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(54) Heat pump laundry treatment apparatus

(57) The present invention relates to a heat pump laundry treatment apparatus, in particular a heat pump laundry dryer or a heat pump washing machine having drying function. A heat pump laundry treatment apparatus (1) according to the invention comprises a cabinet (2) which houses operational components (3, 12, 14) for carrying out a drying operation on laundry, the operational components (3, 12, 14) comprise a rotatable laundry drum (3) for treating laundry using process air, the drum (3) being accessible by a user through a door (4) of the apparatus (1), wherein the laundry treatment apparatus (1) comprises: a process air path (12) for conveying the process air through the drum (3); a heat pump assembly (14) having members (15, 16, 17, 18) comprising a first and a second heat exchanger (15, 16) arranged in the process air path (12), a compressing device (17), a refrigerant expansion device (18) and a refrigerant loop (11) for circulating a refrigerant fluid through the members (15, 16, 17, 18); the refrigerant loop comprising flexible pipes (19) for fluidly connecting each other two members (15, 16, 17, 18) of the heat pump assembly (14). In the apparatus (1) according to the invention at least one of the heat pump members (15, 16, 17, 18) is at least partly removable from the cabinet (2) leaving the remaining heat pump members (15, 16, 17, 18) inside the cabinet (2) and keeping said at least partly removable heat pump member (15, 16, 17, 18) connected to the refrigerant loop (11).

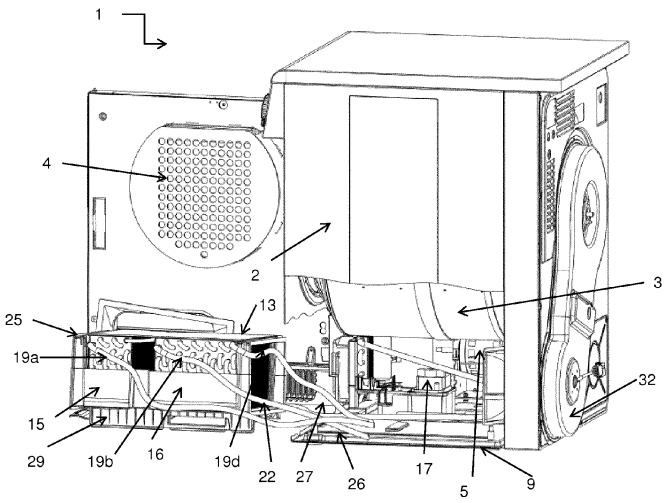

Figure 5

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Description

[0001] The present invention relates to a heat pump laundry treatment apparatus, in particular a heat pump laundry dryer or a heat pump washing machine having drying function.

[0002] As it is known, a heat pump type laundry dryer generally comprises a cabinet enclosing a rotatable drum whose inner region defines a laundry treating chamber where a drying process is carried out. The machine cabinet is closed at the bottom thereof by a basement having a lower surface facing the floor where the machine is to be placed and an upper surface provided with seats for receiving operational components provided for carrying out a drying process on laundry. A heat pump system, an electric motor, a fan, a drying air circuit (process air circuit) and other devices provided for operating the laundry apparatus are operational components of the machine. A heat pump system includes a closed refrigerant loop, a first heat exchanger acting as evaporator for evaporating the refrigerant and cooling process air, a compressing device, a second heat exchanger acting as condenser for cooling the refrigerant and heating the process air, and an expansion device from where the refrigerant is returned to the first heat exchanger.

[0003] Today's heat pump type laundry dryers are notable for their high drying capability and effective energy saving. Typically, when drying laundry, the compressing device of the heat pump is activated while the drum is rotated by a drive unit, the refrigerant is compressed and drying air (process air) is re-circulated through the drum by means of a process air circuit and a blower installed in such circuit. Thus, the process air exhausted from the drum is cooled and dehumidified by heat exchange carried out by the evaporator of the heat pump system. The dehumidified air is heated by heat exchange carried out by the condenser of the heat pump system and, subsequently, the heated and dried air is supplied into the drum for performing the laundry drying process. As a result, dry warm air is repeatedly supplied into the drum, whereby laundry is dried.

[0004] In heat pump type laundry dryers, normally the inspection of the heat exchangers for maintenance reasons is one of the most critical aspects. Normally the portion of the circuit that can be inspected is only partial as the user or the technical service can actually access, for cleaning reasons, only a small portion of the circuit which generally consists in the inlet portion of the heat pump evaporator.

[0005] According to some known heat pump laundry treatment apparatus, in order to simplify the heat pump cleaning, it is possible to remove from the machine the entire heat pump system including evaporator, compressor, condenser and the expansion valve. To allow such operation, large openings should be provided on a side of the laundry dryer machine cabinet in correspondence of the heat pump system, due in particular to the fact that the compressor typically has large dimensions (especially height), even greater than the batteries placed therein for powering the heat exchangers. Such a heat pump laundry treatment apparatus is disclosed in DE 4212700.

[0006] Periodical cleaning of heat exchangers is strongly recommended, in particular periodical cleaning of the evaporator which is the first element in the air circuit to be subjected to the air passage. In fact, the evaporator is subjected to collect lint particles, despite the fact that the evaporator is placed in the air circuit downstream an air filtration unit, so as to receive generally filtered clear air. However, in many cases, it is possible that the evaporator collects fluffs or lint particles, for example passed through the filtration unit, or, for example, after a wrong start of the machine when the filtration unit has not been properly installed therein. In such a case, before the dryer check control system realizes that the dryer is working without filtration unit and, consequently, give a stop command to the drying cycle, an amount of lint particles has already reached the evaporator.

[0007] If in household laundry drying machines used under manufacturer prescribed conditions the collection of a consistent amount of fluff onto the heat pump evaporator takes a relatively long time, the problem becomes much more considerable in semi-professional or professional applications which are used, for example, in self-service laundries. Such kind of machines may be subjected to continuous drying cycles all day long even with clogged or wrongly positioned process air filters. Because of this intensive operation of such kind of machines it is needed to have programmed maintenance periods necessary for the service to clean the heat exchangers or internal fluff-blocking filters.

[0008] Thus, there is the need to have a heat pump laundry treatment apparatus having a reliable configuration for allowing the possibility to perform maintenance operations to the heat exchangers by extracting from the dryer only the essential components without the need to disassemble the complete dryer structure.

SUMMARY OF THE INVENTION

[0009] In compliance with the above aims, according to the present invention there is provided a heat pump laundry treatment apparatus, in particular a heat pump laundry dryer or a heat pump washing machine having drying function, comprising a cabinet which houses operational components for carrying out a drying operation on laundry. The operational components comprise: a) a rotatable laundry drum for treating laundry using process air, the drum being accessible by a user through a door of the apparatus; b) a process air path for conveying the process air through the drum; and c) a heat pump assembly having members comprising a first and a second heat exchanger arranged in the process air path, a compressing device, a refrigerant expansion device and a refrigerant loop for circulating a refrigerant fluid through the members. The refrigerant loop comprises flexible pipes for fluidly connecting two members of the heat

pump assembly. The laundry treatment apparatus of the present invention is further characterized by the fact that at least one of the heat pump assembly members is at least partly removable from the cabinet leaving the remaining heat pump assembly members inside the cabinet and keeping said at least partly removable heat pump member connected to the refrigerant loop.

[0010] In the present invention, the term "operational components" refers to components which contribute to the operation of the heat pump laundry treatment apparatus of the present invention and that are generally supported by the bottom portion of said cabinet. In addition to the ones indicated above - rotatable laundry drum, process air path and heat pump assembly - the operational components may further include, for example, a process air fan; electric motors for rotating a laundry treatment chamber and/or a process air fan; one or more control units or any other device, or portions thereof, operated for carrying out a drying treatment on laundry.

[0011] In the present invention, the term "flexible pipe" refers to a hose which is made of a suitable material which allows the refrigerant fluid to circulate at its inside and which is able to change its path or to occupy a different space region when subjected just to a minimum shear loading transversely applied to it. A typical example of flexible pipe has generally a polymeric core covered by a reinforcing single or double stainless braid giving the tube the characteristics of high pressure resistance and of being free to occupy whichever position.

[0012] By the present invention it is allowed to extract from the heat pump laundry treatment apparatus only the essential components to perform maintenance operations to the heat exchangers without the need to disassemble the complete dryer structure.

[0013] In particular, it is allowed to extract from the heat pump laundry treatment apparatus at least one of the heat exchangers, leaving at least the compressing device inside the cabinet of the heat pump laundry treatment apparatus.

[0014] In the heat pump laundry treatment apparatus of the present invention some elements are provided which may be partly or completely removable from the cabinet, while other elements remain inside the cabinet.

[0015] In a first embodiment, each single member of the heat pump assembly is allowed to be partly or completely removable from the cabinet, leaving the remaining heat pump assembly members inside the cabinet and keeping said removable heat pump member connected to the refrigerant loop.

[0016] In a second embodiment, at least two of said members of the heat pump assembly are partly or completely removable from the cabinet, leaving the remaining heat pump assembly members inside the cabinet and keeping the two or more removable heat pump members connected to the refrigerant loop.

[0017] In whichever embodiment, due to the presence of said flexible pipes, while partly or completely removing from the cabinet one or more of said members of the heat pump assembly, it is not necessary to disconnect it/them from the refrigerant loop. The user is so allowed to operate in a better working conditions when maintenance and/or replacement operations of the heat pump assembly are to be performed.

[0018] Furthermore and preferably, though not necessarily, said cabinet has an opening dimensioned for being passed through by said at least partly removable heat pump member.

[0019] Furthermore and preferably, though not necessarily, a first flexible pipe fluidly connects one of said first or second heat exchangers with the compressing device, and a second flexible pipe fluidly connects the other of said heat exchangers with the compressing device or the refrigerant expansion device.

[0020] By this way, due to the first and second flexible pipes, it is allowed to extract from the heat pump laundry treatment apparatus a sub-assembly of said heat pump assembly, leaving the compressor inside the cabinet and still fluidly connected to said removed heat pump sub-assembly. In fact, for example, it is possible either to extract a heat pump sub-assembly consisting in said first exchanger which is fluidly connected to said refrigerant expansion device which in turn is fluidly connected to said second heat exchanger or to extract a heat pump sub-assembly formed by one of said first or second heat exchanger fluidly connected to said refrigerant expansion device. With the arrangement described above it is further possible to remove the compressor leaving all the other components of the heat pump within the cabinet.

[0021] Furthermore and preferably, though not necessarily, said first flexible pipe fluidly connects one of the first or second heat exchanger with the compressing device, and said second flexible pipe fluidly connects the same first or second heat exchanger with the refrigerant expansion device.

[0022] By this way, said first or second heat exchanger, being fluidly connected on one side with the compressing device and on the other side with the refrigerant expansion device, is allowed to be extracted from the heat pump laundry treatment apparatus, leaving the compressor and all the remaining components of the heat pump assembly inside the cabinet and still fluidly connected to said removed heat exchanger.

[0023] Furthermore and preferably, though not necessarily, said at least one heat pump members is removable from the cabinet by changing the path of said flexible pipes.

[0024] In fact, by changing the path of said flexible pipes, for example, by unrolling, extending, rolling or just moving at least one of them from a first position to a second position, it is allowed, first, to move said at least one member of the heat pump assembly from the working position and, then, to partly or fully extract it from the cabinet.

[0025] The air/refrigerant first heat exchanger of the heat pump assembly of the heat pump laundry treatment apparatus of the present invention is herein below re-

ferred to as the "evaporator" or "gas-heater" of the heat-pump assembly. It is structured so that the airflow arriving from the revolving drum and the low-pressure and low temperature refrigerant directed to the suction of the refrigerant compressing device can flow through it simultaneously, allowing the refrigerant having a temperature lower than that of the airflow, to absorb heat from the airflow, thus causing condensation of the surplus moisture in the airflow arriving from the revolving drum.

[0026] In addition, the air/refrigerant second heat exchanger, in turn, is herein below referred to as the "main condenser" or "gas-cooler" of the heat-pump assembly of the heat pump laundry treatment apparatus of the present invention. It is structured so that the airflow directed back into said revolving drum and the high-pressure and high-temperature refrigerant arriving from the outlet of said refrigerant compressing device can flow through it simultaneously, allowing the refrigerant having a temperature greater than that of the airflow to release heat to the airflow, thus heating the airflow directed back into the revolving drum.

[0027] Furthermore and preferably, though not necessarily, said heat pump assembly further comprises a third heat exchanger arranged in said refrigerant loop between the second heat exchanger, namely the main condenser, and the refrigerant expansion device.

[0028] Furthermore and preferably, though not necessarily, said third heat exchanger is an auxiliary condenser.

[0029] The advantage of said auxiliary condenser being present is that it allows to generate a better working condition in the heat exchanger of the heat pump assembly fluidly connected to said auxiliary condenser and which immediately follows it in said refrigerant loop. In fact, on one side, said auxiliary condenser allows to further condense the refrigerant fluid which exits from the main condenser, rendering as liquid as possible said refrigerant fluid which is to be inputted to the evaporator. The most liquid the refrigerant fluid to be entered into the evaporator is, the better is the workability of the evaporator itself. In fact, if the refrigerant fluid entering the evaporator mainly consists in vapor, the evaporator has not sufficient liquid to evaporate, worsening its working conditions.

[0030] On the other side, if the refrigerant fluid which exits from the main condenser is already sufficiently liquid to be inputted to said evaporator, said auxiliary condenser will reduce the temperature of said sufficiently liquid refrigerant fluid exited from the main condenser. Thus, the refrigerant fluid entering the evaporator will be at a lower temperature than in absence of the auxiliary condenser, allowing the evaporator to work in a better working condition.

[0031] Furthermore and preferably, though not necessarily, said third heat exchanger is fluidly connected to the refrigerant expansion device and to the second heat exchanger through flexible pipes.

[0032] By this way, said third heat exchanger is allowed to be partly or completely removable from the cabinet, leaving the compressor, the refrigerant expansion device, and the second heat exchanger inside the cabinet. The fluid connections between heat pump assembly members are not interrupted.

[0033] Furthermore and preferably, though not necessarily, said process air path comprises a segment having an enclosure that houses the first and the second heat exchangers, said segment being removable from the cabinet.

[0034] Furthermore and preferably, though not necessarily, said refrigerant expansion device is mounted on said segment.

[0035] Furthermore and preferably, though not necessarily, said auxiliary heat exchanger is mounted on said segment.

[0036] Furthermore and preferably, though not necessarily, said segment has a box-like structure comprising an handle.

[0037] By this way, grasping and pulling said handle, it is easier for the user to extract said segment, and all the heat pump assembly members mounted thereon out the cabinet.

[0038] Furthermore and preferably, though not necessarily, said segment is positioned in the lower part of the cabinet.

[0039] Furthermore and preferably, though not necessarily, said segment is slidably mounted onto a basement supporting said operational components.

[0040] Furthermore and preferably, though not necessarily, said segment is mounted onto the basement through a carriage which is movable along at least a driving rail.

[0041] By this way, due to the presence of said driving rail, said carriage is allowed to move in a safety way along a predefined direction established by the driving rail itself, avoiding the risk for the carriage to accidentally hit against obstacles during its movement.

[0042] Furthermore and preferably, though not necessarily, said opening is closed by a movable panel.

[0043] By this way, on one side, said movable panel may be removed by the user when he/she needs to have access, through said opening, to the inside part of the cabinet containing the heat pump assembly, for extracting some members of the heat pump assembly. On the other side, said opening may be closed with said removable panel during normal working conditions of the heat pump laundry treatment apparatus of the present invention.

[0044] Furthermore and preferably, though not necessarily, said compressing device has a flange portion provided with threaded fixing devices for removably fixing the compressing device onto a basement supporting the operational components.

[0045] By this way, the compressing device is firmly fixed to the basement; however, said compressing device may be easily removed from said basement, for maintaining or replacing purposes, by disengaging from the

basement said flange portion provided with threaded fixing devices.

[0046] Furthermore and preferably, though not necessarily, said compressing device is offset relative to said opening provided in the cabinet dimensioned for being passed through by the at least partly removable heat pump member.

[0047] By this way, due to the fact that said compressing device is fixed to the basement and it may be not intended to be extracted from the cabinet when the other members of the heat pump assembly are extracted from the cabinet, being said compressing device offset relative to said opening, the space inside the cabinet in correspondence of said opening is completely exploitable by the user for moving the members of heat pump assembly to be removed from the cabinet.

[0048] A non-limiting embodiment of the present invention will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows in a perspective view a heat pump laundry treatment apparatus realized in accordance with the teachings of the present invention, with parts removed for clarity;

Figure 2 shows a schematic view of the heat pump assembly of the heat pump laundry treatment apparatus of Figure 1;

Figure 3 shows a plan view of the heat pump laundry treatment apparatus of Figure 1, with all the elements of the heat pump assembly shown in Figure 2 positioned inside the cabinet of the heat pump laundry treatment apparatus of Figure 1;

Figure 4 shows a plan view of the heat pump laundry treatment apparatus of Figure 1, with some of the elements of the heat pump assembly shown in Figure 2 extracted from the cabinet of the heat pump laundry treatment apparatus of Figure 1;

Figure 5 shows a lateral perspective view of the heat pump laundry treatment apparatus of Figure 1, with parts removed for clarity, wherein the segment housing the first and second heat exchangers of Figures 2 or 4 has been extracted out of the cabinet from the front of the heat pump laundry treatment apparatus of Figure 1;

Figures 6 shows a perspective view of the segment of Figure 5;

Figures 7 shows a perspective view of an alternative embodiment of the heat pump laundry treatment apparatus of Figure 1, wherein the panel for closing the opening for the removal of the segment including the first and second heat exchangers is laterally positioned.

[0049] With reference to Figure 1, number 1 indicates as a whole a, preferably household, heat pump laundry treatment apparatus which comprises a boxlike cabinet 2 structured for resting on the floor. The cabinet 2 houses a substantially cylindrical, revolving drum 3 for treating laundry using process air, and which is mounted in axially rotating manner inside the boxlike cabinet 2. The revolving drum 3 directly faces a laundry loading/unloading through opening 7 formed in the front wall 8 of cabinet 2; the user is thus allowed to access laundry in the drum 3 through a porthole door 4 of the apparatus 1 in correspondence of said through opening 7. The porthole door 4 hinged to the front wall 8 of cabinet 2 rotates about a preferably, though not necessarily, vertically-oriented reference axis, to and from a closing position in which the porthole door 4 rests completely against the front wall 8 to close the laundry loading/unloading opening and substantially airtight seal the revolving drum 3.

[0050] The heat pump laundry treatment apparatus 1 additionally comprises, inside the boxlike cabinet 2, an electric motor 5, shown in Figure 3 and 4, which is mechanically connected to the revolving drum 3 for driving into rotation the drum 3 about its longitudinal axis; a closed-circuit, hot-air generator 6 which is structured to circulate through the revolving drum 3 a stream of hot air having a low moisture level, and which flows over and rapidly dries the laundry located inside drum 3; and finally a main electronic control unit (not shown) which is provided for controlling both the electric motor 5 and the hot-air generator 6 to perform one of the user-selectable drying cycles preferably. Said main electronic control unit may be formed by a plurality of control sub-units in signal communication with each other. A further control unit (not shown), separated from said main electronic control unit, may be provided to receive instructions input by a user. Said additional control unit may be even integrated in said main electronic control unit.

[0051] Furthermore, the boxlike cabinet 2 preferably comprises a substantially parallelepiped-shaped lower supporting basement 9 which is structured for resting on the floor and for housing at least part of the hot-air generator 6; and a substantially parallelepiped-shaped upper boxlike cabinet 10 which is rigidly fixed to the top of the lower supporting basement 9 and it is structured so as to house the revolving drum 3.

[0052] The laundry loading/unloading opening 7 of cabinet 2 is therefore realized in the front wall 8 of the upper boxlike cabinet 10, and the porthole door 4 is hinged to the front wall 8 of the aforesaid upper boxlike cabinet 10.

[0053] The hot-air generator 6 is a closed-circuit, heat-pump type, air circuit that comprises: an air recirculating conduit having its two ends fluidly connected to the revolving drum 3, on opposite sides of the latter, thereby defining a process air (drying air) path 12; a fan 32 located along the air recirculating conduit to produce, inside such conduit, an airflow which flows through the revolving drum; and finally a heat-pump assembly 14 having at

least two heat exchangers 15,16 located one after the other, along the air recirculating conduit. The arrows in Fig. 2 show the direction of the air in the process air path 12.

[0054] With particular reference to Figure 2, the heat pump assembly 14 schematically comprises:

- a first air/refrigerant heat exchanger 15 which is located along the process air path 12 and is structured for cooling down the airflow arriving from revolving drum 3 to condense and restrain the surplus moisture in the airflow;

- a second air/refrigerant heat exchanger 16 which is located along the process air path 12, downstream of the first heat exchanger 15, and which is structured for heating the airflow arriving from the first heat exchanger 15 and directed back to revolving drum 3, so that the airflow re-entering into revolving drum 3 is heated to a temperature higher than or equal to that of the air flowing out of revolving drum 3;

- an electrically-powered refrigerant compressing device 17 which is interposed between the refrigerant-outlet of the first heat exchanger 15 and the refrigerant-inlet of the second heat exchanger 16, and which is structured for compressing the gaseous-state refrigerant directed towards the second heat exchanger 16 so that refrigerant pressure and temperature are much higher at the refrigerant-inlet of the second heat exchanger 16 than at the refrigerant-outlet of the first heat exchanger 15; and

- an expansion valve or similar passive/operated refrigerant expansion device 18 (for example a capillary tube, a thermostatic valve or an electrically-controlled expansion valve) which is interposed between the refrigerant-outlet of the second heat exchanger 16 and the refrigerant-inlet of the first heat exchanger 15, and it is structured so as to cause an expansion of the refrigerant directed towards the first air/refrigerant heat exchanger 15, so that refrigerant pressure and temperature are much higher at the refrigerant-outlet of the second heat exchanger 16 than at the refrigerant-inlet of the first heat exchanger 15;

- a refrigerant loop 11 for circulating a refrigerant fluid through the members 15, 16, 17, 18 of the heat pump assembly 14.

[0055] The process air path 12 comprises a segment 13 having an enclosure 22 for housing the first and the second heat exchangers 15, 16.

[0056] The air/refrigerant first heat exchanger 15 is conventionally referred to as the "evaporator" or "gas-heater" of the heat-pump assembly 14, and it is structured so that the airflow arriving from revolving drum 3 and the low-pressure and low temperature refrigerant directed to the suction of the refrigerant compressing device 17 can flow through it simultaneously, allowing the refrigerant having a temperature lower than that of the airflow, to absorb heat from the airflow, thus causing condensation of the surplus moisture in the airflow arriving from revolving drum 3.

[0057] The air/refrigerant second heat exchanger 16, in turn, is conventionally referred to as the "condenser" or "gas-cooler" of the heat-pump assembly 14, and it is structured so that the airflow directed back into revolving drum 3 and the high-pressure and high-temperature refrigerant arriving from the delivery of the refrigerant compressing device 17 can flow through it simultaneously, allowing the refrigerant having a temperature greater than that of the airflow to release heat to the airflow, thus heating the airflow directed back into the revolving drum 3.

[0058] The heat-pump assembly 14 is further provided with a number of connecting pipes 19 which connect the two heat exchangers 15 and 16, the refrigerant compressing device 17 and the refrigerant expansion device 18 to one another, so as to allow the refrigerant to continuously flow in closed refrigerant loop 11 from the refrigerant compressing device 17 in sequence to the second air/refrigerant heat exchanger 16, to the refrigerant expansion device 18, to the first air/refrigerant heat exchanger 15, and finally return back to the refrigerant compressing device 17.

[0059] The embodiment of the heat pump assembly 14 of the heat pump laundry treatment apparatus 1 of the present invention shown in Figure 3, further comprises an optional third heat exchanger 20, arranged in said refrigerant loop 11 between the second heat exchanger 16 (the condenser) and the refrigerant expansion device 18 and fluidly connected to them. In this embodiment, such a third heat exchanger 20 is an auxiliary condenser and allows a better working condition in the element of the heat pump assembly 14 fluidly connected to it, in this case the evaporator 15. In fact, the auxiliary condenser 20 further condenses the refrigerant fluid which exits from the condenser 16 (also named as "the main condenser" when an auxiliary condenser 20 is also present as it is the case of the present embodiment), rendering as liquid as possible said refrigerant fluid which is to be inputted to the evaporator 15. If the refrigerant fluid which exits from the main condenser 16 is already sufficiently liquid, the auxiliary condenser 20 will reduce the temperature of such a sufficiently liquid refrigerant fluid. Thus, the refrigerant fluid entering the evaporator 15 will be at a lower temperature than in absence of the auxiliary condenser 20, allowing the evaporator 15 to work in a better working condition in any case. In order to cool the auxiliary condenser 20, an air fan 21 is positioned in front of it.

[0060] The refrigerant loop, schematically indicated with number 11 in Figure 2, for circulating a refrigerant fluid through the members 15, 16, 17, 18 of the heat pump assembly 14, comprises flexible pipes 19 (better shown in Figures 4 to 7) for fluidly connecting each other two of

the members 15, 16, 17, 18 of the heat pump assembly 14.

[0061] In greater details, in the embodiment shown in Figures 2 to 4, the flexible pipe 19a fluidly connects the first heat exchanger (the evaporator) 15 with the compressing device 17 and the flexible pipe 19b fluidly connects the second heat exchanger (the main condenser) 16 with the compressing device 17. Furthermore, the flexible pipe 19c fluidly connects the third heat exchanger 20 (the auxiliary condenser) with the refrigerant expansion device 18 and then with the first heat exchanger (the evaporator) 15, while the flexible pipe 19d fluidly connects the third heat exchanger 20 (the auxiliary condenser) with the second heat exchanger (the main condenser) 16.

[0062] Figure 3 differs from Figure 4 for the fact that Figures 3 shows all the elements (15,16,17,18 and 20) of the heat pump assembly 14 positioned inside the cabinet 2 of the heat pump laundry treatment apparatus 1 of the present invention, while, in Figure 4 the path of the flexible pipes 19a,19b,19c,19d has been changed, allowing in such a way the movement of some of the elements of the heat pump assembly 14. In particular, by comparing Figures 3 and 4, it is evident that, due to the presence of the flexible pipes 19a,19b,19c,19d the first and second heat exchangers 15,16 (i.e. the evaporator and the main condenser) in Figure 4 have been extracted out from the cabinet 2 through an aperture 27 provided in the cabinet front wall 8. Also the refrigerant expansion device 18 has been extracted out from the cabinet being positioned between the first and second heat exchangers 15,16 and being fluidly connected to both of them through said connecting pipes 19c,19d,

[0063] By further changing the path of the flexible pipes 19c and/or 19d, it could be possible to further extract from the cabinet 2 also the auxiliary condenser 20 (the further extraction of such element 20 from the cabinet 2 is not shown in Figure 4), while leaving the compressor device 17 inside the cabinet 2, still fluidly connected to such extracted elements 15,16. The refrigerant expansion device 18 could be extracted from the cabinet 2 whether a flexible pipe connection is provided between the expansion device 18 and both the first and the second heat exchangers 15, 16 in a heat pump assembly 14 without auxiliary condenser 20. In a heat pump assembly 14 with auxiliary condenser 20, the refrigerant expansion device 18 could be extracted from the cabinet 2 if a flexible pipe connection is provided between the auxiliary condenser 20 and the expansion device 18 and between the latter and the evaporator 15.

[0064] Thus, the embodiment illustrated in Figures 2 to 4 shows that it is possible to extract at least some of the elements of the heat pump assembly 14, i.e., at least the evaporator 15 and/or the main condenser 16, and optionally the auxiliary condenser 20, The compressor device 17 still remains inside the cabinet 2, fluidly connected to the elements 15,16,18,20 of the heat pump assembly 14 that have been extracted out from the cabinet 2 of the heat pump laundry treatment apparatus 1 of the present invention. If preferred, the compressor device 17 may be extracted from the cabinet 2 while leaving all the other heat pump elements 15, 16, 18, 20 inside the cabinet 2 without interrupting the fluid connection among the heat pump assembly elements, 15, 16, 17, 18, 20.

[0065] The extraction from the cabinet 2 of the cited above elements of the heat pump assembly 14 offers the possibility to perform maintenance operations by extracting from the dryer only the essential components of the heat pump assembly without the need to disassemble the complete dryer structure.

[0066] It is worth noting that, even if in the embodiment disclosed in Figures 2 to 4, a third heat exchanger 20 has been always shown, the presence of such a third heat exchanger 20 is optional.

[0067] In fact, in another embodiment of the present invention (not shown in the figures) the heat pump assembly 14 of the heat pump laundry treatment apparatus 1 may consists in first and second heat exchangers 15,16, compressing device 17 and refrigerant expansion device 18 only, without the presence of the third optional heat exchanger 20. In such a configuration, both the first and second heat exchangers 15,16 are directly connected, on one side, to the compressing device 17 through, respectively, the flexible pipes 19a,19b and, on the other side, to the refrigerant expansion device 18 through, respectively, the flexible pipes 19c,19d. By this way the heat pump assembly 14 and the interposed refrigerant loop 11 would consist in the following loop: compressing device 17, flexible pipe 19b, second exchanger 16, flexible pipe 19d, refrigerant expansion device 18, flexible pipe 19c, first exchanger 15, flexible pipe 19a and back again to the compressing device 17.

[0068] However, also in said further embodiment (not shown in the figures) in the absence of said third optional heat exchanger, only some of the connecting pipes which connect one another the elements of the heat pump assembly may be flexible, the remaining connecting pipes being rigid. By this way, not all of said elements of the heat pump assembly are allowed to be singularly extracted out of the cabinet.

[0069] Furthermore and preferably, though not necessarily, even in the absence of said third optional heat exchanger, a first flexible pipe fluidly connects one of said first or second heat exchangers with the compressing device, and a second flexible pipe fluidly connects the other of said heat exchangers with the compressing device or the refrigerant expansion device.

[0070] By this way, even in the absence of said third optional heat exchanger, due to the first and second flexible pipes, it is allowed to extract from the heat pump laundry treatment apparatus a sub-assembly of said heat pump assembly, leaving the compressor inside the cabinet and still fluidly connected to the removed heat pump sub-assembly. In fact, for example, it is possible either to extract a heat pump sub-assembly consisting in said first exchanger which is fluidly connected to said refrig-

erant expansion device which in turn is fluidly connected to said second heat exchanger or to extract a heat pump sub-assembly formed by one of said first or second heat exchanger fluidly connected to said refrigerant expansion device. With the arrangement described above it is further possible to remove the compressor leaving all the other components of the heat pump within the cabinet.

[0071] Furthermore and preferably, though not necessarily, even in the absence of said third optional heat exchanger, said first flexible pipe fluidly connects one of the first or second heat exchanger with the compressing device, and said second flexible pipe fluidly connects the same first or second heat exchanger with the refrigerant expansion device.

[0072] By this way, even in the absence of said third optional heat exchanger, said first or second heat exchanger, being fluidly connected on one side with the compressing device and on the other side with the refrigerant expansion device, is allowed to be extracted from the heat pump laundry treatment apparatus, leaving the compressor and all the remaining components of the heat pump assembly inside the cabinet and still fluidly connected to said removed heat exchanger.

[0073] Figure 5 shows a lateral view of the heat pump laundry treatment apparatus of Figure 1, with parts removed for clarity. The evaporator 15 and the condenser 16 shown in Figure 5 have been extracted from the front portion of the basement 9 of the heat pump laundry treatment apparatus 1 of Figure 1 and are still connected to the compressing device 17 (still inside the cabinet 2) through flexible pipes 19a,19b while flexible pipe 19d connects the condenser 16 to the auxiliary condenser 20 that remains within the cabinet 2.

[0074] In Figure 5 is also shown the segment 13 comprised in the process air path 12 and removable from the cabinet 2; the segment 13 is positioned in the lower part of the cabinet 2 and has an enclosure 22 for housing the first and the second heat exchangers 15,16.

[0075] As better shown in Figure 6, the segment 13 has a box-like structure 23 comprising an handle 24 which allows the user, when he/she grasps it, to easily extract the segment 13 out of the cabinet 12. On the segment 13 is also mounted the refrigerant expansion device 18.

[0076] Turning back to Figure 5, the segment 13 is slidably mounted onto the basement 9 which supports the operational components 3, 12, 14; in fact, in greater detail, the segment 13 is mounted onto the basement 9 through a carriage 25 which is movable along a couple of driving rails 26 by the insertion into each of them of the corresponding downwards protuberances 29 of the carriage 25 positioned in the lower portion of the carriage 25 itself (in Figure 5 only one of such protuberances and only one driving rail are shown).

[0077] Figure 7 shows in perspective view an alternative embodiment of the heat pump laundry treatment apparatus 1 of the present invention, wherein is visible the panel 28 for closing the opening 33 for the removal of the segment 13 shown in Figures 5 and 6. In Figure 7 the panel 28 and the corresponding opening 33 are laterally positioned, while in Figures 4 and 5 the similar opening 27 is visible in the front portion of the basement 9 of the heat pump laundry treatment apparatus 1. In Figure 7, by removing the panel 28, the user may easily access to the lateral opening 33 dimensioned for being passed through by the cited above removable heat pump members 15,16,18,20 of the heat pump assembly 14.

[0078] In one embodiment, the compressing device 17 has a flange portion 30 provided with threaded fixing devices 31 for removably fixing the compressing device 17 onto the basement 9 which supports the operational components 3, 12, 14. The compressing device 17 is offset, i.e. staggered, relative to the opening 27 of the embodiment shown in Figures 4 and 5 or relative to the opening 33 of the embodiment shown in Figure 7. In other words, the compressing device 17 is not placed in the basement area just in front of the opening 27 or 33 but it is placed in a basement region which is on a side of the basement area in front of the opening 27 or 33. By this way, due to the fact that the compressing device 17 is fixed to the basement 9 and it is rarely to be extracted from the cabinet 2, the space inside the cabinet 2 in correspondence of the opening 27 or 33 is exploitable in total by the user for allowing the other members 15,16,18,20 of heat pump assembly 14 to be removed from the cabinet 2.

[0079] In addition to the above, the lower supporting basement 9 is also preferably structured so to directly support the electric motor 5.

[0080] Clearly, changes may be made to the heat pump laundry treatment apparatus 1 as described herein without, however, departing from the scope of the present invention.

Claims

1. Heat pump laundry treatment apparatus (1), in particular a heat pump laundry dryer or a heat pump washing machine having drying function, comprising a cabinet (2) which houses operational components (3, 12, 14) for carrying out a drying operation on laundry, the operational components (3, 12, 14) comprise a rotatable laundry drum (3) for treating laundry using process air, the drum (3) being accessible by a user through a door (4) of the apparatus (1), wherein the laundry treatment apparatus (1) comprises:

   a process air path (12) for conveying the process air through the drum (3),
   a heat pump assembly (14) having members (15, 16, 17, 18) comprising a first and a second heat exchanger (15, 16) arranged in the process air path (12), a compressing device (17), a refrigerant expansion device (18) and a refrigerant loop (11) for circulating a refrigerant fluid through the members (15, 16, 17, 18); the refrigerant

loop comprising flexible pipes (19) for fluidly connecting each other two members (15, 16, 17, 18) of the heat pump assembly (14),
characterized in that at least one of the heat pump members (15, 16, 17, 18) is at least partly removable from the cabinet (2) leaving the remaining heat pump members (15, 16, 17, 18) inside the cabinet (2) and keeping said at least partly removable heat pump member (15, 16, 17, 18) connected to the refrigerant loop (11).

2. Heat pump laundry treatment apparatus according to claim 1, wherein the cabinet (2) has an opening (27) dimensioned for being passed through by the at least partly removable heat pump member (15, 16, 17, 18).

3. Heat pump laundry treatment apparatus according to claim 1 or 2, wherein a first flexible pipe (19a) fluidly connects one of the heat exchangers (15,16) with the compressing device (17), and a second flexible pipe (19b) fluidly connects the other of said heat exchangers (16,15) with the compressing device (17) or with the refrigerant expansion device (18).

4. Heat pump laundry treatment apparatus according to one or more of the previous claims, wherein a first flexible pipe (19a, 19b) fluidly connects one of the heat exchangers (15, 16) with the compressing device (17), and a second flexible pipe (19c,19d) fluidly connects the same heat exchangers (15, 16) with the refrigerant expansion device (18).

5. Heat pump laundry treatment apparatus according to one or more of the previous claims, wherein said at least one heat pump member (15, 16, 18) is removable from the cabinet by changing the path of said flexible pipes (19).

6. Heat pump laundry treatment apparatus according to one or more of the previous claims, wherein the heat pump assembly (14) further comprises a third heat exchanger (20) arranged in said refrigerant loop (11) between the second heat exchanger (16) and the refrigerant expansion device (18), said third heat exchanger (20) being fluidly connected to the refrigerant expansion device (18) and the second heat exchanger (16) through flexible pipes (19c,19d).

7. Heat pump laundry treatment apparatus according to one or more of the previous claims, wherein said process air path (12) comprises a segment (13) having an enclosure (22) for housing the first and the second heat exchangers (15, 16), said segment (13) being removable from the cabinet (2).

8. Heat pump laundry treatment apparatus according to claim 7 wherein the segment (13) has a box-like structure (23) comprising an handle (24).

9. Heat pump laundry treatment apparatus according to claim 7 or 8 wherein the refrigerant expansion device (18) is mounted on said segment (13).

10. Heat pump laundry treatment apparatus according to claim 7 to 9 wherein said segment (13) is positioned in the lower part of the cabinet (2).

11. Heat pump laundry treatment apparatus according to any claim 7 to 10 wherein said segment (13) is slidably mounted onto a basement (9) supporting the operational components (3, 12, 14).

12. Heat pump laundry treatment apparatus according to claim 11, wherein said segment (13) is mounted onto the basement (9) through a carriage (25) which is movable along at least a driving rail (26).

13. Heat pump laundry treatment apparatus according to claim 2 or any the previous claims when dependant from claim 2, wherein the opening (27,33) is closed by a movable panel (28).

14. Heat pump laundry treatment apparatus according to one or more of the previous claims, wherein said compressing device (17) has a flange portion (30) provided with threaded fixing devices (31) for removably fixing the compressing device (17) onto a basement (9) supporting the operational components (3, 12, 14).

15. Heat pump laundry treatment apparatus according to one or more of the previous claims, wherein said compressing device (17) is offset relative to said opening (27,33).

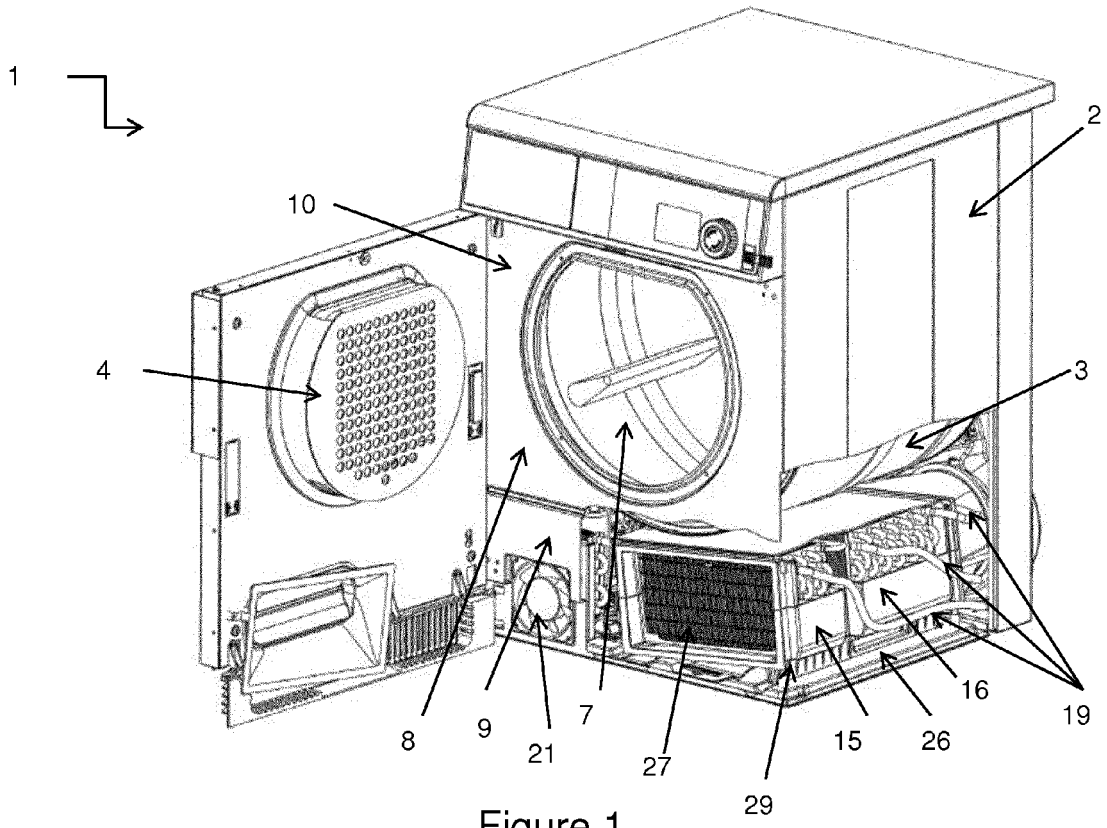


Figure 1

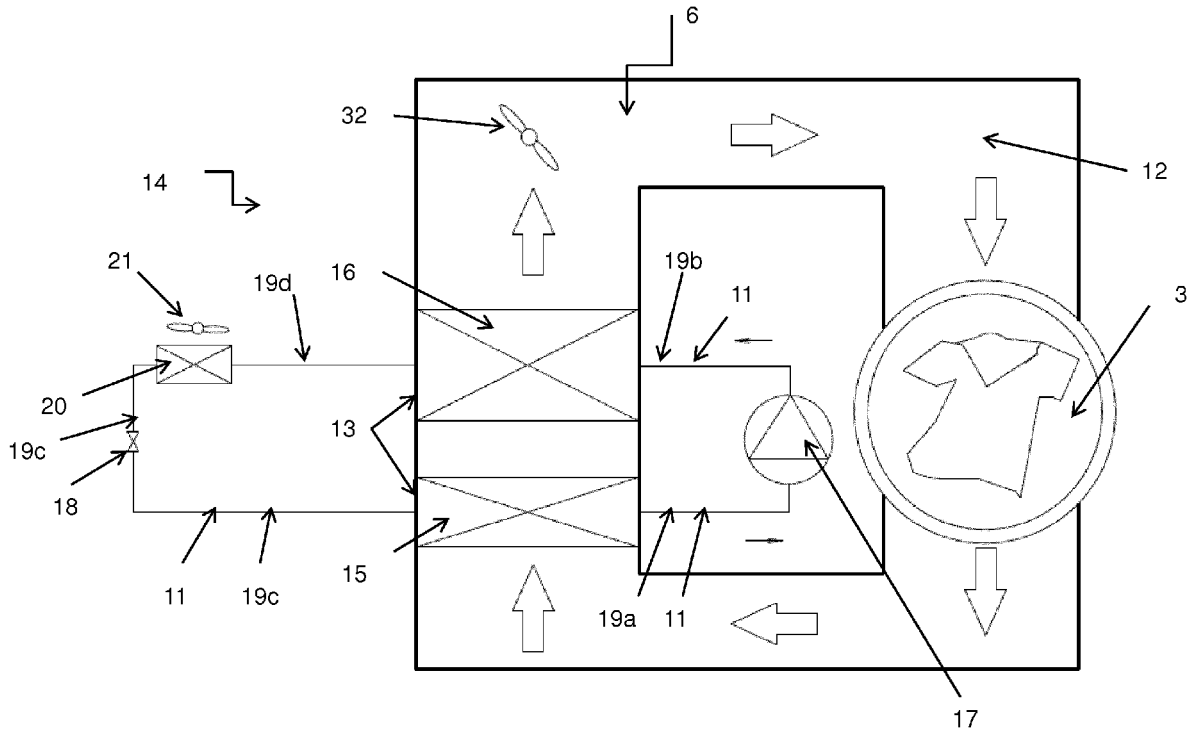


Figure 2

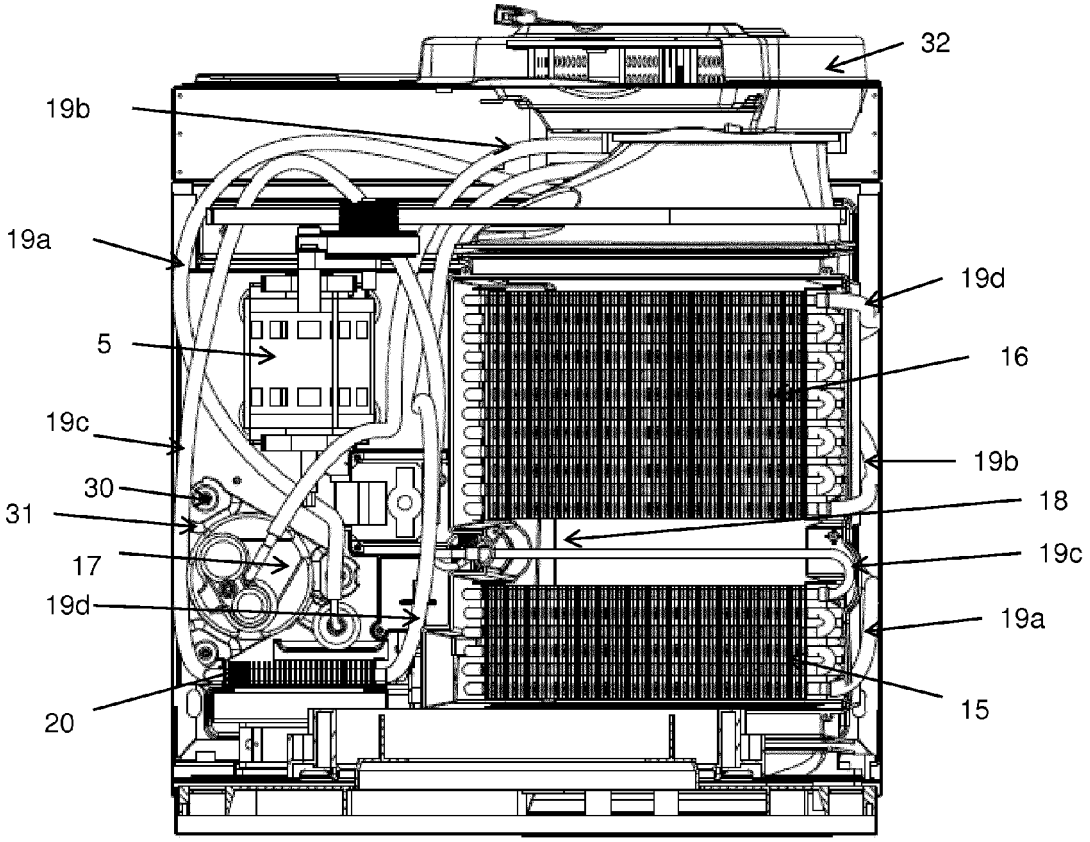
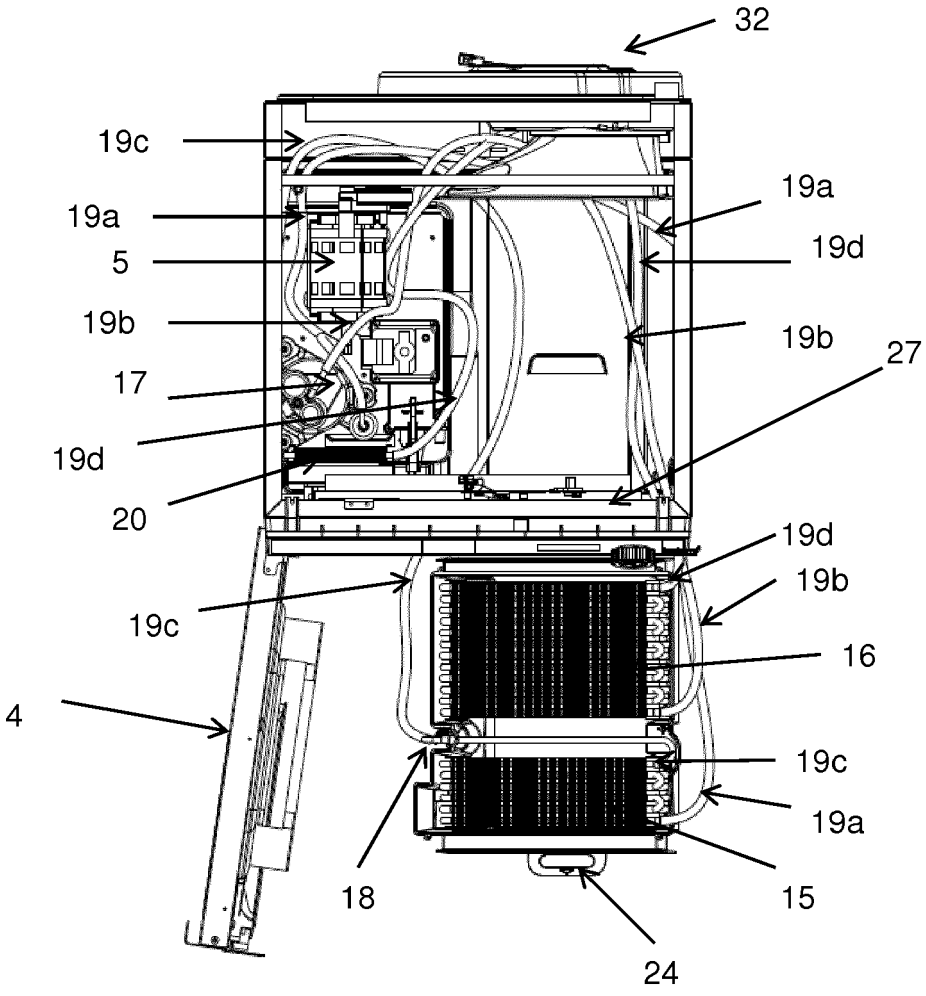


Figure 3


32
19c
19a
5
19b
17
19d
20
19c
4
18
24
19a
19d
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27
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16
19c
19a
15

Figure 4

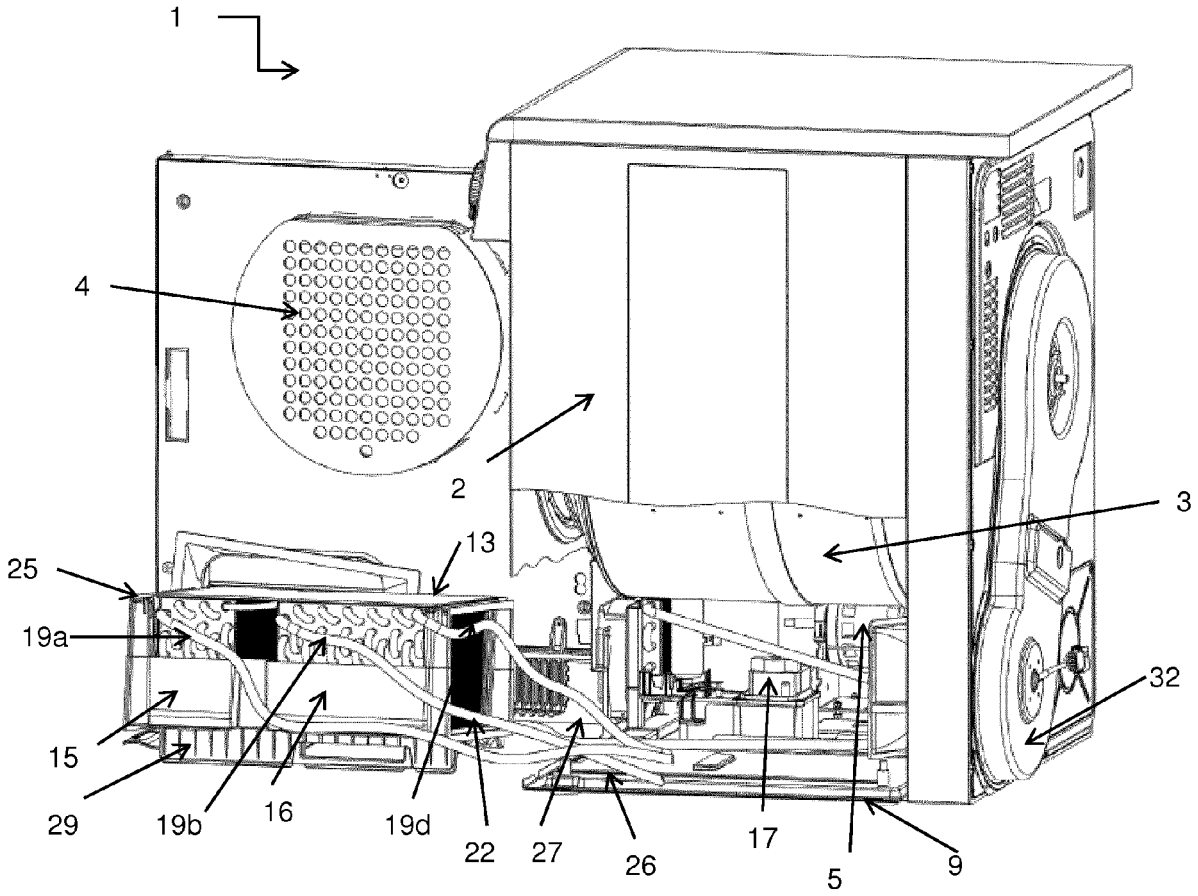

Figure 5

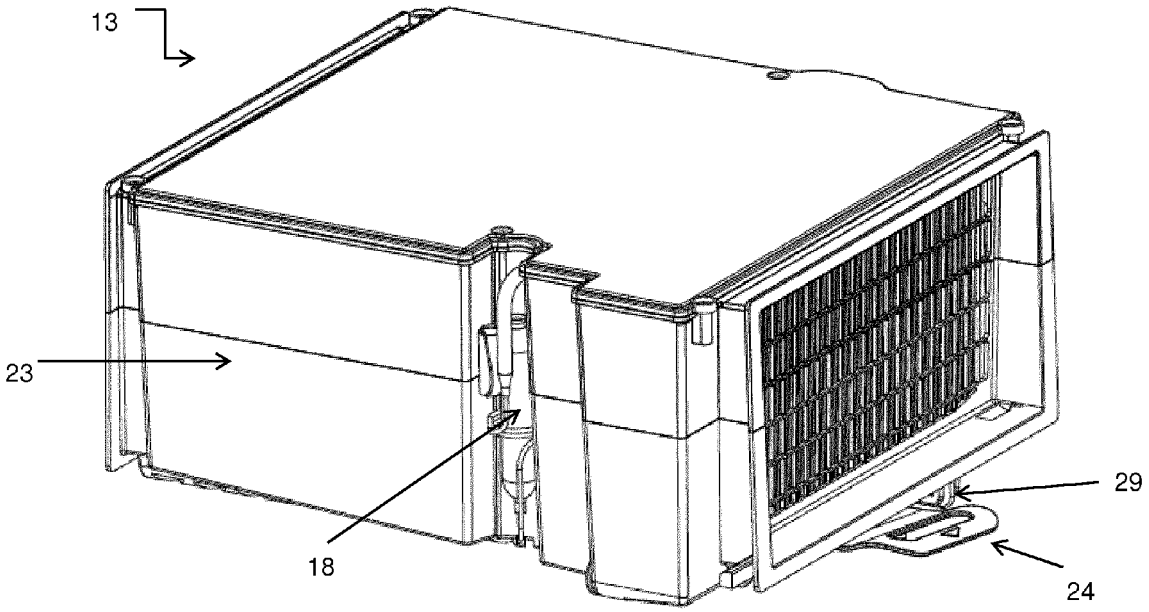

Figure 6

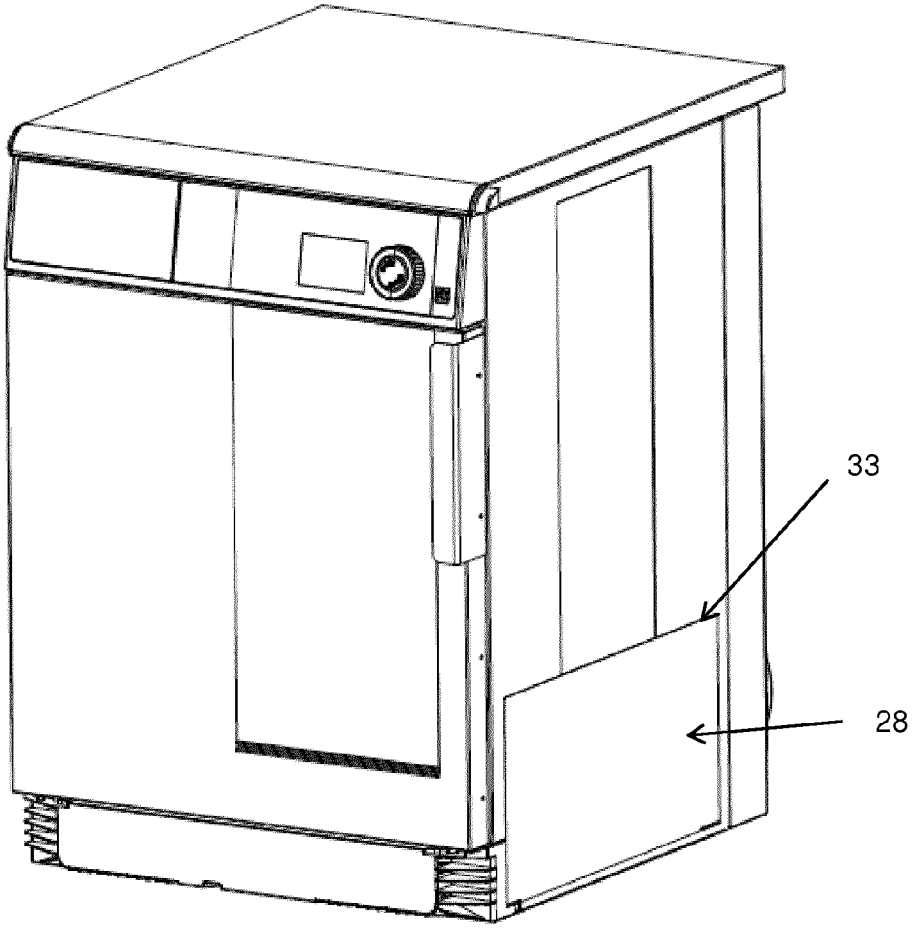

Figure 7

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EUROPEAN SEARCH REPORT

Application Number
EP 13 16 6249

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Place of search	Date of completion of the search	Examiner
Munich	24 October 2013	Weinberg, Ekkehard

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