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(54) **HEAT-SOURCE SIDE UNIT OF A HEAT PUMP SYSTEM WITH A REFRIGERANT CIRCUIT AND METHOD FOR DEFROSTING THEREOF**

(57) The invention refers to an heat-source side unit (1) comprising a casing (2), a first heat-source side heat exchanger (3a) configured to be connected to a refrigerant circuit, a second heat-source side heat exchanger (3b) configured to be connected to the refrigerant circuit, a first partition (4) dividing the interior space into an air inlet chamber (5) and an air outlet chamber (6), a second partition (7) dividing the air inlet chamber (5) into a first and a second air inlet chamber (5a,b), at least one fan (8) configured to flow outside air through the first and second heat-source side heat exchangers (3a,b) into the corresponding first and second air inlet chambers (5a,b), a valve unit (9) configured to control the passage of air from the air inlet chambers (5a,b) through the first partition (4) into the air outlet chamber (6), and a controller (10) configured to control the operation of the heat pump system and of the valve unit (9) so as to selectively reduce or stop the air flow through one of the first and second heat-source side heat exchangers (3a,b).

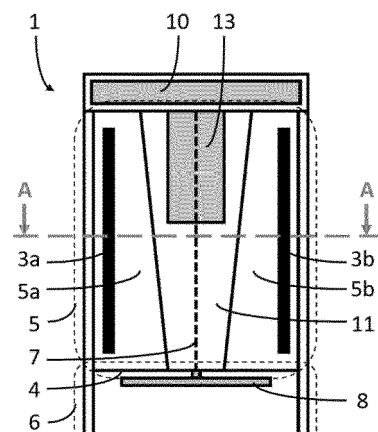


Fig. 3

Description

Technical Field

[0001] The present invention relates to an heat-source side unit of a heat pump system with a refrigerant circuit and to a method for defrosting thereof.

Background

[0002] Heat pump systems, such as air conditioning systems, generally comprise a heat-source side unit having at least one heat-source side heat exchanger and a usage-side unit having at least one usage-side heat exchanger, an expansion valve and a compressor which are connected by pipes to form a refrigerant circuit.

[0003] The heat exchanger/-s of the heat-source side unit may be configured to exchange heat or cold with the outside air and the refrigerant in the refrigerant circuit. The heat exchanger/-s of the usage-side unit may be configured to exchange heat or cold with the air of an indoor space to be conditioned and the refrigerant in the refrigerant circuit. The usage-side heat exchanger may, however, also be used to produce hot water, as domestic hot water and/or for heating purposes (such as floor heating or radiators).

[0004] Most heat pump systems also comprise a switching device, such as a four-way valve, configured to reverse the refrigerant cycle between a cooling mode and a heating mode.

[0005] In the cooling mode, hot compressed refrigerant is cooled by the outside air within the heat exchanger of the heat-source side unit functioning as a condenser. The refrigerant is then decompressed and thereby cooled further in order to provide cold to the heat exchanger of the usage-side unit functioning as an evaporator.

[0006] In the heating mode, cold decompressed refrigerant is heated by the outside air within the heat exchanger of the heat-source side unit functioning as an evaporator. The refrigerant is then compressed and thereby heated further in order to provide heat to the heat exchanger of the usage-side unit functioning as a condenser.

[0007] During the heating mode and especially in cold and humid weather conditions, humidity from the outside air can condensate and subsequently freeze on the heat exchanger of the heat-source side unit. As a result, an ice shield can build up over time, which impedes the heat exchange with the outside air, resulting in a loss of efficiency.

[0008] To avoid this, heat exchangers of heat-source side units must be defrosted regularly by reversing the refrigerant flow so that the ice shield melts and disappears (defrost mode which is similar to the cooling mode but only executed during a predetermined period of time). As the heat-source side heat exchanger cannot be used for regular operation during the defrosting process, the heat supply to the usage-side unit is interrupted so that

the desired room temperature cannot be maintained.

[0009] Thus, the objective of the invention is to provide a heat-source side unit that can be defrosted and operate "normally" at the same time as well as a method to operate such heat-source side unit.

Disclosure of the Invention

[0010] This objective is achieved by the heat-source side unit defined in claim 1 and by the method defined in claim 14, as well as by the preferred embodiments defined in the dependent claims. It should be noted that usage-side unit and heat-source side unit can also be combined in one device. Features of the method and further embodiments thereof can be used in the context of the device. The same applies to features of the device and its preferred further development, which can be used in the context of the method.

[0011] The heat-source side unit according to the invention comprises a casing, a first heat-source side heat exchanger configured to be connected to a refrigerant circuit, a second heat-source side heat exchanger configured to be connected to the refrigerant circuit, a first partition dividing the interior space into an air inlet chamber and an air outlet chamber, a second partition dividing the air inlet chamber into a first and a second air inlet chamber, at least one fan configured to flow outside air through the first and second heat-source side heat exchangers into the corresponding first and second air inlet chambers, a valve unit configured to control the passage of air from the air inlet chambers through the first partition into the air outlet chamber, and a controller configured to control the operation of the heat pump system and of the valve unit so as to selectively reduce or stop the air flow through one of the first and second heat-source side heat exchangers.

[0012] The ability to selectively block the air flow through one of the heat-source side heat exchangers allows defrosting a first heat-source side heat exchanger while the fan, e.g. a common fan (see below), and the second heat-source side heat exchanger continue operating normally. If outside air would continue flowing through the first heat-source side heat exchanger as well, the relatively cold outside air would dissipate the heat resulting in a longer duration and a lower efficiency of the defrosting process.

[0013] In a preferred embodiment, the outside air flows in and/or out through a vertical side of the heat-source side unit. The vertical sides are particularly suitable for air inlets and outlets of an heat-source side unit since they provide large surfaces and can be shielded against rain, e.g. by downward-oriented air flaps. Thus, the heat-source side unit may further comprise an air inlet in at least a vertical side of the casing so that the air may flow in through at least the vertical side of the casing and/or an air outlet in at least a vertical side of the casing so that the air may flow out through at least the vertical side of the casing.

[0014] It is further preferred that the air inlet chamber is located in an upper portion of the casing of the heat-source side unit and the air outlet chamber located in a lower portion of the casing of the heat-source side unit.

[0015] Said separation of the air inlet chamber and the air outlet chamber, which may be a vertical separation, allows a compact design, where the air inlets as well as the air outlets can be located on all vertical sides of the heat-source side unit (see also above). Furthermore, during heating mode, the cold exhaust air is less likely to re-enter through the air inlets when they are located above the air outlets so that the heating efficiency can be increased.

[0016] Preferably, the second partition extends vertically dividing the air inlet chamber horizontally into the first and second air inlet chambers. To put it differently, the first and second air inlet chambers are arranged side-by-side separated by the vertical second partition.

[0017] The horizontal separation of the air inlet chamber allows a compact and efficient design of the heat-source side unit with multiple individual air inlet chambers, which can have direct access to the air inlets on the vertical sides as well as to the air outlet chamber in the bottom of the heat-source side unit.

[0018] In a preferred embodiment, the air inlet chamber has a rectangular horizontal cross section and the second partition extends diagonally, wherein the first and second heat-source side heat exchangers have essentially an L-shaped horizontal cross section.

[0019] A rectangular design is easy to manufacture and therefore very cost-efficient. A diagonal separation of the air inlet chamber yields triangular first and second inlet chambers, each with two sides facing the vertical sides of the heat-source side unit. As a result, the respective heat-source side heat exchangers, which are located between the air inlet chambers and the vertical sides of the casing of the heat-source side unit, are essentially L-shaped with two flat segments. In case of an orthogonal separation, in contrast, the individual air inlet chambers are rectangular and the respective heat-source side heat exchangers are U-shaped with three flat segments. Because of the lower number of flat heat exchanger segments, a diagonal separation is more cost efficient.

[0020] The second partition is preferably further configured to guide the air flow from the first and second heat-source side heat exchangers through the first and second air inlet chambers to the first partition. For example, the second partition may have an inwardly curved or concave guide surface, wherein the inflowing air is guided along the guide surface toward the first partition and the air outlet chamber. In one embodiment, the second partition has a guide surface for redirecting the air flow, e.g. from a substantial horizontal inflow to a substantial vertical flow toward the first partition and the air outlet chamber.

[0021] As the air flows through the air inlet chambers essentially diagonally from the sides towards the bottom,

turbulences can occur in the inner upper corners if the air is not guided properly, resulting in a loss of efficiency. To avoid this, the walls of the second partition are preferably configured to follow the flow of air by being concavely shaped and/or by extending towards the upper outside of the heat-source side unit.

[0022] It is further preferred that the second partition forms an enclosed space accommodating at least one component of the heat pump, preferably a compressor configured to be connected to the refrigerant circuit of the heat pump and/or an electronic box including the controller.

[0023] A second partition with walls extending towards the upper edges of the heat-source side unit to guide the air flow further allows forming an enclosed space within such walls, which can be used for accommodating other components of the heat-source side unit, thereby allowing a compact design of the heat-source side unit.

[0024] The heat-source side unit comprises preferably a common fan configured to flow outside air through the first and second heat-source side heat exchangers. Using a single fan for both heat-source side heat exchangers saves costs not only in the production but also in the operation of the heat-source side unit due to a higher efficiency.

[0025] In a preferred embodiment, the valve unit is a sliding flap configured to be moved in a direction orthogonal to the air flow to selectively block the passage of air from the first and second air inlet chambers through respective openings in the first partition into the air outlet chamber.

[0026] Sliding flaps are simple and cost-efficient means to control the air flow. As it is configured to be moved orthogonally to the air flow, potential vibrations from the air flow can be avoided, resulting in an effective noise reduction.

[0027] It is further preferred that the air outlets are located in a lower portion of the heat-source side unit and made of sound absorbing insulation material. This helps to further reduce unpleasant noise emissions.

[0028] In a preferred embodiment, the heat-source side unit further comprises a third heat-source side heat exchanger, the second partition further divides the air inlet chamber into a third air inlet chamber, and the (e.g. common) fan is further configured to flow outside air through the third heat-source side heat exchanger into the third air inlet chamber.

[0029] A separation of the air inlet chamber into three individual air inlet chambers allows maintaining two of three heat-source side heat exchangers in normal operation while the third heat-source side heat exchanger is being defrosted. As a result, the loss of heat supply to the usage-side unit is reduced so that the desired room temperature be maintained more reliably during the defrosting process.

[0030] In another preferred embodiment, the heat-source side unit further comprises a fourth heat-source side heat exchanger, the second partition further divides

the air inlet chamber into a fourth air inlet chamber, and the fan is further configured to flow outside air through the fourth heat-source side heat exchanger into the fourth air inlet chamber.

[0031] A separation of the air inlet chamber into four individual air inlet chambers allows maintaining three of four heat-source side heat exchangers in normal operation while the fourth heat-source side heat exchanger is being defrosted. As a result, the loss of heat supply to the usage-side unit is further reduced so that the desired room temperature be maintained more reliably during the defrosting process.

[0032] The invention further refers to a method for defrosting an heat-source side unit according to the invention by operating the valve unit such that the air flow through one of the heat-source side heat exchangers is blocked, by operating the heat pump system such that the heat-source side heat exchanger, through which the air flow is blocked, is defrosted, and by operating the heat pump system such that the heat-source side heat exchanger(s), through which the air flow is not blocked, continue normal operation.

[0033] This method allows defrosting one heat-source side heat exchanger while the common fan and the other heat-source side heat exchanger(s) continue operating normally. If outside air would continue flowing through the defrosting heat-source side heat exchanger, the relatively cold outside air would dissipate the heat resulting in a longer duration and a lower efficiency of the defrosting process. In case of two heat-source side heat exchangers, for example, the heat-source side unit can continue operating at least with half capacity during the defrosting process.

[0034] In order to defrost all heat-source side heat exchangers of the heat-source side unit, the method can further comprise the steps of operating the valve unit such that the air flow through the defrosted heat-source side heat exchanger is unblocked and that the air flow through another heat-source side heat exchanger is blocked, operating the heat pump system such that the heat-source side heat exchanger, through which the air flow is blocked, is defrosted and that the heat-source side heat exchanger(s), through which the air flow is not blocked, continue normal operation, and repeating said steps until all heat-source side heat exchangers are defrosted.

[0035] This method allows defrosting all heat-source side heat exchangers of the heat-source side unit sequentially while the respective other heat-source side heat exchanger(s) continue operating normally. In case of two heat-source side heat exchangers, for example, the heat-source side unit can still continue operating with at least half its capacity during the entire defrosting process.

[0036] It is obvious for a skilled person that the heat-source side unit described above and in the claims is not limited to two, three or four heat-source side heat exchangers and that features referring to an embodiment with two heat-source side heat exchangers can be ap-

plied analogously to other embodiments with three, four or more heat-source side heat exchangers.

Brief Description of the Drawings

[0037]

- Fig. 1a shows a schematic flow chart of a heat pump system with a refrigerant circuit in heating mode
- Fig. 1b shows a schematic flow chart of a heat pump system with a refrigerant circuit in cooling mode
- Fig. 1c shows a schematic flow chart of a heat pump system with a refrigerant circuit and two heat-source side heat exchangers in normal heating mode
- Fig. 1d shows a schematic flow chart of a heat pump system with a refrigerant circuit and two heat-source side heat exchangers in heating mode, wherein the second heat exchanger is being defrosted
- Fig. 2a shows a schematic perspective view of an heat-source side unit according to the invention.
- Fig. 2b shows a schematic diagonal side view of an heat-source side unit according to the invention.
- Fig. 3 shows a schematic sectional side view of an heat-source side unit according to the invention.
- Fig. 4 shows a schematic top view of a first partition of an heat-source side unit according to the invention.
- Fig. 5a-c show schematic sectional side views of an heat-source side unit according to the invention during different operating conditions.
- Fig. 6a shows a schematic sectional top view of a rectangular heat-source side unit according to the invention with two diagonally separated air inlet chambers.
- Fig. 6b shows a schematic sectional top view of a rectangular heat-source side unit according to the invention with two orthogonally separated air inlet chambers.
- Fig. 7a shows a schematic sectional top view of a rectangular heat-source side unit according

to the invention with four diagonally separated air inlet chambers.

Fig. 7b shows a schematic sectional top view of a rectangular heat-source side unit according to the invention with four orthogonally separated air inlet chambers.

Fig. 8a shows a schematic sectional top view of a triangular heat-source side unit according to the invention with three air inlet chambers.

Fig. 8b shows a schematic sectional top view of a circular heat-source side unit according to the invention with three air inlet chambers.

Detailed Description of the Drawings

[0038] Same reference numerals, listed in different figures, refer to identical, corresponding or functionally similar elements.

[0039] Preferred embodiments of a device according to the invention are described in the corresponding figures. Modifications of features can be combined to form further embodiments. The device and the corresponding methods described below are to be understood as exemplary and not limiting. Features of the embodiments described below can also be used to further characterize the device and the method defined in the claims.

[0040] It is obvious to a skilled person that individual features described in different embodiments can also be implemented in a single embodiment, given that they are not incompatible. Likewise, features described in the context of a single embodiment can also be provided in multiple respective embodiments individually or in any suitable sub-combination.

[0041] Fig. 1a and 1b show schematic flow charts of a heat pump system with a refrigerant circuit in two operational modes. The system includes a compressor and a decompression (expansion) valve as well as heat-source side and usage-side heat exchangers, all of which are connected by pipes containing a refrigerant. The heat pump system can further comprise a 4-way valve, which allows reversing the refrigerant flow through the heat exchangers without reversing the refrigerant flow through the compressor in order to switch between the operational modes. Said components can be installed separately or at least partially integrated in the usage-side and/or heat-source side unit of the heat pump system.

[0042] Fig. 1a shows a schematic flow chart of a heat pump system with a refrigerant circuit in the heating mode. The tepid refrigerant coming from the heat-source side heat exchanger is compressed by the compressor, which causes its temperature to increase. By flowing through the usage-side heat exchanger, the refrigerant's heat is transferred to the indoor air and the refrigerant cools down again to a moderate temperature. By flowing through the decompression valve, the refrigerant's pres-

sure is reduced, which causes its temperature to drop even further. The cold refrigerant, which has been decompressed by the decompression valve and before being evaporated by the evaporator, flows then back through the heat-source side heat exchanger, where it is heated up again to a moderate temperature by the outside air, before the process begins anew.

[0043] In cold and humid weather conditions, the cold refrigerant flowing through the heat-source side heat exchanger, which can have temperatures below freezing, can cause the humidity of the outside air to condense and freeze on the heat-source side heat exchanger. As a result, an ice shield can build up around the heat-source side heat exchanger over time, which impairs the exchange of heat and the efficiency of the heat pump system. To avoid this, the frozen heat-source side heat exchanger can be defrosted by temporarily reversing the refrigerant flow in order to heat up said heat-source side heat exchanger until the ice shield has melted (see Fig. 1b and 1d).

[0044] Fig. 1b shows a schematic flow chart of a heat pump system with a refrigerant circuit in the cooling mode. The tepid refrigerant coming from the usage-side heat exchanger is compressed by the compressor, which causes its temperature to increase. By flowing through the heat-source side heat exchanger, the refrigerant's heat is transferred to said ice shield or to the outdoor air and the refrigerant cools down again to a moderate temperature. By flowing through the decompression valve, the refrigerant's pressure is reduced, which causes its temperature to drop even further. The cold refrigerant flows then back through the usage-side heat exchanger, where it cools down the inside air and is heated back up to a moderate temperature, before the process begins anew.

[0045] The cooling mode can also be used temporarily to defrost the heat-source side heat exchanger. The reversion of the refrigerant flow is usually achieved by a 4-way valve, which controls the direction, through which the refrigerant flows from the compressor through the rest of the heat pump system. For clarity reasons, this option is not shown in the drawings.

[0046] Fig. 1c shows a schematic flow chart of a heat pump system with a refrigerant circuit and two heat-source side heat exchangers in normal heating mode. In addition to the heat pump system according to Fig. 1a, it comprises a second heat-source side heat exchanger, which is connected in parallel to the first heat-source side heat exchanger, as well as valves (small circles) to control the flow of refrigerant therethrough. In the normal heating mode, the valves are adjusted such that cold refrigerant as well as outside air flows through both heat-source side heat exchangers (solid lines), while the flow of hot refrigerant, which has been compressed by the compressor and before being condensed by the condenser, through the second heat-source side heat exchanger is blocked (dashed lines).

[0047] Fig. 1d shows a schematic flow chart of a heat

pump system with a refrigerant circuit and two heat-source side heat exchangers in heating mode, wherein the second heat-source side heat exchanger is being defrosted. In contrast to the normal heating mode shown in Fig. 1c, the valves are temporarily adjusted such that the flow of cold refrigerant as well as the flow of outside air through the second heat-source side heat exchanger is blocked (dashed lines), while the flow of hot refrigerant therethrough is unblocked (solid lines) so that the second heat-source side heat exchanger is heated up (similar to the usage-side heat exchanger) until the ice shield has melted.

[0048] For clarity reasons, the defrosting mode is only shown for the second heat-source side heat exchanger. It is obvious that the same principle is applicable analogously to the first heat-source side heat exchanger as well.

[0049] Fig. 2a and 2b show schematic views of a heat-source side unit 1 according to the invention. It comprises a rectangular casing 2 with a frame 2a, a top cover 2b and a bottom cover 2c, as well as side surfaces, through which the outside air can enter the heat-source side unit 1, and air outlets 12 arranged in the side surfaces of the bottom cover 2c, through which the air can exit the heat-source side unit 1. In this embodiment, the side surfaces are provided by the heat-source side heat exchangers 3a,3b, but can as well be provided by additional cover grills or the like.

[0050] Both heat-source side heat exchangers 3a,3b are arranged on the vertical sides of the casing 2 and configured to be connected individually to the refrigerant circuit. Using heat-source side heat exchangers 3a,3b without additional covers reduces the size and costs of the heat-source side unit 1 because fewer parts are required. Furthermore, the air can flow more freely, so that weaker fans 8 can be used. Covering the heat-source side heat exchangers 3a,3b e.g. by downward-pointing air flaps on the other hand can help to protect them from external influences like rain, dirt or damages and to guide the air flowing into the heat-source side unit 1 more precisely.

[0051] The air outlets 12 can be covered in the same way to prevent dirt or rain from entering the heat-source side unit 1. Furthermore, they can be made of or covered by a sound absorbing material in order to reduce the noise emissions of the heat-source side unit 1.

[0052] Fig. 3 shows a schematic sectional side view of an heat-source side unit 1 according to the invention. A first partition 4 separates the inner space of the heat-source side unit 1, defined by the casing 2 and the heat-source side heat exchangers 3a,3b, vertically into an air inlet chamber 5 located in the top part and an air outlet chamber 6 located in the bottom part of the heat-source side unit 1. A second partition 7 further separates the air inlet chamber 5 horizontally into a first and a second air inlet chamber 5a,5b.

[0053] The first and second air inlet chambers 5a,5b are arranged diagonally in the corners of the rectangular

casing 2 so that the heat-source side heat exchangers 3a,3b bordering the respective air inlet chambers have an L-shaped horizontal cross section. The second partition 7 is vertically inclined in order to guide the air flowing through the first and second air inlet chambers 5a,5b from the sides towards the bottom.

[0054] Air enters the first air inlet chamber 5a through the first heat-source side heat exchanger 3a and the second air inlet chamber 5b through the second heat-source side heat exchanger 3b. From both air inlet chambers 5a,5b, the air flows then through a valve unit 9 in the first partition 4 into the common air outlet chamber 6 and exits through the air outlets 12 in the vertical side surfaces of the bottom cover 2c. The air flows are caused by a fan 8, which is located below the first partition 4 in the common air outlet chamber 6.

[0055] The fan 8 is preferably a single common fan configured to flow outside air through the first and second heat-source side heat exchangers 3a,3b at the same time, which reduces the costs and increases the efficiency of the heat-source side unit.

[0056] While the enclosed space inside the top cover 2b accommodates a controller 10 that controls the operation of the heat-source side unit 1, the enclosed space 11 between the first and a second air inlet chambers 5a, 5b formed by the second partition 7 accommodates a compressor 13 and/or other components of the heat pump system.

[0057] Fig. 4 shows a schematic top view of a first partition 4 of an heat-source side unit 1 according to the invention. The first partition 4 comprises a valve unit 9, which is movable in the horizontal plane of the first partition 4, and two openings 9a,9b. While the first opening 9a borders the first air inlet chamber 5a, the second opening 9b borders the second air inlet chamber 5b. By rotating the valve unit 9, the passage of air through either one of the first and second openings 9a,9b, and thereby through the first and second air inlet chambers 5a,5b can be blocked individually. As the valve unit 9 is moved orthogonally to the air flow, noises potentially caused by vibrations of the valve unit 9 can be avoided.

[0058] Fig. 5a-c show schematic sectional side views of an heat-source side unit 1 according to the invention during different operating conditions. Fig. 5a shows a normal operating state, where the valve unit 9 is operated such that the fan 8 causes the air to flow through both heat-source side heat exchangers 3a,3b at the same time.

[0059] Fig. 5b shows a defrosting state of the second heat-source side heat exchanger 3b, in which the valve unit 9 blocks the air flow through the second heat-source side heat exchanger 3b while air can still flow through the first heat-source side heat exchanger 3a. Fig. 5c shows a defrosting state of the first heat-source side heat exchanger 3a, in which the valve unit 9 blocks the air flow through the first heat-source side heat exchanger 3a while air can still flow through the second heat-source side heat exchanger 3b.

[0060] To selectively defrost the heat-source side heat exchangers, the valve unit 9 is operated such that the air flow through the first heat-source side heat exchanger 3a is blocked and the heat pump system is operated such that the first heat-source side heat exchanger 3a is defrosted while the second heat-source side heat exchanger 3b continues operating normally (in heating mode). Then, the valve unit 9 is operated such that the air flow through the first heat-source side heat exchanger 3a is unblocked and that the air flow through the second heat-source side heat exchanger 3b is blocked and the heat pump system is operated such that the second heat-source side heat exchanger 3b is defrosted while the first heat-source side heat exchanger 3a operates normally (in heating mode).

[0061] Fig. 6a-b show schematic sectional top views of rectangular heat-source side units 1 according to the invention with two air inlet chambers 5a,5b. In the embodiment shown in Fig. 6a, the air inlet chambers 5a,5b are separated diagonally, so that each heat-source side heat exchanger 3a,3b consists of two flat segments. In the embodiment shown in Fig. 6b, in contrast, the air inlet chambers 5a,5b are separated orthogonally, so that each heat-source side heat exchanger 3a,3b consists of three flat segments. As heat-source side heat exchangers with fewer flat segments are more cost-efficient, the embodiment shown in Fig. 6a is preferred. Alternatively, heat-source side heat exchangers with a single curved segment can be used.

[0062] Fig. 7a-b show schematic sectional top views of rectangular heat-source side units 1 according to the invention with four air inlet chambers 5a-d. In the embodiment shown in Fig. 7a, the air inlet chambers 5a-d are separated diagonally, so that each heat-source side heat exchanger 3a-d consists of a single flat segment. In the embodiment shown in Fig. 7b, in contrast, the air inlet chambers 5a-d are separated orthogonally, so that each heat-source side heat exchanger 3a-d consists of two flat segments. As heat-source side heat exchangers with fewer flat segments are more cost-efficient, the embodiment shown in Fig. 7a is preferred.

[0063] Fig. 8a-b show schematic sectional top views of differently shaped heat-source side units 1 according to the invention with three air inlet chambers 5a-c. The heat-source side unit 1 shown in Fig. 8a has a triangular shape with three flat heat-source side heat exchangers 3a-c, whereas the heat-source side unit 1 shown in Fig. 8b has a circular shape with three curved heat-source side heat exchangers 3a-c.

[0064] A polygonal or circular shape is particularly well suited for accommodating any given number of air inlet chambers with individual heat-source side heat exchangers. In this context it should be noted that the embodiments described above are only exemplary and that any given number of separate air inlet chambers and corresponding heat-source side heat exchangers can be implemented analogously.

List of Reference Numerals

[0065]

5	1	heat-source side unit
	2	casing
	2a	frame
	2b	top cover
	2c	bottom cover
10	3a-d	heat-source side heat exchangers
	4	first partition
	5	air inlet chamber
	5a-d	separate air inlet chambers
	6	air outlet chamber
15	7	second partition
	8	fan
	9	valve unit
	9a-b	openings
	10	controller
20	11	enclosed space
	12	air outlets
	13	compressor

25 Claims

1. An heat-source side unit of a heat pump system with a refrigerant circuit, the heat-source side unit (1) comprising at least:

- 30 a casing (2),
a first heat-source side heat exchanger (3a) configured to be connected to the refrigerant circuit,
a second heat-source side heat exchanger (3b) configured to be connected to the refrigerant circuit,
35 the casing (2) and the heat-source side heat exchangers (3a, 3b) defining an interior space;
a first partition (4) dividing the interior space into an air inlet chamber (5) and an air outlet chamber (6),
a second partition (7) dividing the air inlet chamber (5) into a first and a second air inlet chamber (5a,5b),
45 at least one fan (8) configured to flow outside air through the first heat-source side heat exchanger (3a) into the first air inlet chamber (5a) and through the second heat-source side heat exchanger (3b) into the second air inlet chamber (5b),
a valve unit (9) configured to control the passage of air from the air inlet chambers (5a,5b) through the first partition (4) into the air outlet chamber (6), and
50 a controller (10) configured to control the operation of the heat pump system and of the valve unit (9) so as to selectively reduce or stop the air flow through either one of the first and second

- heat-source side heat exchangers (3a,3b).
2. An heat-source side unit according to claim 1, wherein the air flows in through at least a vertical side of the heat-source side unit (1). 5
 3. An heat-source side unit according to any one of the preceding claims, wherein the air flows out through at least a vertical side of the heat-source side unit (1). 10
 4. An heat-source side unit according to any one of the preceding claims, wherein the air inlet chamber (5) is located in an upper portion of the casing (1) and the air outlet chamber (6) located in a lower portion of the casing (1). 15
 5. An heat-source side unit according to any one of the preceding claims, wherein the second partition (7) extends vertically dividing the air inlet chamber (5) horizontally into the first and second air inlet chambers (5a,5b). 20
 6. An heat-source side unit according to claim 5, wherein the air inlet chamber (5) has a rectangular horizontal cross section and the second partition extends diagonally, wherein the first and second heat-source side heat exchangers (3a,3b) have essentially an L-shaped horizontal cross section. 25
 7. An heat-source side unit according to any one of the preceding claims, wherein the second partition (7) is further configured to guide the air flow from the first and second heat-source side heat exchangers (3a, 3b) through the first and second air inlet chambers (5a,5b) to the first partition (4). 30
 8. An heat-source side unit according to any one of the preceding claims, wherein the second partition (7) forms an enclosed space (11) accommodating at least one component of the heat pump, preferably a compressor configured to be connected to the refrigerant circuit of the heat pump and/or an electronic box including the controller (10). 35
 9. An heat-source side unit according to any one of the preceding claims, wherein the heat-source side unit (1) comprises one common fan (8) configured to flow outside air through the first and second heat-source side heat exchangers (3a, 3b). 40
 10. An heat-source side unit according to any one of the preceding claims, wherein the valve unit (9) is a sliding flap configured to be moved in a direction orthogonal to the air flow to selectively block the passage of air from the first and second air inlet chambers (5a,5b) through respective openings (9a,9b) in the first partition (4) into the air outlet chamber (6). 45
 11. An heat-source side unit according to any one of the preceding claims, wherein the heat-source side unit (1) further comprises one or more air outlets (12) located in a lower portion of the heat-source side unit (1) and made of sound absorbing insulation material. 50
 12. An heat-source side unit according to any one of the preceding claims, wherein the heat-source side unit (1) further comprises a third heat-source side heat exchanger (3c), the second partition (7) further divides the air inlet chamber (5) into a third air inlet chamber (5c), and the fan (8) is further configured to flow outside air through the third heat-source side heat exchanger (3c) into the third air inlet chamber (5c). 55
 13. An heat-source side unit according to claim 12, wherein the heat-source side unit (1) further comprises a fourth heat-source side heat exchanger (3d), the second partition (7) further divides the air inlet chamber (5) into a fourth air inlet chamber (5d), the fan (8) is further configured to flow outside air through the fourth heat-source side heat exchanger (3d) into the fourth air inlet chamber (5d). 60
 14. A method for defrosting an heat-source side unit (10) according to any one of the preceding claims, comprising the following steps:
 - operating the valve unit (9) such that the air flow through one of the heat-source side heat exchangers (3a-d) is blocked,
 - operating the heat pump system such that the heat-source side heat exchanger (3a-d), through which the air flow is blocked, is defrosted, and
 - operating the heat pump system such that the heat-source side heat exchangers (3a-d), through which the air flow is not blocked, continue normal operation.
 15. A method for defrosting an heat-source side unit (10) according to claim 14, further comprising the following steps:

operating the valve unit (9) such that the air flow through the defrosted heat-source side heat exchanger (3a-d) is unblocked,
operating the valve unit (9) such that the air flow through another heat-source side heat exchanger (3a-d) is blocked,
operating the heat pump system such that the heat-source side heat exchanger (3a-d), through which the air flow is blocked, is defrosted,
operating the heat pump system such that the heat-source side heat exchangers (3a-d), through which the air flow is not blocked, continue normal operation, and
repeating said steps until all heat-source side heat exchangers (3a-d) are defrosted.

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

1. A heat-source side unit of a heat pump system with a refrigerant circuit, the heat-source side unit (1) comprising at least:

a casing (2),
a first heat-source side heat exchanger (3a) configured to be connected to the refrigerant circuit,
a second heat-source side heat exchanger (3b) configured to be connected to the refrigerant circuit,
the casing (2) and the heat-source side heat exchangers (3a, 3b) defining an interior space;
a first partition (4) dividing the interior space into an air inlet chamber (5) and an air outlet chamber (6),
a second partition (7) dividing the air inlet chamber (5) into a first and a second air inlet chamber (5a, 5b),
at least one fan (8) configured to flow outside air through the first heat-source side heat exchanger (3a) into the first air inlet chamber (5a) and through the second heat-source side heat exchanger (3b) into the second air inlet chamber (5b),
a valve unit (9) configured to control the passage of air from the air inlet chambers (5a, 5b) through the first partition (4) into the air outlet chamber (6), and
a controller (10) configured to control the operation of the heat pump system and of the valve unit (9) so as to selectively reduce or stop the air flow through either one of the first and second heat-source side heat exchangers (3a, 3b).

2. A heat-source side unit according to claim 1, wherein the air flows in through at least a vertical side of the heat-source side unit (1).

3. A heat-source side unit according to any one of the preceding claims, wherein the air flows out through at least a vertical side of the heat-source side unit (1).

4. A heat-source side unit according to any one of the preceding claims, wherein the air inlet chamber (5) is located in an upper portion of the casing (1) and the air outlet chamber (6) located in a lower portion of the casing (1).

5. A heat-source side unit according to any one of the preceding claims, wherein the second partition (7) extends vertically dividing the air inlet chamber (5) horizontally into the first and second air inlet chambers (5a, 5b).

6. A heat-source side unit according to claim 5, wherein the air inlet chamber (5) has a rectangular horizontal cross section and the second partition extends diagonally, wherein the first and second heat-source side heat exchangers (3a, 3b) have essentially an L-shaped horizontal cross section.

7. A heat-source side unit according to any one of the preceding claims, wherein the second partition (7) is further configured to guide the air flow from the first and second heat-source side heat exchangers (3a, 3b) through the first and second air inlet chambers (5a, 5b) to the first partition (4).

8. A heat-source side unit according to any one of the preceding claims, wherein the second partition (7) forms an enclosed space (11) accommodating at least one component of the heat pump, preferably a compressor configured to be connected to the refrigerant circuit of the heat pump and/or an electronic box including the controller (10).

9. A heat-source side unit according to any one of the preceding claims, wherein the heat-source side unit (1) comprises one common fan (8) configured to flow outside air through the first and second heat-source side heat exchangers (3a, 3b).

10. A heat-source side unit according to any one of the preceding claims, wherein the valve unit (9) is a sliding flap configured to be moved in a direction orthogonal to the air flow to selectively block the passage of air from the first and second air inlet chambers (5a, 5b) through respective openings (9a, 9b) in the first partition (4) into the air outlet chamber (6).

11. A heat-source side unit according to any one of the

preceding claims, wherein
the heat-source side unit (1) further comprises one
or more air outlets (12) located in a lower portion of
the heat-source side unit (1) and made of sound ab-
sorbing insulation material.

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- 12.** A heat-source side unit according to any one of the
preceding claims, wherein

the heat-source side unit (1) further comprises 10
a third heat-source side heat exchanger (3c),
the second partition (7) further divides the air
inlet chamber (5) into a third air inlet chamber
(5c), and
the fan (8) is further configured to flow outside 15
air through the third heat-source side heat ex-
changer (3c) into the third air inlet chamber (5c).

- 13.** A heat-source side unit according to claim 12, where-
in

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the heat-source side unit (1) further comprises
a fourth heat-source side heat exchanger (3d),
the second partition (7) further divides the air
inlet chamber (5) into a fourth air inlet chamber 25
(5d),
the fan (8) is further configured to flow outside
air through the fourth heat-source side heat ex-
changer (3d) into the fourth air inlet chamber
(5d). 30

- 14.** A method for defrosting an heat-source side unit (10)
according to any one of the preceding claims, com-
prising the following steps:

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operating the valve unit (9) such that the air flow
through one of the heat-source side heat ex-
changers (3a-d) is blocked,
operating the heat pump system such that the
heat-source side heat exchanger (3a-d), 40
through which the air flow is blocked, is defrost-
ed, and
operating the heat pump system such that the
heat-source side heat exchangers (3a-d), 45
through which the air flow is not blocked, con-
tinue normal operation.

- 15.** A method for defrosting an heat-source side unit (10)
according to claim 14, further comprising the follow-
ing steps:

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operating the valve unit (9) such that the air flow
through the defrosted heat-source side heat ex-
changer (3a-d) is unblocked,
operating the valve unit (9) such that the air flow 55
through another heat-source side heat exchang-
er (3a-d) is blocked,
operating the heat pump system such that the

heat-source side heat exchanger (3a-d),
through which the air flow is blocked, is defrost-
ed,
operating the heat pump system such that the
heat-source side heat exchangers (3a-d),
through which the air flow is not blocked, con-
tinue normal operation, and
repeating said steps until all heat-source side
heat exchangers (3a-d) are defrosted.

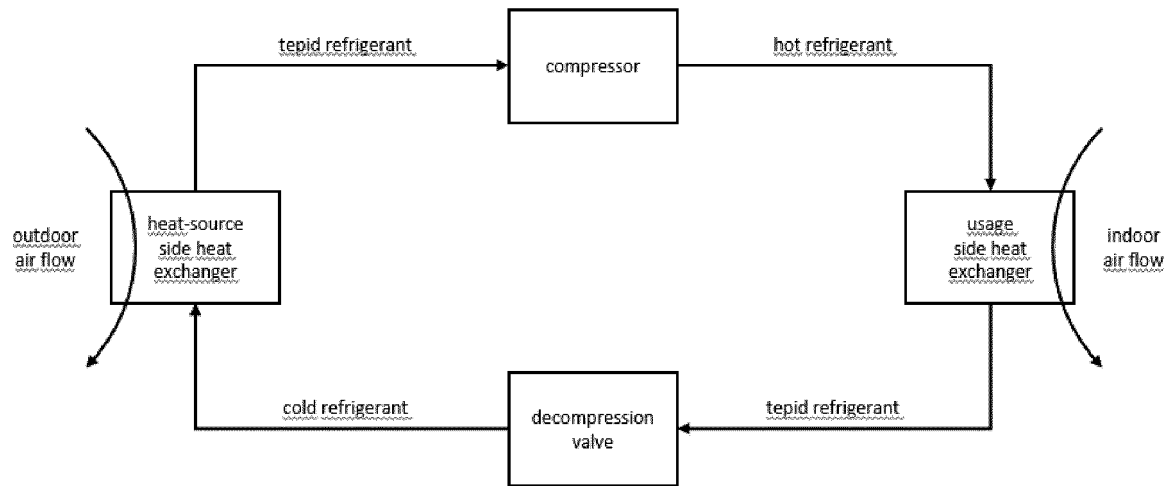


Fig. 1a

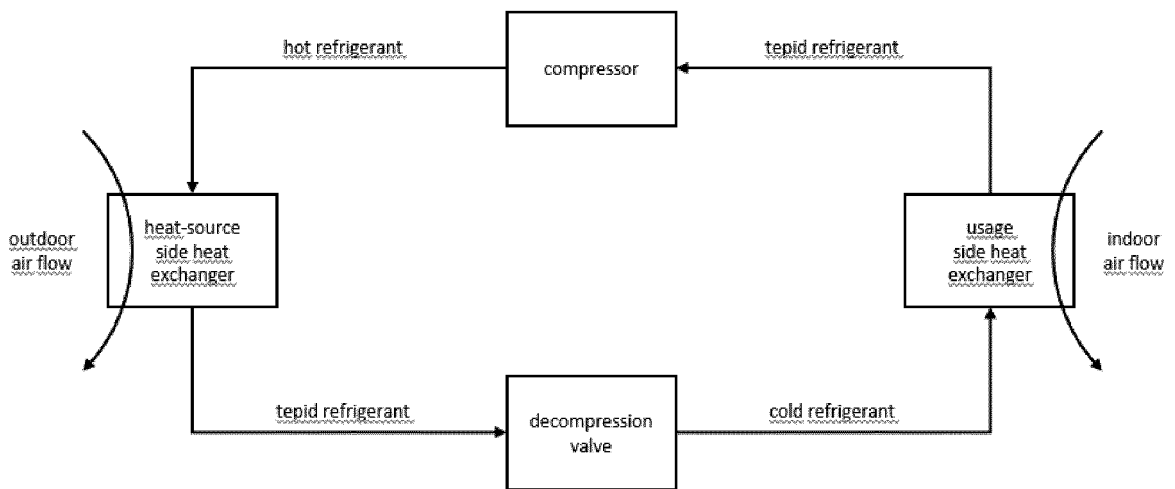


Fig. 1b

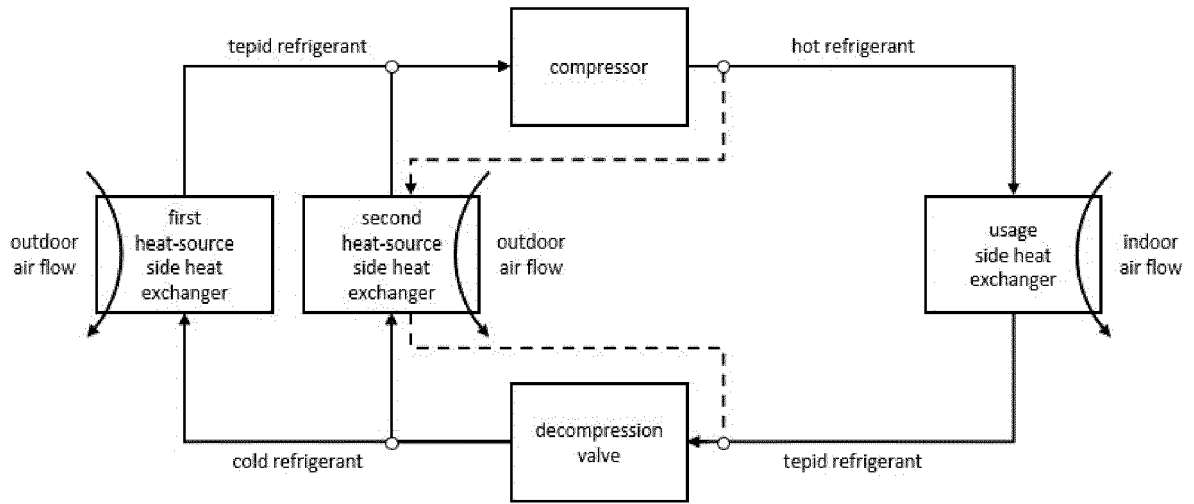


Fig. 1c

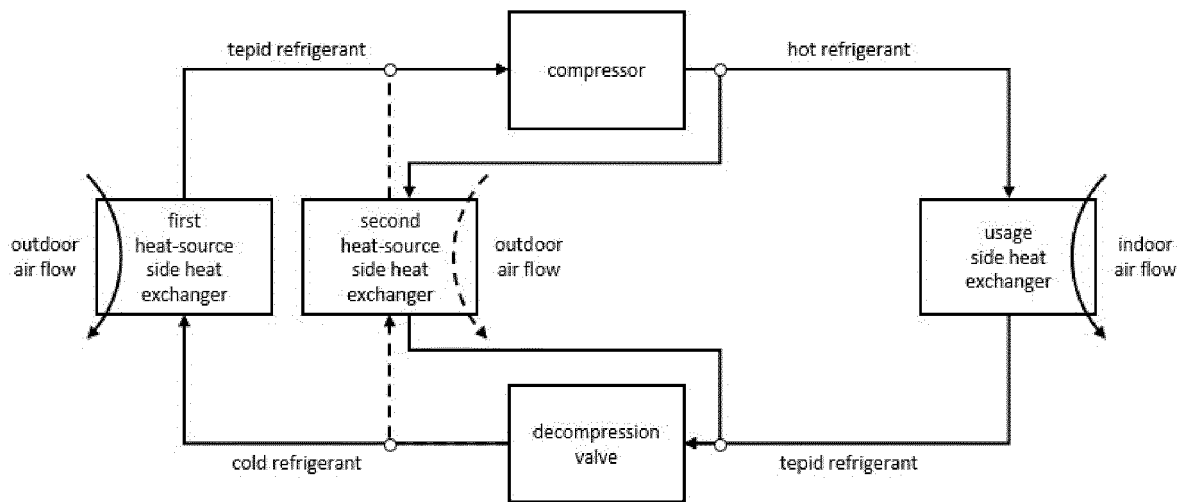


Fig. 1d

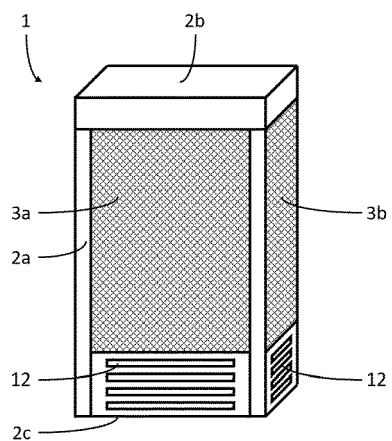


Fig. 2a

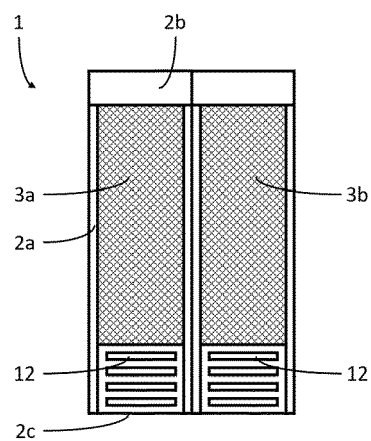


Fig. 2b

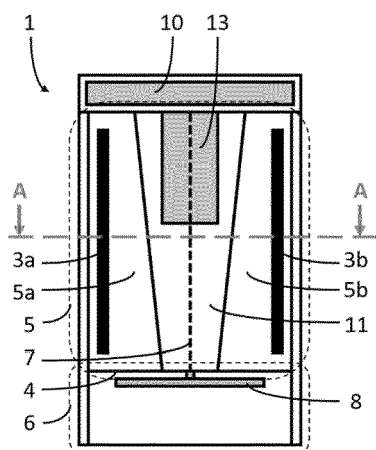


Fig. 3

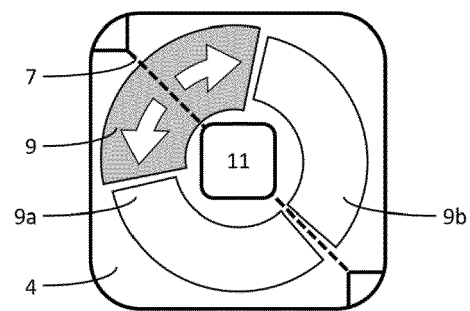


Fig. 4

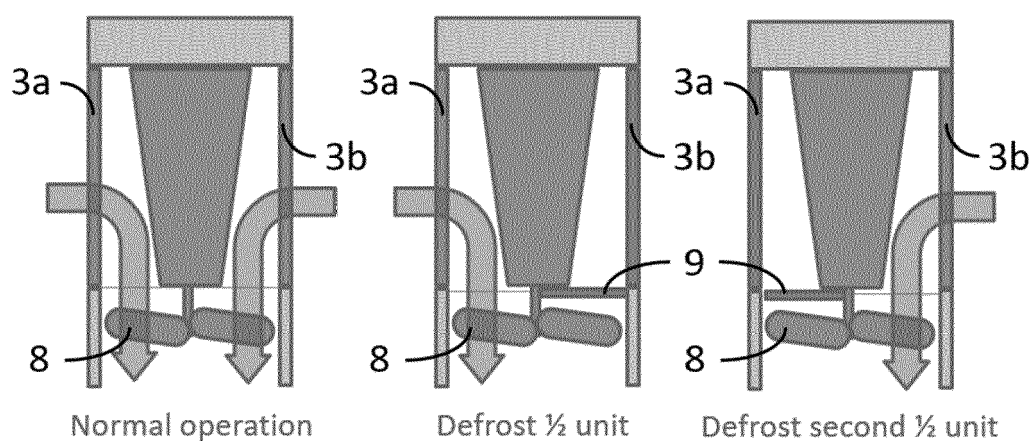


Fig. 5a

Fig. 5b

Fig. 5c

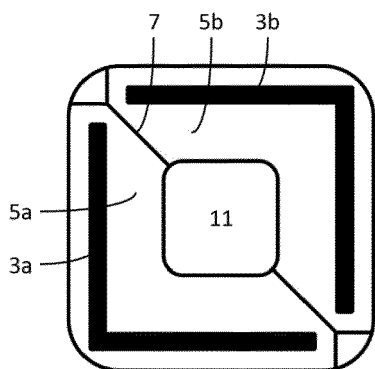


Fig. 6a

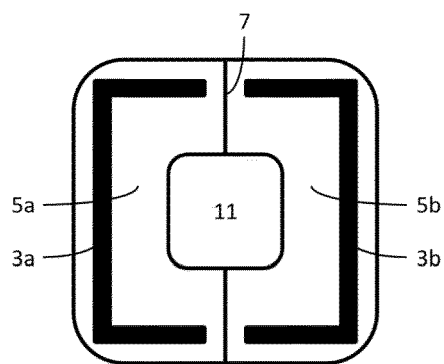


Fig. 6b

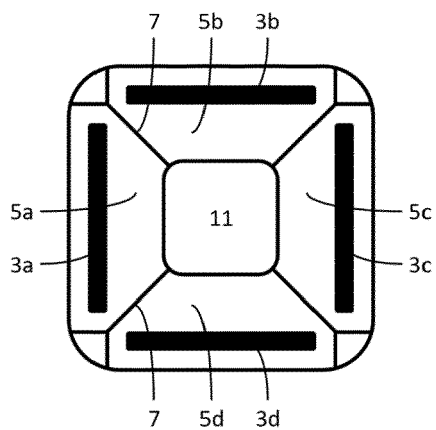


Fig. 7a

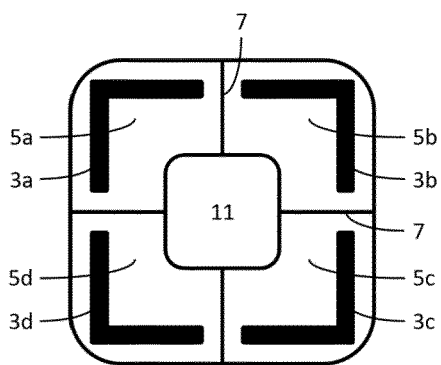


Fig. 7b

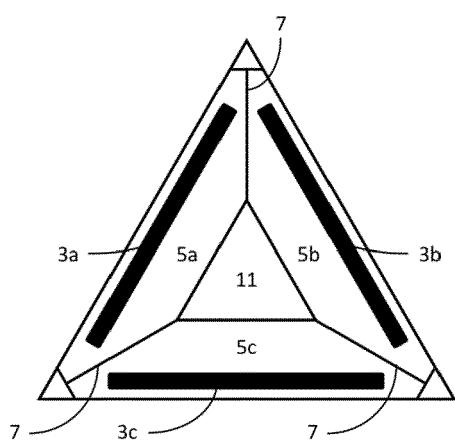


Fig. 8a

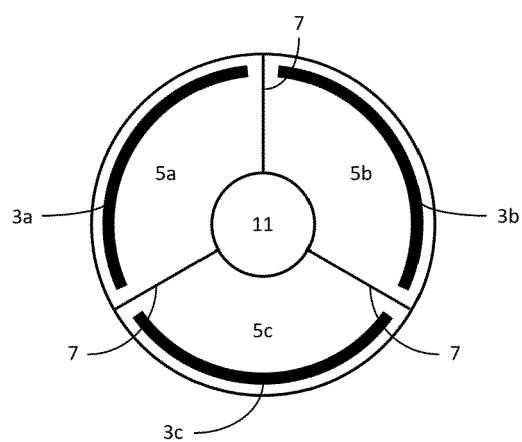


Fig. 8b



EUROPEAN SEARCH REPORT

 Application Number
 EP 21 15 5991

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X	CN 111 664 549 A (QINGDAO HISENSE HITACHI AIR CONDITIONING SYSTEM CO LTD) 15 September 2020 (2020-09-15)	1,2,5,7,9,10,14	INV. F24F1/14 F24F1/16
Y	* abstract; claims 1,2; figures 1-8 *	3,4,6,8,11-13,15	F24F1/18 F24F1/26 F24F1/30
X	JP 2013 160483 A (DAIKIN IND LTD) 19 August 2013 (2013-08-19)	1	F24F1/48 F24F11/42
Y	* abstract; figures 1-18 *	3,4,6,8,11-13,15	F24F11/81
A	KR 101 935 343 B1 (UNIV TONGMYONG IND ACAD COOP FOUND [KR]) 4 January 2019 (2019-01-04) * abstract; figure 1 *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			F24F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 30 June 2021	Examiner Decking, Oliver
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 21 15 5991

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The members are as contained in the European Patent Office EDP file on
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30-06-2021

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JP 2013160483 A	19-08-2013	NONE	
KR 101935343 B1	04-01-2019	NONE	

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82