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(54) **HEAT PUMP**

(57) The present disclosure relates to a heat pump comprising a refrigerant circuit (10) connecting a heat source heat exchanger (12), an expansion valve (14), a usage side heat exchanger (16) and a compressor (18), the refrigerant circuit being accommodated in an outdoor unit housing (2); a heat medium circuit (20) connecting the usage side heat exchanger (16), a pump (22) and a load (29), the heat medium circuit further comprising at least one air purge valve (25, 27) having an outlet for releasing at least gas from the heat medium circuit (20), the air purge valve (25, 27) being accommodated in an indoor unit housing (3), and a release box (40) defining a space (48) having a gas inlet (52, 53) connected to the outlet of the at least one air purge valve (25, 27), and a vent (64) to an outside of the indoor unit housing (3) for guiding gas released from the at least one air purge valve (25, 27) to the outside of the indoor unit housing (3).

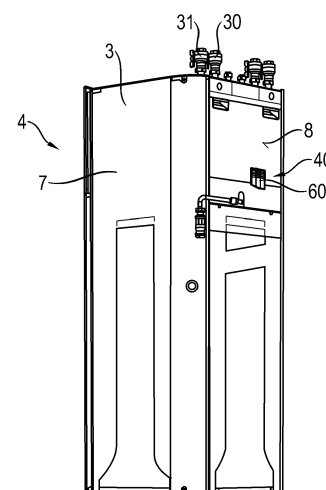


Fig. 2

Description**Technical Field**

5 **[0001]** The present disclosure relates to heat pumps, particularly heat pumps used for heating and/or cooling purposes, particularly in commercial and private buildings. More particularly, the present disclosure relates to heat pumps of the so-called hydro split type comprising a heat exchanger (usage side heat exchanger) for transferring heat between a refrigerant and a heat medium such as water, wherein the refrigerant circuit, including the usage side heat exchanger, is entirely located outdoors.

Background

10 **[0002]** Nowadays, there is a significant thrive for using refrigerants for heat pumps that have a low global warming potential (GWP) and a low ozone depletion potential (ODP). In this context, R290 (propane) is one of the refrigerants used in heat pumps of the above type because propane has a GWP of three and an ODP of zero.

15 **[0003]** Heat pumps of the hydro split type comprise a primary circuit (refrigerant circuit) connecting a heat source heat exchanger, such as an air to refrigerant heat exchanger, an expansion valve, the usage side heat exchanger, such as a plate heat exchanger, and a compressor. The primary circuit of a hydro split type heat pump is usually located outdoors (outside of the building) and particularly in a housing of an outdoor unit.

20 **[0004]** The usage side heat exchanger of the primary circuit is connected via heat medium pipes, such as water pipes, to an indoor unit having an indoor unit housing located inside the building. The indoor unit housing usually houses at least some of the components of a secondary circuit (heat medium circuit). The heat medium circuit particularly connects the usage side heat exchanger by means of the heat medium pipes, a pump and a load. The pump serves circulating the heat medium in the heat medium circuit. The load may for example be a domestic hot water tank, loops of a floor heating and/or radiators. The heat medium circuit further comprises an air purge valve accommodated in the indoor unit housing. The air purge valve is designated for releasing primarily air from the heat medium circuit (even though a small amount of heat medium may also exit the air purge valve when releasing air from the heat medium circuit). The air purge valve may for example be part of a back-up heater and/or a magnetic filter connected to the heat medium circuit.

25 **[0005]** Due to leakage, for example due to a leak in the usage side heat exchanger, refrigerant may leak from the refrigerant circuit into the heat medium circuit. In this case, gaseous refrigerant may exit the heat medium circuit via the air purge valve and enter the indoor unit housing.

30 **[0006]** However, the indoor unit housing very often also accommodates components such as electrical and/or electronic components which may be considered an ignition source. As refrigerants used nowadays are often flammable or even highly flammable, such as R290, refrigerant entering the indoor unit housing is hazardous.

Summary

35 **[0007]** In view of the aforesaid, it is an object of the present disclosure to provide a heat pump that can reduce the risk of hazardous events caused by leaking refrigerant.

40 **[0008]** A heat pump according to the present disclosure is defined in claim 1. Particular embodiments are defined in the dependent claims.

45 **[0009]** A heat pump according to a first aspect, particularly for heating and/or cooling of a space inside a building and/or heating domestic hot water, comprises a refrigerant circuit connecting at least a heat source heat exchanger, an expansion valve, a usage side heat exchanger and a compressor. The refrigerant circuit contains a refrigerant, which may be R290 (propane). The heat source heat exchanger may be an air to refrigerant heat exchanger. The usage side heat exchanger may for example be a plate or a double plate heat exchanger. As previously indicated, the heat pump is a so-called hydro split type heat pump. Accordingly, the refrigerant circuit is accommodated in a housing of an outdoor unit (outdoor unit housing). An outdoor unit is to be understood as a unit being disposed outside the building.

50 **[0010]** The heat pump further comprises a heat medium circuit connecting the usage side heat exchanger, a pump and a load. The heat medium circuit contains a heat medium, which may be water. The pump particularly serves for circulating the heat medium within the heat medium circuit. The load may for example be at least one of a domestic hot water tank, loops of a floor heating and radiators. The heat medium circuit further comprises at least one air purge valve accommodated in the indoor unit housing. Two or more air purge valves accommodated in the indoor unit housing are as well conceivable. The air purge valve(-s) has (have) an outlet for releasing primarily air (gas) from the heat medium circuit (even though a small amount of heat medium may also exit the air purge valve(-s) when releasing air from the heat medium circuit). The air purge valve may for example be part of a back-up heater and/or a magnetic filter connected to the heat medium circuit (see later). The indoor unit housing may have a machine chamber and the air purge valve(-s) is (are) preferably located in the machine chamber. Also other components of the heat medium circuit may be accommodated in

the indoor unit housing, particularly the machine chamber, such as the pump. In case the load is a domestic hot water tank, the domestic hot water tank may be located in a tank chamber of the indoor unit housing below the machine chamber. Moreover, the heat medium circuit may comprise heat medium pipes connecting the usage side heat exchanger located outdoors with the components of the heat medium circuit located indoors, such as in the indoor unit housing.

[0011] The heat pump further comprises a release box defining a space. The release box may be accommodated inside the indoor unit housing. The release box, having a box shape, may have a top, a bottom opposite to the top, opposite lateral sides (left and right sides), a back side and a front side. The release box may be an injection molded product made from resin. The release box may be an integrally formed one-piece product having an open side, particularly the front side (see below). A one-piece release box is advantageous in regard of sealing of the space. Alternatively, the release box may, however, be a two- or more-part product. In one example, the release box may be made from two parts, e.g. a top part and a bottom part, which are attached to each other. In this context, it may be beneficial to have a sealing between the two parts to effectively seal the space. The two parts may also be hinged to each other having a snap connection opposite to the hinge for fixing the parts to each other. This has the advantage, that the release box may later be opened for maintenance purposes such as cleaning.

[0012] The space of the release box has a gas inlet connected to the outlet of the at least one air purge valve. The gas inlet may be connected to the outlet of the at least one air purge valve by a flexible tube.

[0013] The space further has a vent (also referred as a venting opening) to an outside of the indoor unit housing for guiding gas (such as air or refrigerant leaked into the heat medium circuit) released from the at least one air purge valve to the outside of the indoor unit housing.

[0014] According to this aspect, gaseous refrigerant that may have leaked into the heat medium circuit and is discharged from the outlet of the air purge valve is via the inlet of the space of the release box flown into the space and therefore isolated from any potential ignition source in the indoor unit housing. Even further, the gaseous refrigerant may exit the space of the release box via its vent and is therefore no longer present inside the indoor unit housing. Accordingly, any potential risks of the refrigerant being ignited can be avoided.

[0015] According to a second aspect, the indoor unit housing has a lateral side wall defining an opening (referred to as mounting opening). The lateral side wall may be the back wall, a front wall, a right side wall or a left side wall of the indoor unit housing. The indoor unit housing (its walls) or at least the lateral side wall(-s) may be made from sheet metal. The release box may close the mounting opening from an inside of the indoor unit housing and the vent is arranged in the mounting opening.

[0016] According to this aspect, the overall structure of the indoor unit can be simplified providing for ease of manufacture and assembly.

[0017] According to a third aspect, the release box is open or has an opening (referred to as front opening) at a (the) front side corresponding to the mounting opening in the lateral side wall of the indoor unit housing and the mounting opening in the lateral side wall of the indoor unit housing is closed from the outside of the indoor unit housing by a cover having a grille.

In this context, it is conceivable, that the release box comprises at the front side a protruding rim surrounding the open side or the front opening and extending through the mounting opening in the lateral side wall of the indoor unit housing and a shoulder further away from the open side or the front opening than the circumferential rim. The circumferential rim can be engaged with the cover. Thereby, the lateral side wall of the indoor unit housing is sandwiched between the shoulder and the cover. Accordingly, the release box can be fixed to the lateral side wall of the indoor unit housing purely by attaching the cover.

[0018] According to this aspect, the overall structure of the indoor unit can be simplified providing for ease of manufacture and assembly.

[0019] In the third aspect, the cover may have an upper grille portion having the grille and a lower fluid impermeable portion, the grille portion defining the vent. In case, the later described perforated plate, vertically separating the space into an upper and lower portion (space), is provided, it may be beneficial that the perforation plate is located at the transition between the upper grille portion and the lower fluid impermeable portion.

[0020] Thus, the space may be virtually divided into an upper portion, in which gas (air or gaseous refrigerant) may accumulate and exit the space through the upper grille portion as the vent, and a lower portion, in which potential liquid heat medium may accumulate which is discharged from the air purge valve or the later described pressure relief valve into the space.

[0021] According to a fourth aspect, the heat medium circuit further comprises a booster heater having the air purge valve.

[0022] According to a fifth aspect, the heat medium circuit further comprises a magnetic filter having the air purge valve.

[0023] If the fourth and fifth aspect are embodied together, two air purge valves are provided in the indoor unit housing. Accordingly, the space may have two inlets respectively connected, e.g. by means of flexible tubing, to the outlets of the two air purge valves. Yet, it is also conceivable to only provide one inlet and connect the one inlet to the outlets of the two air purge valves, e.g. implementing a Y-piece in the tubing (even though this is not preferred as the Y-piece will be a further potential leakage point). As regards positioning of the inlet or the inlets, there is no potential limitation. Particularly, the

inlet(-s) can be positioned in the top (side or wall), the lateral sides or walls and the back (side or wall). If the vent is provided at the front as described above, it may be beneficial to position the inlet(-s) in the back so that any gaseous medium (air or gaseous refrigerant) is discharged into the space towards the vent and out of the indoor unit housing.

[0024] According to a sixth aspect, the magnetic filter further has a pressure relief valve having an outlet for releasing gas and/or liquid heat medium from the heat medium circuit. The release box has a drain inlet into the space, the outlet of the pressure relief valve being connected to the drain inlet, e.g. by means of tubing such as flexible tubing. The space further has a drainage port.

[0025] Accordingly, the release box or particularly its space may serve as a gas/liquid separator separating any gaseous medium (gaseous refrigerant leaked into the heat medium circuit or gaseous heat medium) from liquid medium (liquid heat medium). Accordingly, it can be avoided that leaked refrigerant is drained through the drainage port together with liquid heat medium.

[0026] The drainage port is arranged in a lower portion of the space such as in a bottom (side or wall) of the release box. Consequently, any liquid medium may effectively be led to the drainage port.

[0027] According to a seventh aspect, the bottom is inclined towards the drainage port.

[0028] As a result, guidance of any liquid medium to the drainage port can be assisted and good drainage be achieved.

[0029] According to an eighth aspect, a float valve is arranged in the drainage port. The float valve only opens the drainage port once a certain amount of liquid medium has accumulated in the space of the release box and only then enables drainage of the liquid medium from the space.

[0030] Accordingly, escaping of gaseous medium such as leaked refrigerant through the drainage port can be prevented or at least be minimized.

[0031] The float valve is particularly a guided float ball. To guide the float ball, vertical ribs may protrude from a circumference of the drainage port and restrict movement of the float ball in a horizontal direction. Furthermore, a stop plate may be located at or near a free end of the vertical ribs restricting movement of the float ball in a vertical direction.

[0032] The provision of a float ball provides for a very simple float valve, whereby costs are minimized.

[0033] According to a ninth aspect, a cross-sectional area of the drainage port is equal to or larger than a cross-sectional area of the drain inlet. In case the drain inlet and the drainage port are circular in cross-section, the diameter of the drainage port is equal to or larger than the diameter of the drain inlet.

[0034] This aspect provides for the advantage of a good discharge performance of liquid medium from the release box. In other words, the liquid medium flowing into the release box from the drain inlet can flow out of the drainage port without flowing out of the vent.

[0035] According to a tenth aspect, the release box has a top (top side or wall) and the drain inlet is arranged in the top.

[0036] Consequently, the drain inlet and the drainage port are distanced from each other so as to enable sufficient separation of gaseous medium (leaked refrigerant) from the liquid medium discharged into the space before being discharged from the drainage port. In addition, placing the drain inlet in the top provides for the advantage that no water is discharged into the space in a direction of the vent (if the vent is located in any of the side walls such as the front side described above). Thus, water may be prevented from exiting through the vent.

[0037] According to an eleventh aspect, the release box has first and second lateral side walls (lateral sides) being opposite to each other and connecting the bottom (side or wall) and the top (side or wall), wherein the drain inlet is arranged closer to the first lateral side wall than to the second lateral side wall and the drainage port is arranged closer to the second lateral side wall than to the first lateral side wall. The first and second lateral side walls are preferably left and right side walls.

[0038] Consequently, the drain inlet and the drainage port are distanced from each other so as to enable sufficient separation of gaseous medium (leaked refrigerant) from the liquid medium discharged into the space before being discharged from the drainage port.

[0039] According to a twelfth aspect, at least one plate is arranged in the space of the release box and separates the space of the release box reducing the cross-sectional area of a flow path for liquid heat medium from the drain inlet to the drainage port.

[0040] To put it differently, the plate is a flow restriction for the liquid heat medium and promotes separation of the liquid heat medium and gaseous medium, such as leaked refrigerant, entrained in the liquid heat medium in the space so that no or less gaseous medium is discharged from the drainage port.

[0041] According to a thirteenth aspect, the plate is a perforated plate having a plurality of apertures and being horizontally arranged in the space of the release box so as to vertically separate the space of the release box. As described above, the perforated plate may separate the space into an upper and a lower portion (space).

[0042] The horizontal plate increases the time liquid heat medium stays in the release box before reaching the drainage port allowing any entrained gas, such as gaseous refrigerant, to separate from the liquid. Additionally, when the drain inlet is positioned in the top of the release box, the liquid heat medium is discharged perpendicularly to the plate and will splash on the plate. This assists separating entrained gas from the liquid heat medium.

[0043] According to a fourteenth aspect, the plate is vertically arranged in the space of the release box so as to

horizontally separate the space of the release box, defining a flow path at a free side end of the plate through which liquid heat medium may pass. For example, the plate can be a vertical wall extending from the back (side or wall) towards the front (side) leaving a passage between its free side (or end) and the front (side), the passage defining the flow path. Alternatively, the plate can be a vertical wall extending from the front (side) towards the back (side or wall) leaving a passage between its free side (or end) and the back (side or wall), the passage defining the flow path.

[0044] Accordingly, the flow path from the drain inlet to the drainage port is lengthened and/or reduced in cross-section. Thereby, separation of the liquid heat medium and gaseous medium, such as leaked refrigerant, entrained in the liquid heat medium is promoted so that no gaseous medium is discharged from the drainage port.

[0045] According to a fifteenth aspect, the volume of the space is between 0,15 l and 0,75 l.

[0046] As a result, the drain capacity of the release box is sufficiently large to prevent liquid heat medium accumulated in the release box from being discharged via the vent at the same time minimizing the dimensions of the release box in view of space restrictions inside the indoor unit housing, particularly the machine chamber.

[0047] According to a sixteenth aspect, a gas sensor is arranged for sensing gaseous refrigerant in the space of the release box. In this context, the gas sensor itself may even be located outside the release box as long as the sensing portion of the gas sensor is located in or fluidly communicated to the space of the release box.

[0048] Because refrigerant leaking into the heat medium circuit is finally discharged via the air purge valve and/or the pressure relief valve into the space of the release box, a gas sensor sensing inside the space can reliably sense that a leak occurred. Consequently countermeasures can be initiated by a heat pump controller.

Brief Description of the Drawings

[0049]

Figure 1 is a schematic view of a hydro split heat pump;

Figure 2 is a perspective back view of an indoor unit of the hydro split heat pump;

Figure 3 is a partial perspective front view of the indoor unit of figure 2 with a lateral side wall of the indoor unit housing being removed;

Figure 4 is a perspective top view of the indoor unit of figure 2 with a top wall of the indoor unit housing being removed;

Figures 5A-C are perspective views of a release box according to a first embodiment;

Figures 6A-C are perspective views of a release box according to a second embodiment;

Figures 7A-C are perspective views of a release box according to a third embodiment;

Figure 8 is a schematic transverse cross-section of a release box according to a fourth embodiment;

Figures 9A-C are perspective views of release boxes according to alternative embodiments.

Detailed Description

[0050] It is to be understood that same reference numerals designate same or similar features throughout the drawings and the description. Same or similar features in the different embodiments are only described once in order to avoid repetition.

[0051] The hydro split heat pump as shown in figure 1 comprises a refrigerant circuit. The entire refrigerant circuit is arranged outside of a building 1, such as a residential house or commercial building.

[0052] The refrigerant circuit 10, in its most general configuration, connects a heat source heat exchanger 12, an expansion valve 14, a usage side heat exchanger 16 and a compressor 18. It is to be understood that the refrigerant circuit 10 may comprise further components as it is well known in the art.

[0053] A refrigerant is circulated in the refrigerant circuit 10 by means of the compressor 18. The refrigerant may be a flammable refrigerant such as R290 (propane). The heat source may be air so that the heat pump may also be called an air-source heat pump. Yet, the heat pump may use a different source, for example a ground source heat pump using heat from soil or groundwater.

[0054] The usage side heat exchanger 16 may be a plate or double plate heat exchanger.

[0055] At least the above-described components of the refrigerant circuit, preferably all components of the refrigerant

circuit may be located in an outdoor unit housing 2 of an outdoor unit.

[0056] The heat pump further comprises a heat medium circuit 20. The heat medium circuit comprises at least the usage side heat exchanger 16, a pump 22 and a load 29 connected by heat medium piping to form the heat medium circuit 20. The heat medium may be water so that the heat pump is an air to water heat pump.

[0057] The load 29 may be a domestic hot water tank, a floor heating and/or a radiator.

[0058] The heat medium circuit 20 further comprises a booster heater 24 and a magnetic filter 26. The booster heater 24 comprises a first air purge valve 25 (see figure 4). The magnetic filter 26 comprises a second air purge valve 27 and a pressure relief valve 28 (see figure 4). Air purge valves are used to automatically purge air (gaseous medium) from the heat medium circuit. Air purge valves are generally mounted vertically and preferably at the top of the booster heater 24 and the magnetic filter 26. A pressure relief valve is a type of safety valve used to control or limit the pressure in the heat medium circuit. Otherwise, excessive pressure might build up and create equipment failure. Also the pressure relief valve 28 is mounted at the top of the magnetic filter 26.

[0059] In the present embodiment, the pump 22, the booster heater 24 including the air purge valve 25, the magnetic filter 26 including the air purge valve 27 and the pressure relief valve 28 are accommodated in an indoor unit housing 3. In particular, the indoor unit 4 may, as in the present embodiment, be divided into a machine chamber 5 located in a top portion of the indoor unit 4 and a tank chamber 9 in a bottom portion of the indoor unit 4. The components of the heat medium circuit 20 are primarily accommodated in the machine chamber 5. The indoor unit housing 3 comprises lateral side walls including a front wall 6, right and left side walls 7 and a back wall 8.

[0060] Heat medium connection pipings 30, 31 (belonging to the heat medium circuit 20) connect the indoor unit 4 to the outdoor unit 2. The heat medium connection pipings 30, 31 particularly connect to the usage side heat exchanger 16. Accordingly, heat may be transferred between the refrigerant circulated in the refrigerant circuit 10 and heat medium (here water) circulated in the heat medium circuit 20.

[0061] In case leakage occurs in the usage side heat exchanger 16, refrigerant from the refrigerant circuit 10 may enter the heat medium circuit 20. The refrigerant will, therefore likely be in the gaseous state and be entrained in the liquid heat medium. The refrigerant being gaseous may thus leave the heat medium circuit via the air purge valves 25 and 27 as well as, if a certain pressure is built up in the heat medium circuit 20, via the pressure relief valve 28.

[0062] The indoor unit housing 3, particularly the machine chamber 5, also accommodates electric and/or electronic equipment such as a control board, the pump, electric valves, etc. Such equipment is a potential ignition source. Hence, if a flammable gaseous refrigerant were to be released inside the indoor unit housing 3, particularly the machine chamber 5, it could be ignited by these ignition sources causing a hazardous event.

[0063] For this reason, the present disclosure suggests a release box 40.

[0064] A first embodiment of the release box 40 is shown in figures 5 A to C.

[0065] The release box 40 has a boxed shaped body 46. The release box 40, or more particularly its body 46, has a top 41, a bottom 42, opposite lateral side walls 43, 44 and a back wall 45. The front side of the body 46 is open defining a front opening 47 or has a front opening 47. The opposite lateral side walls 43, 44 and the back wall 45 respectively connect the bottom 42 and the top 41. In the present embodiment, the body 46 is an integral one-piece injection molded product.

[0066] The release box 40 defines a space 48. The space 48 is delimited by the top wall 41, the bottom wall 42, the lateral side walls 43, 44 and the back wall 45. The space 48 is delimited at the front side by a cover 60. The volume of the space is between 0.15L and 0.75L.

[0067] The space 48 has a first gas inlet 52 and a second gas inlet 53. Further, the space 48 has a drain inlet 54. The first gas inlet 52 is connected to the air purge valve 25 of the booster heater 24 by means of a first flexible tubing 75. The second gas inlet 53 is connected to the air purge valve 27 of the magnetic filter 26 by second flexible tubing 76. The drain inlet 54 is connected to the pressure relief valve 28 of the magnetic filter 26 by a third flexible tubing 77.

[0068] To put it differently, the first and second gas inlets 52, 53 and the drain inlet 54 are integrally formed as ports with the body 46. The first and second gas inlets 52, 53 and the drain inlet 54 fluidly communicate the space 48 with the respective outlets of the air purge valves 25, 27 and the pressure relief valve 28.

[0069] The first and second gas inlets 52, 53 may be located in the top wall 41. Alternatively and as shown in figures 9A to C, the first and second gas inlets 52, 53 may as well be located in one of the lateral side walls 43, 44 or the back wall 45.

[0070] The cover 60 in the present embodiment has a grille 61, wherein the grille 61 corresponds to a grille portion 62 located in an upper portion of the cover 60 and a fluid impermeable portion 63 in a lower portion of the cover 60. The grill 61/grille portion 62 respectively define a vent 64 (or a plurality of venting openings 64).

[0071] Further, the release box 40 comprises at the front side a protruding circumferential rim 49. The protruding circumferential rim 49 surrounds the front opening 47. A lateral side wall of the indoor unit housing 3 (here the back wall 8) is made of sheet-metal and has a mounting opening. The protruding circumferential rim 49 extends through the mounting opening in the lateral side wall 8 of the indoor unit housing 3.

[0072] The body 46 may further comprises shoulders 50 (here four) for contacting the sheet-metal surrounding the mounting opening in the lateral side wall 8. Moreover, recesses 51 are formed in the body 46 to be engaged by clips 66 of the cover 60.

[0073] Further, the cover defines a circumferential groove 65 to be engaged with the protruding circumferential rim 49. A sealing may be provided in the groove 65 and/or at the protruding rim 49.

[0074] Accordingly, once the body 46 or more particular its protruding circumferential rim 49 is inserted into the mounting opening in the lateral side wall 8 of the indoor unit housing 3, the cover 60 can be engaged with the body 46 by engaging the clips 66 and the recesses 51. Thereby, the lateral side wall 8 of the indoor unit housing 3 is sandwiched between the shoulders 50 and the cover 60. Accordingly, the release box can be fixed to the lateral side wall 8 of the indoor unit housing 3 purely by attaching the cover.

[0075] The body 46 of the release box 40 further has a drainage port 55, which may be arranged in the bottom wall 42 and particularly the lowest portion of the body 46. As best apparent from figure 5B, the bottom 42 has an inclined portion, which is inclined towards the drainage port 55. the drainage port 55 is connected to a drainage line 56 (see figure 3) for draining any liquid heat medium from the release box 40.

[0076] The drain inlet 54 and the drainage port 55 may be circular in cross-section. The diameter of the drainage port 55 is equal to the diameter of the drain inlet 54 in figures 5 and 6. However, the diameter of the drainage port 55 may also be larger than the diameter of the drain inlet 54. Further and even though depicted differently in figures 7 to 9, the diameter of the drainage port 55 may be equal to or larger than the diameter of the drain inlet 54 in these embodiments as well. In other words, the liquid medium flowing into the release box from the drain inlet 54 can flow out of the drainage port 55 without flowing out of the vent 64. Accordingly, effective discharge of liquid medium from the release box 40 can be realized.

[0077] In addition, the drain inlet 54 and the drainage port 55 may be arranged offset to each other. For example, the drain inlet 54 may be located closer to the lateral side walls 44, whereas the drainage port 55 may be located closer to the other opposite lateral side wall 43.

[0078] A plate 80 is arranged in the space 48 of the release box 40 and separates the space 48 of the release box 40. In the embodiment in figure 5, the plate 80 is a perforated plate comprising a plurality of apertures 81.

[0079] The plate 80 is horizontally arranged in the space 48 and vertically separates the space 48 of the release box 40 in a top space (upper portion) and a bottom space (lower portion).

[0080] Due to the apertures 81 in the plate 80, the cross-section of the flow path from the air inlet 52, 53 and the drain inlet 54 to the drainage port 55 is reduced in that any medium entering the space 48 (top space) needs to first pass through the apertures 81 before being able to reach the drainage port 55.

[0081] The plate 80 in this embodiment is located in the space 48 at a height of or slightly below a lower end of the grille portion 62 so that the grille portion 62 and, hence the vent 64, is located only in the top space and not the bottom space.

[0082] In the following, the function is explained in more detail.

[0083] In normal operation, in which no leakage of refrigerant from the refrigerant circuit to the heat medium circuit occurs, air may be released from the first and second air purge valves 25 and 27. The air is guided via the first and second flexible tubing 75, 76 and the first and second gas inlets 52, 53 into the space 48 of the release box 40 without being discharged into the interior of the indoor unit housing 3, particularly the machine chamber 5. The air is then released from the release box 40 to the outside of the indoor unit housing 3 via the vent 64 formed by the grill 61/grille portion 62 of the cover 60.

[0084] Further, in case of a pressure increase above a certain threshold, air and liquid heat medium may be released from the pressure relief valve 28. The air and the liquid heat medium are guided via the third flexible tubing 77 and the drain inlet 54 into the space 48. As the drain inlet 54 is oriented facing the plate 80, the liquid heat medium entraining the air will splash onto the plate 18 assisting the separation of air and liquid heat medium. The liquid heat medium will eventually pass through the apertures 81 of the plate 80 reaching the bottom space of the space 48. Subsequently, the liquid heat medium flows along the inclined portion of the bottom wall 42 towards the drainage port 55 from which the liquid heat medium is drained via the drainage line 56.

[0085] In case a leakage occurs in the usage side heat exchanger 16 and gaseous refrigerant enters the heat medium circuit, the gaseous refrigerant may exit the heat medium circuit again via the first and second air purge valves 25, 27 and the pressure relief valve 28. As the air, the gaseous refrigerant may then also be exhausted from the release box 40 and the indoor unit housing 3 via the vent 47.

[0086] Because the liquid heat medium enters via the drain inlet 54, the liquid heat medium splashes onto the plate 80, whereby gaseous refrigerant may reliably be separated from the liquid heat medium in order to prevent refrigerant from being drained via the drainage port 55 but rather be vented via the vent 47. This is further assisted in that the liquid heat medium stays longer in the upper space of the space 48 before passing through the apertures 81 to the bottom space so that the gaseous refrigerant has time to separate from the liquid heat medium.

[0087] Due to the volume of the release box 40, particularly the space 48 and even more particular the bottom space, a certain amount of liquid heat medium may be temporarily stored in the release box 40 while being drained through the drainage port 55 without any liquid heat medium flowing out of the vent 64.

[0088] A further embodiment of the release box 40 is shown in figures 6A to C.

[0089] The body 46 of the release box 40 of this embodiment is made of two parts, a lower part 90 and an upper part 91. In this embodiment, the body 46 is separated along a horizontal separation line 92.

[0090] The drainage port 55 is located in the lower part 90, whereas the first and second gas inlets 52, 53 and the drain inlet 54 are located in the upper part 91. The lower part 90 may have a circumferential rim 93 whereas the upper part 91 may have a circumferential groove (not visible). In order to attach the two parts 90, 91, the circumferential rim 93 may be engaged with the circumferential groove. A sealing may be arranged in the circumferential groove. To fasten the two parts 90, 91 together, a clip 94 arranged at the upper part 91 may engage an undercut 95 in the lower part 90, whereby the sealing is pressed in the circumferential groove.

[0091] The front opening 47 is partly formed by the lower part 90 and partly formed by the upper part 91. The cover 60 in this embodiment is configured as a grille defining the vent 64 (venting openings). In addition, the release box 40 may have a front wall 96 comprising the front opening 47. The protruding rim 49 surrounds the front opening 47. The shoulders 50 of the embodiment in figure 5 are resembled by portions of the front wall 96 so that the release box 40 may still be fixed to the lateral side wall (here the back wall 8) of the indoor unit housing 3 by attaching the cover 60 wherein the portions of the front wall 96 come into contact with the lateral side wall of the indoor unit housing 3.

[0092] Moreover, a floating valve 100 is provided with respect to the drainage port 55. The floating valve 100 comprises a float ball 101 adapted in diameter to fit into and seal an inlet opening of the drainage port 55. The floating valve 100 further comprises vertical ribs 102 to provide a guide for the ball 101 in the horizontal direction so that the ball may only float in a substantially vertical direction (away from the drainage port 55).

[0093] Further, a stop plate 103 having a plurality of apertures 104 is located at the top of the vertical ribs 102 as a stop for the ball 101 in the vertical direction. To put it differently, the plate 103 restricts the movement of the ball 101 in the vertical direction. In the present embodiment, the stop plate 103 does not horizontally separate the space 48 but only extends along a portion of the space 48 in the horizontal direction. Yet, if some liquid heat medium would end up on the top of the stop plate 103, it may pass through the apertures 104 so as to reach the drainage port 55. The stop plate 103 may be arranged in the space 48 at a height equal to or lower than a lower end of the front opening 47 to prevent water from exiting through the vent 64.

[0094] The function of the release box 40 of this embodiment is basically the same as that of the first embodiment. Yet, any liquid heat medium reaching the bottom wall 42 is not automatically drained via the drainage port 55. Rather, a certain amount of liquid medium needs to be present near the inlet opening of the drainage port 55 in order to float the ball 101 and open the inlet opening of the drainage port 55. Only subsequently, the liquid heat medium may be drained via the drainage port 55 and the drainage line 56. Accordingly, the time of the liquid heat medium stays inside the release box 40 is lengthened and any air or gaseous refrigerant entrained in the liquid heat medium may reliably separate inside the release box 40 being vented via the vent 64.

[0095] Due to the arrangement of the stop plate 103 at a height equal to or lower than a lower end of the front opening 47 it can together with the volume of the lower part 90 (bottom space) be ensured that no liquid heat medium flows out from the release box 40 via the vent 64.

[0096] An even further embodiment of the release box 40 is shown in figures 7 A to C.

[0097] The body 46 of the release box 40 of this embodiment is also made of two parts, the lower part 90 and the upper part 91. However, in this embodiment the lower part 90 and the upper part 91 are connected to each other by means of a hinge 97 so that the two parts 90, 91 may be unfolded. Opposite to the hinge 97 is a clip 94 mounted to the upper part 91 and being engageable with an undercut 95 of the lower part 90 as in the previous embodiment.

[0098] In addition, it will be apparent from figure 7C, that the gas inlets 52, 53 are located closer to the front wall (front side) 96 than the drain inlet 54.

[0099] In addition, the volume of the release box 40 is smaller than in the other embodiments. In order to prevent entrained gaseous refrigerant from directly exiting through the drainage port 55, vertically arranged obstruction plates 105 to 109 are provided, which separate the space 48 in a horizontal direction.

[0100] The obstruction plates 105 and 108 are integrally formed with the upper part 91 whereas the obstruction plates 106, 107 and 109 are integrally formed with the lower part 90 for injection moulding purposes, particularly demoulding.

[0101] The obstruction plates 105 and 106 together form a first separation. The obstruction plates 105 and 106 are connected to the back wall 45 and have free ends 110 and 111, wherein a flow path 112 is formed by a passage between the free ends 110, 111 and the front wall 96 (see figure 7C).

[0102] The obstruction wall 107 forms a second separation. The obstruction wall 107 is connected to the front wall 96 and has a free end 113 facing the obstruction plates 108, 109.

[0103] Accordingly, a flow path 114 is formed by a passage between the free end 113 and the obstruction plates 108, 109.

[0104] The obstruction plates 108 and 109 together form a third separation. The obstruction plates 108 and 109 are connected to the back wall 45 and have free ends 115 and 116, wherein a flow path 117 is formed by a passage between the free ends 115, 116 and the front wall 96.

[0105] Hence, the space 48 is separated in a first space 48a, a second space 48b and the third space 48c.

[0106] The drain inlet 54 opens into the first space 48a. The first space 48a is defined between the side wall 44 and the obstruction plates 105, 106 as well as the top wall 41 and the bottom wall 42.

[0107] The first and second gas inlets 52, 53 open into the second space 48b. The second space 48b is defined between

the obstruction plates 105, 106 on one side and the obstruction plates 108, 109 on the other opposite side as well as the top wall 41 and the bottom wall 42.

[0108] The drainage port 54 opens into the third space 48c. The third space 48c is defined between the obstruction plates 108, 109 and the side wall 43 as well as the top wall 41 and the bottom wall 42.

[0109] Hence in use, any liquid medium, is introduced in the first space 48a via the drain inlet 54 and splashes on the bottom wall 42, whereby potential gaseous refrigerant is separated from the liquid heat medium. In addition, the liquid heat medium flows along the bottom wall 42 through the flow paths 112, 114 as well as 117 so that the time until any liquid heat medium is drained via the drainage port 55 is lengthened and any gaseous refrigerant may in the meantime separate from the liquid heat medium and exit via the vent.

[0110] An even further embodiment, which may be implemented in any of the above embodiments is shown in figure 8.

[0111] This embodiment is basically a schematic view of an embodiment similar to the embodiment in figure 5.

[0112] Yet, the drain inlet 54 is located closer to the front side (front wall or cover 60) than the gas inlets 52, 53.

[0113] In addition, a vertical wall 118 is formed inside the space 48. The vertical wall 118 has a height higher than the height of the plate 80 and/or higher than the lower end of the vent 64 (here the grille portion 62). Thereby a gas accumulation space 48d is formed between the back wall 45 and the vertical wall 118, whereas the drainage port 55 is located between the vertical wall 118 and the front side (front opening 47 or cover 60). Liquid heat medium is, thus, prevented from flowing into the gas accumulation space by means of the vertical wall 118.

[0114] A gas sensor 120 is arranged for sensing gaseous refrigerant in the space 48, particularly the gas accumulation space 48d of the release box 40. The gas sensor 120 has a gas sensing portion 121 which in the present embodiment is directed downwards and located in the gas accumulation space 48d. In the present embodiment, the gas sensor 120 is located inside the space 48. Yet, it would be sufficient that the gas sensing portion 121 is located in the space 48, whereas the remainder of the gas sensor 120 could also be located outside the space 48 (the release box 40).

[0115] Further, an electrical line 122 is guided via a grommet 123 to the outside of the release box 40 to maintain the space 48 sealed to the outside or more particularly the inside of the indoor unit housing 3.

[0116] As a result, if any gaseous refrigerant accumulates inside the space 48, particularly the gas accumulation space 48d, the gas detector can sense the gaseous refrigerant and communicate it to a control of the heat pump which can initiate countermeasures and/or measures for informing the user as it is known in the art.

[0117] In any of the above embodiments, the release box 40 enables to securely guide any gaseous refrigerant that has been leaked into the heat medium circuit and which would otherwise be released into the interior of the indoor unit housing 3 to the outside of the indoor unit housing 3. Therefore, the risk of the gaseous refrigerant being ignited by an ignition source also located inside the indoor unit housing 3 can reliably be prevented.

[0118] Additionally, the overflow of liquid from the release box 40 to the outside of the indoor unit housing 3 can be prevented by providing the drainage port 55, creating a sufficient volume inside the release box 40 for temporarily accommodating any liquid heat medium and/or lengthen the flow path the liquid heat medium has to take from the drain inlet 40 to the drainage port 55 and thereby the time the liquid heat medium stays inside the release box 40.

[0119] It is to be understood that the various features of the above described embodiments can also be combined unless in contradiction.

Reference Sign List

40	building	1
	outdoor unit housing	2
	indoor unit housing	3
	indoor unit	4
45	machine chamber	5
	front wall	6
	left and right side walls	7
	back wall	8
50	tank chamber	9
	refrigerant circuit	10
	heat source heat exchanger	12
	expansion valve	14
55	usage side heat exchanger	16
	compressor	18
	heat medium circuit	20

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(continued)

	pump	22
	booster heater	24
5	first air purge valve	25
	magnetic filter	26
	second air purge valve	27
	pressure relief valve	28
	load	29
10	connection piping	30, 31
	release box	40
	top wall	41
15	bottom wall	42
	opposite lateral side walls	43, 44
	back wall	45
	boxed shaped body	46
	front opening	47
20	space	48
	protruding rim	49
	shoulder	50
	recess	51
25	first gas inlet	52
	second gas inlet	53
	drain inlet	54
	drainage port	55
	drainage line	56
30	cover	60
	grille	61
	grille portion	62
35	fluid impermeable portion	63
	vent	64
	circumferential groove	65
	clips	66
40	first flexible tubing	75
	second flexible tubing	76
	third flexible tubing	77
45	plate	80
	apertures	81
	lower part	90
	upper part	91
50	horizontal separation line	92
	circumferential rim	93
	clip	94
	undercut	95
	front wall	96
55	hinge	97
	floating valve	100
	float ball	101

(continued)

5	vertical ribs	102
	stop plate	103
	apertures	104
10	obstruction plates	105 to 109
	free ends	110, 111, 113, 115, 116
	flow path	112, 114, 117
15	vertical wall	118
	gas sensor	120
	gas sensing portion	121
	electrical line	122
	grommet	123

Claims

1. Heat pump comprising

a refrigerant circuit (10) connecting a heat source heat exchanger (12), an expansion valve (14), a usage side heat exchanger (16) and a compressor (18), the refrigerant circuit being accommodated in an outdoor unit housing (2);

a heat medium circuit (20) connecting the usage side heat exchanger (16), a pump (22) and a load (29), the heat medium circuit further comprising at least one air purge valve (25, 27) having an outlet for releasing at least gas from the heat medium circuit (20), the air purge valve (25, 27) being accommodated in an indoor unit housing (3),

characterized by

a release box (40) defining a space (48) having a gas inlet (52, 53) connected to the outlet of the at least one air purge valve (25, 27), and a vent (64) to an outside of the indoor unit housing (3) for guiding gas released from the at least one air purge valve (25, 27) to the outside of the indoor unit housing (3).
2. Heat pump according to claim 1, wherein the indoor unit housing (3) has a lateral side wall (8) defining a mounting opening, wherein the release box (40) closes the mounting opening from an inside of the indoor unit housing (3) and the vent (64) is arranged in the mounting opening.
3. Heat pump according to claim 2, wherein the release box (40) is open or has a front opening (74) at a front side corresponding to the mounting opening in the lateral side wall (8) of the indoor unit housing (3) and the mounting opening in the lateral side wall (8) of the indoor unit housing (3) is closed from the outside of the indoor unit housing (3) by a cover (60) having a grille (61), the cover (60) optionally having an upper grille portion (62) having the grille (61) and a lower fluid impermeable portion (63), the grille portion (62) defining the vent (64).
4. Heat pump according to any one of the preceding claims, wherein the heat medium circuit (20) further comprises a booster heater (24) having the air purge valve (25).
5. Heat Pump according to any one of the preceding claims, wherein the heat medium circuit (20) further comprises a magnetic filter (26) having the air purge valve (27).
6. Heat pump according to claim 5, wherein the magnetic filter (26) further has a pressure relief valve (28) having an outlet for releasing gas and/or liquid heat medium from the heat medium circuit, wherein the release box (40) has a drain inlet (54) into the space (48), the outlet of the pressure relief valve being connected to the drain inlet (54), and a drainage port (55), wherein the drainage port (55) is optionally arranged in a bottom (42) of the release box (40).
7. Heat pump according to claim 6, wherein the bottom (42) is inclined towards the drainage port (55).
8. Heat pump according to claim 6 or 7, wherein a float valve (100), particularly a guided float ball (101), is arranged in the drainage port (55).

9. Heat pump according to claim 6, 7 or 8, wherein a cross-sectional area of the drainage port (55) is equal to or larger than a cross-sectional area of the drain inlet (54).
10. Heat pump according to claim 6, 7, 8 or 9, wherein the release box (40) has a top (41) and the drain inlet (54) is arranged in the top (41).
11. Heat pump according to claim 10, wherein the release box (41) has first and second lateral side walls (43, 44) being opposite to each other and connecting the bottom (42) and the top (41), wherein the drain inlet (54) is arranged closer to the first lateral side wall (43) than to the second lateral side wall (44) and the drainage port (55) is arranged closer to the second lateral side wall (44) than to the first lateral side wall (43).
12. Heat pump according to any one of claims 6 to 11, wherein at least one plate (80; 105 to 109) is arranged in the space (48) of the release box (40) and separates the space (48) of the release box (40) reducing the cross-sectional area of a flow path for liquid heat medium from the drain inlet (54) to the drainage port (55).
13. Heat pump according to claim 12, wherein the plate (80) is a perforated plate having a plurality of apertures (81) and being horizontally arranged in the space (48) of the release box (40) so as to vertically separate the space (48) of the release box (40).
14. Heat pump according to claim 12, wherein the plate (105 to 109) is vertically arranged in the space (48) of the release box (40) so as to horizontally separate the space (48) of the release box (40), defining a flow path at a free side end (110 to 116) of the plate (105 to 109) through which liquid heat medium may pass.
15. Heat pump according to any one of the preceding claims, wherein the volume of the space (48) is between 0.15L and 0.75L.
16. Heat pump according to any one of the preceding claims, wherein a gas sensor (120) is arranged for sensing gaseous refrigerant in the space (48) of the release box.

Amended claims in accordance with Rule 137(2) EPC.

1. Heat pump comprising

a refrigerant circuit (10) connecting a heat source heat exchanger (12), an expansion valve (14), a usage side heat exchanger (16) and a compressor (18), the refrigerant circuit being accommodated in an outdoor unit housing (2); a heat medium circuit (20) connecting the usage side heat exchanger (16), a pump (22) and a load (29), the heat medium circuit further comprising at least one air purge valve (25, 27) having an outlet for releasing at least gas from the heat medium circuit (20), the air purge valve (25, 27) being accommodated in an indoor unit housing (3), and
a release box (40) defining a space (48) having a gas inlet (52, 53) connected to the outlet of the at least one air purge valve (25, 27), and a vent (64) to an outside of the indoor unit housing (3) for guiding gas released from the at least one air purge valve (25, 27) to the outside of the indoor unit housing (3).

2. Heat pump according to claim 1, wherein the indoor unit housing (3) has a lateral side wall (8) defining a mounting opening, wherein the release box (40) closes the mounting opening from an inside of the indoor unit housing (3) and the vent (64) is arranged in the mounting opening.
3. Heat pump according to claim 2, wherein the release box (40) is open or has a front opening (74) at a front side corresponding to the mounting opening in the lateral side wall (8) of the indoor unit housing (3) and the mounting opening in the lateral side wall (8) of the indoor unit housing (3) is closed from the outside of the indoor unit housing (3) by a cover (60) having a grille (61), the cover (60) optionally having an upper grille portion (62) having the grille (61) and a lower fluid impermeable portion (63), the grille portion (62) defining the vent (64).
4. Heat pump according to any one of the preceding claims, wherein the heat medium circuit (20) further comprises a booster heater (24) having the air purge valve (25).
5. Heat Pump according to any one of the preceding claims, wherein the heat medium circuit (20) further comprises a magnetic filter (26) having the air purge valve (27).

6. Heat pump according to claim 5, wherein the magnetic filter (26) further has a pressure relief valve (28) having an outlet for releasing gas and/or liquid heat medium from the heat medium circuit, wherein the release box (40) has a drain inlet (54) into the space (48), the outlet of the pressure relief valve being connected to the drain inlet (54), and a drainage port (55), wherein the drainage port (55) is optionally arranged in a bottom (42) of the release box (40).
7. Heat pump according to claim 6, wherein the bottom (42) is inclined towards the drainage port (55).
8. Heat pump according to claim 6 or 7, wherein a float valve (100), particularly a guided float ball (101), is arranged in the drainage port (55).
9. Heat pump according to claim 6, 7 or 8, wherein a cross-sectional area of the drainage port (55) is equal to or larger than a cross-sectional area of the drain inlet (54).
10. Heat pump according to claim 6, 7, 8 or 9, wherein the release box (40) has a top (41) and the drain inlet (54) is arranged in the top (41).
11. Heat pump according to claim 10, wherein the release box (41) has first and second lateral side walls (43, 44) being opposite to each other and connecting the bottom (42) and the top (41), wherein the drain inlet (54) is arranged closer to the first lateral side wall (43) than to the second lateral side wall (44) and the drainage port (55) is arranged closer to the second lateral side wall (44) than to the first lateral side wall (43).
12. Heat pump according to any one of claims 6 to 11, wherein at least one plate (80; 105 to 109) is arranged in the space (48) of the release box (40) and separates the space (48) of the release box (40) reducing the cross-sectional area of a flow path for liquid heat medium from the drain inlet (54) to the drainage port (55).
13. Heat pump according to claim 12, wherein the plate (80) is a perforated plate having a plurality of apertures (81) and being horizontally arranged in the space (48) of the release box (40) so as to vertically separate the space (48) of the release box (40).
14. Heat pump according to claim 12, wherein the plate (105 to 109) is vertically arranged in the space (48) of the release box (40) so as to horizontally separate the space (48) of the release box (40), defining a flow path at a free side end (110 to 116) of the plate (105 to 109) through which liquid heat medium may pass.
15. Heat pump according to any one of the preceding claims, wherein the volume of the space (48) is between 0.15L and 0.75L.
16. Heat pump according to any one of the preceding claims, wherein a gas sensor (120) is arranged for sensing gaseous refrigerant in the space (48) of the release box.

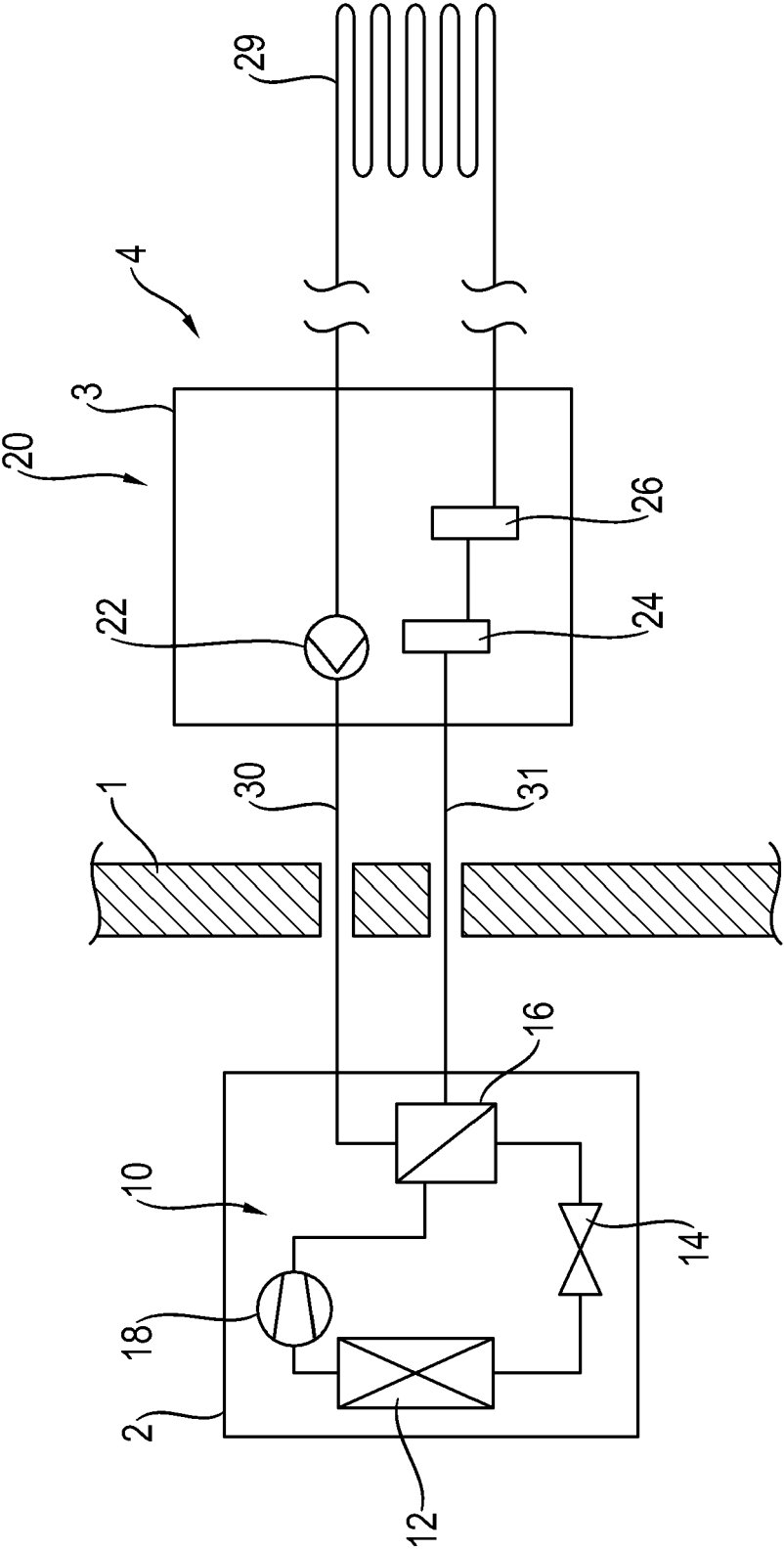


Fig. 1

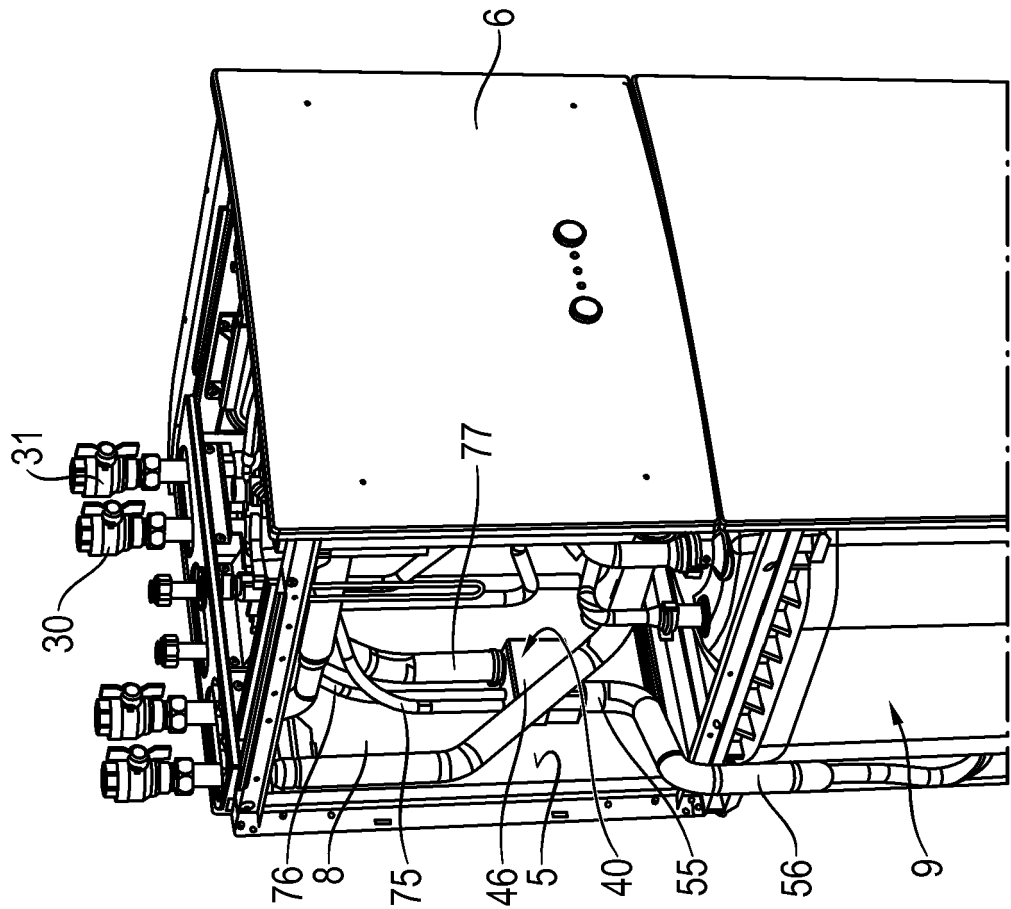


Fig. 3

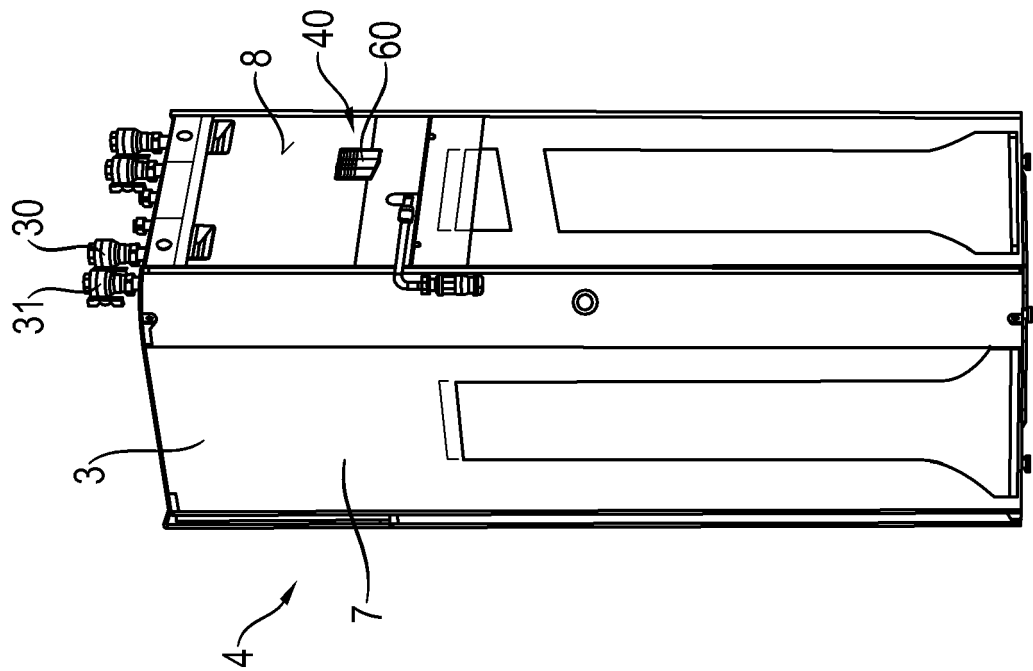


Fig. 2

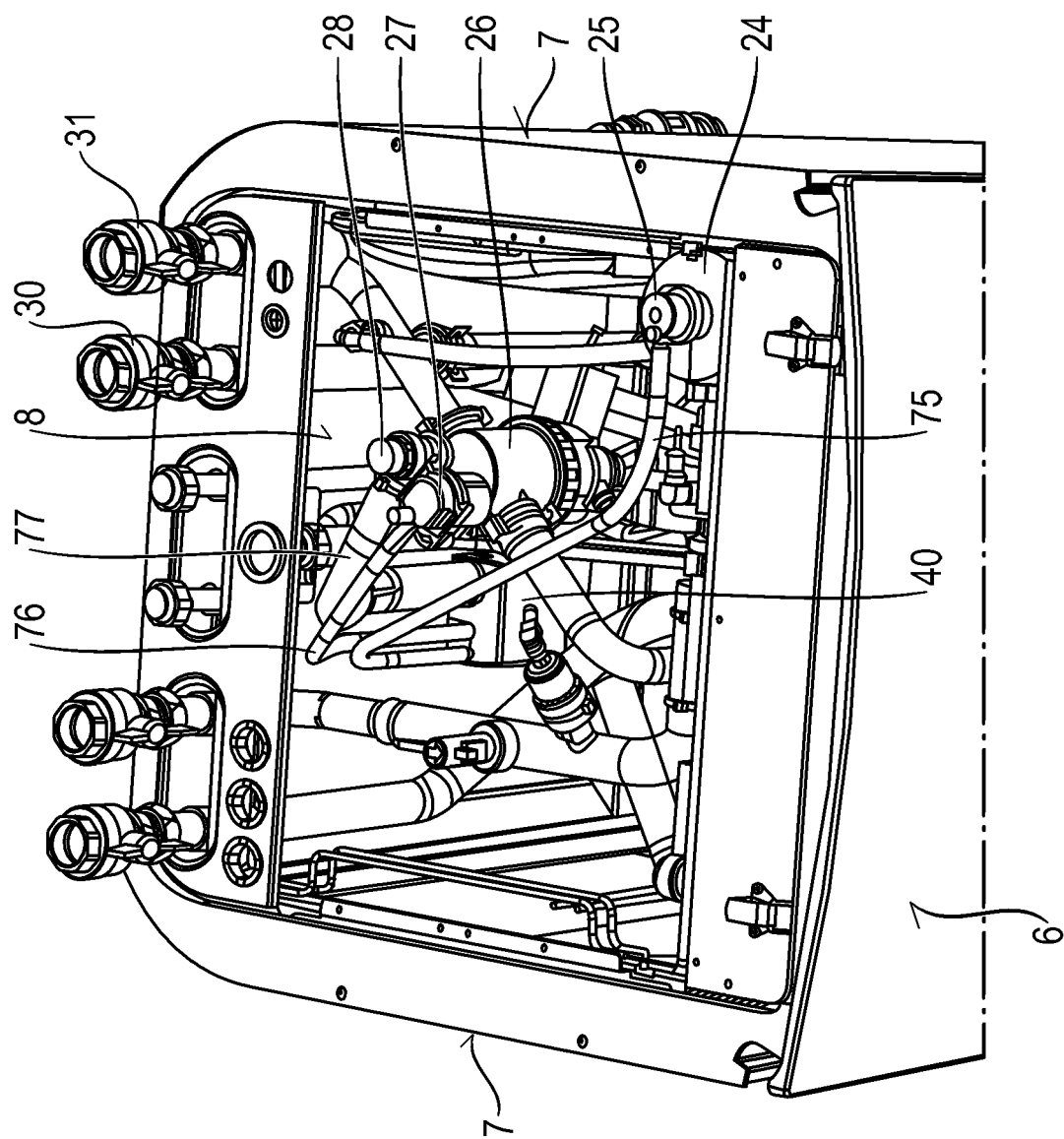
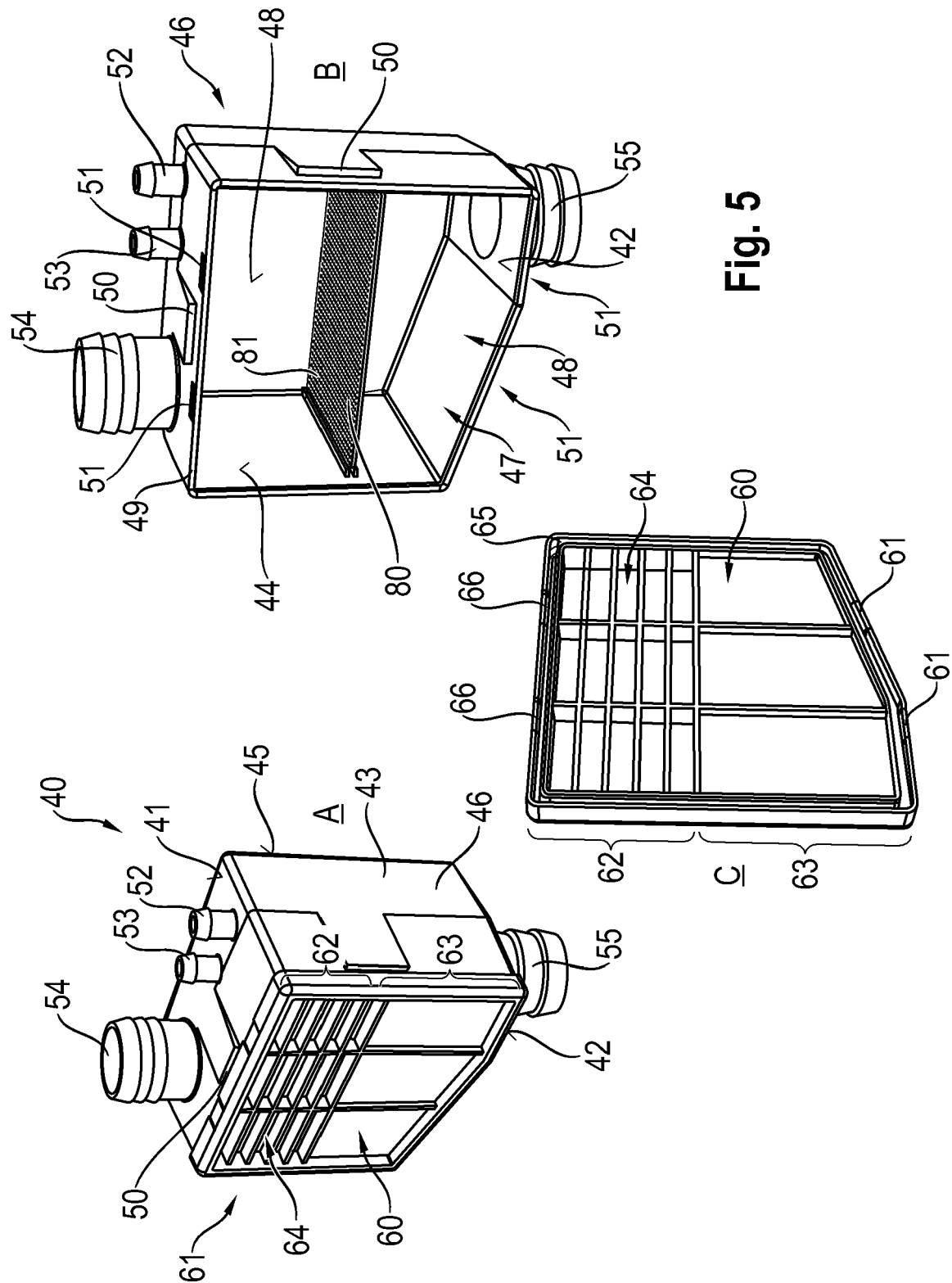


Fig. 4



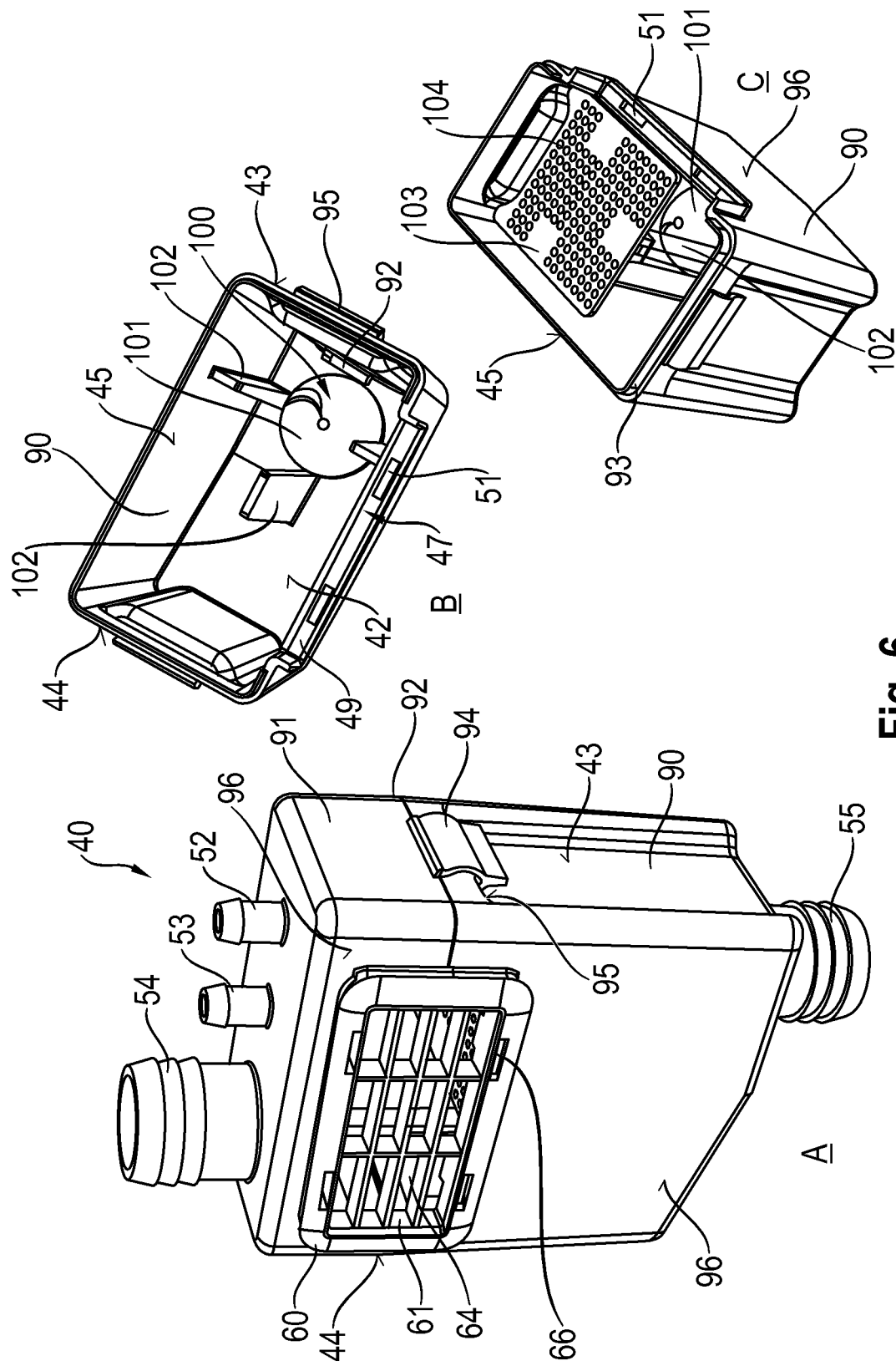


Fig. 6

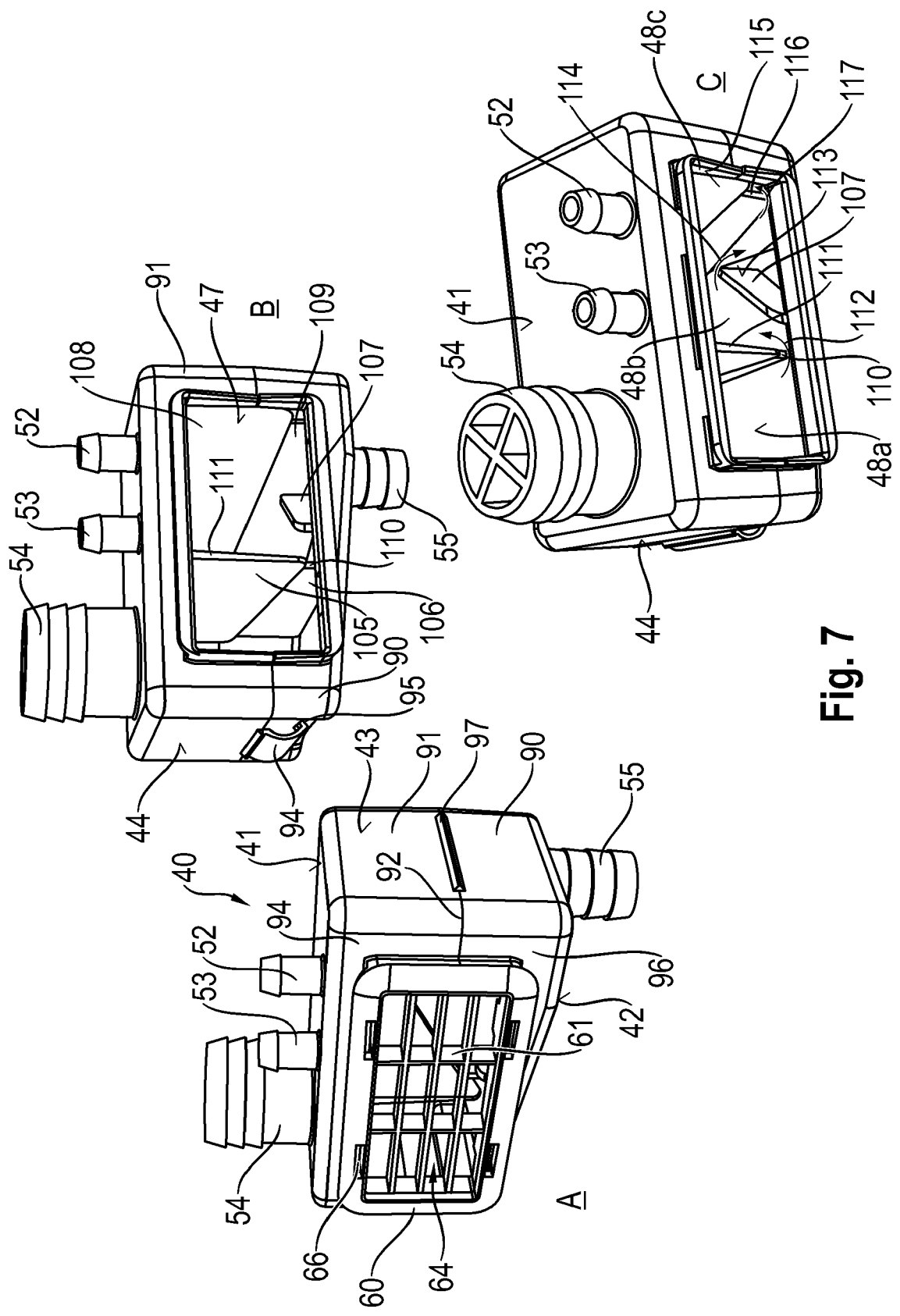


Fig. 7

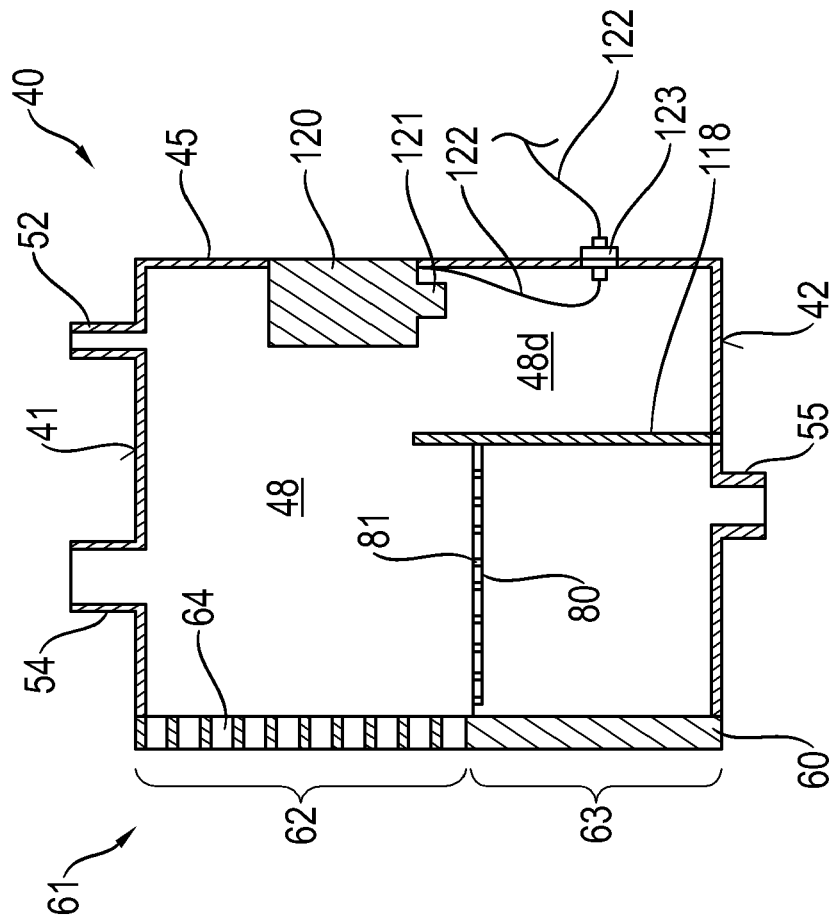


Fig. 8

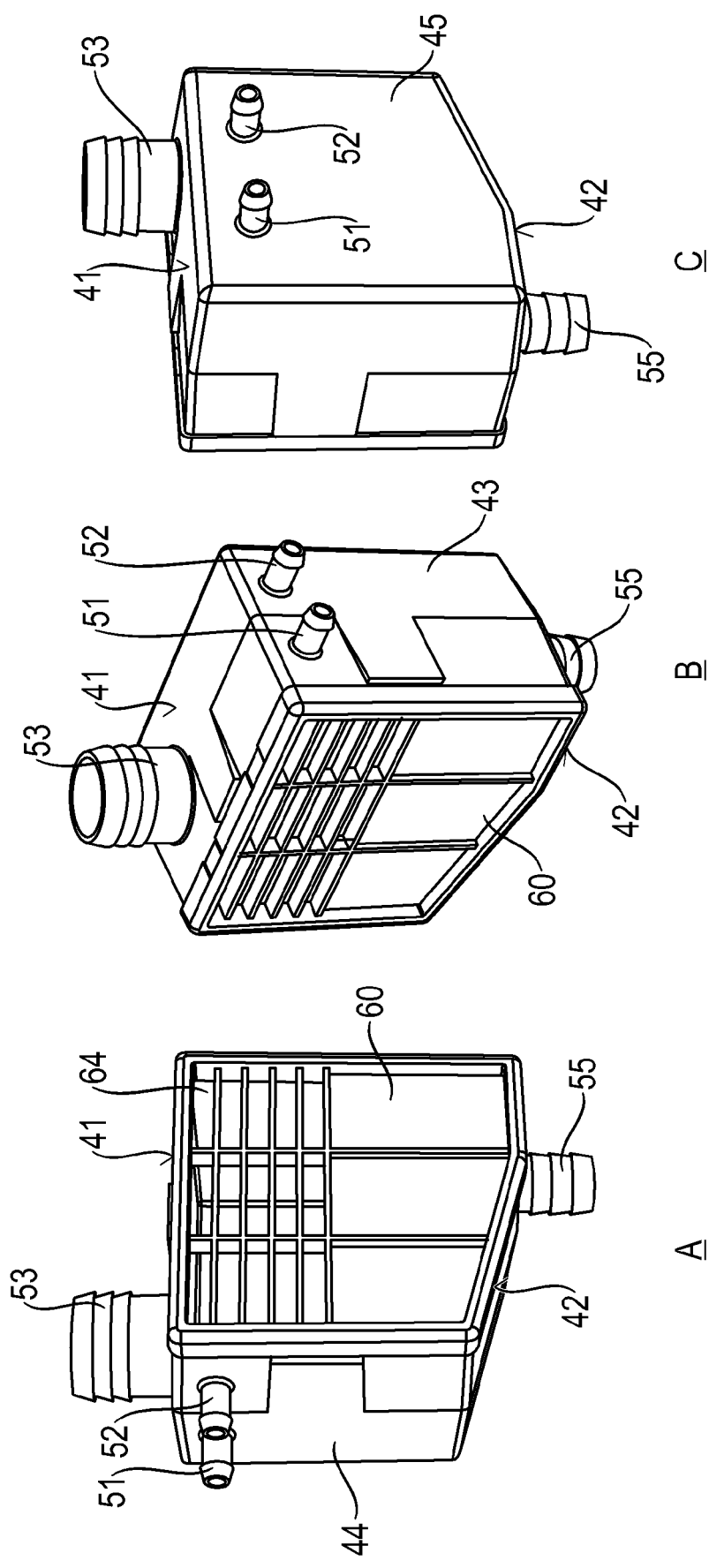


Fig. 9



EUROPEAN SEARCH REPORT

Application Number

EP 23 21 9883

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A	* paragraph [0026]; figure 1 *	1-3, 5-16	
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Place of search		Date of completion of the search	Examiner
Munich		7 May 2024	Anconetani, Mirco
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