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(54) EVAPORATOR ASSEMBLY

(57) Provided in the present application is an evaporator assembly, comprising an evaporator and at least one oil cooler. The evaporator comprises an evaporator housing for accommodating a refrigerant. The oil cooler comprises an oil cooler housing and at least one oil cooler heat exchange pipe which is arranged in the oil cooler housing and used for receiving a fluid to be cooled. The evaporator housing comprises at least one evaporator housing opening. The oil cooler housing comprises at least one oil cooler housing opening which is in fluid communication with the at least one corresponding evaporator housing opening. The positions of the evaporator and the oil cooler are configured such that at least a portion of the liquid refrigerant in the evaporator housing can flow into the oil cooler housing via the evaporator housing opening and the corresponding oil cooler housing opening by gravity so as to be used for cooling the fluid to be cooled in the oil cooler heat exchange pipe. **In** addition, a gaseous refrigerant in the oil cooler housing can also flow back into the evaporator housing via the oil cooler housing opening and the corresponding evaporator housing opening.

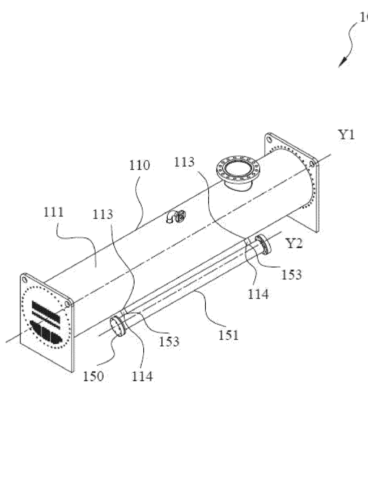

FIG. 1

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Description

Technical Field

[0001] The present application relates to an evaporator assembly, particularly an evaporator assembly for a chiller unit or a heat pump unit.

Background Art

[0002] A compressor in a refrigeration system of a chiller unit and a heat pump unit does work to compress a low-temperature, low-pressure refrigerant gas drawn from an evaporator into a high-temperature, high-pressure refrigerant gas. In this process, the temperature of a lubricating oil will increase after it flows through bearings of the compressor. The high-temperature lubricating oil, if directly pumped into the compressor without being cooled, will have a higher oil temperature after it flows through bearings of the compressor. Excessively high oil temperature, due to reduced viscosity, will lead to insufficient lubrication and ultimately cause serious compressor reliability issues. Therefore, it is necessary to cool the lubricating oil used in the compressor to ensure the compressor works properly. In the chiller unit and the heat pump unit, there is also a need to cool other fluids in some cases. For example, it may be necessary to cool an ethylene glycol solution used for cooling a variable frequency drive. Thus, depending on specific conditions of the chiller unit or the heat pump unit being used, it is necessary to cool the compressor lubricating oil, other fluids such as ethylene glycol solution, or to cool both the compressor lubricating oil and other fluids such as ethylene glycol solution simultaneously.

Summary of the Invention

[0003] The present application provides an evaporator assembly and a chiller unit or a heat pump unit comprising the evaporator assembly. The evaporator assembly according to the present application comprises an evaporator and an oil cooler that are connected to each other, a refrigerant in the evaporator flowing into the oil cooler by gravity to cool the fluid to be cooled in the oil cooler. The evaporator assembly of the present application has a simple structure, is easy to manufacture, and enables the use of the refrigerant in the evaporator to cool the fluid to be cooled in the oil cooler as soon as the chiller unit or the heat pump unit is started.

[0004] According to one aspect of the present application, the present application provides an evaporator assembly. The evaporator assembly comprises an evaporator and at least one oil cooler. The evaporator comprises an evaporator housing for accommodating a refrigerant. The at least one oil cooler comprises an oil cooler housing and at least one oil cooler heat exchange pipe arranged in the oil cooler housing, the at least one oil cooler heat exchange pipe being used for receiving a fluid to be cooled. The evaporator housing comprises at least one evaporator housing opening, the oil cooler housing comprises at least one oil cooler housing opening, and the at least one evaporator housing opening is in fluid communication with at least one corresponding oil cooler housing opening. The positions of the evaporator and the at least one oil cooler are configured such that at least a portion of a liquid refrigerant accommodated in the evaporator housing can flow into the oil cooler housing via the at least one evaporator housing opening and the at least one corresponding oil cooler housing opening by gravity so as to be used for cooling the fluid to be cooled in the at least one oil cooler heat exchange pipe. A gaseous refrigerant in the oil cooler housing can also flow back into the evaporator housing via the at least one oil cooler housing opening and at least one corresponding evaporator housing opening.

[0005] In the evaporator assembly described above, the positions of the evaporator and the at least one oil cooler are configured such that an actual liquid level of the liquid refrigerant in the evaporator housing is higher than an actual liquid level of the liquid refrigerant in the oil cooler housing.

[0006] In the evaporator assembly described above, the oil cooler housing and the evaporator housing are connected by at least one connecting pipe so that the at least one evaporator housing opening is in fluid communication with the at least one corresponding oil cooler housing opening.

[0007] In the evaporator assembly described above, the evaporator housing and the oil cooler housing are directly connected at the at least one evaporator housing opening and the at least one corresponding oil cooler housing opening, respectively, so that the at least one evaporator housing opening is in fluid communication with the at least one corresponding oil cooler housing opening.

[0008] In the evaporator assembly described above, the evaporator housing is cylindrical and has a longitudinal axis Y1 extending along a length direction of the evaporator housing, and the at least one evaporator housing opening is located on a cylindrical surface of the evaporator housing. The oil cooler housing is cylindrical and has a longitudinal axis Y2 extending along a length direction of the oil cooler housing, and the at least one oil cooler housing opening is located on a cylindrical surface of the oil cooler housing. The longitudinal axis Y2 of the oil cooler housing is substantially parallel to the longitudinal axis Y1 of the evaporator housing.

[0009] In the evaporator assembly described above, the evaporator housing is cylindrical and has a longitudinal axis Y1 extending along a length direction of the evaporator housing, and the at least one evaporator housing opening is located on a cylindrical surface of the evaporator housing. The oil cooler housing is cylindrical and has a longitudinal axis Y2 extending along a length direction of the oil cooler housing, and the at least one oil cooler housing opening is located on a cylindrical surface of the oil cooler housing. The longitudinal axis Y2 of the oil cooler housing is substantially perpendicular to the longitudinal axis Y1 of the evaporator housing.

[0010] In the evaporator assembly described above, the evaporator housing is cylindrical and has a longitudinal axis Y1 extending along a length direction of the evaporator housing, and the at least one evaporator housing opening is located on a cylindrical surface of the evaporator housing. The oil cooler housing is cylindrical and has a longitudinal axis Y2 extending along a length direction of the oil cooler housing, and the at least one oil cooler housing opening is located at one end of the oil cooler housing. The longitudinal axis Y2 of the oil cooler housing is substantially perpendicular to the longitudinal axis Y1 of the evaporator housing.

[0011] In the evaporator assembly described above, the at least one oil cooler heat exchange pipe extends between two ends of the oil cooler housing. The at least one oil cooler further comprises an internal support plate, a first end support plate and a second end support plate, as well as a first cover plate and a second cover plate. The internal support plate is accommodated in the oil cooler housing, the internal support plate has at least one internal support plate hole arranged thereon, and the at least one oil cooler heat exchange pipe is inserted into the at least one internal support plate hole, respectively. The first end support plate and the second end support plate are arranged at the two ends of the oil cooler housing, respectively, the first end support plate and the second end support plate have at least one end support plate hole arranged thereon, and the at least one oil cooler heat exchange pipe is inserted into the at least one end support plate hole, respectively. The first cover plate and the second cover plate are arranged at the two ends of the oil cooler housing, respectively, and cover the first end support plate and the second end support plate respectively, and the first cover plate has a fluid-to-be-cooled inlet and a fluid-to-be-cooled outlet arranged thereon.

[0012] In the evaporator assembly described above, the first cover plate and the second cover plate are configured such that the fluid to be cooled flows in the at least one oil cooler heat exchange pipe for a predetermined number of passes.

[0013] In the evaporator assembly described above, the first cover plate comprises a first inner surface, a first periphery, a first cover plate first guide plate, and a first cover plate second guide plate. The first inner surface faces the first end support plate. The first periphery extends from the first inner surface towards the first end support plate and abuts the first end support plate, and the first periphery and the first inner surface define a first cavity of the first cover plate. The first cover plate first guide plate is located in the first cavity, extends from the first inner surface towards the first end support plate and abuts the first end support plate, and the first cover plate first guide plate divides the first cavity into a first region and a second region. The first cover plate second guide plate is located in the second region of the first cavity, extends from the first inner surface towards the first end support plate and abuts the first end support plate, the first cover plate second guide plate is perpendicular to the first cover plate first guide plate and divides the second region into a third region and a fourth region, and the fluid-to-be-cooled inlet and the fluid-to-be-cooled outlet are located in the third region and the fourth region, respectively. The second cover plate comprises: a second inner surface, a second periphery, and a second cover plate guide plate. The second inner surface faces the second end support plate. The second periphery extends from the second inner surface towards the second end support plate and abuts the second end support plate, and the second periphery and the second inner surface define a second cavity of the second cover plate. The second cover plate guide plate divides the second cavity into a fifth region and a sixth region, and the second cover plate guide plate is perpendicular to the first cover plate first guide plate.

[0014] In the evaporator assembly described above, the at least one oil cooler heat exchange pipe is accommodated in the oil cooler housing in the form of a coil. The at least one oil cooler further comprises a spacer, a cover plate, a fluid-to-be-cooled reception pipe, and a fluid-to-be-cooled discharge pipe. The spacer is arranged between adjacent ones of the at least one oil cooler heat exchange pipe. The cover plate is arranged at an end of the oil cooler housing opposite to the at least one oil cooler housing opening, and the cover plate has an inlet and an outlet arranged thereon. The fluid-to-be-cooled reception pipe is inserted into and fixed to the inlet and is in fluid communication with the at least one oil cooler heat exchange pipe, and the fluid-to-be-cooled reception pipe is used for receiving the fluid to be cooled and guiding the fluid to be cooled into the at least one oil cooler heat exchange pipe. The fluid-to-be-cooled discharge pipe is inserted into and fixed to the outlet and is in fluid communication with the at least one oil cooler heat exchange pipe, and the fluid-to-be-cooled discharge pipe is used for receiving and discharging the fluid to be cooled from the at least one oil cooler heat exchange pipe.

[0015] In the evaporator assembly described above, the evaporator comprises at least one evaporator heat exchange pipe, end pipe plates, and an internal pipe plate. The at least one evaporator heat exchange pipe is arranged in the evaporator housing and is used for receiving a liquid to be cooled. The end pipe plates are arranged at two ends of the evaporator housing, and the end pipe plates have at least one end pipe plate hole arranged thereon, the at least one evaporator heat exchange pipe being inserted into and fixed to the at least one end pipe plate hole, respectively. The internal pipe plate is arranged within the evaporator housing, the internal pipe plate has at least one internal pipe plate hole arranged thereon, and the at least one evaporator heat exchange pipe passes through the at least one internal pipe plate hole, respectively, wherein each of the at least one evaporator housing opening is located at a position near one of the end pipe plates and the internal pipe plate, and wherein the internal pipe plate near the at least one evaporator housing opening is fixedly connected to the at least one evaporator heat exchange pipe.

[0016] According to another aspect of the application, the present application provides a chiller unit or heat pump unit, comprising the evaporator assembly according to the present application.

Brief Description of the Drawings

[0017] In the following, exemplary embodiments of the present invention will be described in detail with reference to the accompanying drawings, in which:

FIG. 1 is a perspective view of an evaporator assembly according to one embodiment of the present application.
FIG. 2 is a perspective view of an oil cooler in the evaporator assembly shown in FIG. 1, with the housing omitted.
FIG. 3 is a perspective view of two cover plates located at two ends of the oil cooler shown in FIG. 2.
FIG. 4 is a perspective view of an evaporator in the evaporator assembly shown in FIG. 1, with the housing omitted.
FIG. 5 is a perspective view of an evaporator assembly according to another embodiment of the present application.
FIG. 6 is a perspective view of an evaporator assembly according to yet another embodiment of the present application.
FIG. 7 is an exploded perspective view of the evaporator and oil cooler in the evaporator assembly shown in FIG. 6.
FIG. 8 is a perspective view of an evaporator assembly according to yet another embodiment of the present application.
FIG. 9 is an exploded perspective view of the evaporator and oil cooler in the evaporator assembly shown in FIG. 8.
FIG. 10 is a front view of the evaporator assembly shown in FIG. 8.
FIG. 11a shows a plan view of several oil cooler heat exchange pipes in an unwound state in the oil cooler shown in FIG. 8.
FIG. 11b shows a top view of an oil cooler accommodating an arrangement of an oil cooler heat exchange pipe coil, with the oil cooler heat exchange pipe coil being formed by winding the oil cooler heat exchange pipe shown in FIG. 11a.
FIG. 11c shows a spacer for insertion into the coil of the oil cooler shown in FIG. 11b.
FIG. 11d shows a schematic top view of a spacer when it is inserted into the oil cooler heat exchange pipe coil shown in FIG. 11b.
FIG. 11e shows a top view of another arrangement of an oil cooler heat exchange pipe coil formed by winding the oil cooler heat exchange pipe shown in FIG. 11a.

Detailed Description of Embodiments

[0018] Various specific implementations of the present application will be described below with reference to the accompanying drawings, which constitute a part of this specification. It should be understood that, where possible, the same or similar reference numerals used in the present application refer to the same components.

[0019] In a heat pump unit or a chiller unit, a refrigerant gas, after passing through a condenser, is condensed and liquefied. After passing through the throttle valve, the liquid refrigerant turns into a low-temperature gas-liquid two-phase mixture and enters an evaporator. It undergoes heat exchange with the liquid to be cooled (e.g., water) that enters the evaporator heat exchange pipes, is vaporized, and cools the liquid to be cooled that enters the evaporator heat exchange pipes. The vaporized refrigerant then enters a compressor and is compressed into a high-temperature, high-pressure refrigerant gas, and returns to the condenser, which cycle repeats continuously. Through the working cycle of the refrigerant, a working product of the heat pump unit or chiller unit is obtained, such as cold water or hot water.

[0020] The present application further utilizes the low-temperature liquid refrigerant entering the evaporator to cool the fluid used during the operation of the heat pump unit or the chiller unit (hereinafter referred to as "fluid to be cooled"). Such fluids to be cooled include but are not limited to a compressor lubricating oil, ethylene glycol solution used to cool a variable frequency drive, etc. The present application connects an oil cooler to an evaporator to form an evaporation assembly, thereby utilizing the low-temperature liquid refrigerant in the evaporator to cool the fluid to be cooled used during the operation of the heat pump unit or the chiller unit.

[0021] FIG. 1 is a perspective view of an evaporator assembly 100 according to one embodiment of the present application. As shown in FIG. 1, the evaporator assembly 100 comprises an evaporator 110 and an oil cooler 150 that are connected to each other. The evaporator 110 comprises an evaporator housing 111, the evaporator housing 111 being used for accommodating a refrigerant. The evaporator housing 111 is cylindrical and has a longitudinal axis Y1 extending along its length direction. The oil cooler 150 comprises an oil cooler housing 151. The oil cooler housing 151 is cylindrical and has a longitudinal axis Y2 along its length direction. As shown in FIG. 1, the longitudinal axis Y2 of the oil cooler housing 151 is substantially parallel to the longitudinal axis Y1 of the evaporator housing 111, which makes it possible to connect an oil cooler 150 with a longer axial length onto the evaporator housing 111 without occupying additional installation space. The longer axial length of the oil cooler 150 is capable of providing a longer flow pass for a fluid to be cooled within the oil cooler heat exchange pipes 152 (shown in FIG. 2), which is advantageous in cooling the fluid to be cooled. When the longitudinal axis Y2 of the oil cooler housing 151 is arranged substantially parallel to the longitudinal axis Y1 of the evaporator housing 111, the axial length of the oil cooler housing 151 is designed such that the oil cooler heat exchange pipes 152 (shown in FIG. 2) can be withdrawn from the oil cooler housing 151 without moving the evaporator assembly 100, allowing for replacement of the oil cooler heat exchange pipe 152 when necessary.

[0022] A cylindrical surface of the oil cooler housing 151 has two oil cooler housing openings 153 arranged thereon, which are located near two ends of the oil cooler housing 151, respectively. Correspondingly, a cylindrical surface of the evaporator housing 111 also has two evaporator housing openings 113 arranged thereon, which are in fluid communication with corresponding oil cooler housing openings 153, respectively, via connecting pipes 114. In one embodiment, two ends of the connecting pipe 114 are connected to the evaporator housing 111 and the oil cooler housing 151, respectively, by welding. The positions of the evaporator 110 and the oil cooler 150 are configured such that an actual liquid level of a liquid refrigerant in the evaporator housing 111 is higher than an actual liquid level of a liquid refrigerant in the oil cooler housing 151, so that at least a portion of the liquid refrigerant accommodated in the evaporator housing 111 can flow into the oil cooler housing 151 by gravity via the two evaporator housing openings 113 and the corresponding oil cooler housing openings 153. The actual liquid level refers to the level of the liquid refrigerant in the evaporator housing 111 and the oil cooler housing 151 when the liquid refrigerant is not boiling. The liquid refrigerant entering the oil cooler housing 151 undergoes heat exchange within the oil cooler housing 151 with the fluid to be cooled that enters the oil cooler heat exchange pipes 152 (shown in FIG. 2) in the oil cooler housing 151 to enable cooling of the fluid to be cooled. After the heat exchange with the fluid to be cooled, the liquid refrigerant entering the oil cooler housing 151 absorbs heat and transforms into a gaseous state. The gaseous refrigerant can flow back into the evaporator housing 111 via the two oil cooler housing openings 153 and the corresponding evaporator housing openings 113. FIG. 1 shows that one oil cooler 150 is connected to the evaporator 110. It should be understood that more oil coolers can be connected to the evaporator 110 as needed.

[0023] FIG.1 shows that two oil cooler housing openings 153 are arranged at positions of the oil cooler housing 151 near its two ends, which makes it possible for the gaseous refrigerant in the oil cooler housing 151 to exit promptly through a nearby oil cooler housing opening 153, when the oil cooler housing 151 has a longer axial length. This prevents the issue where the gaseous refrigerant at one end of the oil cooler housing 151 has to travel to an oil cooler housing opening 153 at the other end of the oil cooler housing before it can exit the oil cooler housing 151, which could otherwise lead to excessive pressure within the oil cooler housing 151. Moreover, the two oil cooler housing openings 153 are arranged near the two ends of the oil cooler housing 151, so that the connection between the oil cooler housing 151 and the evaporator housing 111 is realized via two connecting pipes 114, which makes the connection between the oil cooler housing 151 and the evaporator housing 111 more solid. It should be understood that, in other embodiments, a different number of oil cooler housing openings 153 and the corresponding number of evaporator housing openings 113 can be arranged, such as one, or three or more.

[0024] FIG. 2 is a perspective view of the oil cooler 150 shown in FIG. 1, with the oil cooler housing 151 omitted. As shown in FIG. 2, the oil cooler heat exchange pipe 152 extending between the two ends of the oil cooler housing 151 is arranged in the oil cooler housing 151 for receiving the fluid to be cooled. When the liquid refrigerant in the evaporator 110 enters the oil cooler housing 151, the fluid to be cooled in the oil cooler heat exchange pipes 152 can undergo heat exchange with the liquid refrigerant to enable cooling, while the liquid refrigerant transforms into a gaseous state. FIG. 2 shows several oil cooler heat exchange pipes 152. It should be understood that the number of oil cooler heat exchange pipes 152 can be set as needed, and may be one or more.

[0025] With continued reference to FIG. 2, the oil cooler 150 further comprises two end support plates 157 and 158, which are arranged at the two ends of the oil cooler housing 151, respectively. End support plate holes 159 are arranged on both end support plates 157 and 158, and the oil cooler heat exchange pipes 152 are inserted into the corresponding end support plate holes 159. FIG. 2 shows several end support plate holes 159. It should be understood that the number of end support plate holes 159 can be set as needed. The oil cooler 150 further comprises an internal support plate 155 accommodated within the oil cooler housing 151. Internal support plate holes 156 are arranged on the internal support plate 155, and the oil cooler heat exchange pipes 152 are inserted through the corresponding internal support plate holes 156. The oil cooler heat exchange pipes 152 are inserted into the end support plate holes 159 and the internal support plate holes 156, so that when one or some of the oil cooler heat exchange pipes 152 need to be maintained and replaced, the oil cooler heat exchange pipes 152 that are required to be maintained and replaced can be withdrawn from the oil cooler housing 151, and a maintained or replacement oil cooler heat exchange pipe 152 can be inserted. FIG. 2 shows one internal support plate 155. It should be understood that, in other embodiments, a greater number of internal support plates 155 can be arranged as needed. FIG. 2 shows that several internal support plate holes 156 are arranged on the internal support plate 155. It should be understood that the number of internal support plate holes 156 can be set as needed. The arrangement of the internal support plate

155 having internal support plate holes 156 within the oil cooler housing 151 to receive the oil cooler heat exchange pipes 152 is advantageous in securing the oil cooler heat exchange pipes 152 and preventing them from being damaged. Specifically, the temperature difference between the refrigerant entering the oil cooler housing 151 and the fluid to be cooled within the oil cooler heat exchange pipes 152 is high, causing the refrigerant to vaporize and violently boil within the oil cooler housing 151. This results in vibrations of the oil cooler heat exchange pipes 152 within the oil cooler 150. Therefore, it is important to securely install the oil cooler heat exchange pipes 152 to prevent the oil cooler heat exchange pipes 152 from being damaged or broken due to vibrations.

[0026] As further shown in FIG. 2, the oil cooler 150 comprises two cover plates 160 and 161, which are arranged at the two ends of the oil cooler housing 151 and cover the two end support plates 157 and 158, respectively. The cover plate 160 has a fluid-to-be-cooled inlet 181 and a fluid-to-be-cooled outlet 182 arranged thereon (shown in FIGS. 3 and 4). The cover plates 160 and 161 are configured such that the fluid to be cooled flows in the oil cooler heat exchange pipes 152 for a predetermined number of passes to enable cooling of the fluid to be cooled. When the fluid to be cooled flows from one end of the oil cooler heat exchange pipes 152 to the other end, it completes one pass. FIG. 3 shows an embodiment of the configuration of the cover plates 160 and 161, in which the fluid to be cooled can flow in the oil cooler heat exchange pipes 152 for four passes.

[0027] As shown in FIG. 3, the cover plate 160 comprises an inner surface 164 and a periphery 166. The inner surface 164 faces the end support plate 157, and the periphery 166 extends from the inner surface 164 towards the end support plate 157 and abuts the end support plate 157. The periphery 166 and the inner surface 164 define a cavity 168 of the cover plate 160. The cover plate 160 comprises a first guide plate 170 and a second guide plate 171 that are arranged within the cavity 168. The first guide plate 170 extends from the inner surface 164 towards the end support plate 157 to the same height as the periphery 166 to abut the end support plate 157 and divides the cavity 168 into a first region 173 and a second region 174. The second guide plate 171 is located in the second region 174 and extends from the inner surface 164 towards the end support plate 157 to the same height as the periphery 166 to abut the end support plate 157. The second guide plate 171 is perpendicular to the first guide plate 170 and further divides the second region 174 into a third region 175 and a fourth region 176. The fluid-to-be-cooled inlet 181 is arranged in the third region 175 and penetrates through the cover plate 160, and the fluid-to-be-cooled outlet 182 is arranged in the fourth region 176 and penetrates through the cover plate 160. Since the first guide plate 170 and the second guide plate 171 extend to the same height as the periphery 166 to abut the end support plate 157, the first region 173, the third region 175, and the fourth region 176 are not in communication with each other. In one embodiment, the first region 173 and the second region 174 may be of the same size, and the third region 175 and the fourth region 176 may also be of the same size.

[0028] The cover plate 161 comprises an inner surface 165 and a periphery 167. The inner surface 165 faces the end support plate 158, and the periphery 167 extends from the inner surface 165 towards the end support plate 158 and abuts the end support plate 158. The periphery 167 and the inner surface 165 define a cavity 169 of the second cover plate 161. The cover plate 161 comprises a guide plate 172, and the guide plate 172 is arranged in the cavity 169, is perpendicular to the first guide plate 170 of the cover plate 160, and divides the cavity 169 into a fifth region 177 and a sixth region 178. The guide plate 172 extends from the inner surface 165 towards the end support plate 158 to the same height as the periphery 167 to abut the end support plate 158, which causes the fifth region 177 and the sixth region 178 not to be in communication. In one embodiment, the fifth region 177 and the sixth region 178 may be of the same size.

[0029] The first region 173 of the cover plate 160 is in communication with the fifth region 177 and the sixth region 178 of the cover plate 161 through some of the oil cooler heat exchange pipes 152. The third region 175 of the cover plate 160 is in communication with the sixth region 178 of the cover plate 161 through some of the oil cooler heat exchange pipes 152. The fourth region 176 of the cover plate 160 is in communication with the fifth region 177 of the cover plate 161 through some of the oil cooler heat exchange pipes 152. The fluid to be cooled from the fluid-to-be-cooled inlet 181 enters the third region 175 of the cover plate 160 and reaches the sixth region 178 of the cover plate 161 through the oil cooler heat exchange pipes 152 connecting the third region 175 of the cover plate 160 and the sixth region 178 of the cover plate 161. At this point, the fluid to be cooled completes the first pass. Next, the fluid to be cooled that has entered the sixth region 178 of the cover plate 161 enters the first region 173 of the cover plate 160 via the oil cooler heat exchange pipes 152 connecting the sixth region 178 and the first region 173 of the cover plate 160. At this point, the fluid to be cooled completes two passes. Subsequently, the fluid to be cooled that has entered the first region 173 of the cover plate 160 enters the fifth region 177 of the cover plate 161 via the oil cooler heat exchange pipes 152 connecting the first region 173 of the cover plate 160 and the fifth region 177 of the cover plate 161. At this point, the fluid to be cooled completes three passes. Finally, the fluid to be cooled that has entered the fifth region 177 of the cover plate 161 reaches the fourth region 176 of the cover plate 160 via the oil cooler heat exchange pipes 152 connecting the fifth region 177 of the cover plate 161 and the fourth region 176 of the cover plate 160. At this point, the fluid to be cooled completes four passes. After reaching the fourth region 176, the fluid to be cooled is discharged through the fluid-to-be-cooled outlet 182 arranged in the fourth region 176. The fluid to be cooled achieves cooling by completing four passes of flow in the oil cooler heat exchange pipes 152.

[0030] FIG. 4 is a perspective view of the evaporator 110 shown in FIG. 1, with the evaporator housing 111 omitted. As shown in FIG. 4, the evaporator 110 comprises evaporator heat exchange pipes 112 arranged in the evaporator housing 111 and extending between two ends of the evaporator housing 111 for receiving the liquid to be cooled (such as water). The liquid refrigerant in the evaporator housing 111 undergoes heat exchange with the liquid to be cooled (such as water) in the evaporator heat exchange pipes 112 so as to enable the chiller unit or the heat pump unit to produce the desired working product. The liquid to be cooled in the evaporator heat exchange pipes 112 is cooled by undergoing heat exchange with the liquid refrigerant entering the housing 111 of the evaporator 110. FIG. 4 shows several evaporator heat exchange pipes 112. It should be understood that the number of evaporator heat exchange pipes 112 can be set as needed, and may be one or more.

[0031] As further shown in FIG. 4, the evaporator 110 comprises end pipe plates 117 arranged at two ends of the evaporator housing 111. The end pipe plates 117 have end pipe plate holes 119 arranged thereon, and the evaporator heat exchange pipes 112 are inserted and fixed (such as adhesively fixed) into the corresponding end pipe plate holes 119. The evaporator 110 further comprises internal pipe plates 115 arranged within the evaporator housing 111. The internal pipe plates 115 have internal pipe plate holes 116 arranged thereon. The evaporator heat exchange pipes 112 are inserted through the corresponding internal pipe plate holes 116. It should be understood that the number of end pipe plate holes 119 and internal pipe plate holes 116 can be set as needed.

[0032] In one embodiment where two evaporator housing openings 113 are arranged, the two evaporator housing openings 113 are arranged near the two internal pipe plates 115, respectively (as shown in FIG. 1). The internal pipe plates 115 near the evaporator housing openings 113 are fixedly connected (such as by expansion jointing) to the evaporator heat exchange pipes 112 inserted therein. In an embodiment where one evaporator housing opening 113 is arranged, the evaporator housing opening 113 is arranged near the end pipe plate 117 or the internal pipe plate 115 that is fixedly connected to the evaporator heat exchange pipes 112. It should be understood that, since the evaporator heat exchange pipes 112 are fixedly connected to the end pipe plate holes 119, arranging the evaporator housing opening 113 at the end pipe plate 117 is advantageous in preventing damage to or breakage of the evaporator heat exchange pipes 112 at the evaporator housing opening 113. Specifically, the refrigerant gas in the oil cooler housing 151 enters the evaporator housing 111 via the evaporator housing opening 113, resulting in a large number of bubbles at the evaporator housing opening 113. This phenomenon causes vibration of the evaporator heat exchange pipes 112 at the evaporator housing opening 113. The fixed connection between the end pipe plates 117 and the evaporator heat exchange pipes 112 is advantageous in preventing damage to or breakage of the evaporator heat exchange pipes 112 near the end pipe plates 117 of the evaporator 110 due to vibration. To prevent damage to or breakage of the evaporator heat exchange pipes 112 due to vibration, if the evaporator housing opening 113 is not arranged at a position near an end of the evaporator housing 111, it should be arranged at a position near the internal pipe plate 115, with the internal pipe plate 115 near the evaporator housing opening 113 being fixedly connected to the evaporator heat exchange pipes 112 inserted through the internal pipe plate 115.

[0033] FIG. 5 shows a perspective view of an evaporator assembly 200 according to another embodiment of the present application. The evaporator assembly 200 comprises an evaporator 210 and an oil cooler 250. Similar to the embodiment of FIG. 1, the evaporator 210 and the oil cooler 250 are also connected by a connecting pipe (not shown). Moreover, the evaporator 210 has a structure similar to that of the evaporator 110 in the embodiment of FIG. 1, and the oil cooler 250 has a structure similar to that of the oil cooler 150 in the embodiment of FIG. 1. The only difference between the embodiment of FIG. 5 and the embodiment of FIG. 1 is that a longitudinal axis Y1 of an evaporator housing 211 and a longitudinal axis Y2 of an oil cooler housing 251 are arranged perpendicular to one another. This arrangement allows that the operation of withdrawing the oil cooler heat exchange pipes from the oil cooler housing 251 is not interfered with by the end plate 217 of the evaporator 210 when maintenance or replacement of the oil cooler heat exchange pipes in the oil cooler housing 251 is required. Although two oil coolers 250 are shown in FIG. 5, it should be understood that a different number of oil coolers 250 can be arranged in other embodiments.

[0034] FIG. 6 shows a perspective view of an evaporator assembly 300 according to another embodiment of the present application. The evaporator assembly 300 comprises an evaporator 310 and an oil cooler 350. The evaporator 310 has a structure similar to that of the evaporator 110 in the embodiment of FIG. 1. The oil cooler 350 has a structure similar to that of the oil cooler 150 in the embodiment of FIG. 1. The difference between the embodiment of FIG. 6 and the embodiment of FIG. 1 is that the evaporator 310 and the oil cooler 350 are directly connected, and a longitudinal axis Y1 of an evaporator housing 311 and a longitudinal axis Y2 of an oil cooler housing 351 are arranged perpendicular to one another. Although two oil coolers 350 are shown in FIG. 5, it should be understood that a different number of oil coolers 350 can be arranged in other embodiments.

[0035] FIG. 7 shows an exploded perspective view of the evaporator 310 and the oil cooler 350 in the evaporator assembly 300 shown in FIG. 6. As shown in FIG. 7, a cylindrical surface of the evaporator housing 311 has an evaporator housing opening 313 arranged thereon, and a cylindrical surface of the oil cooler housing 351 has an oil cooler housing opening 353 arranged thereon. The evaporator housing 311 and the oil cooler housing 351 are directly connected at their respective evaporator housing opening 313 and oil cooler housing opening 353. In one embodiment, the evaporator housing 311 and the oil cooler housing 351 are directly connected by welding.

[0036] FIG. 8 shows a perspective view of an evaporator assembly 400 according to yet another embodiment of the present application. The evaporator assembly 400 comprises an evaporator 410 and an oil cooler 450. The evaporator 410 has a cylindrical evaporator housing 411, and the oil cooler 450 has a cylindrical oil cooler housing 451. The evaporator housing 411 has a longitudinal axis extending along its length direction, and the oil cooler housing 451 has a longitudinal axis Y2 extending along its length direction. The longitudinal axis Y1 of the evaporator housing 411 and the longitudinal axis Y2 of the oil cooler housing 451 are substantially perpendicular. Although two oil coolers 450 are shown in FIG. 8, a different number of oil coolers 450 can be arranged in other embodiments.

[0037] FIG. 9 shows an exploded perspective view of the evaporator 410 and the oil cooler 450 in the evaporator assembly 400 shown in FIG. 8. As shown in FIG. 9, a cylindrical surface of the evaporator housing 411 has an evaporator housing opening 413 arranged thereon. The oil cooler 450 has an oil cooler housing opening 453 arranged at one end of the oil cooler housing 451 and a cover plate 480 at the end opposite to the oil cooler housing opening 453. The evaporator 410 and the oil cooler 450 are directly connected at their respective evaporator housing opening 413 and oil cooler housing opening 453 (see FIG. 8). In one embodiment, the evaporator housing 411 and the oil cooler housing 451 are directly connected by welding. FIG. 10 shows a front view of the evaporator assembly 400 shown in FIG. 8. As shown in FIG. 10, the cover plate 480 of the oil cooler 450 has an inlet 481 and an outlet 482 arranged thereon. The inlet 481 receives a fluid-to-be-cooled reception pipe 483, and the outlet 482 receives a fluid-to-be-cooled discharge pipe 484.

[0038] The evaporator 410 has a structure similar to that of the evaporator 110 in the embodiment of FIG. 1. The configuration of the oil cooler 450 will be discussed in conjunction with FIGS. 11c-11d. The oil cooler housing 451 accommodates therein an oil cooler heat exchange pipe coil formed by winding the oil cooler heat exchange pipes. FIG. 11a shows a plan view of several oil cooler heat exchange pipes 452 in an unwound state. FIG. 11b is a top view of the oil cooler 450, which shows that the oil cooler housing 451 accommodates therein an oil cooler heat exchange pipe coil 454 formed by winding the oil cooler heat exchange pipes 452.

[0039] FIG. 11a shows that several oil cooler heat exchange pipes 452 are distributed longitudinally along the oil cooler 450, with longitudinal gaps 492 between adjacent oil cooler heat exchange pipes 452. It should be understood that a different number of oil cooler heat exchange pipes 452 can also be arranged, such as one or more. One end of each of the several oil cooler heat exchange pipes 452 is connected to the fluid-to-be-cooled reception pipe 483, allowing the fluid to be cooled from the fluid-to-be-cooled reception pipe 483 to flow into the several oil cooler heat exchange pipes 452. The other end of each of the several oil cooler heat exchange pipes 452 is connected to the fluid-to-be-cooled discharge pipe 484, allowing the fluid to be cooled that has entered the several oil cooler heat exchange pipes 452 to be discharged through the fluid-to-be-cooled discharge pipe 484. The connections between the oil cooler heat exchange pipes 452 shown in FIG. 11a and the fluid-to-be-cooled reception pipe 483 and the fluid-to-be-cooled discharge pipe 484 can be wound around the fluid-to-be-cooled reception pipe 483 for several turns to form the oil cooler heat exchange pipe coil 454 accommodated within the oil cooler housing 451, as shown in FIG. 11b.

[0040] As shown in FIG. 11b, in the oil cooler heat exchange pipe coil 454, the fluid-to-be-cooled reception pipe 483 is located at the center of the oil cooler heat exchange pipe coil 454, while the fluid-to-be-cooled discharge pipe 484 is located at the edge of the oil cooler heat exchange pipe coil 454. This allows the fluid-to-be-cooled reception pipe 483 to be inserted and fixed (e.g., by welding) to the inlet 481 on the cover plate 480 of the oil cooler 450, and allows the fluid-to-be-cooled discharge pipe 484 to be inserted and fixed (e.g., by welding) to the outlet 482 on the cover plate 480 of the oil cooler 450. It should be understood that the arrangement of the positions of the fluid-to-be-cooled reception pipe 483 and the fluid-to-be-cooled discharge pipe 484 is not restricted by the embodiments depicted in FIGS. 11a and 11b. In other embodiments, the winding direction can be altered such that the fluid-to-be-cooled discharge pipe 484 is located at the center of the oil cooler heat exchange pipe coil 454, while the fluid-to-be-cooled reception pipe 483 is located at the edge of the oil cooler heat exchange pipe coil 454. FIG. 11b further shows that the oil cooler heat exchange pipes 452 after being wound form several turns 494 in the radial direction, with radial gaps 493 between adjacent turns 494.

[0041] FIG. 11c shows a spacer 479 for insertion into the oil cooler heat exchange pipe coil 454 shown in FIG. 11b. As shown in FIG. 11c, the spacer 479 comprises a beam 489 and several strings of spacer units 491 extending downward from the beam 489. Each string of spacer units 491 comprises several spacer units 488, and notches 490 are formed between adjacent spacer units 488. The number of the string of spacer unit 491 is determined based on the number of turns 494 of the oil cooler heat exchange pipes 452 in the radial direction, while the number of spacer units 488 is determined by the number of oil cooler heat exchange pipes 452 distributed along the longitudinal direction of the oil cooler 450. The spacer 479 is inserted into the oil cooler heat exchange pipe coil 454 by individually inserting several strings of spacer units 491 into the radial gaps 493 between adjacent turns 494 formed by winding the oil cooler heat exchange pipes 452. At this point, the notches 490 between adjacent spacer units 488 receive the corresponding oil cooler heat exchange pipes 452, while the spacer units 488 fill the longitudinal gaps 492 and the radial gaps 493. In one embodiment, the spacer 479 can be made of plastic. Since the spacer units 488 fill the longitudinal gaps 492 between adjacent oil cooler heat exchange pipes 452 and the radial gaps 493 between adjacent turns 494 formed by winding the oil cooler heat exchange pipes 452, when the liquid refrigerant entering the oil cooler housing 451 violently boils due to a large temperature difference with the fluid to be cooled inside the oil cooler heat exchange pipes 452, causing the oil cooler heat exchange pipes 452 to vibrate, friction between adjacent oil cooler heat exchange pipes 452 and adjacent turns 494 formed by winding the oil cooler heat exchange pipes 452 due to vibration is avoided, thereby avoiding damage to the oil cooler heat exchange pipes 452. FIG. 11d shows a top view of the oil cooler 450 after several spacers 479 have been inserted into the oil cooler heat exchange pipe coil 454. When the spacers 479 are inserted into the oil cooler heat exchange pipe coil 454, the beams 489 of the spacers 479 span across the several turns 494 formed by the oil cooler heat exchange pipes 452 at the top. Therefore, beams 489 provide positional stability for spacers 479. The several spacers 479 shown in FIG. 11d are evenly distributed along the circumference of the oil cooler heat exchange pipe coil 454.

[0042] FIG. 11e shows a top view of another arrangement of an oil cooler heat exchange pipe coil 455 formed by the oil cooler heat exchange pipes 452 shown in FIG. 11a. In the embodiment shown in FIG. 11e, both the fluid-to-be-cooled reception pipe 483 and the fluid-to-be-cooled discharge pipe 484 are located at the center of the oil cooler heat exchange pipe coil 455. The arrangement of the oil cooler heat exchange pipe coil 455 shown in FIG. 11e is obtained by first folding the oil cooler heat exchange pipes 452 shown in FIG. 11a and then winding the folded oil cooler heat exchange pipes 452 around the fluid-to-be-cooled reception pipe 483 and fluid-to-be-cooled discharge pipe 484. Such arrangement allows for a smaller diameter of the oil cooler heat exchange pipe coil 455, enabling the oil cooler 450 to have a correspondingly smaller diameter. When the arrangement of the oil cooler heat exchange pipe coil 455 shown in FIG. 11e is employed, the inlet 481 and outlet 482 on the cover plate 480 of the oil cooler 450 are correspondingly arranged at the center of the cover plate 480 to receive the fluid-to-be-cooled reception pipe 483 and fluid-to-be-cooled discharge pipe 484.

[0043] The present application has at least the following technical effects:

1. The oil cooler and the evaporator of the present application are connected in such a way that there is no need to arrange an additional cooling circulation loop for the fluid to be cooled used during the operation of a chiller unit or a heat pump unit. Therefore, the structure of the present application is simple and easy to manufacture.
2. Since the evaporator housing always contains a low-temperature liquid refrigerant, and the configuration of the present application allows the low-temperature liquid refrigerant in the evaporator housing to enter the oil cooler housing simply by gravity, a chiller unit or a heat pump unit using the evaporator assembly according to the present application can immediately use the refrigerant from the evaporator to cool the fluid to be cooled in the oil cooler upon startup, without waiting for the refrigerant to enter the oil cooler housing. This ensures the reliability of components in the chiller unit or the heat pump unit that use the fluid to be cooled (such as compressors using lubricating oil). Especially during the early stages after the chiller unit or the heat pump unit is started, when the unit has not yet reached the conditions required to cool the lubricating oil, the low-temperature refrigerant retained in the evaporator can effectively cool the high-temperature lubricating oil that has been heated by a heater during shutdown.
3. The oil cooler heat exchange pipes in the oil cooler housing of the present application are easy to install and remove, thus allowing for maintenance or replacement of specific oil cooler heat exchange pipes.
4. In the evaporator assembly of the present application, the fluid to be cooled is accommodated within the oil cooler heat exchange pipes, resulting in a reduced volume of the fluid to be cooled (such as compressor lubricating oil) to be charged and achieving cost savings.
5. The guide plates on the oil cooler cover plate enable the fluid to be cooled to automatically flow in the oil cooler heat exchange pipes for a predetermined number of passes.

[0044] Although the present disclosure has been described in conjunction with the examples of embodiments outlined above, various alternatives, modifications, variations, improvements and/or substantial equivalents, whether currently known or foreseeable now or in the near future, may be obvious to those of at least ordinary skill in the art. In addition, the technical effects and/or technical problems described in the present specification are exemplary, and not limiting. Therefore, the disclosure in the present specification may be used to address other technical problems and have other technical effects and/or can address other technical problems. Accordingly, the examples of embodiments of the present disclosure, as set forth above, are intended to be illustrative, and not limiting. Various changes can be practiced without departing from the spirit or scope of the present disclosure.

Accordingly, the present disclosure is intended to cover all known or earlier developed alternatives, modifications, variations, improvements and/or substantial equivalents.

Claims

1. An evaporator assembly, comprising:

    an evaporator (110, 210, 310, 410), the evaporator (110, 210, 310, 410) comprising an evaporator housing (111, 211, 311, 411), the evaporator housing (111, 211, 311, 411) being used for accommodating a refrigerant; and
    at least one oil cooler (150, 250, 350, 450), the at least one oil cooler (150, 250, 350, 450) comprising an oil cooler housing (151, 251, 351, 451) and at least one oil cooler heat exchange pipe (152, 452) arranged in the oil cooler housing (151, 251, 351, 451), the at least one oil cooler heat exchange pipe (152, 452) being used for receiving a fluid to be cooled;
    wherein the evaporator housing (111, 211, 311, 411) comprises at least one evaporator housing opening (113, 313, 413), the oil cooler housing (151, 251, 351, 451) comprises at least one oil cooler housing opening (153, 353, 453), and the at least one evaporator housing opening (113, 313, 413) is in fluid communication with at least one corresponding oil cooler housing opening (153, 353, 453);
    wherein positions of the evaporator (110, 210, 310, 410) and the at least one oil cooler (150, 250, 350, 450) are configured such that at least a portion of a liquid refrigerant accommodated in the evaporator housing (111, 211, 311, 411) can flow into the oil cooler housing (151, 251, 351, 451) via the at least one evaporator housing opening (113, 313, 413) and the at least one corresponding oil cooler housing opening (153, 353, 453) by gravity so as to be used for cooling the fluid to be cooled in the at least one oil cooler heat exchange pipe (152, 452); and
    wherein a gaseous refrigerant in the oil cooler housing (151, 251, 351, 451) can also flow back into the evaporator housing (111, 211, 311, 411) via the at least one oil cooler housing opening (153, 353, 453) and at least one corresponding evaporator housing opening (113, 313, 413).

2. The evaporator assembly according to claim 1, wherein
the positions of the evaporator (110, 210, 310, 410) and the at least one oil cooler (150, 250, 350, 450) are configured such that an actual liquid level of the liquid refrigerant in the evaporator housing (111, 211, 311, 411) is higher than an actual liquid level of the liquid refrigerant in the oil cooler housing (151, 251, 351, 451).

3. The evaporator assembly according to claim 1, wherein
the oil cooler housing (151, 251) and the evaporator housing (111, 211) are connected by at least one connecting pipe (114) so that the at least one evaporator housing opening (113) is in fluid communication with the at least one corresponding oil cooler housing opening (153).

4. The evaporator assembly according to claim 1, wherein
the evaporator housing (311, 411) and the oil cooler housing (351, 451) are directly connected at the at least one evaporator housing opening (313, 413) and the at least one corresponding oil cooler housing opening (353, 453), respectively, so that the at least one evaporator housing opening (313, 413) is in fluid communication with the at least one corresponding oil cooler housing opening (353, 453).

5. The evaporator assembly according to claim 1, wherein

    the evaporator housing (111) is cylindrical and has a longitudinal axis Y1 extending along a length direction of the evaporator housing, and the at least one evaporator housing opening (113) is located on a cylindrical surface of the evaporator housing (111);
    the oil cooler housing (151) is cylindrical and has a longitudinal axis Y2 extending along a length direction of the oil cooler housing, and the at least one oil cooler housing opening (153) is located on a cylindrical surface of the oil cooler housing (151); and
    the longitudinal axis Y2 of the oil cooler housing (151) is substantially parallel to the longitudinal axis Y1 of the evaporator housing (111).

6. The evaporator assembly according to claim 1, wherein

    the evaporator housing (211) is cylindrical and has a longitudinal axis Y1 extending along a length direction of the evaporator housing, and the at least one evaporator housing opening is located on a cylindrical surface of the evaporator housing (211);
    the oil cooler housing (251) is cylindrical and has a longitudinal axis Y2 extending along a length direction of the oil cooler housing, and the at least one oil cooler housing opening is located on a cylindrical surface of the oil cooler housing (251); and
    the longitudinal axis Y2 of the oil cooler housing

(251) is substantially perpendicular to the longitudinal axis Y1 of the evaporator housing (211).

7. The evaporator assembly according to claim 1, wherein

the evaporator housing (411) is cylindrical and has a longitudinal axis Y1 extending along a length direction of the evaporator housing, and the at least one evaporator housing opening (413) is located on a cylindrical surface of the evaporator housing (411);
the oil cooler housing (451) is cylindrical and has a longitudinal axis Y2 extending along a length direction of the oil cooler housing, and the at least one oil cooler housing opening (453) is located at one end of the oil cooler housing (451); and
the longitudinal axis Y2 of the oil cooler housing (451) is substantially perpendicular to the longitudinal axis Y1 of the evaporator housing (411).

8. The evaporator assembly according to claim 1, wherein

the at least one oil cooler heat exchange pipe (152) extends between two ends of the oil cooler housing (151); and
the at least one oil cooler (150) further comprises:

an internal support plate (155), the internal support plate (155) being accommodated in the oil cooler housing (151), the internal support plate (155) having at least one internal support plate hole (156) arranged thereon, the at least one oil cooler heat exchange pipe (152) being inserted into the at least one internal support plate hole (156), respectively;
a first end support plate (157) and a second end support plate (158), the first end support plate (157) and the second end support plate (158) being arranged at two ends of the oil cooler housing (151), respectively, the first end support plate (157) and the second end support plate (158) having at least one end support plate hole (159) arranged thereon, the at least one oil cooler heat exchange pipe (152) being inserted into the at least one end support plate hole (159), respectively; and
a first cover plate (160) and a second cover plate (161), the first cover plate (160) and the second cover plate (161) being arranged at two ends of the oil cooler housing (151), respectively, and covering the first end support plate (157) and the second end support plate (158), respectively, the first cover plate (160) having a fluid-to-be-cooled inlet (181) and a fluid-to-be-cooled outlet (182) arranged thereon.

9. The evaporator assembly according to claim 8, wherein
the first cover plate (160) and the second cover plate (161) are configured such that the fluid to be cooled flows in the at least one oil cooler heat exchange pipe (152) for a predetermined number of passes.

10. The evaporator assembly according to claim 9, wherein

the first cover plate (160) comprises:

a first inner surface (164), the first inner surface (164) facing the first end support plate (157);
a first periphery (166), the first periphery (166) extending from the first inner surface (164) towards the first end support plate (157) and abutting the first end support plate (157), the first periphery (166) and the first inner surface (164) defining a first cavity (168) of the first cover plate (160);
a first cover plate first guide plate (170), the first cover plate first guide plate (170) being located in the first cavity (168), extending from the first inner surface (164) towards the first end support plate (157) and abutting the first end support plate (157), the first cover plate first guide plate (170) dividing the first cavity (168) into a first region (173) and a second region (174); and
a first cover plate second guide plate (171), the first cover plate second guide plate (171) being located in the second region (174) of the first cavity (168), extending from the first inner surface (164) towards the first end support plate (157) and abutting the first end support plate (157), the first cover plate second guide plate (171) being perpendicular to the first cover plate first guide plate (170) and dividing the second region (174) into a third region (175) and a fourth region (176), the fluid-to-be-cooled inlet (181) and the fluid-to-be-cooled outlet (182) being located in the third region (175) and the fourth region (176), respectively; and

the second cover plate (161) comprises:

a second inner surface (165), the second inner surface (165) facing the second end support plate (158);
a second periphery (167), the second per-

iphery (167) extending from the second inner surface (165) towards the second end support plate (158) and abutting the second end support plate (158), the second periphery (167) and the second inner surface (165) defining a second cavity (169) of the second cover plate (161); and

a second cover plate guide plate (172), the second cover plate guide plate (172) dividing the second cavity (169) into a fifth region (177) and a sixth region (178), and the second cover plate guide plate (172) being perpendicular to the first cover plate first guide plate (170).

11. The evaporator assembly according to claim 1, wherein

the at least one oil cooler heat exchange pipe (452) is accommodated in the oil cooler housing (451) in the form of a coil; and

the at least one oil cooler (450) further comprises:

a spacer (479), the spacer (479) being arranged between adjacent ones of the at least one oil cooler heat exchange pipe (452);

a cover plate (480), the cover plate (480) being arranged at an end of the oil cooler housing (451) opposite to the at least one oil cooler housing opening (453), the cover plate (480) having an inlet (481) and an outlet (482) arranged thereon;

a fluid-to-be-cooled reception pipe (483), the fluid-to-be-cooled reception pipe (483) being inserted into and fixed to the inlet (481) and being in fluid communication with the at least one oil cooler heat exchange pipe (452), the fluid-to-be-cooled reception pipe (483) being used for receiving the fluid to be cooled and guiding the fluid to be cooled into the at least one oil cooler heat exchange pipe (452); and

a fluid-to-be-cooled discharge pipe (484), the fluid-to-be-cooled discharge pipe (484) being inserted into and fixed to the outlet (482) and being in fluid communication with the at least one oil cooler heat exchange pipe (452), the fluid-to-be-cooled discharge pipe (484) being used for receiving and discharging the fluid to be cooled from the at least one oil cooler heat exchange pipe (452).

12. The evaporator assembly according to claim 1, wherein the evaporator (110) comprises:

at least one evaporator heat exchange pipe (112), the at least one evaporator heat exchange pipe (112) being arranged in the evaporator housing (111) and used for receiving a liquid to be cooled;

end pipe plates (117), the end pipe plates (117) being arranged at two ends of the evaporator housing (111), the end pipe plates (117) having at least one end pipe plate hole (119) arranged thereon, the at least one evaporator heat exchange pipe (112) being inserted into and fixed to the at least one end pipe plate hole (119), respectively; and

an internal pipe plate (115), the internal pipe plate (115) being arranged within the evaporator housing (111), the internal pipe plate (115) having at least one internal pipe plate hole (116) arranged thereon, the at least one evaporator heat exchange pipe (112) passing through the at least one internal pipe plate hole (116), respectively;

wherein each of the at least one evaporator housing opening (113) is located at a position near one of the end pipe plates (117) and the internal pipe plate (115), and wherein the internal pipe plate (115) near the at least one evaporator housing opening (113) is fixedly connected to the at least one evaporator heat exchange pipe (112).

13. A chiller unit or heat pump unit, comprising the evaporator assembly (100, 200, 300, 400) according to any one of claims 1-12.

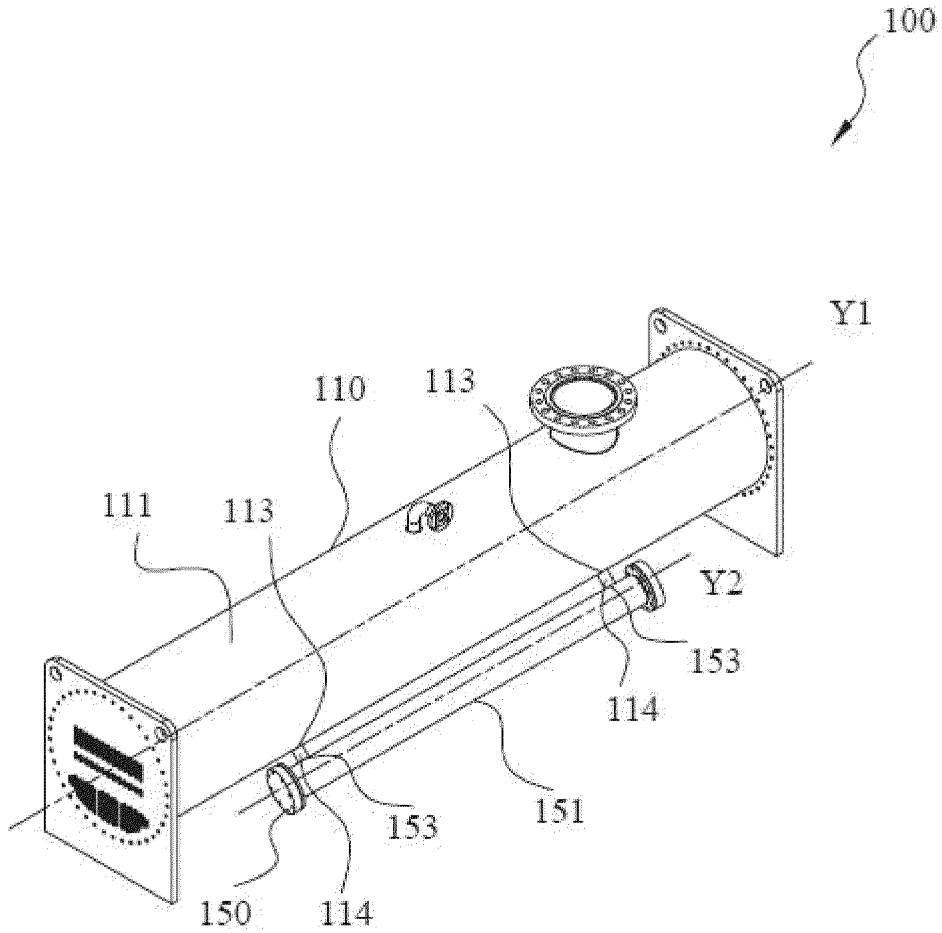

FIG. 1

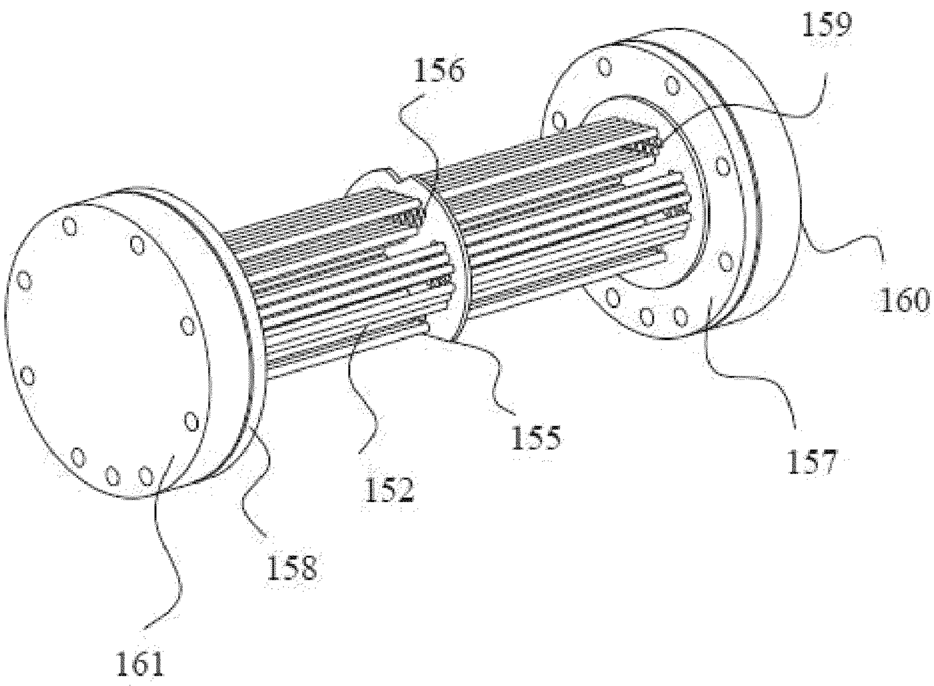

FIG. 2

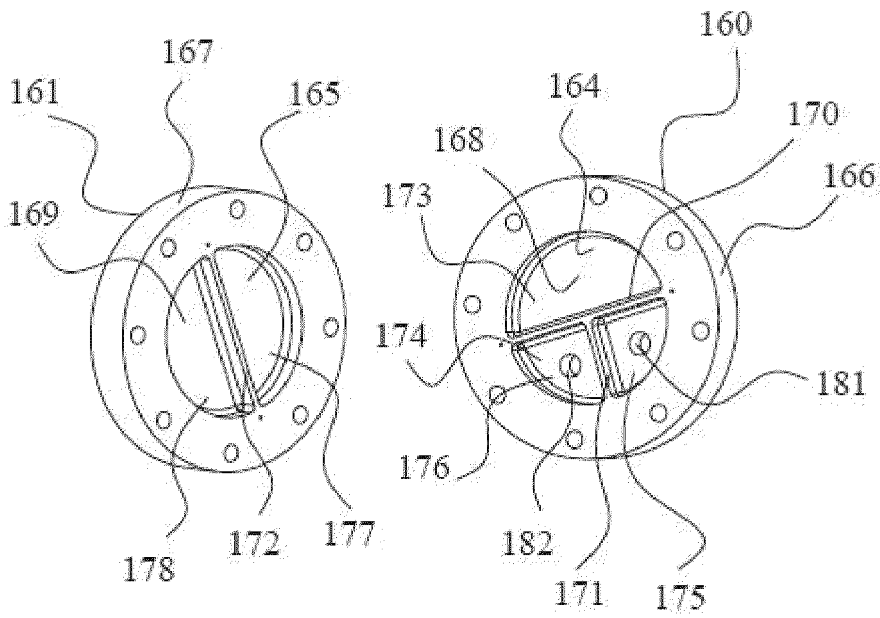
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FIG. 3

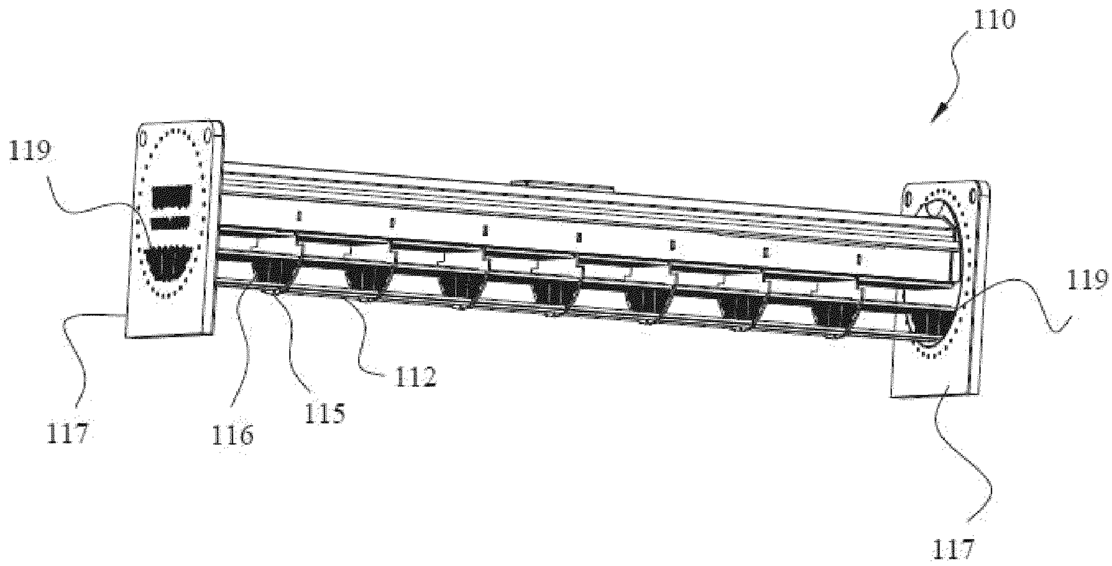

FIG. 4

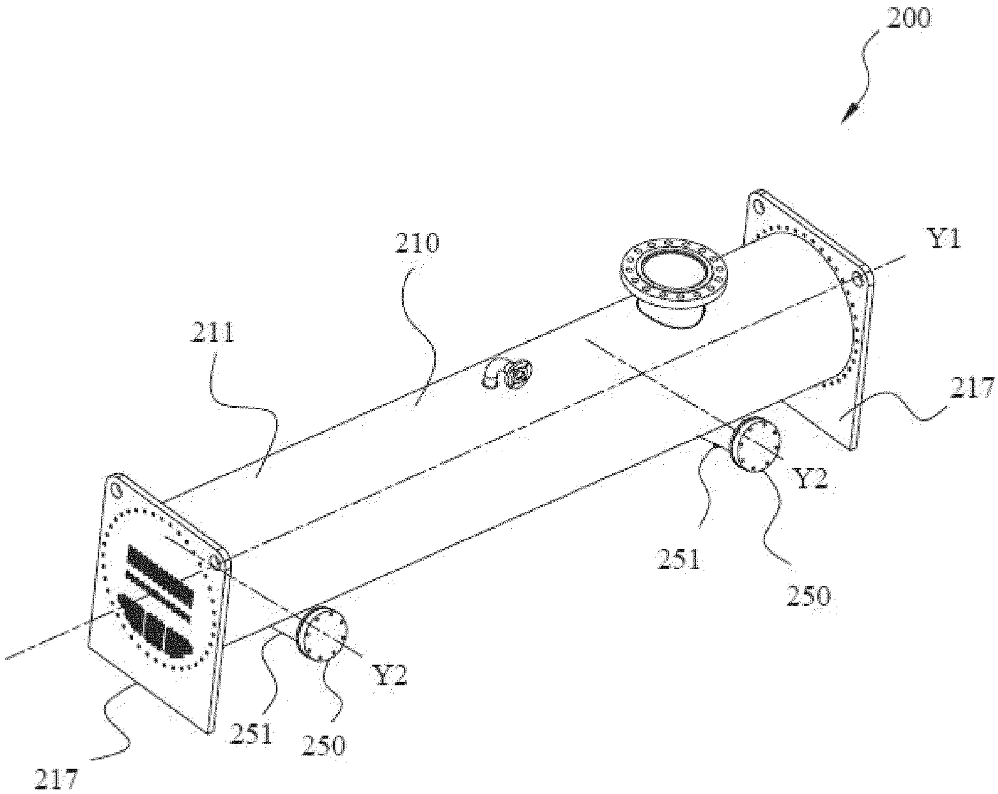

FIG. 5

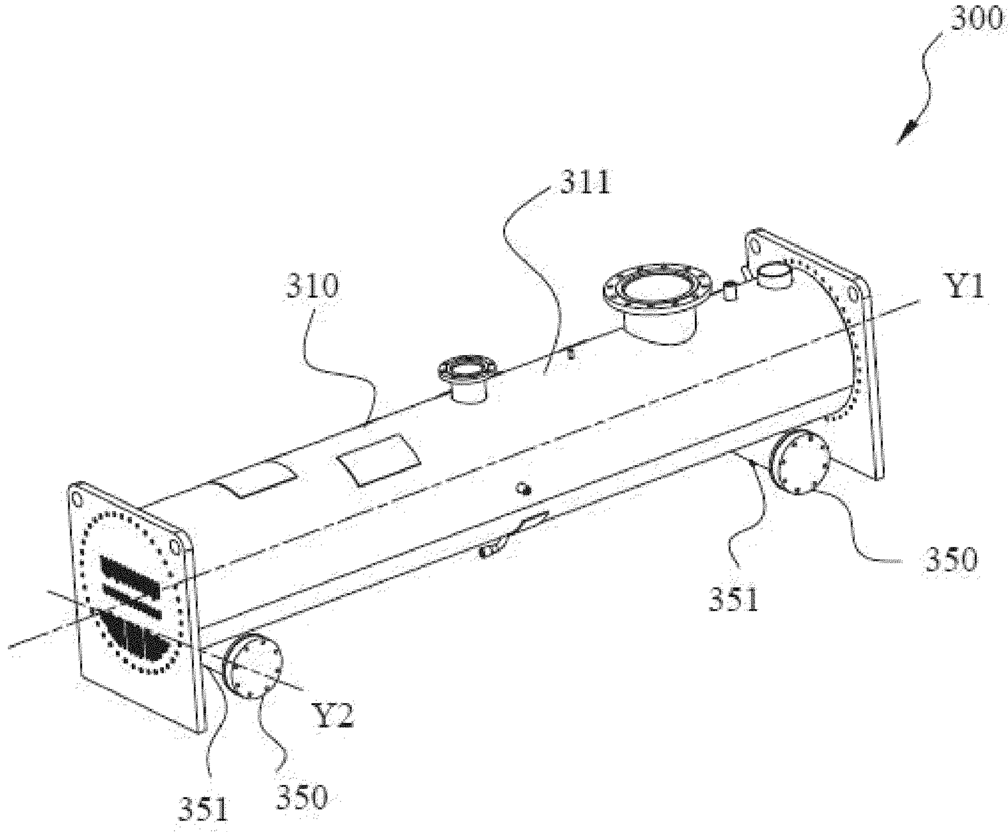

FIG. 6

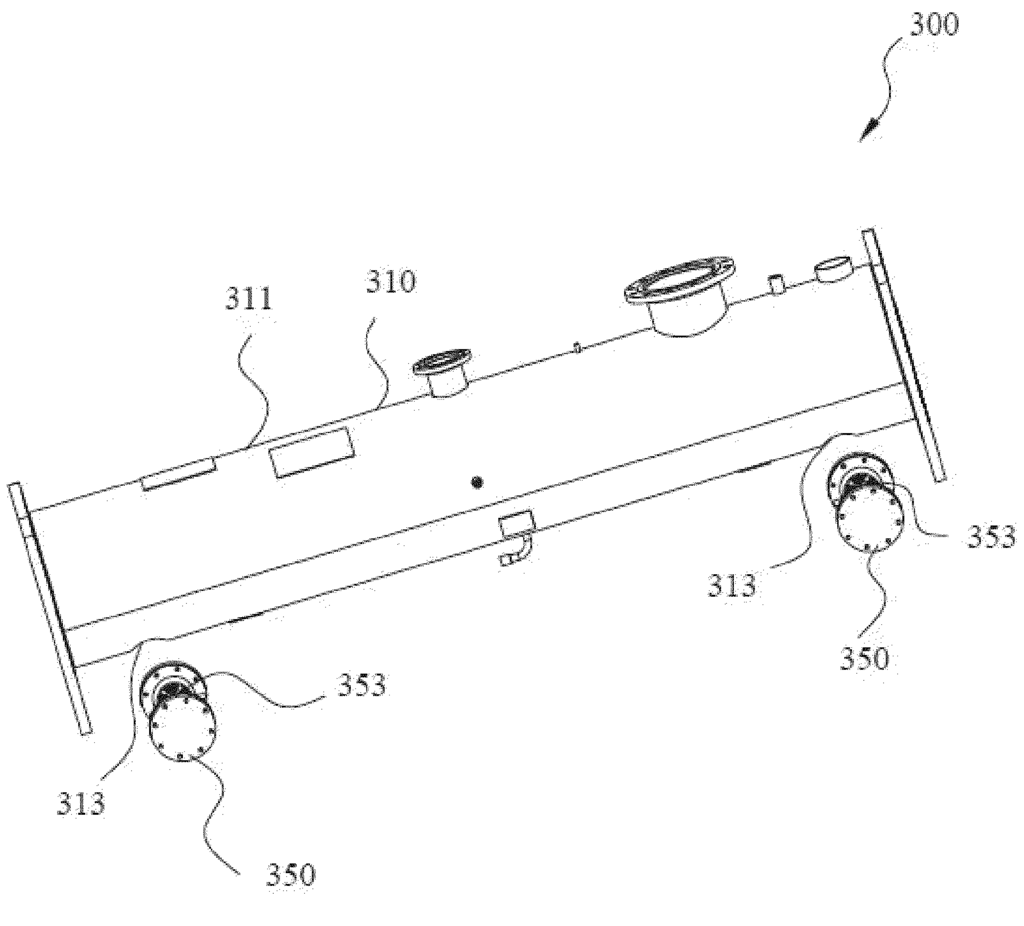

FIG. 7

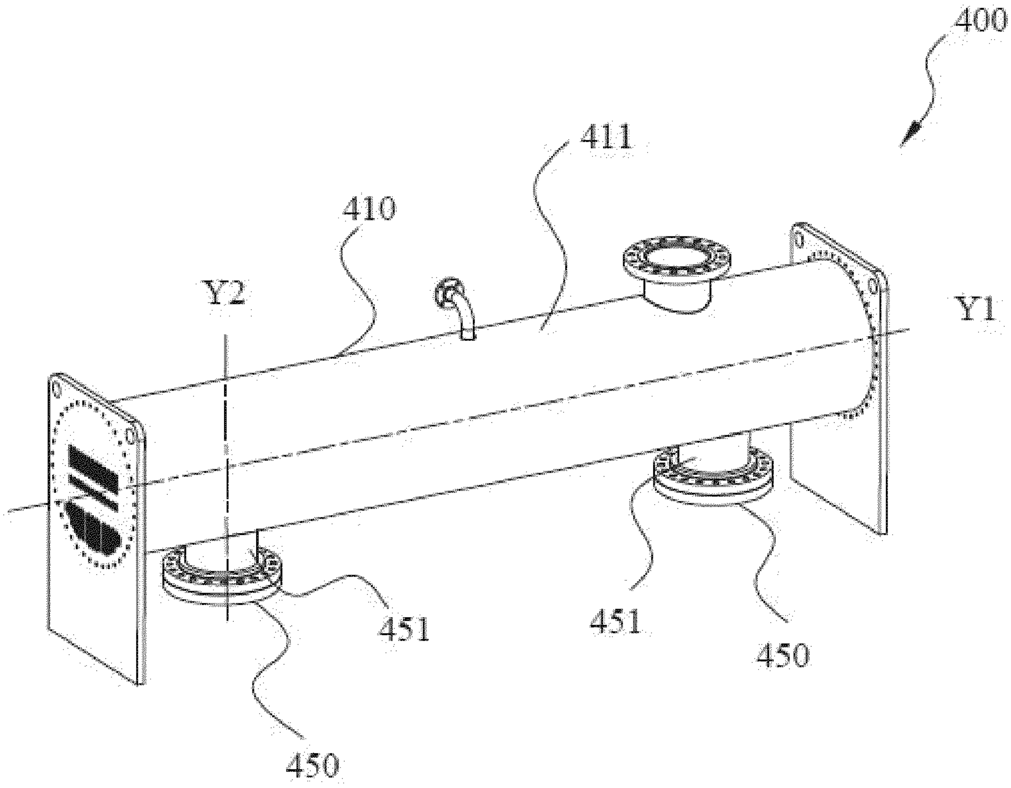

FIG. 8

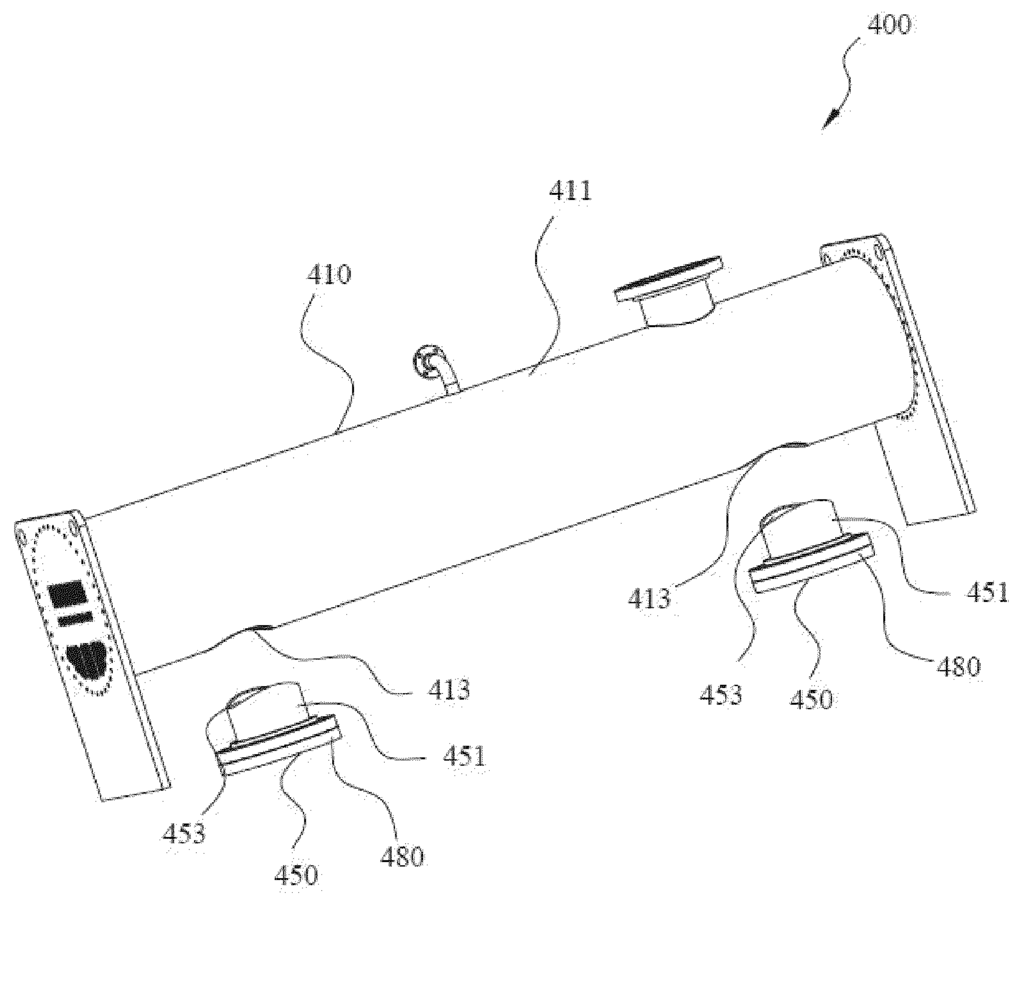

FIG. 9

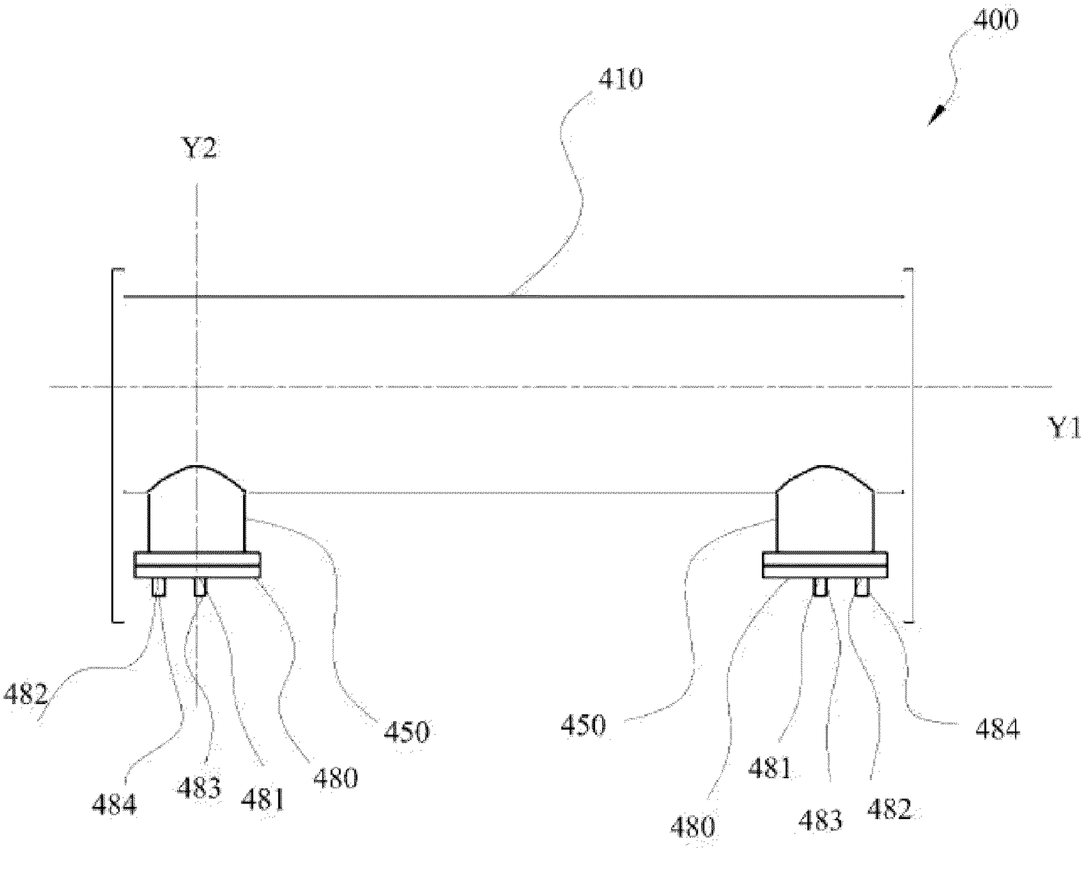

FIG. 10

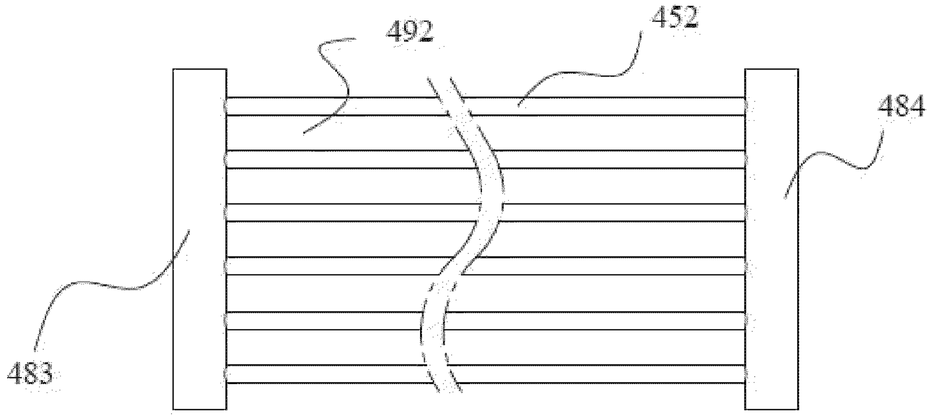

FIG. 11a

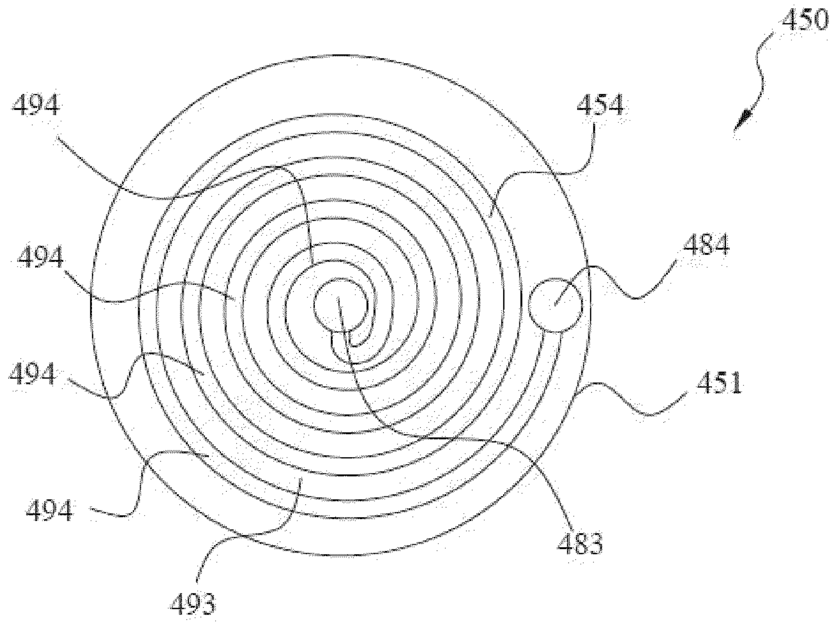

FIG. 11b

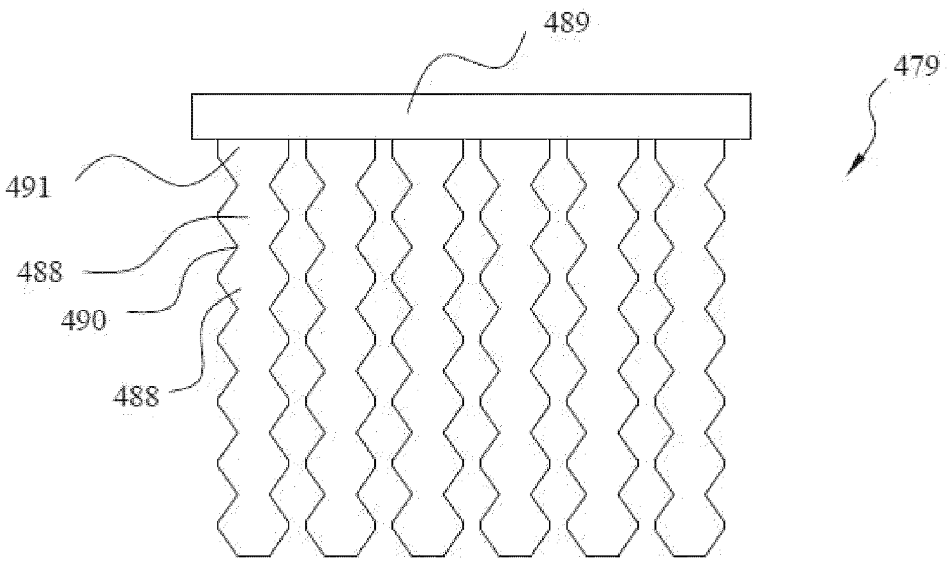

FIG. 11c

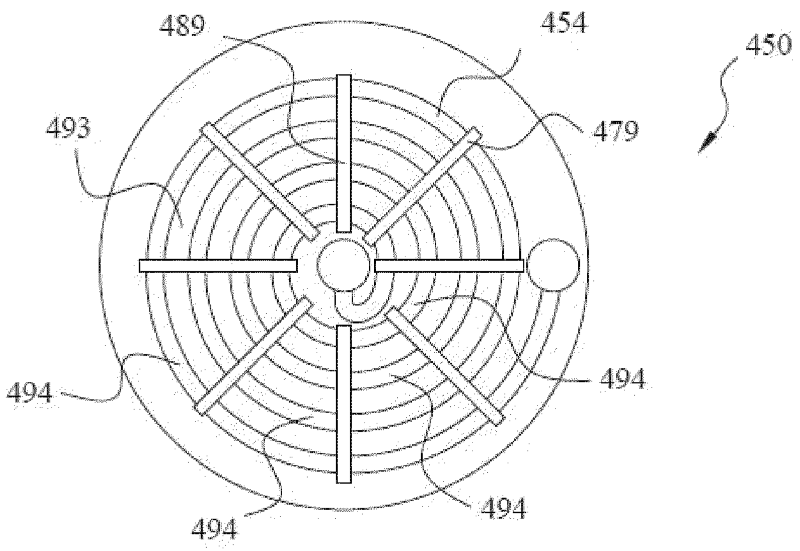

FIG. 11d

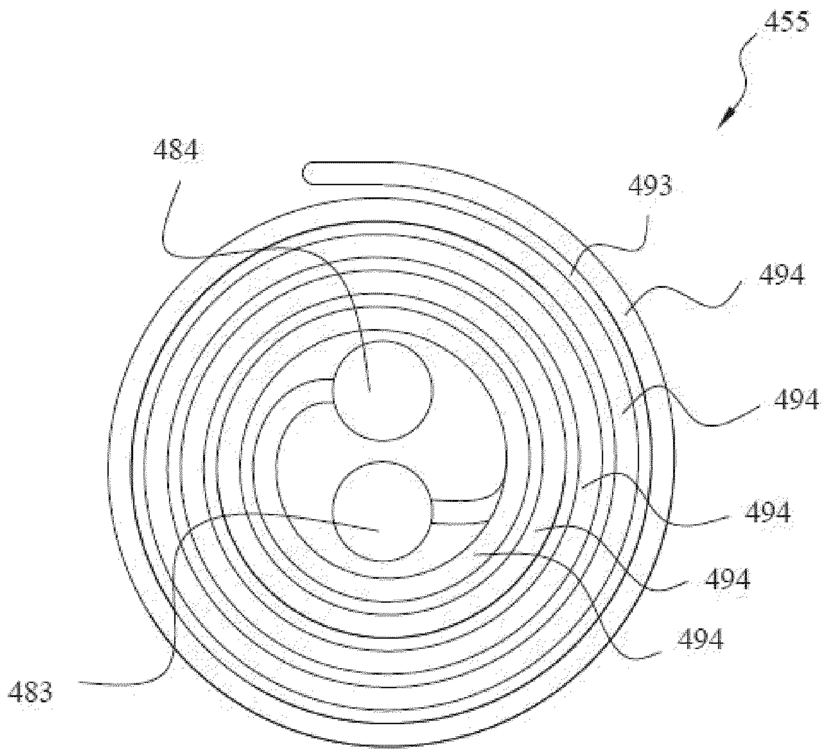

FIG. 11e

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2023/113660

A. CLASSIFICATION OF SUBJECT MATTER

F25B39/02(2006.01)i；F25B31/00(2006.01)i；F25B41/40(2021.01)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)

IPC: F25B

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

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

CNTXT, CNABS, CNKI, ENTXTC, VEN: 蒸发器, 油冷却器, 油冷器, 壳, 管, 开口, 连通, 重力, 制冷剂, 液位, evaporator, oil, cool, shell, tube, pipe, openning, connect, communicat+, gravity, refrigerant, liquid, level

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 115682470 A (YORK (WUXI) AIR CONDITIONING AND REFRIGERATION CO., LTD. et al.) 03 February 2023 (2023-02-03) description, specific embodiments, and drawings	1-13
A	CN 206330325 U (JIANGNAN LMART EQUIPMENT MANUFACTURING (ZHANGJIAGANG) CO., LTD.) 14 July 2017 (2017-07-14) description, paragraphs [0024]-[0038], and figure 1	1-13
A	CN 114061178 A (YORK GUANGZHOU AIR CONDITIONER AND REFRIGERATION CO., LTD. et al.) 18 February 2022 (2022-02-18) entire document	1-13
A	CN 204923593 U (NANJING RONDO ENERGY SAVING TECHNOLOGY CO., LTD. et al.) 30 December 2015 (2015-12-30) entire document	1-13
A	CN 203837341 U (CHONGQING MIDEA GENERAL REFRIGERATION EQUIPMENT CO., LTD.) 17 September 2014 (2014-09-17) entire document	1-13

☑ 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
23 October 2023	**24 October 2023**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN)** **China No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088**	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2023/113660

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2022228781 A1 (JOHNSON CONTROLS DENMARK APS) 21 July 2022 (2022-07-21) entire document	1-13

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2023/113660

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 115682470 A	03 February 2023	None	
CN 206330325 U	14 July 2017	None	
CN 114061178 A	18 February 2022	None	
CN 204923593 U	30 December 2015	None	
CN 203837341 U	17 September 2014	None	
US 2022228781 A1	21 July 2022	US 11725856 B2	15 August 2023
		EP 4030119 A1	20 July 2022

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