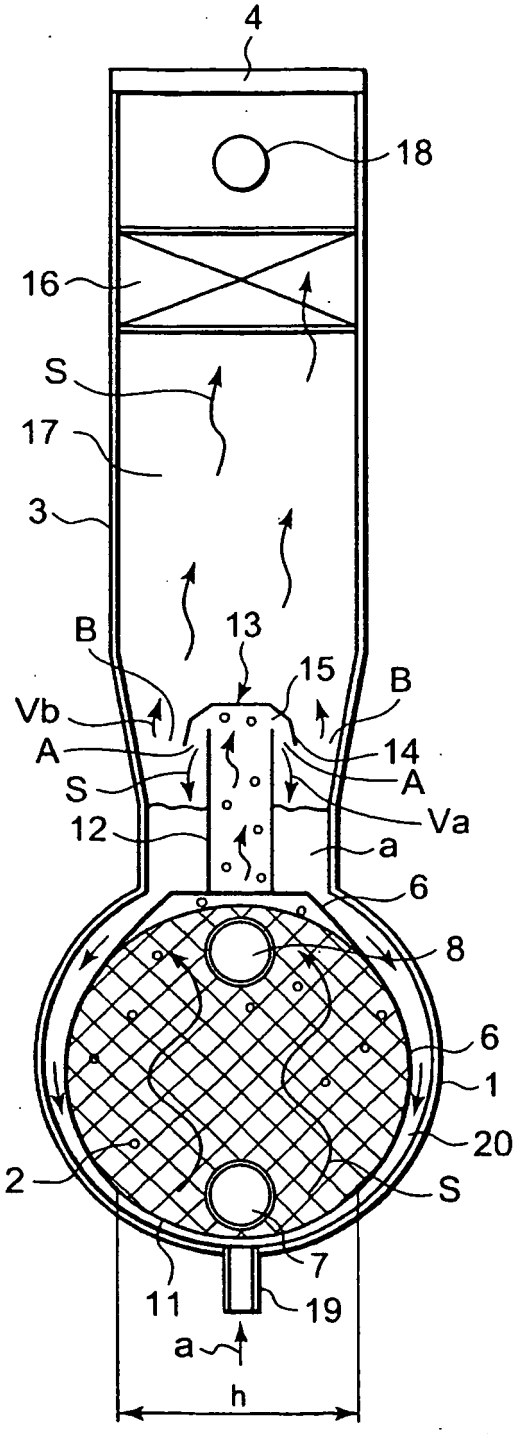


FIG. 2

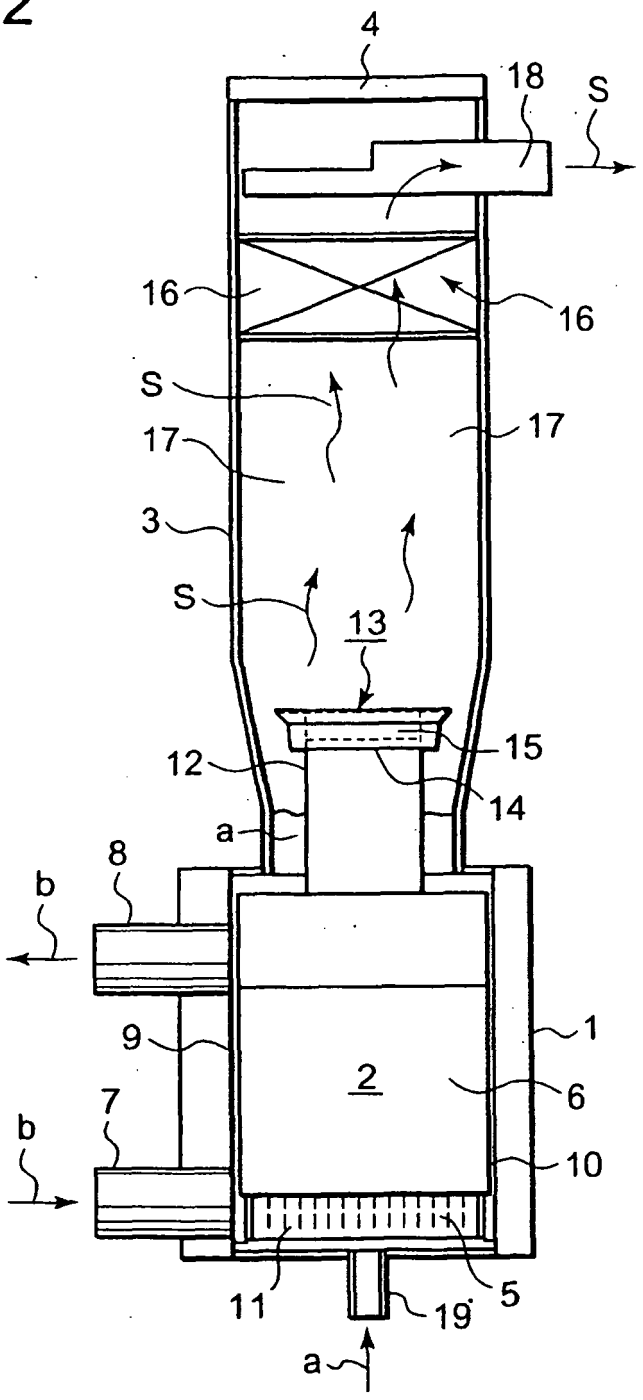


FIG. 3

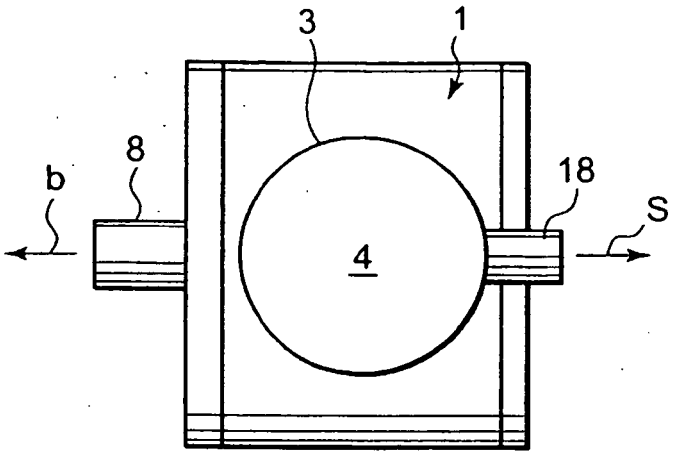
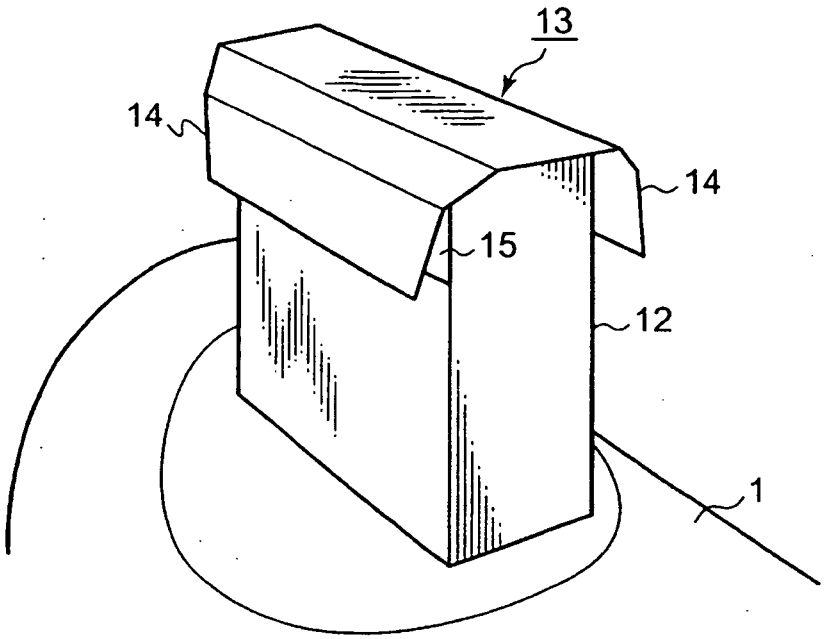


FIG. 4



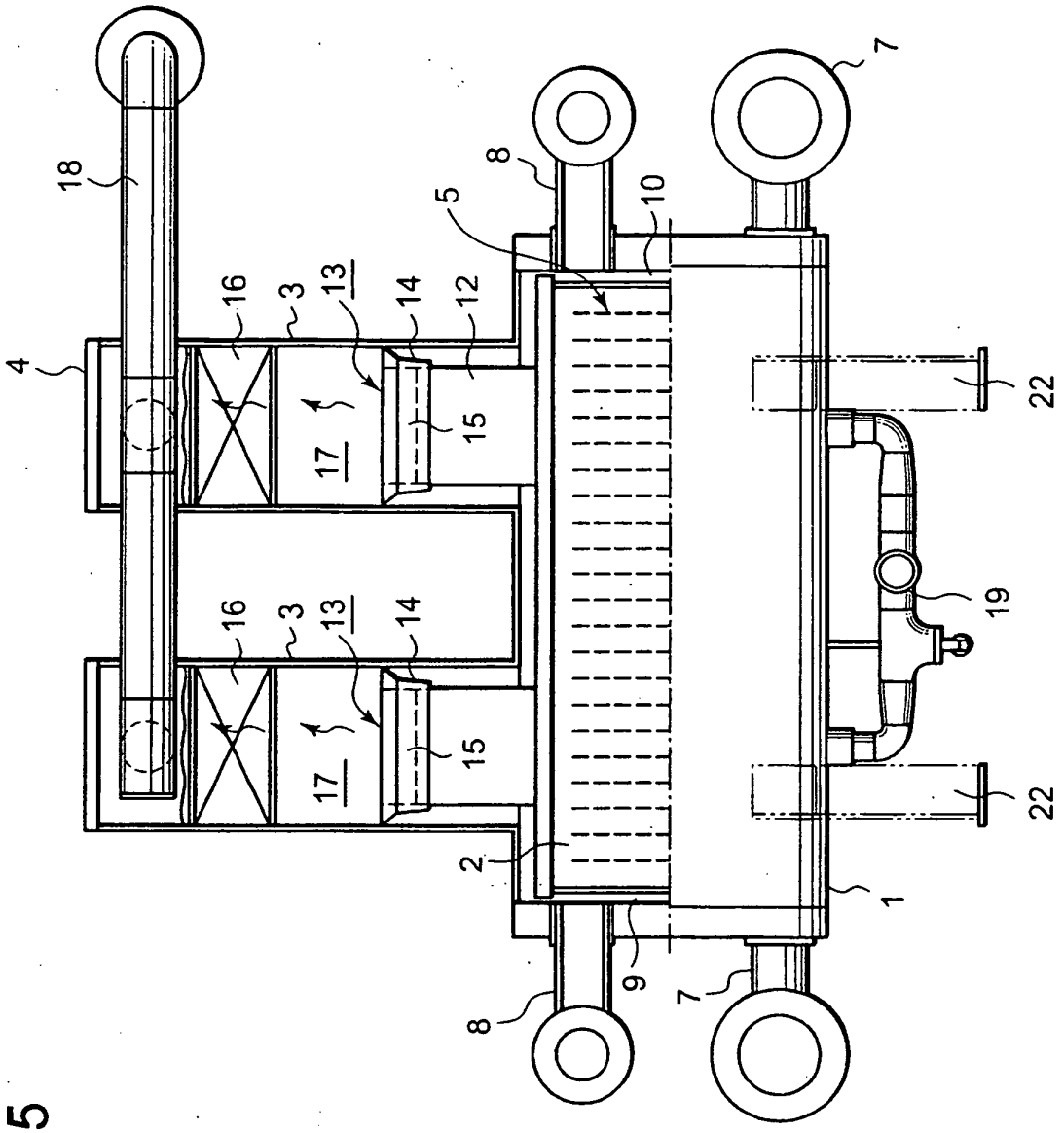
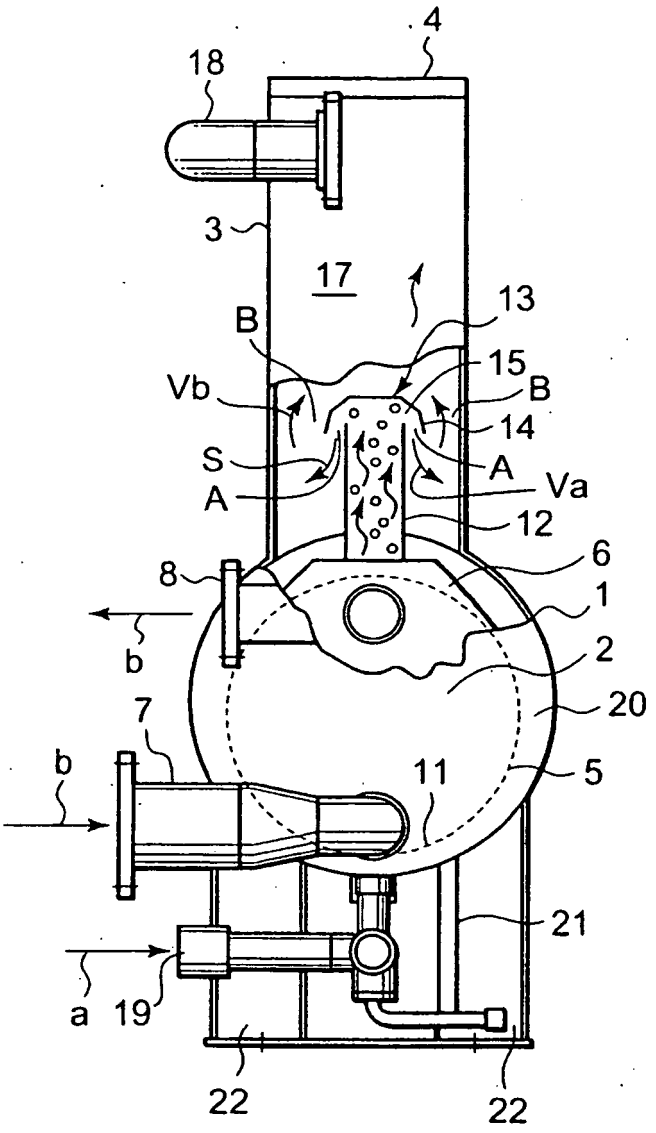


FIG. 5

FIG. 6



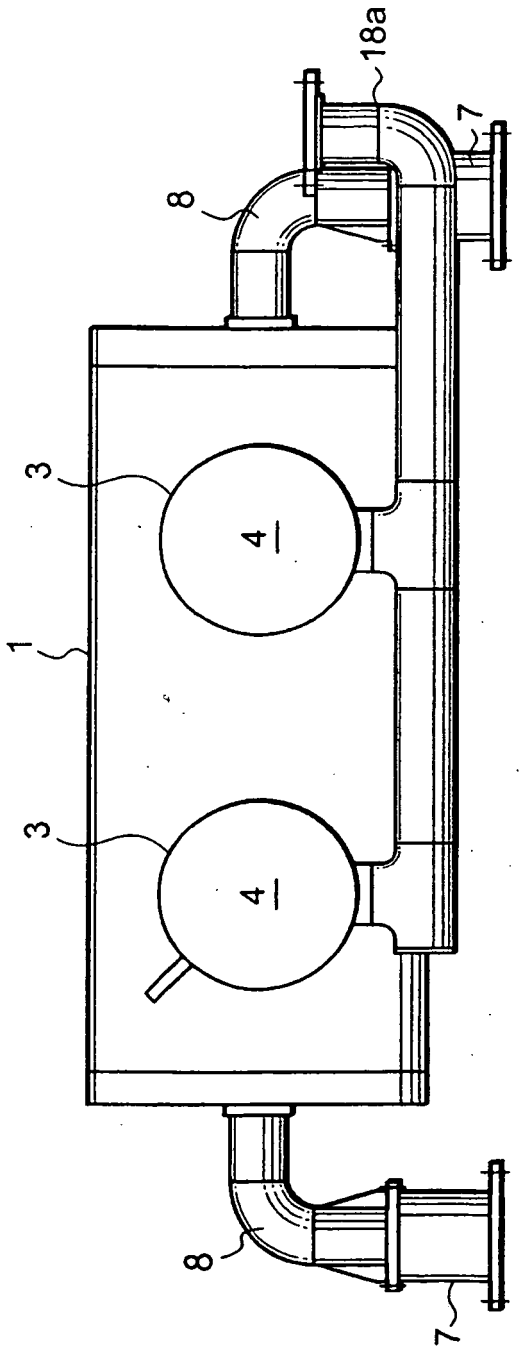


FIG. 7

FIG. 8

PRIOR ART

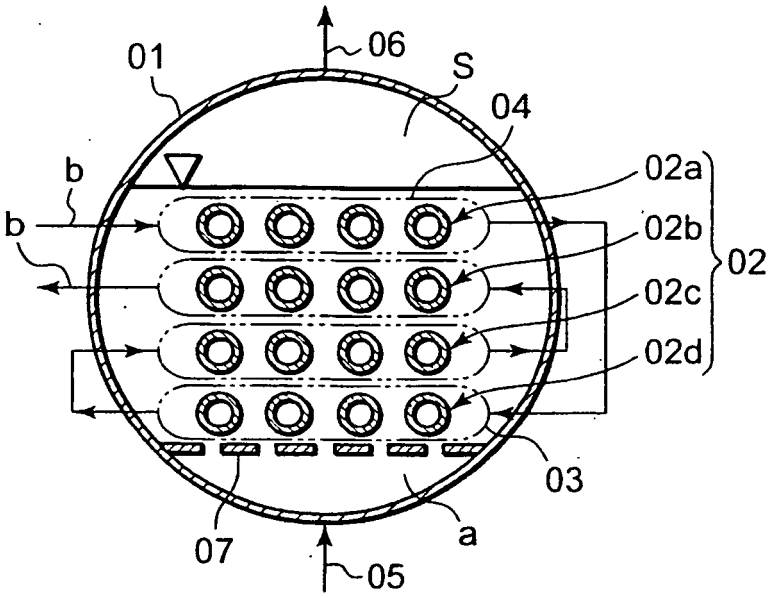


FIG. 9A

PRIOR ART

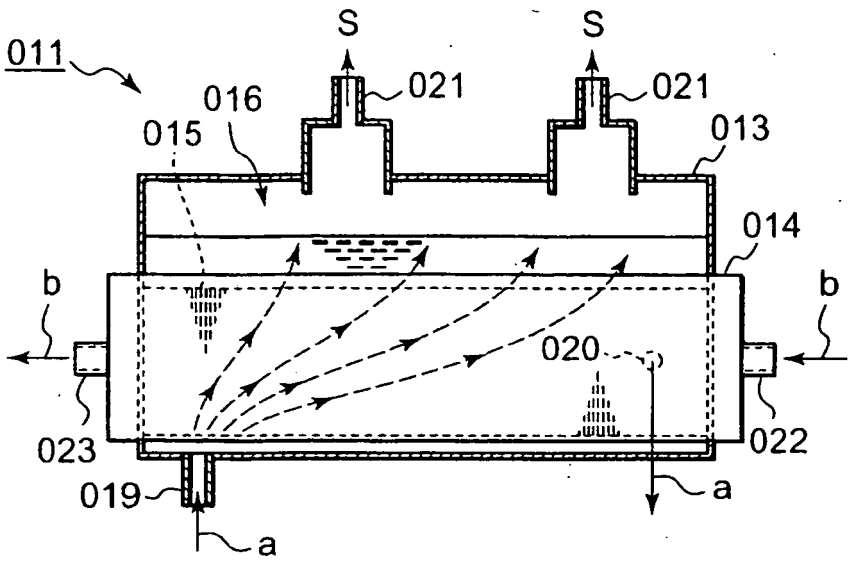
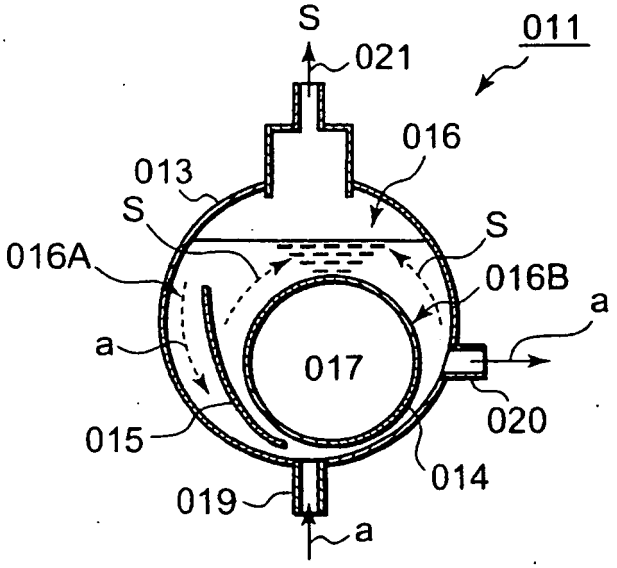


FIG. 9B

PRIOR ART



REFERENCES CITED IN THE DESCRIPTION

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