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(54) **INDOOR UNIT AND HEAT PUMP**

(57) The present invention relates to an indoor unit and a heat pump. An indoor unit for a heat pump installed inside of a building, comprising a part of a heat medium circuit for circulating a heat medium, an intermediate heat exchanger to exchange heat between a refrigerant and the heat medium, a pressure relief valve to release the heat medium, which is provided in the heat medium circuit, a container accommodating the intermediate heat exchanger, and the pressure relief valve, wherein the container comprises a first duct and a second duct, wherein the first duct is connected to an upper part of the container and communicates an inside of the container with an outdoor space for air exchange between the inside of the container and the outdoor space, wherein the outdoor space is outside of the building, wherein the second duct is connected to a lower part of the container for drainage of liquid from the container.

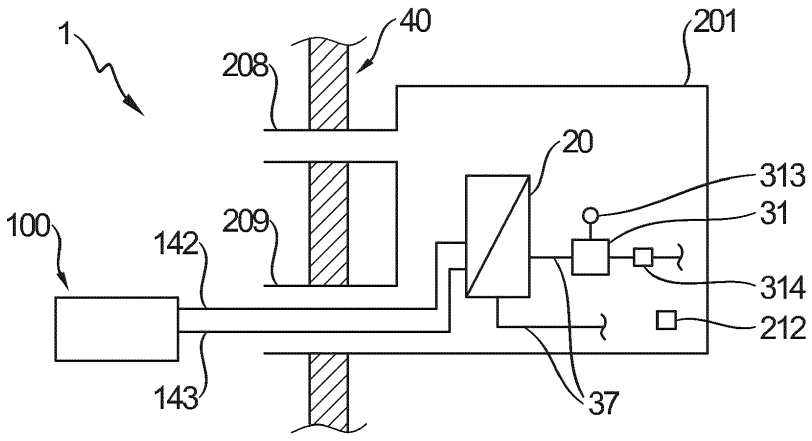

Fig. 3

EP 4 467 885 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to an indoor unit and a heat pump.

BACKGROUND ART

[0002] The development of heat pumps is facing a vast variety of requirements due to environmental and technical challenges. On the one hand, heat pumps should work as efficient as possible, whereas, on the other hand, the refrigerant used therein should avoid any environmental risks, such as ozone depletion or the potential to negatively influence the global warming.

[0003] When switching from non-flammable refrigerants to flammable refrigerants, increased care needs to be taken when handling the flammable refrigerants. In fact, leakage of flammable refrigerant into an indoor space, in which the heat pump or at least a part of the heat pump is installed, causes an indoor refrigerant concentration to increase, which potentially leads to formation of a flammable concentration region.

[0004] Such a concentration of leaked flammable refrigerant is dangerous, as flammable refrigerant oftentimes has a density greater than air under atmospheric pressure, such that the leaking flammable refrigerant accumulates in the bottom part of the indoor space, i.e. in a floor surface region thereof. This may lead to an inflammation and risks for users, buildings, etc.

[0005] Accordingly, it is desired to avoid such a formation of a flammable concentration region in an indoor space.

[0006] To do so, FR 3070755 A1 describes an approach having a box containing at least part of the heat pump system at an indoor space and having a sealed conduit that opens to the exterior of the building, so that leaking refrigerant can be exhausted to the exterior of the building. However, the compressor of FR 3070755 A1 being a possible ignition source is also placed inside the box. This is particularly dangerous when refrigerant is leaking inside the box and comes into contact with an ignition source like the compressor. This may lead to an increased inflammation risk. Furthermore, the degasser is arranged outside of the box in the indoor space and a separate piping is provided to transport the leaked refrigerant into the box. Since the degasser is arranged in FR 3070755 A1 outside of the box and in the indoor space, there is also the risk of a refrigerant leaking into the indoor space at a welded part of the piping or at a connection from the degasser to the box. Another aspect is that FR 3070755 A1 only comprises a single sealed conduit which may not ventilate the interior of the box sufficiently in case of leaking refrigerant. In the case of a leaking refrigerant, it is also not possible in the box of FR 3070755 A1 that accumulated liquid is transported from the box to the exterior of the building.

[0007] For heat pump systems it is also known to use a double-walled plate heat exchanger in the indoor unit in order to prevent a refrigerant leakage into a water circuit. However, the costs of double-walled heat exchangers are higher than of normal plate heat exchangers. When using a normal heat exchanger, a gas-liquid separator as a further component is needed to prevent that the leaked refrigerant travels in the heat medium circuit. Also, a gas purge valve is provided together with a gas-liquid separator. However, if a gas purge valve is arranged outside of a box and in the indoor space like FR 3070755 A1, there is also the risk of a refrigerant leaking into the indoor space at a welded part of the piping or at a connection from the degasser to the box.

[0008] To ensure a safe application of heat pumps and/or at least indoor units thereof inside indoor spaces, international standards, namely IEC60335-1 and IEC60335-2-40, and European standards, namely DIN EN 378-2 have been established. Therein, international rules for a charge limit of a leaked refrigerant in an indoor space are defined. This aims to avoid a flammable refrigerant concentration, especially in small indoor spaces.

SUMMARY OF THE INVENTION

[0009] In view of the above, it is an object of the present invention to provide a more cost-effective indoor unit and a heat pump having a simple configuration, which reduces or prevents a leakage of refrigerant in an indoor space.

[0010] In other words, it is a key idea of the present invention to provide an improved indoor unit or heat pump configuration, which prevents a leakage of refrigerant in an indoor space.

[0011] This object is solved by an indoor unit according to claim 1 and by a heat pump according to claim 2. The dependent claims describe optional features and preferred embodiments.

[0012] According to a first aspect of the invention, an indoor unit for a heat pump is installed inside of a building. The indoor unit comprises a part of a heat medium circuit for circulating a heat medium, an intermediate heat exchanger to exchange heat between a refrigerant and the heat medium, a pressure relief valve to release the heat medium, which is provided in the heat medium circuit, a container accommodating the intermediate heat exchanger, and the pressure relief valve, wherein the container comprises a first duct and a second duct, wherein the first duct is connected to an upper part of the container and communicates an inside of the container with an outdoor space for air exchange between the inside of the container and the outdoor space, wherein the outdoor space is outside of the building, wherein the second duct is connected to a lower part of the container for drainage of liquid from the container. The pressure relief valve may be an automatic pressure relief valve.

[0013] A possible refrigerant leakage of the refrigerant

circuit into the heat medium circuit in the intermediate heat exchanger may cause a pressure increase in the heat medium circuit. For such a possible pressure increase in the heat medium circuit a countermeasure, such as the pressure relief valve, is provided in the heat medium circuit. Thus, it is possible in case of a possible refrigerant leakage into the heat medium circuit and pressure increase in the heat medium circuit that heat medium can leak from the pressure relief valve and also refrigerant can leak from the pressure relief valve and that the leaked heat medium and refrigerant are not transported in the heat medium piping. The container allows that in case of a possible leakage of refrigerant and heat medium from a pressure relief valve, the leaked refrigerant and heat medium accumulate in the container and are transported through the first duct and/or second duct to the outdoor space. It is also possible that refrigerant may leak from piping connections or welded portions of the refrigerant piping in the container. The container allows also for the case of a leakage of refrigerant from the piping that the leaked refrigerant accumulates in the container. By the provision of a first duct and a second duct the accumulated leaked refrigerant and heat medium are transported from the container to the outdoor space. The leaked heat medium is in a liquid state and may flow through the second duct to the outdoor space. The leaked refrigerant may be in a gaseous state and may be exhausted through the first duct to the outdoor space.

[0014] Thus, by the indoor unit a possible flow of leaked refrigerant in the indoor space is prevented. Additionally, connections of the refrigerant piping with the intermediate heat exchanger or connections of the heat medium piping with the gas-liquid separator can be constructed simpler and may require a good sealing only. Thus, the indoor unit is provided with a simpler structure and less expensive. Also, since the heat medium and refrigerant are exhausted to the outdoor space via their respective ducts, the heat medium and refrigerant can be effectively exhausted from inside the container to the outdoor space.

[0015] An indoor unit according to a second aspect is the indoor unit of the first aspect, wherein the second duct communicates the inside of the container with the outdoor space for air exchange between the inside of the container and the outdoor space.

[0016] The second duct also allows that air is supplied through the second duct into the container and that air is exhausted through the first duct to the outdoor space. Thereby a good ventilation of the container is achieved.

[0017] An indoor unit according to a third aspect is the indoor unit of the first to second aspects, wherein a gas-liquid separator is provided in the heat medium circuit, the gas-liquid separator comprising a gas purge valve to release refrigerant, and wherein the container further accommodates the gas-liquid separator and the gas purge valve.

[0018] A possible high pressure in the heat medium is reduced due to the pressure relief valve. However, to prevent that the pressure is still high after the pressure relief valve, it might become necessary to provide a further countermeasure to prevent a high pressure in the heat medium circuit. Such a further countermeasure may be the gas-liquid separator comprising a gas purge valve to release refrigerant. Thus, it is possible that a high pressure in the heat medium circuit is reduced by the gas purge valve and the pressure relief valve. Simultaneously, the pressure might gradually or rapidly increase in the container. If heat medium and/or leaked refrigerant is released from the pressure relief valve and the gas purge valve, the heat medium and/or refrigerant accumulates in the container. By the provision of the first duct and the second duct the accumulated leaked gas and liquid are transported to the outdoor space. Thus, it is possible to prevent a high pressure in the heat medium circuit and in the container due to leaked refrigerant and heat medium, and to prevent leaked refrigerant from entering the indoor space.

[0019] An indoor unit according to a fourth aspect is the indoor unit of the first to third aspects, wherein the container comprises an air intake configured to allow an airflow from outside the container in the inside of the container.

[0020] The air intake may be provided on the front wall of the container. The air intake may be provided on a first side of the container and the first duct may be provided on a second side of the container, wherein the second side is different to the first side. The air intake may allow an airflow from the indoor space into the container. The air intake may prevent an airflow from the container in the indoor space. The air intake may be opened mechanically due to an under pressure generated from the fan operation. An example of an air intake may be a shutter or a closing valve.

[0021] By the air intake it is possible that air enters the container from the indoor space. A negative pressure may be created in the container by air flowing from the container to the outdoor space. In the event of such a negative pressure in the container, air may enter the container through the air intake.

[0022] An indoor unit according to a fifth aspect is the indoor unit of the first to fourth aspects, wherein a fan is arranged at an outdoor end of the first duct, the fan being configured to generate an airflow from the inside of the container to the outdoor space through the first duct.

[0023] The fan may be provided either in the container, at the first duct or at the second duct. When the fan is operated, supply air flows in the second duct in the container and exhaust air flows in the first duct to the outdoor space. The operation of the fan may create a lower pressure in the container. The fan may comprise a fan motor that is controlled by a control unit. The fan motor may be controlled by the refrigerant leakage detector. The fan motor may be operated by the control unit if refrigerant is detected at the refrigerant leakage detector. The fan motor may be arranged at an outdoor space, so

that the leaked refrigerant and heat medium do not come into contact with the motor of the fan.

[0024] By the provision of a fan at an end of the first duct, an air flow is ensured. Due to the air flow created by the fan the container is ventilated so that no leaked refrigerant accumulates in the container and a possible high pressure in the container is prevented. Further, a leakage of refrigerant in the indoor space is prevented.

[0025] An indoor unit according to a sixth aspect is the indoor unit of the first to fourth aspects, wherein the inside of the container is hermetically sealed from the outside of the container. Also, by the provision of a fan at an end of the first duct and by the provision of the drainage through the second duct, the fan can be prevented from getting wet by a drained liquid, because the drainage of liquid is exhausted through the second duct.

[0026] In this context, hermetically sealed means that no gas or liquid can enter the container or can escape from the container in the indoor space, including any sealings used between the different components of the container. In other words, refrigerant inside the container should not leak from the container into the indoor space when a high pressure occurs in the container.

[0027] By the provision of a hermetically sealed container, it is further enhanced that no refrigerant may leak into the indoor space. Having a hermetically sealed container further increases the safety of the indoor unit using flammable refrigerant. The hermetically sealed container may further act as a gas-liquid accumulator and separator. In the hermetically sealed container, the leaked heat medium and refrigerant may accumulate and be separated into gas in the upper part and liquid at the bottom of the container. The accumulated leaked refrigerant may flow through the first duct to the outdoor space and the accumulated heat medium may flow through the second duct to the outdoor space. The container may be airtight and ventilated by the first duct and/or second duct. In this context, airtight means that no air or gas can escape or pass through.

[0028] An indoor unit according to a seventh aspect is the indoor unit of the first to sixth aspects, wherein the container has a box shape with a first side wall and a second side wall, opposing the first side wall, a rear wall extending between the first side wall and the second side wall, a top wall being connected to upper ends of the first side wall, the second side wall, and the rear wall, a front wall opposing the rear wall, and a bottom wall opposing the top wall, wherein the first duct is arranged at the top wall of the container, and wherein the second duct is arranged at the rear wall or at the bottom wall of the container. Alternatively, the first duct may be provided at the first side wall, the second side wall, the front wall or the rear wall. Alternatively, the second duct may be provided at the first side wall, the second side wall, the front wall or the top wall.

[0029] By the arrangement of the first duct at the top wall and the second duct at the rear wall or bottom wall, the indoor unit is more compact and smaller in size. In addition, a leakage of refrigerant in the indoor space is prevented by the ventilation of the container so that a low concentration of leaked refrigerant is ensured in the container.

[0030] An indoor unit according to an eighth aspect is the indoor unit of the seventh aspect, wherein the bottom wall of the container is inclined towards an opening of the second duct. The bottom wall of the container may be inclined so that a liquid flows towards an opening of the second duct. By the provision of an inclination in the bottom wall, it is ensured that a liquid can drain from the container. Thus, a low concentration of leaked refrigerant and heat medium in the container can be maintained and a leakage of refrigerant in the indoor space is prevented.

[0031] An indoor unit according to a ninth aspect is the indoor unit of the first to eighth aspects, wherein the second duct is arranged at a lowest position of the container. The second duct may be arranged at a lowest position of the container in the rear wall. The second duct may be arranged at the lowest position of the container in the bottom wall. Due to the position of the second duct at the lowest position of the container it is ensured that the accumulated liquid can drain from the container. A low concentration of leaked refrigerant in the container can be maintained due to the drainage of liquid from the container and a leakage of refrigerant in the indoor space is prevented.

[0032] An indoor unit according to a tenth aspect is the indoor unit of the first to ninth aspects, wherein the gas refrigerant pipe and the liquid refrigerant pipe are disposed in the first duct or in the second duct. The liquid refrigerant pipe may be covered by an insulating material and the gas refrigerant pipe may be covered by an insulating material. The liquid refrigerant pipe and the gas refrigerant pipe may be covered together by an insulating material.

[0033] Due to the arrangement of the gas refrigerant pipe and the liquid refrigerant pipe in the first duct or in the second duct, a possible leaked refrigerant can flow to the outdoor space. By providing the liquid refrigerant pipe and the gas refrigerant pipe together in the second duct, a better ventilation of air is possible through the first duct. Hence, a leakage of refrigerant in the indoor space is prevented. Furthermore, by arranging the liquid refrigerant pipe and the gas refrigerant pipe in the first duct or second duct, further additional sealings on the liquid refrigerant pipe and the gas refrigerant pipe are no longer necessary. Thus, a simpler and safer structure of the indoor unit is provided.

[0034] An indoor unit according to an eleventh aspect is the indoor unit of the first to tenth aspects, wherein the container further comprises a detachable lid. The top wall of the container may comprise the detachable lid. The detachable lid may be arranged on the first side wall, the second side wall, or the front wall. The detachable lid may allow the maintenance person to open the container for inspection and service. The detachable lid may be made

of a sheet metal or plastic material. A sealing may be provided between the detachable lid and the container.

[0035] An indoor unit according to a twelfth aspect is the indoor unit of the first to eleventh aspects, wherein the first duct is configured to discharge air from the inside of the container to the outdoor space and the second duct is configured to allow an air inflow from the outdoor space to the inside of the container, or wherein the first duct is configured to allow an air inflow from the outdoor space to the inside of the container and the second duct is configured to discharge air from the inside of the container to the outdoor space. By providing a first duct and a second duct natural ventilation of the container is ensured, so that a low concentration of leaked refrigerant can be maintained in the container and a leakage of refrigerant in the indoor space from the container is prevented.

[0036] An indoor unit according to a thirteenth aspect is the indoor unit of the first to twelfth aspects, wherein the indoor unit further comprises a refrigerant leakage detector and the container further accommodating the refrigerant leakage detector. The refrigerant leakage detector may be connected with a control unit being configured to indicate to a user when a refrigerant leakage has occurred in the container. The fan may comprise a fan motor that is controlled by a control unit. The fan motor may be controlled by the refrigerant leakage detector. The fan motor may be operated by the control unit if refrigerant is detected at the refrigerant leakage detector.

[0037] The refrigerant leakage detector allows that in case of a leakage of refrigerant in the container, the leakage of refrigerant is detected.

[0038] The refrigerant leakage detector may be arranged below the gas purge valve and/or the pressure relief valve. The refrigerant leakage detector may be arranged below the gas-liquid separator. The refrigerant leakage detector may be arranged above the bottom wall of the container.

[0039] Due to the arrangement of the refrigerant leakage detector below the gas purge valve and/or the pressure relief valve, it is possible to detect small amounts of leaked refrigerant in the container. By providing the refrigerant leakage detector above the bottom wall of the container, it is ensured that the refrigerant leakage detector does not come into contact with liquids that may accumulate on the bottom wall.

[0040] An indoor unit according to a fourteenth aspect is the indoor unit of the first to thirteenth aspects, wherein the first duct is connected to a first side of the container and the air intake is connected to a second side of the container and the first side is different to the second side.

[0041] By providing the air intake on a different side to the first duct, it is possible that the airflow from the air intake flows through the container to the first duct and ensures a good ventilation of the container. Thus, a low concentration of leaked refrigerant is ensured in the container and a leakage of refrigerant into the indoor space is prevented.

[0042] According to a fifteenth aspect of the invention, a heat pump comprising a refrigerant circuit for circulating a refrigerant comprising a liquid refrigerant pipe, a heat source heat exchanger, a compressor, an expansion valve, a gas refrigerant pipe, and an intermediate heat exchanger is provided. Further, the heat pump comprises a heat medium circuit for circulating a heat medium comprising a pump and the intermediate heat exchanger, the intermediate heat exchanger to exchange heat between the refrigerant and the heat medium, a pressure relief valve to release the heat medium, which is provided in the heat medium circuit, a container accommodating the intermediate heat exchanger, and the pressure relief valve, wherein the container comprises a first duct and a second duct, wherein the first duct is connected to an upper part of the container and communicates an inside of the container with an outdoor space for air exchange between the inside of the container and the outdoor space, wherein the outdoor space is where the heat source heat exchanger and the compressor are located, wherein the second duct is connected to a lower part of the container for drainage of liquid from the container.

[0043] The heat pump allows that in case of a possible leakage of refrigerant, the leaked refrigerant accumulates in the container and is naturally transported through the first duct and/or second duct to the outdoor space. Thus, by the heat pump it is possible to prevent a leak of refrigerant from the container into the indoor space.

[0044] The indoor unit of the first aspect may be installed in the heat pump of the fifteenth aspect. The heat pump of the fifteenth aspect is compatible with the first to fourteenth aspects of the indoor unit. The features described above for the indoor unit of the invention also apply to the heat pump of the invention. The heat pump of the invention provides the technical effects and advantages already described in detail above for the indoor unit of the invention. In particular, the heat pump enables that a possible flow of leaked refrigerant in the indoor space is prevented.

[0045] The heat pump may be an air heat pump using air as a heat source or a ground source heat pump using the ground as a heat source. The heat pump may be used for producing domestic hot water, air conditioning (heating and/or cooling) and the like. In an air heat pump, an outdoor unit may be provided which comprise the compressor, the expansion valve and the heat source heat exchanger of the refrigerant circuit. The outdoor unit may be disposed outdoors. The indoor unit may be configured to be arranged in an indoor space comprising a heat exchanger unit.

[0046] Even further, the heat pump may be an enhanced tightness refrigerating system. An 'enhanced tightness refrigerating system' is a system in which the indoor unit is designed and fabricated to ensure a high level of confidence that large refrigerant leak rates will not occur in normal and abnormal operation.

[0047] The 'duct' is to be understood as a rigid or flexible pipe. The duct may be a tube. Alternatively, the duct may be made up of several parts that are fluidly, such

as airtightly, connected. The duct may comprise a plurality of sections that are in fluid connection with each other. At least one section of the duct may be flexible. Using a plurality of sections improves the constructional flexibility, as the container can be arranged at different positions in the indoor space. The duct may be made of a plastic material, for example of polyvinyl chloride, or of a metal. The duct may comprise a cover at the end that faces the outdoor space. The cover may protect the duct from any kind of pollution. The first duct may be an air inlet and/or an air outlet. The second duct may be an air inlet and/or an air outlet. The second duct may be an air inlet and a liquid outlet.

[0048] In an embodiment, the duct may extend from the container in the indoor space through a housing wall to the outdoor space. The first duct and/or second duct may be arranged within a breakthrough in the house wall or in an opening in the house wall.

[0049] The heat pump may heat water (one example of a use-side fluid) supplied to a target space to heat the target space. The heat pump may include an outdoor unit disposed at an outdoor space, a heat exchanger unit and an indoor unit installed in the indoor space. The outdoor unit and the heat exchanger unit may be connected to each other by refrigerant piping, including a liquid refrigerant pipe and a gas refrigerant pipe. The heat exchanger unit and the indoor unit may be connected to each other by heat medium piping. The refrigerant circuit and the heat medium circuit may be constituted in the heat pump.

[0050] The heat medium circuit may include at least an intermediate heat exchanger, a first heat medium pipe, a second heat medium pipe, a gas-liquid separator with a gas purge valve, a pressure relief valve, and a pump. The heat medium circuit may be filled with a heat medium (one example is water) that circulates to achieve a heat medium cycle. The heat medium circuit may be for circulating a heat medium comprising the intermediate heat exchanger.

[0051] The refrigerant circuit may comprise at least a compressor, a heat source heat exchanger (e.g., outdoor air heat exchanger or ground source heat exchanger), an expansion valve (one example of an expansion mechanism), an intermediate heat exchanger, a liquid refrigerant pipe, and a gas refrigerant pipe. All elements may be connected by a refrigerant piping, such that refrigerant can flow from one component to the other and can achieve heat exchange with a heat medium. The refrigerant circuit may be configured to circulate a refrigerant. The refrigerant circuit may be filled with a refrigerant that circulates to achieve a refrigeration cycle. The refrigerant may, for example, be R290, R744, or the like. The refrigerant may be a flammable refrigerant. The refrigerant may include propane or carbon dioxide.

[0052] A 'flammable refrigerant' is to be understood as having a density higher than air under atmospheric pressure. 'Flammable refrigerant' may be refrigerant classified as class A2L, A2 or A3 according to ISO 817.

[0053] The outdoor unit may comprise an outdoor unit casing that is disposed at an outdoor space. The outdoor unit casing may accommodate the compressor, the heat source heat exchanger, the expansion valve, a part of the liquid refrigerant pipe, and a part of the gas refrigerant pipe.

[0054] The indoor unit may comprise the heat exchanger unit. The heat exchanger unit may comprise a container. The indoor unit may comprise an indoor unit casing and a container. The container may be separate to the indoor unit casing.

[0055] The heat exchanger unit for a heat pump may be installed inside of a building. The heat exchanger unit may comprise a container that is disposed in an indoor space. The heat exchanger unit may comprise a part of the heat medium circuit for circulating a heat medium, the intermediate heat exchanger to exchange heat between a refrigerant and the heat medium, the gas-liquid separator provided in the heat medium circuit, and the container. The heat exchanger unit may further comprise a part of the refrigerant circuit for circulating a refrigerant. The intermediate heat exchanger may exchange heat between the refrigerant and the heat medium. The heat medium circuit may be filled with a heat medium (one example is water) that circulates to achieve a heat medium cycle. The heat medium circuit may be for circulating a heat medium comprising the intermediate heat exchanger. The gas-liquid separator may comprise the gas purge valve to release refrigerant. The gas-liquid separator may separate gas and liquid. The gas-liquid separator may be arranged on a downstream side of the intermediate heat exchanger. The downstream side of the intermediate heat exchanger is the side of the intermediate heat exchanger on which the heat medium flows away from the intermediate heat exchanger. The gas purge valve may be arranged at the upper most portion of the gas-liquid separator to release the separated gas. The container further accommodates the pressure relief valve. The pressure relief valve may be arranged on a downstream side of the gas-liquid separator. The downstream side of the gas-liquid separator is the side of the gas-liquid separator on which the heat medium flows away from the gas-liquid separator. The gas purge valve and the pressure relief valve may be provided in the heat medium circuit.

[0056] The container may further accommodate a part of the liquid refrigerant pipe and the gas refrigerant pipe, and a part of the heat medium piping. The container may accommodate the connection of the liquid refrigerant pipe with the intermediate heat exchanger and the connection of the gas refrigerant pipe with the intermediate heat exchanger. The container may accommodate the connection of the heat medium piping with the intermediate heat exchanger. The container may accommodate the connection of the heat medium piping with the gas-liquid separator. The container may not comprise an ignition source such as electronic components which generate heat. The container may accommodate leaked refrigerant. The container may accommodate released

heat medium that has been released at the pressure relief valve. The container may accommodate any released gas or liquid from the gas purge valve and/or the pressure relief valve. At the bottom of the container liquid heat medium may accumulate. In other words, accumulated liquid may be leaked heat medium.

[0057] The top wall may be connected to the first side wall, the second side wall, the rear wall and the front wall by connecting elements (one example may be screws that are fixed by bolds) and may optionally further comprise sealing elements (an example may be a rubber seal or a sealing made of a plastic material).

[0058] The top wall of the container may comprise a first inner duct connection and a second inner duct connection. The first inner duct connection may be configured to receive the first duct. The second inner duct connection may be configured to receive the second duct. The top wall of the container may comprise an outer duct connection and the rear wall may comprise a third duct connection. The outer duct connection may be configured to receive the first duct. The third duct connection may be configured to receive the second duct.

[0059] The container may withstand an internal pressure build up of 4.5 time of the ambient pressure. The ambient pressure is the pressure of the indoor space. The container may be made from a plastic material, such as acrylonitrile styrene acrylate or similar.

BRIEF DESCRIPTION OF THE DRAWINGS

[0060]

Fig. 1 is a piping diagram depicting a configuration of a refrigerant circuit and heat medium circuit in a heat pump according to an embodiment of the present invention.

Fig. 2 is a schematic view illustrating the container with a first duct and a second duct of the first embodiment of the present invention.

Fig. 3 is a schematic view illustrating the container with a first duct and a second duct of a first modification of the first embodiment of the present invention.

Fig. 4 is a perspective view from below of the container according to the first embodiment.

Fig. 5 is a perspective view from above of the container according to the first embodiment.

Fig. 6 is a perspective view from the side of the container according to the first embodiment.

Fig. 7 is a perspective view from the front of the container according to the first embodiment.

Fig. 8 is a perspective view from the rear of the container according to the first embodiment.

DESCRIPTION OF EMBODIMENTS

[0061] Hereinafter, embodiments according to the disclosure will be described in detail with reference to the accompanying drawings in order to describe the disclosure using illustrative examples. Further modifications of certain individual features described in this context can be combined with other features of the described embodiments to form further embodiments of the disclosure. Throughout the drawings, the same reference numerals are used for the same or similar elements.

[0062] Description is made herein to a heat pump 1 as an exemplary refrigeration apparatus.

[0063] Fig. 1 is a piping diagram depicting a configuration of a refrigerant circuit 10 and heat medium circuit 30 in a heat pump 1 according to an embodiment of the present invention. The heat pump 1 heats water (one example of a use-side fluid) supplied to a target space (not illustrated) to heat the target space. As illustrated in Fig. 1, the heat pump 1 includes an outdoor unit 100 disposed at an outdoor space, a heat exchanger unit 200 and an indoor unit 300 (not illustrated) installed in the indoor space. The outdoor unit 100 and the heat exchanger unit 200 are connected to each other by the refrigerant piping 14. The heat exchanger unit 200 and the indoor unit 300 (not illustrated) are connected to each other by the heat medium piping 37. The refrigerant circuit 10 and the heat medium circuit 30 are accordingly constituted in the heat pump 1.

[0064] The heat medium circuit 30 includes at least an intermediate heat exchanger 20, a first heat medium pipe 37, a second heat medium pipe 37, a gas-liquid separator 31 with a gas purge valve 313, a pressure relief valve 314 (not illustrated), and a pump 36 (not illustrated). The heat medium circuit 30 is filled with a heat medium (one example is water) that circulates to achieve a heat medium cycle. The heat medium circuit 30 is for circulating a heat medium comprising the intermediate heat exchanger 20.

[0065] The refrigerant circuit 10 used in the heat pump of the present invention corresponds to a commonly known refrigerant circuit, which comprises at least a compressor 11, a heat source heat exchanger 12 (e.g., outdoor air heat exchanger or ground source heat exchanger), an expansion valve 13 (one example of an expansion mechanism), an intermediate heat exchanger 20, a liquid refrigerant pipe 142, and a gas refrigerant pipe 143. All elements are connected by a refrigerant piping, such that refrigerant can flow from one component to the other and can achieve heat exchange with a heat medium. The refrigerant circuit 10 is filled with a refrigerant that circulates to achieve a refrigeration cycle. The refrigerant circuit 10 is configured to circulate a refrigerant. Refrigerant used in the exemplary embodiments of the present invention consists of R290 or R744. Usually, R290 and R744 comprise a higher density than air under

atmospheric pressure. Thus, R290 or R744 usually concentrates at bottom sections of spaces or volumes. The refrigerant piping 14 may be covered by an insulation and a sealing material. The refrigerant piping 14 may be bent at angles between 20° and 90° and are thus vulnerable for leakage.

[0066] The outdoor unit 100, as illustrated in Fig. 1, comprises an outdoor unit casing 101 that is disposed at an outdoor space. The outdoor unit casing 101 accommodates the compressor 11, the heat source heat exchanger 12, the expansion valve 13, and a part of the liquid refrigerant pipe 142 and the gas refrigerant pipe 143.

[0067] The indoor unit 300 comprises an indoor unit casing (not illustrated) that is dispose in the indoor space. The indoor unit casing accommodates the pump 36, and a part of the heat medium piping 37. The indoor unit casing (not illustrated) further includes a machine chamber part and a tank chamber part, wherein the tank chamber part may further include a hot water tank and a coil.

[0068] The indoor unit 300 further comprises the heat exchanger unit 200. The heat exchanger unit 200 comprises a container 201 and especially the container 201 may be separate to the indoor unit casing. The indoor unit 300 comprises an indoor unit casing and a container 201.

[0069] The heat exchanger unit 200, as illustrated in Fig. 1, for a heat pump 1 is installed inside of a building. The heat exchanger unit 200 comprises a container 201 that is disposed in an indoor space. The heat exchanger unit 200 comprises a part of the heat medium circuit 30 for circulating a heat medium, the intermediate heat exchanger 20 to exchange heat between a refrigerant and the heat medium, the gas-liquid separator 31 provided in the heat medium circuit, and the container 201. The container 201 accommodates the intermediate heat exchanger 20, the gas purge valve 313, and the gas-liquid separator 31. The gas-liquid separator 31 comprises the gas purge valve 313 to release refrigerant. The container 201 accommodates the pressure relief valve 314. The container 201 further accommodates a part of the liquid refrigerant pipe 142 and the gas refrigerant pipe 143, and a part of the heat medium piping 37.

[0070] Fig. 4 and Fig. 5 show a container 201 of the heat exchanger unit 200 of the embodiment as illustrated in Fig. 1. The container 201 has a box shape with a first side wall 202 and a second side wall 203, opposing the first side wall 202, a rear wall 204 extending between the first side wall 202 and the second side wall 203, a top wall 205 being connected to upper ends of the first side wall 202, the second side wall 203, and the rear wall 204, a front wall 206 opposing the rear wall 204, and a bottom wall 207 opposing the top wall 205. The container 201 may comprise a detachable lid 215, which is preferably arranged on the top wall 205.

[0071] Fig. 8 shows a perspective view from the rear of the container 201 of the first embodiment. The top wall 205 may comprise an outer duct connection 216. The rear wall 204 may comprise a third duct connection 218. The third duct connection 218 may be arranged in the lowest part of the container 201. The third duct connection 218 may be arranged in the bottom wall 207 of the container 201. The outer duct connection 216 is configured to receive the first duct 208 of the first embodiment. The third duct connection 218 is configured to receive the second duct 209 of the first embodiment.

[0072] The container 201 of the first embodiment may further comprise an air intake 210 configured to allow an air flow from an outside of the container 201 to the inside of the container 201 (Fig. 7). The air intake 210 is preferably provided on the front wall in a lower portion. The first duct 208 is connected to a first side of the container and the air intake 210 is connected to a second side of the container and the first side is different to the second side. The first duct 208 is connected to the top wall 205 and the air intake 210 is provided in a lower portion of the front wall, so that a ventilation of the container 201 is achieved. The inside of the container 201 is hermetically sealed from the outside of the container 201. Preferably, the top wall 205 is connected to the first side wall 202, the second side wall 203, the rear wall 204 and the front wall 206 by connecting elements 219 (one example is screws that are fixed by bolts).

[0073] The container 201 further comprises a refrigerant leakage detector 212 and the container 201 may further accommodate the refrigerant leakage detector 212. The refrigerant leakage detector 212 is preferably arranged in a lower half of the container 201, as illustrated in Fig. 3. The refrigerant leakage detector 212 may be arranged below the gas purge valve 313. The refrigerant leakage detector 212 may be configured to control a motor of a fan (not illustrated), which is provided at the end of the first duct 208 which opens into the outdoor space. The fan is configured to generate an airflow from the inside of the container 201 to the outdoor space through the first duct 208.

[0074] The indoor space is separate from the outdoor space and may be separated by a house wall 40. The house wall may comprise two openings. The opening of the house wall 40 may be a breakthrough in the house wall and may receive a duct of the heat exchanger unit 200.

[0075] Further commonly known elements of an indoor unit, such as a magnetic filter, a control unit, a three-way-valve, a flow sensor, an expansion vessel, a pressure sensor, a backup heater, a connection terminal, a switch box, a user interface, a circulation pump, etc. are not relevant for the description of the exemplary embodiments and are well known to a skilled person, such that a further description thereof will be omitted. Accordingly, some of the elements are also not illustrated in the drawings for orientation purposes.

[0076] Subsequently, several embodiments of the heat pump 1 of the present invention will be described in detail.

First embodiment

[0077] Next, the heat exchanger unit 200 of a first embodiment will be described with reference to Fig. 1, 2, 4, 5, 6, 7, and 8. The first embodiment uses the heat pump 1 as previously described, and as illustrated in Fig. 1. Thus, the description of similar elements than the ones of the previously described will be omitted. The first embodiment comprises a heat pump with a first duct.

[0078] Fig. 2 is a schematic view illustrating the container 201 with a first duct 208 and second duct 209 of a first embodiment of the present invention. In the heat exchanger unit 200 of the first embodiment of the heat pump 1, the container 201 comprises a first duct 208 and a second duct 209. The first duct 208 is arranged in an opening in the house wall 40. The first duct 208 is separate from the second duct 209. The second duct 209 is arranged in a separate opening to the first duct 208 in the house wall 40. The first duct 208 is provided at the container 201, especially at the top wall 205 of the container 201. Alternatively, the first duct 208 may be provided at the rear wall 204 of the container 201. The second duct 209 is provided at the container 201, especially at the rear wall 204 or the bottom wall 207 of the container 201. The first duct 208 has a first end that is arranged at the container 201 and a second end that is arranged in the house wall 40 and extends towards the outdoor space, where the outdoor unit 100 is situated. The first duct 208 communicate an inside of the container 201 with an outdoor space for air exchange between the inside of the container 201 and the outdoor space. The outdoor space is outside of the building, where the outdoor unit 100 is situated. The second duct 209 has a first end that is arranged at the container 201 and a second end that is arranged in the house wall 40 and extends towards the outdoor space, where the outdoor unit 100 is situated. The second duct 209 also communicates the inside of the container 201 with the outdoor space for air exchange between the inside of the container 201 and the outdoor space. Thus, by the provision of the first duct 208 and the second duct 209 it is possible that supply air enters the container 201 through the first duct 208 and that exhaust air flows out of the container 201 through the second duct 209. It is also possible that air is supplied to the container 201 through the second duct 209 and that the air is exhausted from the container 201 through the first duct 208. The second duct 209 is connected to a lower part of the container 201 for drainage of liquid from the container 201. The second duct 209 is provided at a lower portion of the container and may be inclined to the outdoor space so that a liquid can flows towards the outdoor space. Alternatively, the second duct 209 may be arranged at the bottom wall 207 of the container 201 and may be inclined to the outdoor space. Accumulated liquid may flow on the inclined bottom wall 207 towards the second duct 209 and to the outdoor space.

[0079] In the first duct 208, the gas refrigerant pipe 143 and the liquid refrigerant pipe 142 are disposed. Alternatively, the liquid refrigerant pipe 142 may be disposed in the first duct 208 and the gas refrigerant pipe 143 may be disposed in the second duct 209.

[0080] A ventilation duct (not illustrated) may be further disposed in the first duct 208. A fan (not illustrated) is provided at an end of the first duct 208 opening into the outdoor space. The fan is configured to create an airflow through the first duct 208 from the inside of the container 201 to the outdoor space. The fan can be preferably provided at an end of the ventilation duct opening into the outdoor space. Accordingly, possible leaked refrigerant of the container is transported by the airflow through the first duct to the outdoor space. In the second duct 209 a drainage for accumulated liquid is provided so that accumulated liquid in the container 201 can flow towards the outdoor space. The second duct 209 is at the lowest position of the container 201 and has an inclination towards the outdoor space so that accumulated liquid flows towards the outdoor space.

[0081] The container 201 accommodates the intermediate heat exchanger 20, the gas purge valve 313, the gas-liquid separator 31, the pressure relief valve 314, parts of the heat medium piping 37, and parts of the refrigerant piping 14. The refrigerant piping 14 comprises the liquid refrigerant pipe 142 and the gas refrigerant pipe 143. Additionally, the connections of the refrigerant piping 14 with the intermediate heat exchanger 20 are accommodated in the container 201. The gas purge valve 313 and the pressure relief valve 314 which are likely sources of refrigerant and heat medium leakage are accommodated in the container 201. Accordingly, a possible refrigerant leakage of the refrigerant piping 14 or of the components of the heat medium circuit 30 and refrigerant circuit 10 can be accumulated in the container 201 and a refrigerant leakage into the indoor space is prevented.

[0082] Fig. 4 is a perspective view from below of the container 201 according to the first embodiment and Fig. 5 is a perspective view from above of the container 201 according to the first embodiment. The heat exchanger unit 200 comprises the container 201, the first duct 208, and the second duct 209. The first duct 208 is provided at the container 201. The second duct 209 is provided at the third duct connection 218 at the lower portion of the rear wall 204 (not illustrated). The container 201 further comprises a rear wall 204, a first side wall 202, a second side wall 203, a top wall 205, and a bottom wall 207. At the bottom wall 207, a heat medium pipe connection point 371 is provided for connecting the heat medium piping 37. The heat medium piping 37 includes a first heat medium piping 37 and a second heat medium piping 37. As illustrated in Fig. 5, the first duct 208 is provided at the top wall 205. In the first duct 208, the refrigerant pipe connection point 141 is arranged for connecting the refrigerant piping 14. When the refrigerant piping 14 is connected at the refrigerant pipe connection point 141 with the intermediate heat exchanger, the refrigerant piping 14 is arranged in the first duct 208.

[0083] Fig. 6 is a perspective view from the side of the container 201 according to the first embodiment and Fig. 7 is a perspective view from the front of the container 201 according to the first embodiment. At the bottom wall 207 of the container 201, a heat medium pipe connection point 371 is provided for connecting the heat medium piping 37 that continues further to the indoor unit casing. In the front wall 206, a further air intake 210 is provided. In particular, the air intake 210 is provided in a lower portion of the front wall 206 of the container 201. As illustrated in Fig. 6 and Fig. 7 of the first embodiment, the front wall 206 of the container 201 may be recessed in the lower portion so that the air intake 210 is partially covered by the front wall 206. Alternatively, it is also possible that the air intake 210 is not provided in the first embodiment.

[0084] Fig. 8 is a perspective view from the rear of the container 201 according to the first embodiment. The first duct 208 is arranged on one side of the container 201, in particular at the top wall 205 of the container 201 (not illustrated). The first duct 208 is attached to the top wall 205 of the container 201. In the rear wall 204 of the container 206, a third duct connection 218 is provided. The second duct 209 is arranged on one side of the container 201, in particular at the rear wall 204 of the container (not illustrated). The second duct 209 is attached to the third duct connection 218. The connection between the second duct 209 and the third duct connection 218 is airtight. The third duct connection 218 is provided at the lowest position of the container 201. The provision of the third duct connection 218 at the lowest position allows that the accumulated liquid can flow through the second duct 209 from the container 201 to the outdoor space.

[0085] In the first duct 208 the refrigerant piping 14 is arranged. In the second duct 209 air exchange with the outdoor space and the container is possible and accumulated liquid may flow from the container to the outdoor space.

[0086] The bottom wall 207 of the container 201 (not illustrated) is further constructed with an inclination so that accumulated liquid flows towards the third duct connection 218. The second duct 209 is further constructed with an inclination so that the accumulated liquid further flows towards an outdoor space. It is also possible that in the second duct 209 a separate drain pipe is provided. Through the drain pipe the accumulated liquid may be drained to the outdoor space. Accordingly, by the heat pump 1 of the first embodiment a leakage of refrigerant in the indoor space is prevented. By the provision of the first duct and second duct it is possible that a leaked refrigerant and heat medium are ventilated and/or transported to the outdoor space so that a low concentration of refrigerant can be maintained in the container 201 in case of a refrigerant leakage.

First modification of the first embodiment

[0087] A first modification of the first embodiment is shown in the schematic view of Fig. 3. The first modification of the first embodiment differs from the embodiments described above in the configuration of the first duct 208 and second duct 209. Nonetheless, the description of similar elements than the ones of the previously described embodiments will be omitted.

[0088] In the second duct 209 of the first modification of the first embodiment the liquid refrigerant pipe 142 and the gas refrigerant pipe 143 are arranged. The first duct 208 of the first modification of the first embodiment does not accommodate the refrigerant piping 14.

[0089] Thus, in the heat pump 1 of the first modification of the first embodiment, the refrigerant piping 14 is arranged in the second duct 209. In the second duct 209 the drainage of liquid is further possible. In the first duct 208 only air ventilation can occur. Thus, the second duct 209 may provide an air inlet to supply air into the container 201 and may provide a drainage for accumulated liquid. The first duct 208 may provide an air outlet to exhaust air from the container 201 to the outdoor space. By the first modification of the first embodiment, it is easy to dispose a fan at an end of the first duct 208 opening into the outdoor space. By the first modification of the first embodiment the same technical effects as described for the first embodiment are achieved.

REFERENCE LIST

[0090]

1	Heat pump
10	Refrigerant circuit
11	Compressor
12	Heat source heat exchanger
13	Expansion valve
14	Refrigerant piping
141	Refrigerant pipe connection point
142	Liquid refrigerant pipe
143	Gas refrigerant pipe
20	Intermediate heat exchanger
30	Heat medium circuit
31	Gas-liquid separator
313	Gas purge valve
314	pressure relief valve
36	Pump
37	Heat medium piping
371	Heat medium pipe connection point
40	house wall
100	Outdoor unit
101	Outdoor unit casing
200	Heat exchanger unit
201	Container
202	First side wall
203	Second side wall
204	Rear wall
205	Top wall
206	Front wall
207	Bottom wall

208 First duct
209 Second duct
210 Air intake
212 Refrigerant leakage detector
215 Detachable lid
216 outer duct connection
218 third duct connection
219 connecting element
300 Indoor unit

Claims

1. An indoor unit for a heat pump (1) installed inside of a building, comprising

a part of a heat medium circuit (30) for circulating a heat medium,
an intermediate heat exchanger (20) to exchange heat between a refrigerant and the heat medium,
a pressure relief valve (314) to release the heat medium, which is provided in the heat medium circuit (30),
a container (201) accommodating the intermediate heat exchanger (20) and the pressure relief valve (314),
wherein the container (201) comprises a first duct (208) and a second duct (209), wherein the first duct (208) is connected to an upper part of the container (201) and communicates an inside of the container (201) with an outdoor space for air exchange between the inside of the container (201) and the outdoor space, wherein the outdoor space is outside of the building,
wherein the second duct (209) is connected to a lower part of the container (201) for drainage of liquid from the container.

2. A heat pump (1), comprising

a refrigerant circuit (10) for circulating a refrigerant comprising a liquid refrigerant pipe (142), a heat source heat exchanger (12), a compressor (11), an expansion valve (13), a gas refrigerant pipe (143), and an intermediate heat exchanger (20),
a heat medium circuit (30) for circulating a heat medium comprising a pump and the intermediate heat exchanger (20),
the intermediate heat exchanger (20) to exchange heat between the refrigerant and the heat medium,
a pressure relief valve (314) to release the heat medium, which is provided in the heat medium circuit (30),
a container (201) accommodating the intermediate heat exchanger (20) and the pressure relief valve (314),
wherein the container (201) comprises a first duct (208) and a second duct (209), wherein the first duct (208) is connected to an upper part of the container (201) and communicates an inside of the container (201) with an outdoor space for air exchange between the inside of the container (201) and the outdoor space, wherein the outdoor space is where the heat source heat exchanger (12) and the compressor (11) are located,
wherein the second duct (209) is connected to a lower part of the container (201) for drainage of liquid from the container (201).

3. The indoor unit according to claim 1 or the heat pump according to claim 2,
wherein the second duct (209) communicates the inside of the container (201) with the outdoor space for air exchange between the inside of the container (201) and the outdoor space.

4. The indoor unit or the heat pump according to any one of the preceding claims, wherein

a gas-liquid separator (31) is provided in the heat medium circuit (30), the gas-liquid separator (31) comprising a gas purge valve (313) to release refrigerant, and
wherein the container (201) further accommodates the gas-liquid separator (31) and the gas purge valve (313).

5. The indoor unit or the heat pump according to any one of the preceding claims,
wherein the container (201) comprises an air intake (210) configured to allow an airflow from outside the container (201) in the inside of the container (201).

6. The indoor unit or the heat pump according to any one of the preceding claims,
wherein a fan is arranged at an outdoor end of the first duct (208), the fan being configured to generate an airflow from the inside of the container (201) to the outdoor space through the first duct (208).

7. The indoor unit or the heat pump according to any one of the preceding claims,
wherein the inside of the container (201) is hermetically sealed from the outside of the container (201).

8. The indoor unit or the heat pump according to any one of the preceding claims,

wherein the container (201) has a box shape with a first side wall (202) and a second side wall (203), opposing the first side wall (202), a rear wall (204) extending between the first side wall

(202) and the second side wall (203), a top wall (205) being connected to upper ends of the first side wall (202), the second side wall (203), and the rear wall (204), a front wall (206) opposing the rear wall (204), and a bottom wall (207) opposing the top wall (205),
wherein the first duct (208) is arranged at the top wall (205) of the container (201), and
wherein the second duct (209) is arranged at the rear wall (204) or at the bottom wall (207) of the container (201) .

9. The indoor unit or the heat pump according to claim 8,
wherein the bottom wall (207) of the container (201) is inclined towards an opening of the second duct (209).

10. The indoor unit or the heat pump according to any one of the preceding claims,
wherein the second duct (209) is arranged at a lowest position of the container (201).

11. The indoor unit or the heat pump according to any one of the preceding claims,
wherein the gas refrigerant pipe (143) and the liquid refrigerant pipe (142) are disposed in the first duct (208) or in the second duct (209).

12. The indoor unit or the heat pump according to any one of the preceding claims,
wherein the container further comprises a detachable lid (215) .

13. The indoor unit or the heat pump according to any one of the preceding claims,

wherein the first duct (208) is configured to discharge air from the inside of the container (201) to the outdoor space and the second duct (209) is configured to allow an air inflow from the outdoor space to the inside of the container (201), or
wherein the first duct (208) is configured to allow an air inflow from the outdoor space to the inside of the container (201) and the second duct (209) is configured to discharge air from the inside of the container (201) to the outdoor space.

14. The indoor unit or the heat pump according to any one of the preceding claims,
further comprising a refrigerant leakage detector (212) and the container (201) further accommodating the refrigerant leakage detector (212).

15. The indoor unit or the heat pump according to any one of the preceding claims,
wherein the first duct (208) is connected to a first side of the container (201) and the air intake (210) is connected to a second side of the container (201) and the first side is different to the second side.

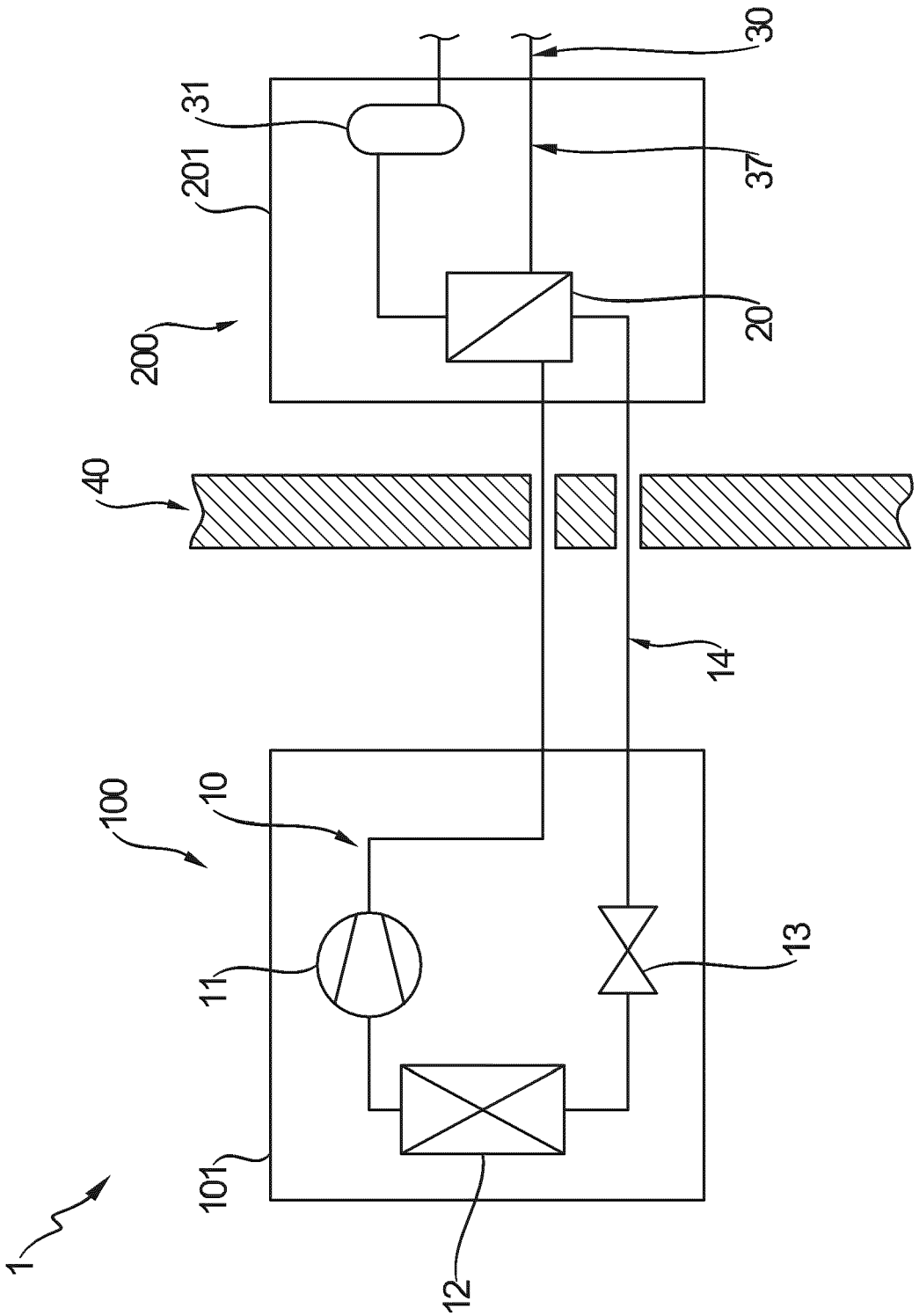

Fig. 1

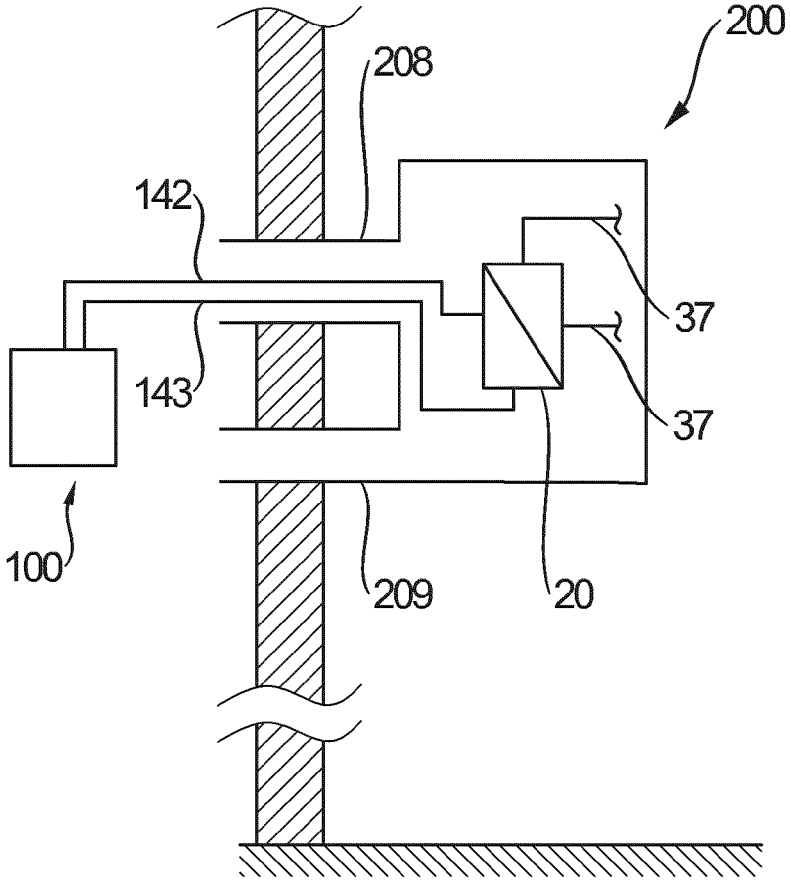
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Fig. 2

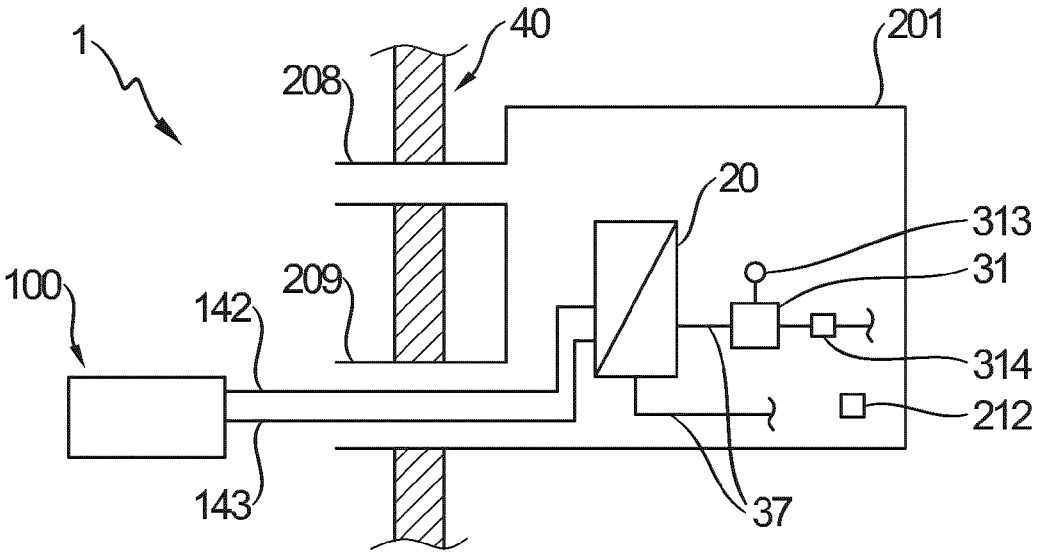
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Fig. 3

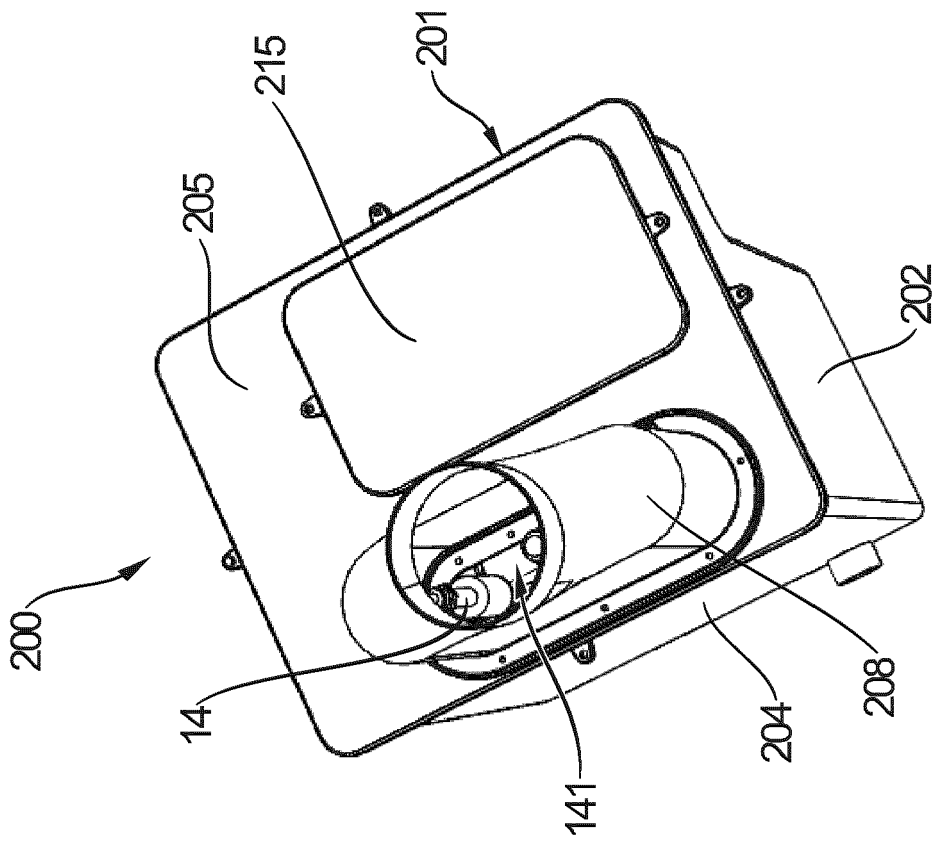
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Fig. 5

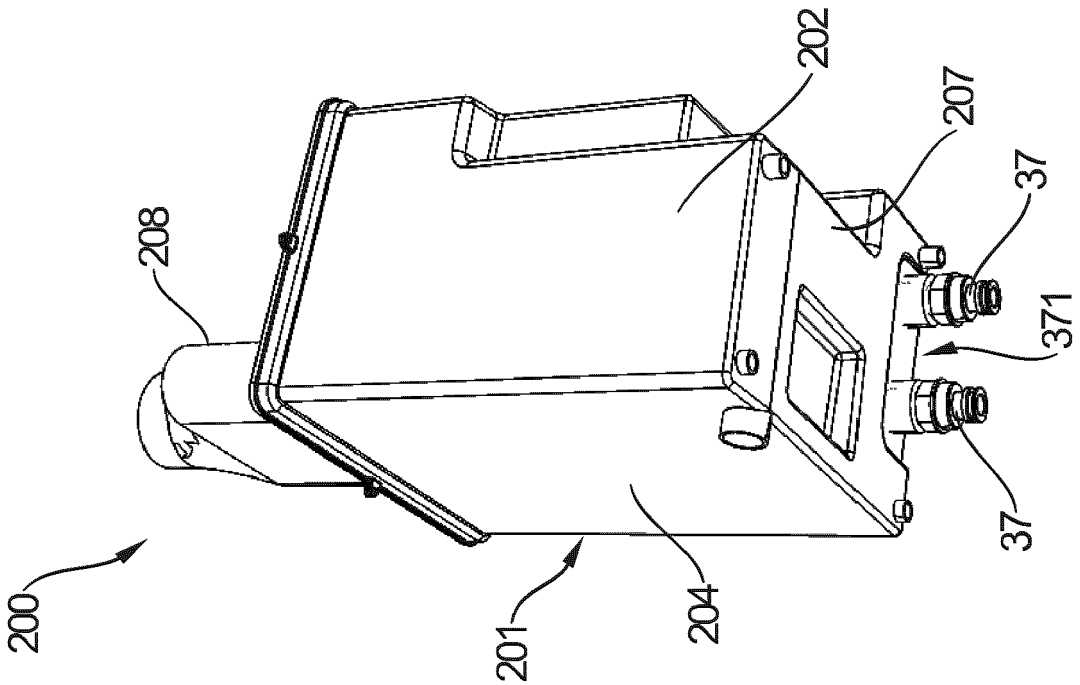
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Fig. 4

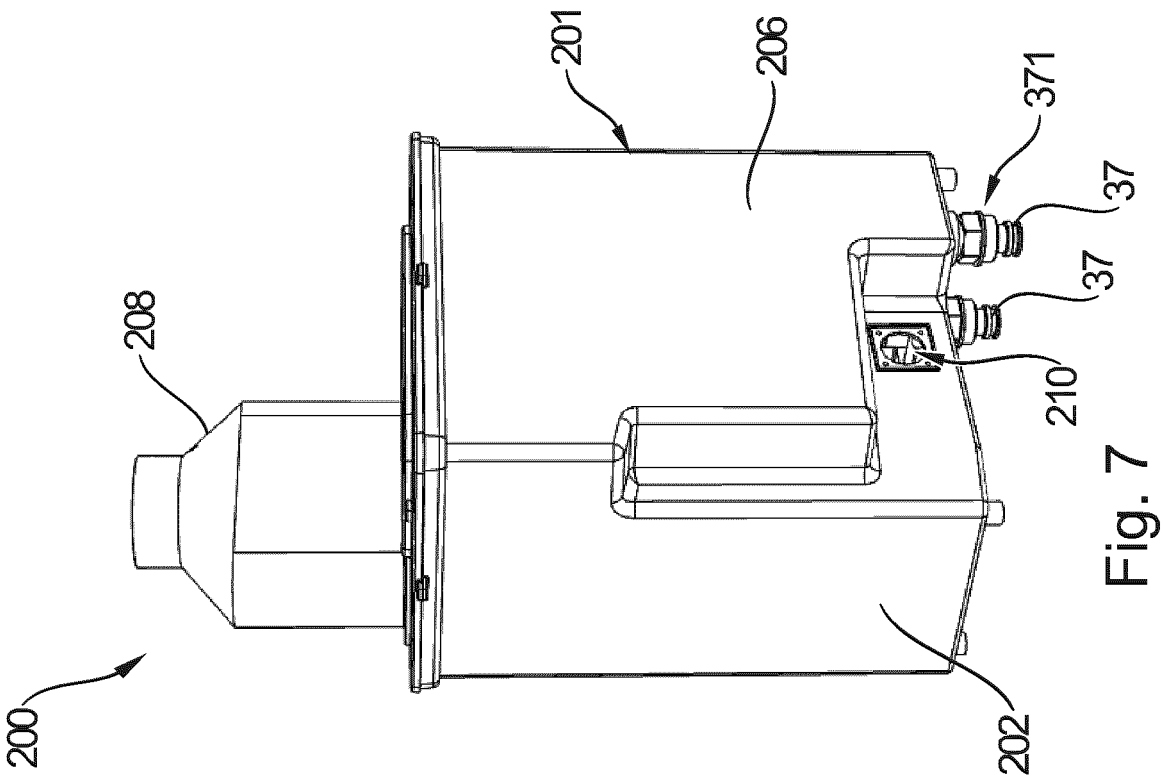
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Fig. 7

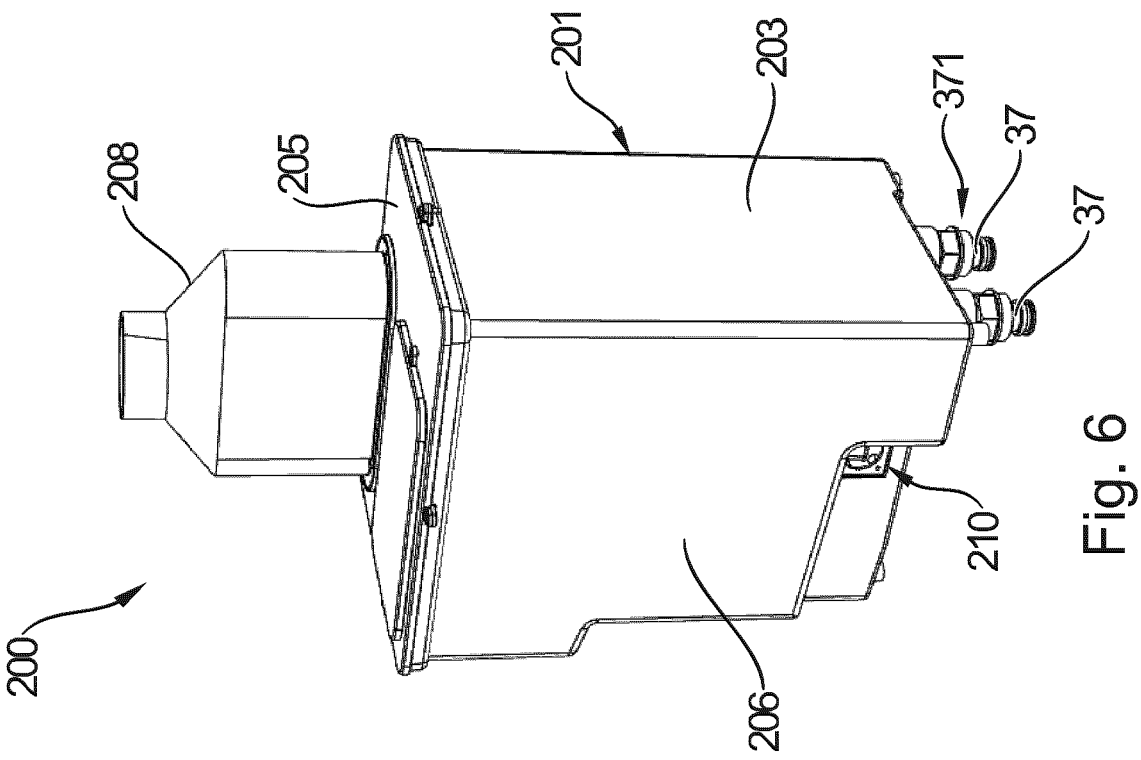
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Fig. 6

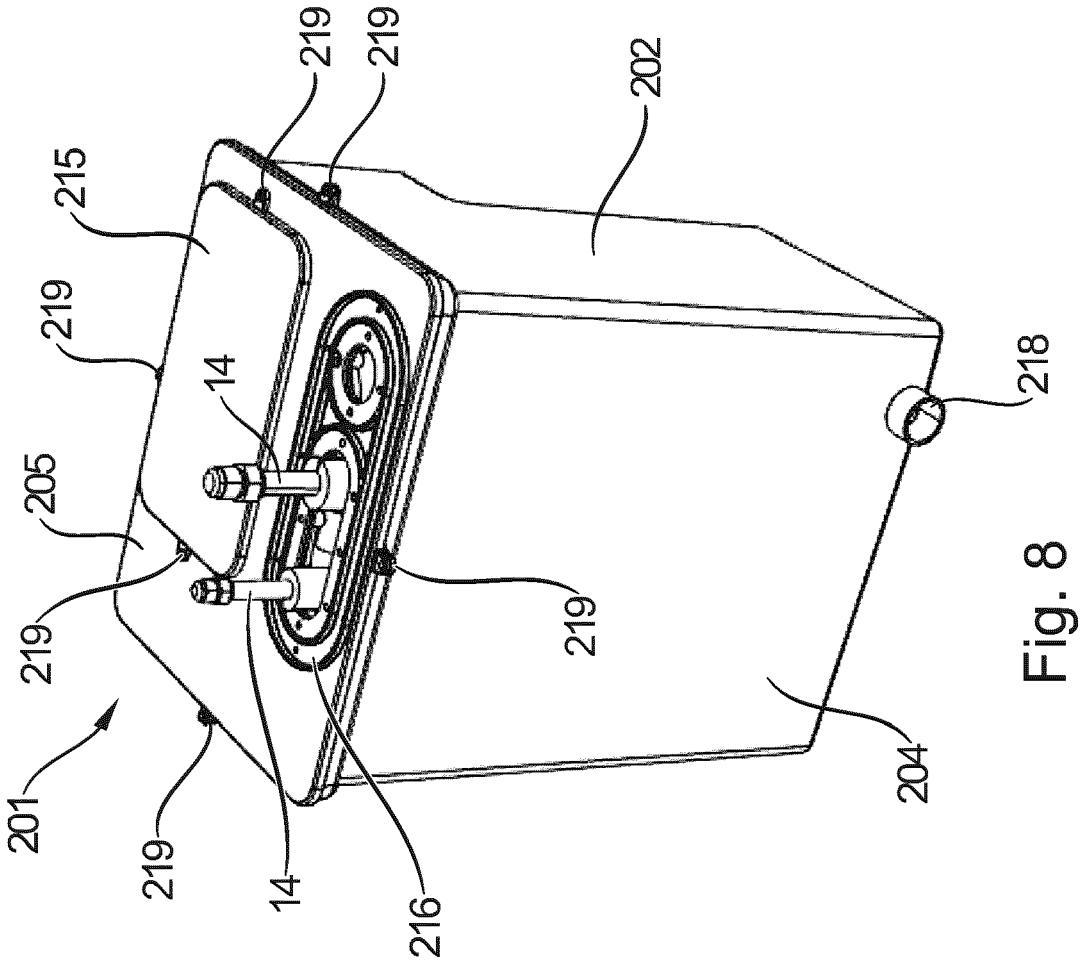

Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 23 17 5739

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F24F
F25B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	16 November 2023	Silex, Anna

CATEGORY OF CITED DOCUMENTS

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