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(54) **AIR CONDITIONER**

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Description

Technical field

[0001] The present invention relates to air conditioners and particularly air conditioners using outside air as heat source. Such air-conditioners may as well be called air heat pumps. Further, the air-conditioners may be used for cooling and/or heating of a space to be conditioned.

Background

[0002] Generally speaking, air-conditioners consist of one or more outdoor units and one or more indoor units connected via a refrigerant piping. The outdoor and indoor units each comprise a heat exchanger for, on the one hand, exchanging heat with the heat source and, on the other hand, exchanging heat with the space to be conditioned. Outdoor units of air-conditioners are in most cases installed outside a building for example on the roof or at the façade. This, however, has under certain circumstances being perceived disadvantageous from an aesthetical point of view. Therefore, EP 2 108 897 A1 suggested to integrate the outdoor unit into a ceiling of the building so as to be hidden therein and not to be noticeable from the outside of the building.

[0003] Yet, the outdoor unit suggested in this document has certain disadvantages. One negative aspect is that the outdoor unit produces noises which may be perceived disturbing by individuals inside the building. A second negative aspect is installation and maintenance, because the outdoor unit is relatively heavy and because of its construction requires a relatively large installation space with respect to its height.

[0004] An air conditioner having the features defined in the preamble of claim 1 is disclosed in JP 2000-039185 A, wherein the heat source unit is disposed outdoors. Similar disclosures may be found in GB 828979 A, JP H10-89723 A, JP H08-200746 A or WO 2011/069220 A1. WO 2013/094049 A1 further discloses an outdoor unit (heat source unit) having a vertically oriented V-shaped heat exchanger.

Brief description of the invention

[0005] Accordingly, one object the present invention intends to solve is the provision of an air conditioner which may substantially maintain the aesthetical improvements of the prior art but at the same time produces less noise and is improved regarding maintenance and installation.

[0006] This object is solved by an air conditioner as defined in claim 1. Embodiments of the invention are named in the dependent claims, the following description and the accompanying drawings.

[0007] According to one aspect, an air conditioner for conditioning a space, such as a room inside a building, comprises a heat source unit. In a particular embodiment, the heat source unit uses outside air (i.e. air outside the

building) as heat source. The heat source unit is in prior art documents often defined as outdoor unit of the air conditioner. The heat source unit has a heat exchanger unit (heat source heat exchanger unit) comprising a first heat exchanger (heat source heat exchanger) and a first casing. The first heat exchanger is disposed in the first casing and configured to exchange heat with a heat source, particularly outside air. For this purpose, it is preferred that the first casing has a first connection at one side of the heat exchanger and a second connection at an opposite side of the heat exchanger.

[0008] The first and second connections are preferably connected to ducting fluidly communicated with the outside of the building so that outside air may pass the first heat exchanger. Furthermore, the heat source unit comprises a compressor unit. The compressor unit has a compressor and a second casing separate from the first casing. "Separate" in this context means that the casings represent separate assemblies or units and should not encompass that one casing is disposed within the other casing. The compressor is disposed in the second casing. The first heat exchanger and the compressor are preferably connected by refrigerant piping. For this purpose, first and second refrigerant piping connections may be provided at each of the compressor unit and the heat source unit. Preferably the first and second refrigerant piping connections are accessible from the outside of the first and/or second casing, respectively. Moreover, the air conditioner also comprises at least one indoor unit, the inner unit has a second heat exchanger configured to exchange heat with the space to be conditioned or more particular air within this space. The second heat exchanger is also fluidly communicated to the heat exchanger unit and/or the compressor unit. This may as well be obtained by refrigerant piping and providing third and fourth refrigerant piping connections at the indoor unit and third and fourth refrigerant piping connections at the compressor unit. According to this aspect the first heat exchanger unit is disposed inside the building and fluidly communicated to the outside of the building. In particular and as previously mentioned, the first heat exchanger unit takes the outside air in and exhausts air heated/cooled by the first heat exchanger to the outside.

[0009] Because the heat source unit is split into a heat exchanger unit and a compressor unit, the respective casings may be optimized with respect to size and noise insulation. Further, the splitting enables different positioning of the two units, wherein the heat source unit may be disposed in the ceiling or a wall of the building without any restrictions regarding noise and being hidden to comply with the aesthetical requirements. At the same time, the heat exchanger unit is reduced in weight not comprising the compressor. Therefore, installation in the ceiling and maintenance are improved. The compressor unit in turn may be installed at a location where noises are no problem and because of its weight preferably at a lower height compared to the heat exchanger unit and even more preferably on the floor. In addition and be-

cause of the lower size of the compressor unit as compared to prior art outdoor units also comprising the first heat exchanger, the compressor unit may even be disposed outside without impairing the aesthetical appearance. An additional advantage of separating the compressor unit and the heat exchanger unit is that noises from the compressor usually entrained by the air passing the heat exchanger unit and thereby transferred to the space to be conditioned disturbing the individuals within the space can be avoided.

[0010] As previously mentioned, the first and/or second casing is sound insulated. Additionally and if required a thermal insulation may as well be provided. Because of the splitting, the insulation may be optimized to the respective unit and particularly the compressor unit may be encapsulated to avoid any noise distinction even if disposed inside the building.

[0011] According to one embodiment, the compressor unit is as mentioned disposed inside the building and preferably at a lower height than the heat exchanger unit and even more preferred on the floor. This enables easy installation and maintenance of the compressor unit. For this purpose, the second casing of the compressor unit may be provided with feet at its bottom to place the compressor unit on a horizontal supporting surface.

[0012] In one embodiment the second casing, i.e. the casing of the compressor unit has a width and/or height and/or depth complying with DIN EN 1116 for kitchen furniture and kitchen appliances. Accordingly, the compressor unit may be disposed in a kitchen of the building such as for example below a countertop.

[0013] According to a further aspect, the first heat exchanger is V-shaped in side view with an apex at one end, wherein a line, particularly a centerline and even more preferred a line of symmetry of the V-shaped heat exchanger in the side view or cross-sectional view and passing the apex extends horizontally. Thereby, the height of the heat exchanger unit may be reduced so as to enable installation of the heat exchanger unit even at locations with limited insulation space such as the ceiling. Moreover, the heat exchanging surface is maintained relatively large or even increased so as to improve efficiency of the heat exchanger.

[0014] As previously mentioned, the first casing may define a duct to be flown through by a fluid (in the following, reference is made only to outside air, but it is to be understood that other fluids as heat source may as well be used). In order to induce a flow of the outside air through the duct in a flow direction, the heat exchanger unit further comprises one or more fans disposed in the first casing. Preferably, the fans are backward curved centrifugal fans. As previously described, the heat exchanger unit is disposed in a fluid path (air duct). Therefore, a relatively large pressure drop has to be overcome because of fences and filters. Hence, a relatively high ESP (external static pressure) is required. In addition a relatively high airflow is required so as to enable the use in an air conditioner supplying a plurality of indoor units

disposed in the spaces to be conditioned. In this context, normal outdoor units provide for an air flow of 120 m³ per minute, whereas common indoor units provide for an air flow of 30 m³ per minute. The appliance of the heat exchanger unit as described above only requires a lower flow rate as compared to normal outdoor units but a higher flow rate as compared to usual indoor units. In one embodiment, the flow rate to be induced by the fans resides between about 60 m³ per minute and 100 m³ per minute and preferably about 60 m³ per minute and 85 m³ per minute. This may efficiently be obtained with one or more backward curved centrifugal fans. In addition, the flow rate should also be adjustable in the aforesaid ranges. The use of a backward curved centrifugal fan is desirable to achieve a relatively high ESP and air flow with high-efficiency. An additional requirement for the heat exchanger unit to be placed in the ceiling is that the whole unit and also the fans have to be restricted in regard of weight and size. In addition, the fluid flow rate needs to be adjustable. Also these requirements can be met by the use of a backward curved centrifugal fan. The use of a plurality of backward curved centrifugal fans further provides for a reduced overall fluid speed in the high velocity zones of the fans. Accordingly, the fans may be positioned closer to the heat exchanger without condensation water formed on the outer surface of the heat exchanger being drawn into the fans. By positioning the fans closer to the heat exchanger, a more compact heat exchanger unit as regards its length may be achieved. In particular embodiments, the apex of the "V" must stay away from the fan between 20 and 30 cm to avoid water from being sucked into the fan at a flow rate of 85 m³ per minute when two backward curved centrifugal fans are used. In addition, the use of more fans leads to less noise because each fan may be driven at a lower RPM to reach a certain air flow rate as compared to the use of fewer fans to reach the same air flow rate.

[0015] According to one aspect and in order to increase efficiency of the first heat exchanger and allow for an even distribution of outside air flowing through the first heat exchanger, the fan is disposed downstream of the first heat exchanger in the flow direction. In other words, the fan sucks air through the first heat exchanger rather than blowing air towards the first heat exchanger.

[0016] Particularly because of the configuration of the heat exchanger in a "V", the height of the first casing may be reduced and is not more than 500 mm, preferably not more than 450 mm, more preferred not more than 400 mm and most preferred not more than 350 mm.

[0017] According to another aspect, the first casing is completely closed (encapsulated) relative to the inside of the building and particularly the space/s to be conditioned as regards the flow of air. Air flowing through the first casing is preferably taken from the outside of the building via the first connection and returned to the outside of the building via the second connection. In one embodiment, another connection of the first casing may be the fluid (refrigerant) connection to the compressor

unit by means of the refrigerant piping. One additional fluid connection may be a connection to drainage, wherein a drain pan also disposed in the first casing and having a drain opening is connected to drainage so that condensation water accumulated in the drain pan may automatically be removed from the drain pan via the drainage. These two connections, however, have no significant influence on noises. Noises of the fans, however, entrained with the outside air passing the heat exchanger unit could influence the perception of noises from the air conditioner. Due to the encapsulation of the heat exchanger unit, those noises are however not transferred to the space/s to be conditioned.

[0018] As previously mentioned, the heat exchanger unit, the compressor unit and the indoor unit/-s are fluidly communicated by refrigerant piping. This particularly concerns the first heat exchanger, the second heat exchanger and the compressor as well as other components such as a main expansion valve, a switching valve, e.g. a 4 way valve, filters, sensors, a subcooling heat exchanger, a subcooling expansion valve and/or an indoor expansion valve. In other words, the first heat exchanger, the compressor, the second heat exchanger and at least a main expansion valve are fluidly communicated to constitute a refrigerant circuit by refrigerant piping.

[0019] Further features and effects of the heat source unit may be obtained from the following description of embodiments. In the description of these embodiments reference is made to the accompanying drawings.

Brief description of drawings

[0020]

Figure 1 shows a schematic circuit diagram of an air conditioner,

Figure 2 a schematic sketch of the air conditioner shown in figure 1 installed in a building,

Figure 3 shows a perspective view of a heat exchanger unit,

Figure 4 shows a perspective view of a compressor unit, and

Figure 5 shows a longitudinal section of the heat exchanger unit of figure 3.

Description of an embodiment

[0021] Figure 1 shows the circuit diagram of an air conditioner. The air-conditioner has a heat source unit 30 comprising a heat exchanger unit 31 and a compressor unit 32.

[0022] The heat exchanger unit 31 comprises a heat exchanger 5 which consists of an upper heat exchanger

element 6 and a lower heat exchanger element 7 which are positioned relative to each other to form the shape of a "V" in a side view or cross sectional view (see figure 5). The heat exchanger unit 31 further comprises the main expansion valve 33 of the refrigerant circuit.

[0023] The heat exchanger unit is also shown in more detail in figures 3 and 5.

[0024] Figures 3 and 5 show a heat exchanger unit 31 which may be part of the heat source unit 30.

[0025] The heat exchanger unit 31 comprises a casing 2 (first casing) being configured for connection to an outside air duct of an air conditioner. In particular, the heat exchanger unit is configured as an "outdoor" unit of an air conditioner which is, however, disposed inside particularly within the ceiling of a building. Hence, a first connection 3 is provided at the casing 2 for connection to an air duct communicating the heat exchanger unit 31 with the outside of the building and so as to enable taking of outdoor air into the casing 2. A connection 4 (See Figure 5), provided for the connection of the heat exchanger unit 31 to the air duct again leading to the outside of the building and to enable exhausting of air having passed the heat exchanger 5 to the outside, is disposed at the opposite end of the casing 2.

[0026] The casing 2 is substantially rectangular and flat, meaning that the height H is a smaller than the width W and the length L. In one embodiment the height H is not more than 500 mm, preferably not more than 450 mm, more preferred not more than 400mm and most preferred not more than 350 mm.

[0027] The heat exchanger unit 31 further comprises a heat exchanger 5 (first heat exchanger) which is also visible in figure 3. However, the configuration of the heat exchanger 5 can be best seen from figure 5. Figure 5 also represents a side view of the heat exchanger 5 in the sense of the present application.

[0028] The heat exchanger 5 comprises an upper heat exchanger element 6 and a lower heat exchanger element 7. Both, the upper and lower heat exchanger elements 6, 7 are flat or planar shaped and are positioned with an angle α enclosed between them. As best visible from figure 1, the upper and lower heat exchanger elements 6, 7 are fluidly connected in parallel to the refrigerant piping. Hence the heat exchanger 5 has a V-shape wherein the "V" is oriented horizontally. A line CL passing the apex 8 of the "V" is oriented horizontally, that is along the length L extension of the heat exchanger unit 31. The line CL is also the centerline of the heat exchanger 5 or to put it differently a line of symmetry as regards the heat exchanger elements 6, 7.

[0029] The heat exchanger 5 is arranged within the air duct formed by the casing 2 so that all air sucked in through the opening at the connection 3 has to flow through the heat exchanger 5 without any air bypassing the heat exchanger 5 at the top or the bottom or the sides of the heat exchanger 5 in the width direction W.

[0030] The upper and lower heat exchanger elements 6, 7 are connected to each other at the apex 8 by a con-

necting element 9. The connecting element is impermeable to air and also used to mechanically or physically connect the upper and lower heat exchanger elements 6, 7. Each of the heat exchanger elements 6, 7 comprises heat exchanger coils 10 (loops of tubing) and fins 11 disposed there between. The heat exchanger of the present embodiment is applied for outdoor applications, i.e. as part of the heat source unit of an air conditioner. In this case, the fins of the upper and lower heat exchanger element 6, 7 are preferably waffled fins. Even though louvered fins are preferably used for a good air flow through the heat exchanger as several holes are provided to allow the air to flow through the fins, condensation water may accumulate in these holes and may lead to problems regarding the formation of frost during heating operation, when the ambient temperature is lower than about 7°C. To prevent these problems it is in these cases preferred to use waffled fins.

[0031] Two backward curved centrifugal fans 20 are provided inside the casing. These backward curved centrifugal fans 20 each have a suction opening 21. In the side view (figure 5), the center axis of the suction opening 21 and hence the fans 20 is substantially congruent or aligned with the center line CL of the heat exchanger 5. In some appliances, it may however be sufficient as in the depicted embodiment that the center axis of the suction opening 21 and the centerline CL of the heat exchanger 5 are parallel but displaced relative to each other in a horizontal direction.

[0032] In use, the fans 20 create a suction force at the suction opening 21 so as to induce a fluid flow (airflow) in the direction F. Thus air, particularly outside air is drawn in through the connection 3 toward the open end 12 of the heat exchanger 5, passes through the upper and lower heat exchanger elements 6, 7 and is sucked through the suction opening 21 to be flown out through the connection 4. As such the casing 2 defines a duct from the connection 3 via the heat exchanger 5 and the fan 20 to the connection 4. In this context, the connection 3 and the connection 4 define an inlet opening 13 and an outlet opening 14.

[0033] Furthermore, a drain pan 15 is provided within the casing. The drain pan 15 is separated into two halves 16, 17 along the length L of the casing 2 in the side view. In figure 5, the two halves 16, 17 are identified by the dotted line with one half being located on the left side and one half being located on the right side of the dotted line. The drain pan 15 has a lowest position 18 at which a drain opening 19 is provided. The bottom of the drain pan 15 slants toward the drain opening 19 and hence the lowest position 18. Thus water dropping from any component into the drain pan is directly guided to the drain opening 19 and the lowest position 18 which is furthest away from the fan 20. Thereby it is prevented that water accumulated within the drain pan may be sucked into the fan 20 and hence through the opening 14 into the duct. The drain opening 19 is directly connected to drainage so that water is directly drained.

[0034] Moreover, a sound and/or thermal insulation 22 are provided within the casing 2 at the side opposite to the drain pan 15 with respect to the line CL. In the cross section and hence a side view (figure 5), the inner surfaces of the drain pan 15 and the insulation 22 respectively directed to the heat exchanger 15 should be approximated so that the duct created within the casing 2 is as symmetric as possible.

[0035] Further, the distance between the apex 8 and the entry of the suction opening 21 should be as short as possible to reduce the length. In particular, the high velocity zone of the fans should in the side view not overlap with the heat exchanger 5 and/or the drain pan 15.

[0036] At a side of the casing 2, one can see a first and second refrigerant piping connection 34 and 35 for connecting the heat exchanger unit 31 to the refrigerant piping of the refrigerant circuit. In addition a connection port 36 for connecting the drain opening 19 to drainage (not shown) extends from the same side surface of the casing 2 as the refrigerant piping connections 34 and 35.

[0037] The casing 2 is completely closed relative to the environment except for the connections 3 and 4 as well as the refrigerant piping connections 34 and 35 and the connection 36 to the drainage. Accordingly and as can be seen from figure 5 the casing may be sound insulated and thereby encapsulated to prevent any noises for example from the fans from being transferred to the space to be conditioned. In addition and because the compressor 37 is not disposed in the casing 2 but the compressor unit 32 as described below, no noise of the compressor is induced and transferred via the air flowing through the heat exchanger unit 31 and in the air duct connected to the outside of the building.

[0038] The compressor unit 32 has a casing 44 (second casing) wherein in figure 4 a front wall of the casing 44 and a corresponding sound insulation have been removed to partly show the interior of the casing 44. The second casing 44 may as the first casing 2 be completely closed (encapsulated) except for ventilation openings required for preventing overheating within the casing 44. A compressor 37 (see figure 1) is disposed in the casing 44 (second casing). Furthermore, all other components of the compressor unit described below and if present will be disposed in the casing 44 as well. In addition, the compressor unit may comprise an optional accumulator 38 and a 4-way valve 39. In addition the compressor unit 32 may comprise as an optional component a subcooling heat exchanger 40 and a subcooling expansion valve 41. The compressor unit 32 further comprises first and second refrigerant piping connections 42 and 43 as shown in figure 4.

[0039] A stop valve 45 (two stop valves, one for each connection 42, 43) may be provided close to the first and second refrigerant piping connections 42 and 43, respectively.

[0040] Further a third and fourth refrigerant piping connection 46 and 47 are provided for connection of one or more indoor units 50 (one in the present embodiment)

disposed in fluid communication with the space to be conditioned. A stop valve 48 (two stop valves, one for each connection 46, 47) is also provided close to the refrigerant piping connections 46 and 47, respectively.

[0041] Moreover, a refrigerant piping 80 (second refrigerant piping) connects the refrigerant piping connection 42 and the refrigerant piping connection 47 with the 4 way valve 39, the compressor 37, the optional accumulator 38, the connection (81) to the refrigerant piping 57, the connection 82 to the refrigerant piping 52 and the 4-way valve 39 being interposed in this order.

[0042] The aforesaid components are disposed in the following order from the refrigerant piping connection 47 to the refrigerant piping connection 42 considering cooling operation (solid arrows in figure 1): the 4-way valve 39, the accumulator 38, the compressor 37, the 4 way valve 39 and the refrigerant piping connection 42. The aforesaid components are disposed in the following order from the refrigerant piping connection 42 to the refrigerant piping connection 47 considering heating operation (broken arrows in figure 1): the 4-way valve 39, the accumulator 38, the compressor 37, the 4 way valve 39 and the refrigerant piping connection 47.

[0043] Furthermore, a refrigerant piping 49 connects the first refrigerant piping connection 43 and the third refrigerant piping connection 46. A refrigerant piping 51 connects the accumulator 38 (the accumulator 38 is preferably a suction accumulator) and the 4-way valve 39. Even further, a refrigerant piping 52 connects at one end to the refrigerant piping 49 and at the other end to the refrigerant piping 51. Further, a refrigerant piping 57 connects the refrigerant piping 49 and the refrigerant piping 51 with a pressure regulating valve 58 being integrated into the refrigerant piping 57 at an intermediate position. The subcooling heat exchanger 40 is configured to exchange heat between the refrigerant flowing in the refrigerant piping 49 and the refrigerant flowing in the refrigerant piping 52. A subcooling expansion valve 41 is disposed in the refrigerant piping 52 between the subcooling heat exchanger and the refrigerant piping connection 43. To put it differently, the subcooling expansion valve 41 is disposed between the connection of the refrigerant piping 52 with the refrigerant piping 49 and the subcooling heat exchanger 40. In any case and during heating and cooling operation, the subcooling expansion valve 41 is disposed upstream of the subcooling heat exchanger 40 and the refrigerant piping 52.

[0044] The casing 44 of the compressor unit 32 may be sound insulated so that noise produced by the compressor 37 can be prevented from exiting the casing and disturbing individuals inside the building. Further, the casing 44 can because of its compact size be disposed on the floor for easy installation and maintenance and even below a cupboard of a kitchen or other technical equipment rooms. The casing 44 may additionally comprises feet 59 as shown in figure 4 for placing and fixing the casing 44 on a horizontal supporting surface. The size of the casing 44 particularly relating to its height,

widths and dabs complies with DIN EN 1116 for kitchen furniture and kitchen appliances. DIN EN 1116 is a European Standard containing coordinating sizes for kitchen furniture including worktops as well as for kitchen appliances, sinks and decorative panels. For convenience, in this standard the terms "furniture" and "appliance" are used for "kitchen furniture" and "kitchen appliance". The standard particularly defines dimensions for the height, the width, the depth and the space to enable furniture, appliances, sinks and decorative panels to fit together as elements of kitchen equipment.

[0045] An example of an indoor unit 50 comprises an indoor heat exchanger 53 (second heat exchanger) connected respectively via third and fourth refrigerant piping connections 54 and 55 and a refrigerant piping to the third and fourth refrigerant connections 46 and 47 of the compressor unit 32. Optionally, the indoor unit 50 may comprise an indoor expansion valve 56 disposed between the indoor heat exchanger 53 and the third refrigerant piping connection 54. The indoor unit 50 may in principle be configured as a common indoor units used in such air-conditioners.

[0046] As can be best seen from figure 2, the air conditioner may be installed in a building 70. In one possible embodiment, the heat exchanger unit 31 can be disposed in the ceiling 71 of a space 72 to be conditioned and being hidden within the ceiling 71. The connections 3 and 4 are preferably connected to an air duct 73 so that the casing 2 of the heat exchanger unit 31 forms part of the air duct 73. The end of the air duct 73 opens at both ends 74 and 75 to the outside of the building so that outside air may be sucked in through the end 74 passes the heat exchanger 5 of the heat exchanger unit 31 and is exhausted through the end 75.

[0047] The heat exchanger unit 31 is connected by refrigerant piping 76 to the compressor unit 32 using the refrigerant piping connections 34 and 35 as well as 43 and 42, respectively. The compressor unit 32 again is connected to the indoor unit/-s 50 via refrigerant piping 77 using the third to fourth refrigerant piping connections 46, 47 and 54, 55 respectively.

[0048] The operation of the air conditioner described above is as follows. During cooling operation (solid arrows in figure 1), refrigerant flows into the compressor unit 32 at the refrigerant piping connection 47 passes the 4-way valve 39 and is introduced into the accumulator 38. When passing the accumulator associated liquid refrigerant is separated from the gaseous refrigerant and liquid refrigerant is temporarily stored in the accumulator 38.

[0049] Subsequently, the gaseous refrigerant is introduced into the compressor 37 and compressed. The compressed refrigerant is introduced into the heat exchanger unit 31 via the first refrigerant piping connections 42, 35 and a refrigerant piping. The refrigerant passes the heat exchanger 5 with its plates 6, 7 of the heat exchanger unit 31, whereby the refrigerant is condensed (the heat exchanger 5 functions as a condenser). Hence,

heat is transferred to the outside air parallelly passing through the heat exchanger elements 6, 7 of the heat exchanger 5. The expansion valve 33 is entirely opened to avoid high pressure drops during cooling. Then, the refrigerant flows into the compressor unit 32 via the third refrigerant piping connections 34, 43 and refrigerant piping. In the compressor unit 32, the refrigerant flows in part through the refrigerant piping 52 and, hence, the subcooling expansion valve 41 and the subcooling heat exchanger 40 and in part through the refrigerant piping 49 being introduced via the third refrigerant piping connection 46, a refrigerant piping and the third refrigerant connection 54 into the indoor unit 50. The refrigerant is then further expanded by the indoor expansion valve 56 and evaporated in the heat exchanger 53 (the heat exchanger 53 functions as evaporator) cooling the space 72 to be conditioned. Accordingly, the heat is transferred from air in the space to be conditioned to the refrigerant flowing through the heat exchanger 53. Finally, the refrigerant is again introduced via the fourth refrigerant piping connections 55, 47 and refrigerant piping into the compressor unit 32.

[0050] As is generally known, the capacity of an air conditioner at the indoor side is the multiplication of enthalpy and mass flow. Hence a reduced mass flow may be used when the enthalpy is increased. The subcooling heat exchanger serves to increase enthalpy at the indoor side. As a consequence, the mass flow can be reduced without impairing capacity. As a result the pressure drop in the liquid pipe can be reduced so that the compressor 37 needs to deliver less work improving the entire system efficiency.

[0051] During heating, this circuit is reversed wherein heating is shown by the broken arrows in figure 1. The process is in principle the same. Yet, the first heat exchanger 5 functions as evaporator whereas the second heat exchanger 53 functions as condenser during heating. In particular, refrigerant is introduced into the compressor unit 32 via the first refrigerant piping connection 42, flows via the 4-way valve 39 into the accumulator 38 and is then compressed in the compressor 37 before flowing into the 4-way valve 39 and through the fourth refrigerant piping connections 47, 55 and refrigerant piping into the indoor unit 50 and particularly the indoor heat exchanger 53 where the refrigerant is condensed (the indoor heat exchanger 53 functions as a condenser). Subsequently, the refrigerant is expanded by the expansion valve 56 and then reintroduced via the third refrigerant piping interconnections 54, 46 into the compressor unit 32 where the refrigerant flows into the piping 49 and passes the subcooling heat exchanger 40. By refrigerant injection after the evaporator, the suction superheat before the compressor can be optimized. As a result, the discharge temperature can be reduced with the beneficial effect of better efficiency of the system and prolonged lifetime.

[0052] Subsequently, part of the refrigerant flows into the refrigerant piping 52, is expanded in the subcooling

expansion valve 41 and flows through the subcooling heat exchanger 40 before being reintroduced into the refrigerant piping 51 upstream of the accumulator 38 thereby pre-cooling the refrigerant flowing through the refrigerant piping 49 passing the subcooling heat exchanger 40. The remaining part flows into the heat exchanger unit 31 via the second refrigerant piping connections 43 and 34 and refrigerant piping. The refrigerant is further expanded by the main expansion valve 33 in the heat exchanger unit 31 and then evaporated in the heat exchanger 5 (the heat exchanger 5 functions as evaporator) before being reintroduced into the compressor unit 32 via the first refrigerant piping connections 35 and 42 and refrigerant piping.

[0053] Because of the splitting of the compressor module 32 and the heat exchanger module 31, the compressor unit 32 may be installed in areas that are not noise sensitive so that there is no noise disturbance caused by the compressor even though disposed indoors. In addition the casing 44 of the compressor unit 32 may be well insulated with sound insulation. Even further, there is no compressor noise in the air flowing through the heat exchanger unit 31 due to the split concept between the heat exchanger unit 31 and the compressor unit 32 which could be transferred into the space to be conditioned.

[0054] Because of the low lower weight per unit of the heat exchanger unit 31 and the compressor unit 32, the installation is improved. In addition, the compressor unit 32 may be installed on the floor so that there is no need to lift the heavy compressor module. Because of a relatively small footprint (width and depth) of the compressor unit 32 and a lower height of the compressor unit 32 and particularly its casing 44, the compressor unit 32 may even be hidden when disposed inside the room to be conditioned such as below a cupboard or counter-board.

[0055] The heat exchanger unit 31 has also the advantage that there is no noise disturbance. Because the compressor is not contained in the heat exchanger unit 31 the only sound that can be entrained in the airstream is the noise of the fan whereby the noise in the airstream is drastically reduced. Further, the casing can be entirely closed to the space 72 to be conditioned so that no sounds are transferred into the space. Also this casing may be well insulated with sound insulation. Because of the lower height of the heat exchanger unit 31, it is easy to hide the unit for example in the ceiling. Therefore, the unit 31 is not visible from the outside. The installation is also improved because of the lower weight as compared to units having the compressor in the same casing and because of the lower height of the heat exchanger unit 31. The lower height is particularly assisted by using the "V" shape of the heat exchanger 5, which enables high-efficiency with a relatively low height.

Claims

1. Air conditioner for conditioning a space (72) inside

a building (70) comprising:

a heat source unit (30) having a heat exchanger unit (31) comprising a first heat exchanger (5) disposed in a first casing (2) and configured to exchange heat with a heat source and a compressor unit (32) comprising a compressor (37) disposed in a second casing (44) separate from the first casing; and

at least one indoor unit (50) having a second heat exchanger (53) configured to exchange heat with the space to be conditioned and being fluidly communicated to the heat exchanger unit and/or the compressor unit,

characterized in that the heat exchanger unit (31) is disposed inside the building and fluidly communicated to the outside of the building.

2. Air conditioner according to claim 1, wherein the first (2) and/or second casing (44) is sound insulated. 20
3. Air conditioner according to claim 1 or 2, wherein the compressor unit (32) is disposed inside the building.
4. Air conditioner according any one of the preceding claims, wherein the second casing (44) has a width and/or height and/or depth complying with DIN EN 1116 for kitchen furniture and kitchen appliances. 25
5. Air conditioner according any one of the preceding claims, wherein the first heat exchanger (5) is V-shaped in side view with an apex (8) at one end, wherein a centerline (CL) of the V-shaped heat exchanger in the side view and passing the apex extends horizontally. 30
6. Air conditioner according to claim 5, wherein the first casing (2) has a duct to be flown through by a fluid and the heat exchanger unit (31) further comprises a fan (20) disposed in the first casing (2) and configured to induce a flow of the fluid through the duct in a flow direction (F). 40
7. Air conditioner according to claim 6, wherein the fan (20) is disposed downstream of the first heat exchanger (5) in the flow direction. 45
8. Air conditioner according any one of the preceding claims, wherein the first casing (2) has a height of not more than 500 mm, preferably not more than 450 mm, more preferably not more than 400 mm and most preferred not more than 350 mm. 50
9. Air conditioner according any one of the preceding claims, wherein the first casing (2) is completely closed relative to the inside of the building. 55
10. Air conditioner according any one of the preceding

claims, wherein the heat exchanger unit (31), the compressor unit (32) and the indoor unit/s (50) are fluidly communicated by a refrigerant piping.

Patentansprüche

1. Klimaanlage zum Klimatisieren eines Raums (72) innerhalb eines Gebäudes (70), umfassend:

eine Wärmequelleneinheit (30), die eine Wärmetauschereinheit (31) hat, die einen ersten Wärmetauscher (5) umfasst, der in einem ersten Gehäuse (2) angeordnet ist und dazu konfiguriert ist, Wärme mit einer Wärmequelle auszutauschen, und eine Kompressoreinheit (32), die einen Kompressor (37) umfasst, der in einem zweiten Gehäuse (44) getrennt von dem ersten Gehäuse angeordnet ist; und
mindestens eine Innenraumeinheit (50) mit einem zweiten Wärmetauscher (53), der dazu konfiguriert ist, Wärme mit dem zu klimatisierenden Raum auszutauschen, und in Fluidkommunikation mit der Wärmetauschereinheit und/oder der Kompressoreinheit steht,
dadurch gekennzeichnet, dass die Wärmetauschereinheit (31) innerhalb des Gebäudes angeordnet ist und in Fluidkommunikation mit dem Äußeren des Gebäudes steht.
2. Klimaanlage nach Anspruch 1, wobei das erste (2) und/oder zweite Gehäuse (44) schallisoliert ist.
3. Klimaanlage nach Anspruch 1 oder 2, wobei die Kompressoreinheit (32) innerhalb des Gebäudes angeordnet ist.
4. Klimaanlage nach einem der vorhergehenden Ansprüche, wobei das zweite Gehäuse (44) eine Breite und/oder Höhe und/oder Tiefe hat, die der DIN EN 1116 für Küchenmöbel und Kücheneinrichtungen entspricht.
5. Klimaanlage nach einem der vorhergehenden Ansprüche, wobei der erste Wärmetauscher (5) in der Seitenansicht V-förmig mit einer Spitze (8) an einem Ende ist, wobei eine Mittellinie (CL) des V-förmigen Wärmetauschers in der Seitenansicht, die die Spitze passiert, horizontal verläuft.
6. Klimaanlage nach Anspruch 5, wobei das erste Gehäuse (2) einen Kanal hat, der von einem Fluid durchströmt werden soll, und die Wärmetauschereinheit (31) weiter ein Gebläse (20) umfasst, das im ersten Gehäuse (2) angeordnet ist und dazu konfiguriert ist, ein Strömen des Fluids durch den Kanal in einer Strömungsrichtung (F) zu induzieren.

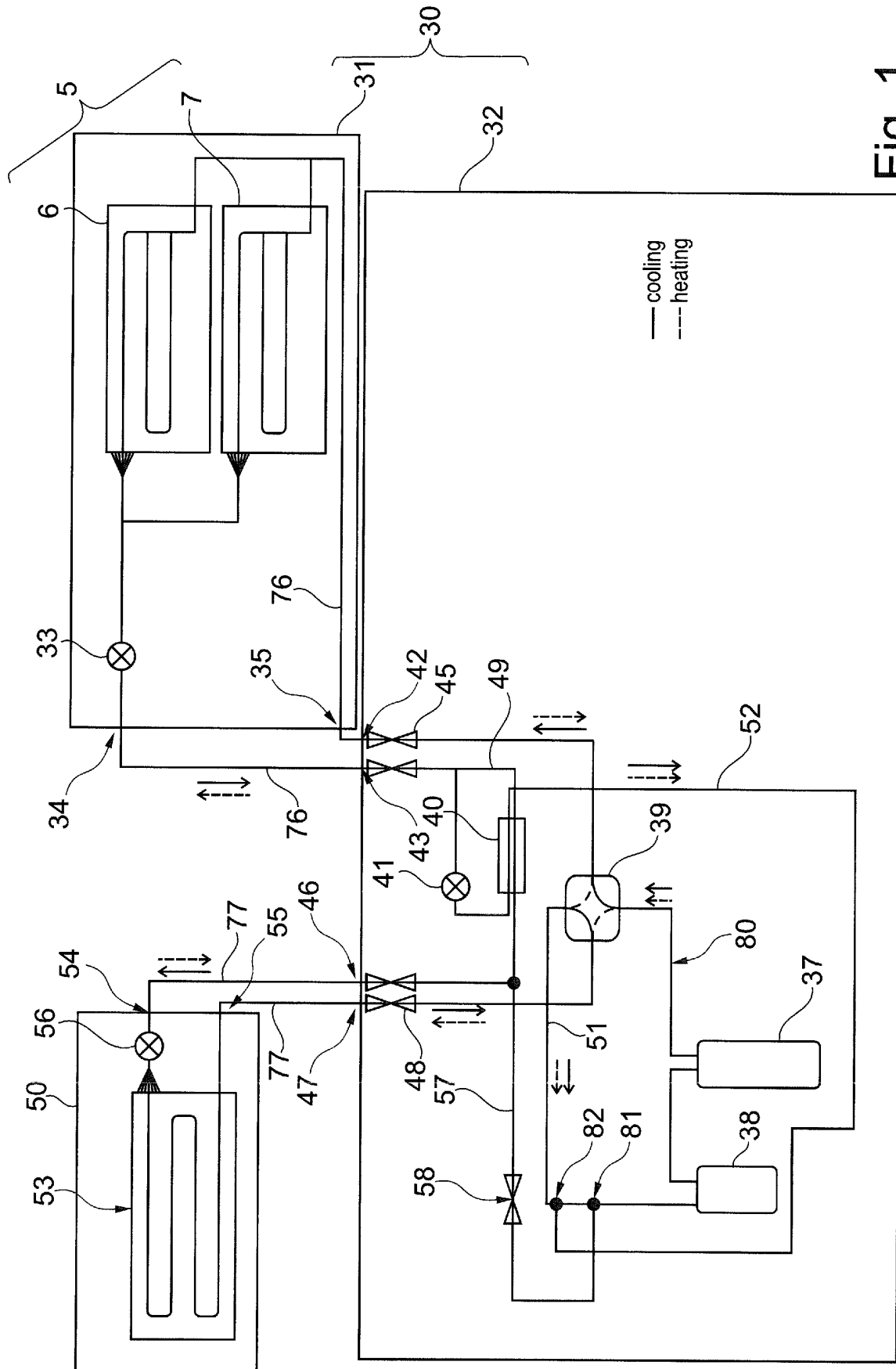
7. Klimaanlage nach Anspruch 6, wobei das Gebläse (20) stromabwärts des ersten Wärmetauschers (5) in der Strömungsrichtung angeordnet ist.
8. Klimaanlage nach einem der vorhergehenden Ansprüche, wobei das erste Gehäuse (2) eine Höhe von nicht mehr als 500 mm, bevorzugt nicht mehr als 450 mm, noch bevorzugter nicht mehr als 400 mm und am bevorzugtesten nicht mehr als 350 mm hat.
9. Klimaanlage nach einem der vorhergehenden Ansprüche, wobei das erste Gehäuse (2) vollständig relativ zum Inneren des Gebäudes geschlossen ist.
10. Klimaanlage nach einem der vorhergehenden Ansprüche, wobei die Wärmetauschereinheit (31), die Kompressoreinheit (32) und die Innenraumeinheit/-en (50) mittels eines Kältemittel-Leitungssatzes in Fluidkommunikation stehen.

Revendications

1. Climatiseur pour la climatisation d'un espace (72) à l'intérieur d'un bâtiment (70) comprenant :
 - une unité source de chaleur (30) possédant une unité échangeur de chaleur (31) comprenant un premier échangeur de chaleur (5) disposé dans un premier boîtier (2) et configuré pour échanger de la chaleur avec une source de chaleur et une unité compresseur (32) comprenant un compresseur (37) disposé dans un second boîtier (44) séparé premier boîtier; et
 - au moins une unité intérieure (50) possédant un second échangeur de chaleur (53) configuré pour échanger de la chaleur avec l'espace à climatiser et étant mis en communication par fluide avec l'unité échangeur de chaleur et/ou l'unité compresseur;
 - caractérisé en ce que** l'unité échangeur de chaleur (31) est disposée à l'intérieur du bâtiment et est mise en communication par fluide avec l'extérieur du bâtiment.
2. Climatiseur selon la revendication 1, dans lequel le premier (2) et/ou le second boîtier (44) est isolé phoniquement.
3. Climatiseur selon la revendication 1 ou 2, dans lequel l'unité compresseur (32) est disposée à l'intérieur du bâtiment.
4. Climatiseur selon l'une quelconque des revendications précédentes, dans lequel le second boîtier (44) possède une largeur et/ou hauteur et/ou profondeur qui respectent la norme DIN EN 1116 pour le mobilier

de cuisine et pour les appareils de cuisine.

5. Climatiseur selon l'une quelconque des revendications précédentes, dans lequel le premier échangeur de chaleur (5) est configuré en V dans une vue latérale comprenant un sommet (8) à une extrémité, dans lequel une ligne médiane (CL) de l'échangeur de chaleur configuré en V dans la vue latérale et passant par le sommet s'étend horizontalement.
6. Climatiseur selon la revendication 5, dans lequel le premier boîtier (2) possède un conduit destiné être emprunté par un fluide et l'unité échangeur de chaleur (31) comprend en outre un ventilateur (20) disposé dans le premier boîtier (2) et configuré pour induire un écoulement du fluide à travers le conduit dans une direction d'écoulement (F).
7. Climatiseur selon la revendication 6, dans lequel le ventilateur (20) est disposé en aval du premier échangeur de chaleur (5) dans la direction d'écoulement.
8. Climatiseur selon l'une quelconque des revendications précédentes, dans lequel le premier boîtier (2) possède une hauteur qui n'est pas supérieure à 500 mm, de préférence pas supérieure à 450 mm, de manière plus préférée pas supérieure à 400 mm, et de la manière la plus préférée pas supérieure à 350 mm.
9. Climatiseur selon l'une quelconque des revendications précédentes, dans lequel le premier boîtier (2) est complètement fermé par rapport à l'intérieur du bâtiment.
10. Climatiseur selon l'une quelconque des revendications précédentes, dans lequel l'unité échangeur de chaleur (31), l'unité compresseur (32) et la ou les unités intérieures (50) sont mises en communication par fluide via une tuyauterie de réfrigérant.



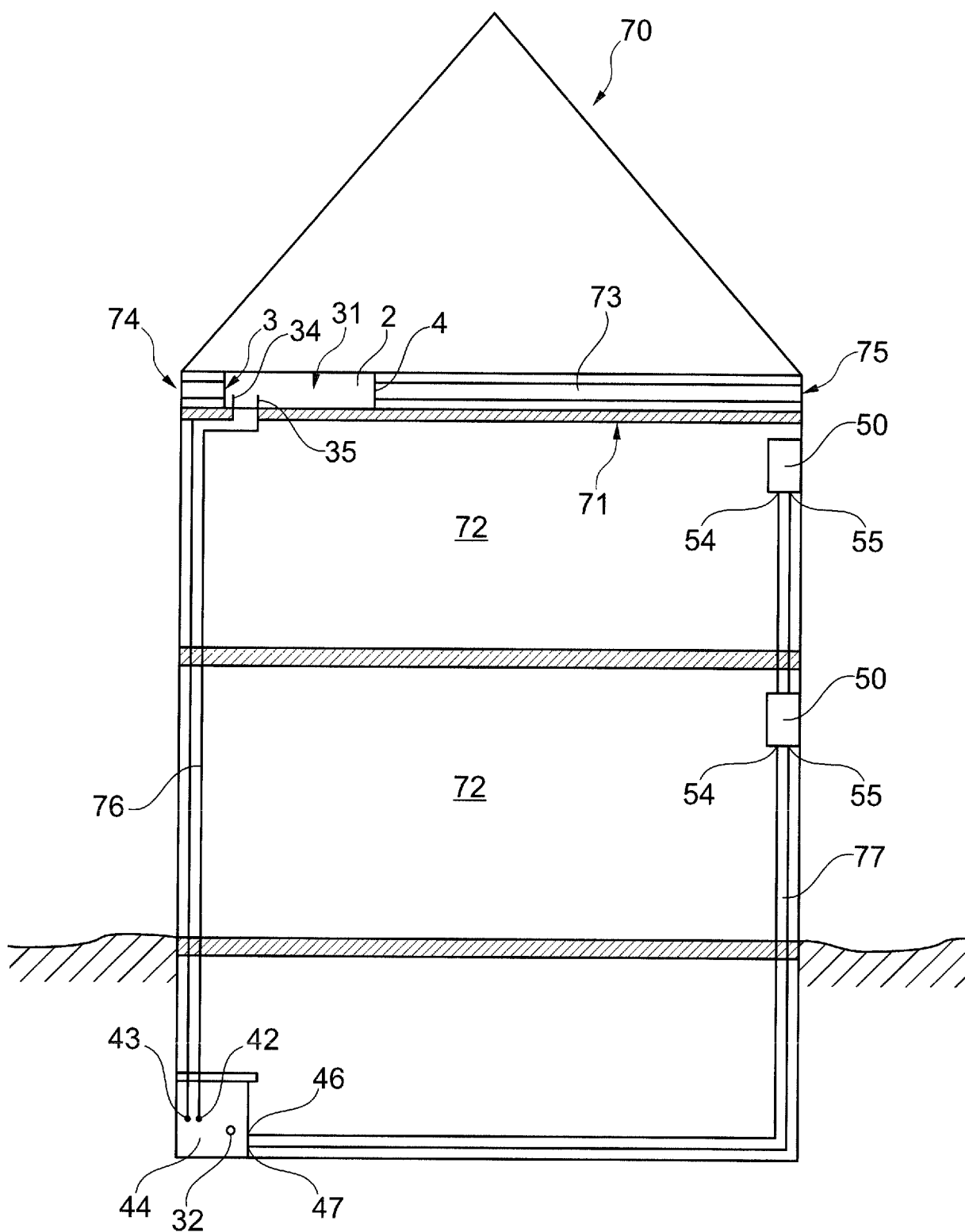


Fig. 2

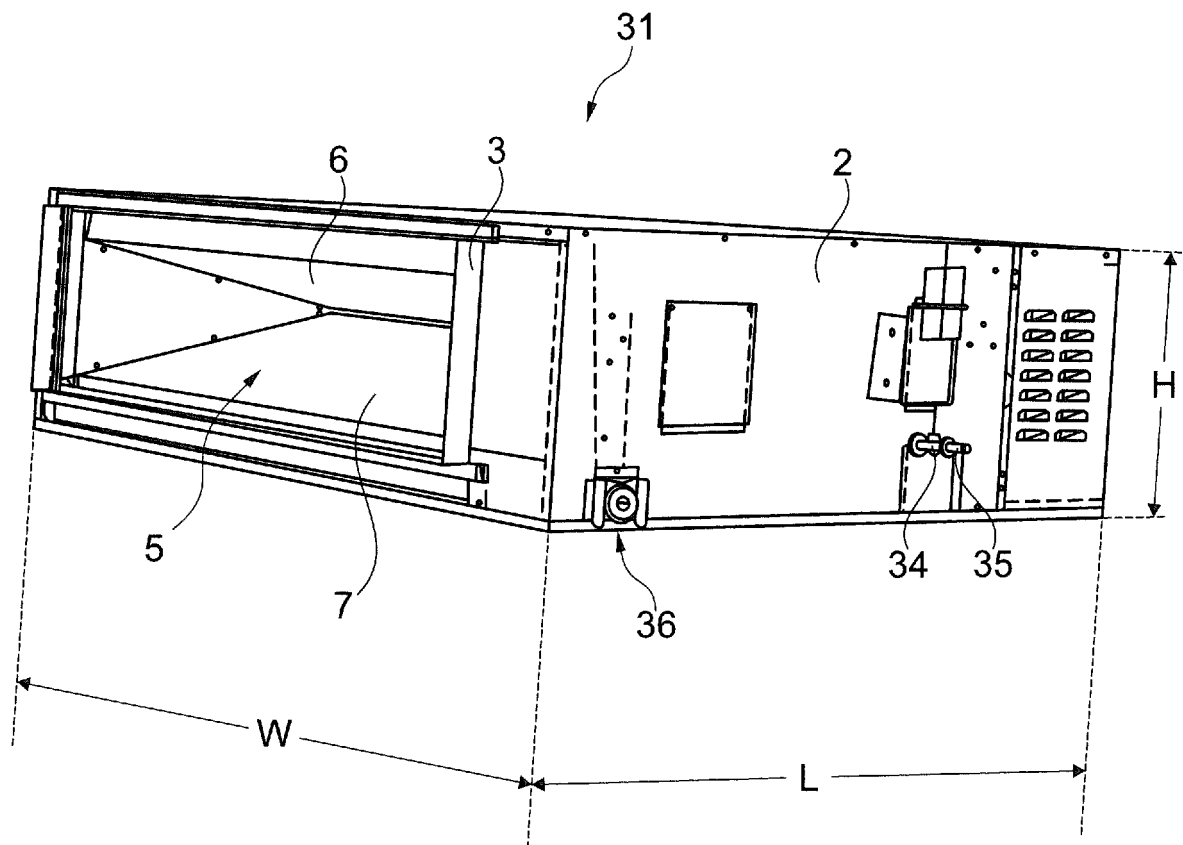


Fig. 3

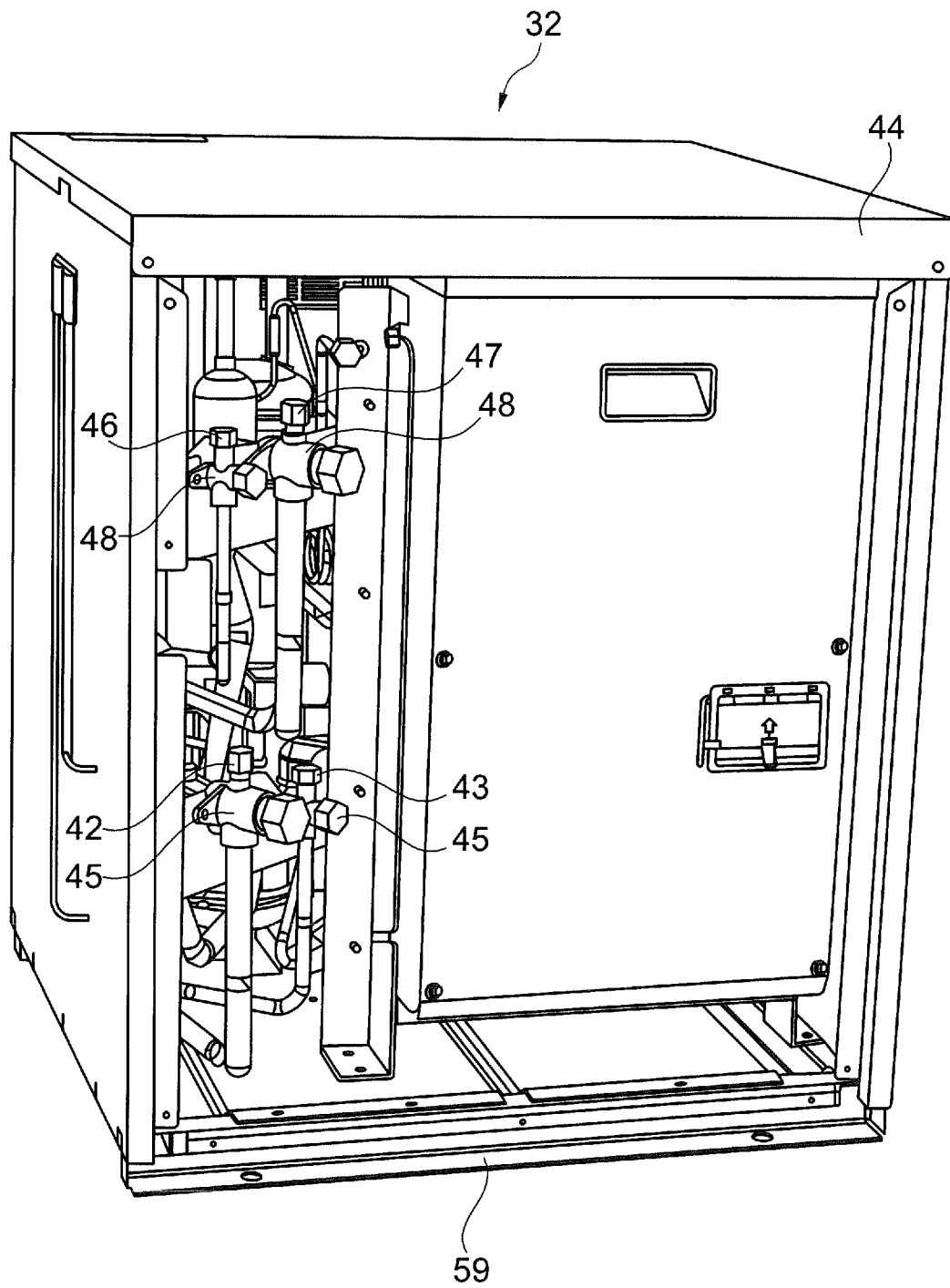


Fig. 4

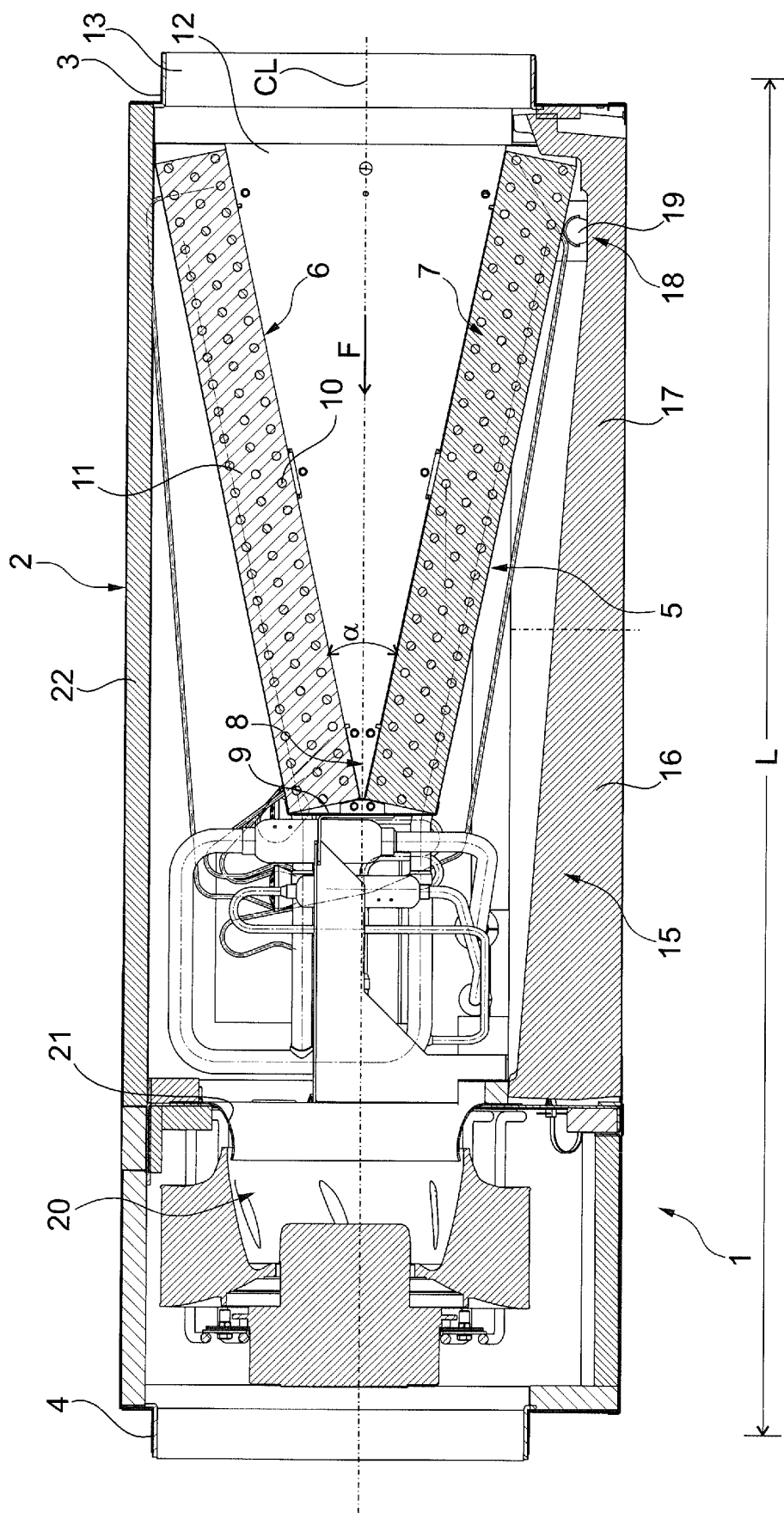


Fig. 5

REFERENCES CITED IN THE DESCRIPTION

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