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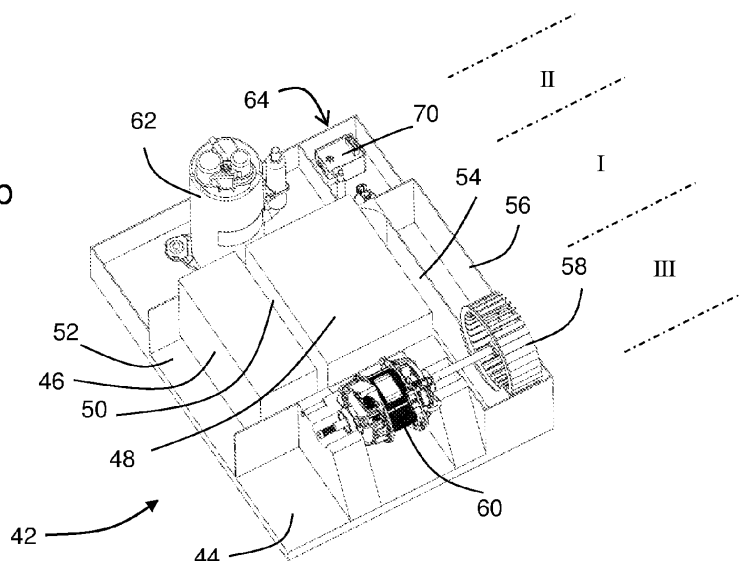
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33080 Porcia (PN) (IT)**(54) **Basement arrangement in heat pump laundry treatment apparatus**

(57) The invention relates to a laundry treatment apparatus, in particular to a dryer or washing machine having drying function, comprising: a laundry storing chamber for treating laundry using process air, a process air loop for circulating the process air through the laundry storing chamber, a motor (60) for driving the rotatably supported laundry storing chamber and/or for driving a process air blower (58) arranged in the process air loop, and a heat pump system for dehumidifying and heating the process air, the heat pump system having a refrigerant loop comprising: a first heat exchanger (46) for heating a refrigerant and cooling the process air, a second heat exchanger (48) for cooling the refrigerant and heating the process air, a refrigerant expansion device ar-

anged in the refrigerant loop, and a compressor (62) arranged in the refrigerant loop, wherein the first and second heat exchangers (46, 48) are arranged in a process air duct section (50) of the process air loop which is located in a base section (42) of the apparatus. According to the invention the process air duct section (50) is arranged in a middle region (I) of the base section (42), a first region (II/III) of the base area of the base section (42) is at a first side of or with respect to the process air duct section (50), and a second region (III/II) of the base area of the base section (42) is at a second side of or with respect to the process air duct section (50), such that the process air duct section (50) is between the first and second region (II, III).

Fig. 2b



Description

[0001] The invention relates to a laundry treatment apparatus having a heat pump system in which process air for laundry treatment is dehumidified and heated.

[0002] EP 1 209 277 A2 provides a heat pump tumble dryer having a compact base section that is supporting the main components of the heat pump system. Therein and when standing in front of the dryer, a battery channel housing the evaporator and the condenser are arranged at the left side of the base section and the compressor and motor for driving the process air blower and the rotatable drum are arranged at the right side. The battery channel is part of the process air loop through which the process air for dehumidifying the laundry is guided from the drum outlet to the drum inlet. Such arrangement has the advantage that integration of most heat pump and drum drive components in the base section leaves the open space in the middle and upper section of the dryer cabinet for arranging a big volume laundry drum that nearly fully extends from left to right and front to back in the cabinet.

[0003] WO 2008/155263 A1 suggests a similar arrangement for the main heat pump and drum drive components in the base section.

[0004] It is an object of the invention to provide a laundry treatment apparatus having a base section in which drive components and heat pump components are arranged in a compact and balanced way.

[0005] The invention is defined in claim 1. Particular embodiments are set out in the dependent claims.

[0006] According to claim 1 a laundry treatment apparatus having a laundry storing chamber for treating the laundry and a heat pump system for dehumidifying and heating process air vented through the laundry storing chamber is provided. Preferably the laundry treatment apparatus is a dryer, a washing machine or a washer-dryer. The process air is circulated in a preferably closed process air loop that is formed by the flow path through the laundry storing chamber and a process air channel connecting the laundry storing chamber outlet to the chamber inlet. The main components of the heat pump system (at least the first and second heat exchangers and the compressor) are arranged in a base section of the apparatus. A section of the process air channel ('the process air duct section') is arranged in a middle region of the base section. The process air duct section houses the first and second heat exchanger, wherein this arrangement of heat exchangers and duct section is sometimes called the 'battery' of the heat pump system. Preferably the middle region, in which the process air duct section is arranged, is extending from a middle front bottom region (in the base section) of the apparatus to a middle rear bottom region (in the base section) of the apparatus. Thus the middle zone or region of the base section is occupied by the process air duct section and in the horizontal plane (in the operation orientation of the apparatus) a first region of the base area of the base

region is at a first side of or with respect to the process air duct section and a second region of the base area of the base region is at a second side of or with respect to the process air duct section. This means that the first region is opposite to the second region with respect to the process air duct section or the process air duct section is between the first and second region.

[0007] The term 'middle region' may include the center with respect to the base section and may mean an extension of the process air duct section symmetrically along a center line of the base section. However 'middle region' also includes an arrangement of the process air duct section parallel to a center line through the base section (and preferably spatially including the centerline) where base areas of the base section to the left and right side of the process air duct section are not occupied by the process air duct section. Preferably the main axis or main flow path through the process air duct section is vertically aligned or approximately vertically aligned to the main axis (e.g. rotation axis) of the laundry storing compartment. In an embodiment the middle region is arranged below the laundry storing chamber and is preferably aligned to the main process air flow direction or the drum axis of the laundry storing chamber. In particular the direction of the center or main flow through the process air duct section (the battery channel) is parallel to the center line of the laundry storing chamber and in particular the center or main flow line through the process air duct section is vertically below thereto (i.e. the two center lines lie in a vertical plane).

[0008] Preferably the fraction of the total base area of the base section that is remained exposed or non-occupied by the process air duct section is at least 12%, 15%, 18%, 20%, 22% or 25% for each of the left and right sides. One of the right or left side forms the first side region and the other forms the second side region of the base section which respectively occupies the side base areas at the sides of the process air duct section.

[0009] In an embodiment the base section comprises a bottom shell which has a structure to form the bottom wall and at least a part of the side walls of at least one or more of: the process air duct section, a process air front duct section, a process air rear duct section, and a process air rising duct section. Preferably the bottom shell provides at least partially the base areas for the middle, first and second side regions. Preferably the bottom shell provides the support structures for components of the apparatus, in particular of the heat pump system. Preferably a cover or cover shell is provided that, when mounted on the bottom shell, closes or partially closes (e.g. except rising or descending process air passages) one or more of: the process air duct section, the process air front duct section (except descending passage), the process air rear duct section, and a process air rising duct section (except a rising passage). More preferably the cover or cover shell comprises support elements for mounting thereon rollers for rotatably supporting the rotatable laundry storing compartment (e.g. drum). In an

embodiment the bottom shell provides mounting and/or fixing locations and/or elements for one or more of the following: cabinet walls of the apparatus: a left side wall, a right side wall, a front wall, a rear wall and a bottom front cover panel. Preferably the bottom shell provides mounting sites for electronic components, like power electronic components, of the apparatus. Normally the bottom shell is made of electrically insulating material, like plastics, so that mounting electronic components thereon provides electrical insulation. Preferably the bottom shell and/or the cover shell are fabricated by injection molding.

[0010] The heat pump system has a refrigerant loop that has in this order the following components: A refrigerant compressor for circulating and compressing the refrigerant, a second heat exchanger for cooling the refrigerant and heating the process air, an expansion device for expanding the compressed refrigerant and a first heat exchanger for heating the refrigerant and cooling the process air, whereafter the refrigerant is feed back to the compressor's inlet. The first heat exchanger is for example an evaporator or a gas heater in case of transcritical or totally critical refrigerant cycles. The second heat exchanger (or if applicable an auxiliary heat exchanger) is for example a condenser or a gas cooler in case of transcritical or totally critical refrigerant cycles. The expansion device may be a controllable valve that operates under the control of a control unit to adapt the flow resistance for the refrigerant in dependency of operating states of the heat pump system. In alternative embodiments the expansion device can be a capillary tube, a valve with fixed expansion cross-section, a throttle valve with variable cross section that automatically adapts the expansion cross-section in dependency of the refrigerant pressure (e.g. by elastic or spring biasing), a semi-automatic throttle valve in which the expansion cross-section is adapted in dependency of the temperature of the refrigerant (e.g. by actuation of a thermostat and/or where the temperature of the refrigerant is taken at any of the components in thermal contact with the refrigerant. In case an auxiliary heat exchanger is used, it may be included in the refrigerant loop between the compressor and the second heat exchanger or between the second heat exchanger and the expansion device.

[0011] At least one component of the apparatus is arranged each on or at the first and second side region. Preferably at least one component of the heat pump system is arranged each on or at the first and second side region. Such components are: power electronics, a drum drive motor, a process air blower motor, a drum drive electronic module or inverter, a compressor electronic module or inverter, the compressor, the refrigerant expansion device, the first or second heat exchanger, an auxiliary heat exchanger, a cooling air/process air heat exchanger.

[0012] According to an embodiment, the compressor is arranged at the first side region with respect to the process air duct section or middle region. And at least

one or more of the following are arranged at the second side region with respect to the middle region:

- a motor for rotating the laundry storing chamber (if the laundry chamber is e.g. a rotatable drum) and/or for rotating a process air blower,
- an auxiliary heat exchanger, and
- one or more power electronic components of the apparatus.

[0013] By the way it is mentioned that the due to the process air duct section being in the middle region, the process air duct section fully or partially forms a 'shield' between the first side region and the second side region.

The term 'shielding' includes:

- a flow path shielding in that the process air duct section prevents a direct air exchange between the first side region and the second side region,
- (in conventional metal construction of the first and second heat exchanger) an electromagnetic shielding between components at the first side region and components at the second side region due to the metal material of the first and second heat exchanger, and
- a thermal shielding in that heat radiation or contact heat transfer between components on the first side region and the second side region is excluded due to separation.

[0014] By providing components of the apparatus divided between the first side region and the second side region, a more homogeneous weight distribution over the base area of the apparatus (which is the base area of the base section) is achieved. This facilitates storing, transporting and on-place positioning of the apparatus. Except the first and second heat exchanger, which are light weight per volume due to their open structure, the other components (e.g. compressor, motor, power electronics) to be arranged in the base section are normally heavy weight so that by the division onto two side regions at opposite ends of the base section results in the improved weight distribution as compared to the conventional base section arrangement.

[0015] Another advantage of the distributed first side region / second side region arrangement results from improved accessibility to the components from the sides of the base section during assembling of the apparatus or during servicing of components. In the conventional arrangement the components in the basement can only be accessed from one apparatus side, while in the invention mounting and service can be performed from two sides.

[0016] The process air loop is preferably circulated in a closed loop in which the process air is preferably continuously flown through the laundry storing chamber. However it may also be provided that a (preferably smaller) portion of the process air is exhausted from the process air loop and fresh air (e.g. ambient air) is taken into

the process air loop to replace the exhausted process air. And/or the process air loop is temporally opened (preferably only a small fraction of the total processing time) to have an open loop discharge - which e.g. may be used to remove smell from the laundry treated.

[0017] In an embodiment a condensate collection unit is arranged at the first side region, preferably in a back section of the first side region. The condensate collection unit collects the condensate formed in the first heat exchanger in a condensate collection reservoir. Preferably the condensate is collected in the reservoir only temporarily and drained from there from time to time or in dependency of a condensate level in the reservoir as detected by a condensate level detector. Preferably a condensate pump is used to drain the reservoir; preferably it is pumped to a second reservoir provided at an upper region of the apparatus for being emptied by a user. Preferably the condensate is drained out of the process air duct section, in which the first heat exchanger is arranged, to the reservoir through a siphon that prevents process air loss out of the process air loop or entering of ambient air into the process air loop. In an embodiment the condensate collection unit is provided at a front section of the first side region and preferably in this case the condensate reservoir or the second condensate reservoir can be removed by the user towards the front side of the apparatus for condensate removal.

[0018] Preferably the condensate collection unit is arranged in the first side region in a depth section that is arranged opposite to a depth section in the second side region where the blades of the process air blower are arranged. In particular if the condensate collection unit and the blower are arranged in the rear sections of the respective first and second side region, a rearward extension of the condensate collection unit beyond the depth limit of the process air duct section or the rear or rising channel sections of the process air channel is avoided, thus assisting in keeping the depth extension of the apparatus low.

[0019] In a preferred embodiment the blades of the process air blower are arranged in the middle region, preferably in alignment to the vertical cross section of the process air duct section, more preferably in line with the process air flow direction of the flow path through the process air duct section (i.e. the first and second heat exchangers). In this arrangement the flow path length and thus the flow resistance is reduced in the flow section from the exit of the second heat exchanger to the blower. Also a process air flow path and loop can be provided that does not require flow deflection and process air channel sections that run from a middle section to a side section and back. More preferably the process air path is or is essentially in a plane that is defined by the main flow path axis through the laundry storing compartment (the rotation axis in case of a rotatable laundry storing compartment or drum) and the flow path through the process air duct section. In this case the required path length and number of process air deflections is significantly reduced.

[0020] Preferably the blades of the process air blower and/or a cooling air blower are driven by the motor which is the drum drive motor (in case of a rotatable laundry storing compartment). Thereby no separate motor is required. The process air blower and/or a cooling air blower may be arranged on a rotating shaft of the motor or may be connected to the motor via transmission, e.g. by using a belt or gears. In embodiments the motor and the cooling air blower are arranged in the second side region and the cooling air blower sucks or blows the cooling air from or to the auxiliary heat exchanger and/or the power electronics. In an alternative embodiment or additionally a compressor blower is provided at the first side region to cool the compressor by blowing cooling air thereto or sucking cooling air therefrom. Cooling of the compressor and/or auxiliary heat exchanger is used to remove excessive heat from the heat pump system as soon as it has reached or is approaching its steady state condition.

[0021] Preferably the motor is arranged in the second side region opposite to the compressor with respect to the middle region. More preferably the compressor and motor are arranged in or close to a middle section of the respective first side region and second side region. In this way a weight balancing in the base section is achieved not only regarding left/right side, but also in view of rear/front sections of the base section.

[0022] In an embodiment the compressor is a variable speed compressor such that the refrigerant conveyance rate and/or refrigerant pressure can be controlled by the control unit of the apparatus by corresponding control of the compressor speed. For example the refrigerant pressure and/or temperature is detected by the control unit using sensor(s) and the compressor speed is modified in dependency of the detected temperature and/or pressure. Alternatively the drum motor speed and/or the process air blower speed can also be varied under the control of the control unit.

[0023] The above elements and the elements described for the detailed embodiments of the invention can be combined in any combination.

[0024] Reference is made in detail to preferred embodiments of the invention, examples of which are illustrated in the accompanying figures, which show:

- 45 Fig. 1a and 1b a perspective view and a top view to a basement section of a conventional heat pump tumble dryer,
- Fig. 1c a perspective view of the basement section of Fig. 1a with a cover shell and a drum rotatably supported thereon,
- 50 Fig. 2a and 2b a top view and a perspective view to a basement section of a heat pump tumble dryer according to the invention,
- 55

- Fig. 3 a and 3b a perspective view and a top view to another embodiment of a basement section of a heat pump tumble dryer,
- Fig. 3c the basement section of Fig. 3a with a cover shell and a drum rotatably supported, and
- Fig. 4 a schematic top view of a basement section according to a further embodiment.

[0025] Fig. 1a and 1b show a perspective and a top view to a base section 2 of a conventional heat pump tumble dryer and Fig. 1c shows the perspective view of the base section with a cover shell mounted and a drum 30 rotatably supported on the cover shell. The heat pump tumble dryer uses a heat pump system for dehumidifying and heating process air that is circulated in a closed process air loop through drum 30. The components of the heat pump system are arranged and mounted in a bottom shell 4 forming the lower part of the base section 2. The structure of the bottom shell 4 provides part of the process air channel, mounting structures for components, dryer feet, venting openings, support brackets and so on. The heat pump system comprises a refrigerant loop in which a compressor 22 for pressurizing and pumping the refrigerant, a second heat exchanger 8 (condenser or gas cooler for heating the process air), an expansion device (no reference numeral shown), and a first heat exchanger 6 (evaporator or gas heater for cooling and dehumidifying the process air) are arranged in this flow direction order.

[0026] The process air flow P1 of the conventional dryer is schematically indicated in Fig. 1c. When it exits the drum 32 at the drum side forming the loading opening, it enters a descending process air channel section at the front side of the dryer. Only a portion of this process air channel is shown in the figures immediately in front of the first heat exchanger 6 and being denoted with reference numeral 12. This lower front section of the process air channel receives a fluff filter drawer (not shown) and represents the filter compartment channel 12. After passing the fluff filter in the filter compartment channel 12 the process air enters a battery channel 10 in which the first and second heat exchangers 6, 8 are housed. This channel section with the heat exchangers is also called the heat pump battery. The process air outlet from the second heat exchanger 8 is guided in a rear channel 14 to the inlet of a radial blower 18. The process air blower 18 conveys the process air in a rising channel 16 arranged at the rear side of the dryer upwards to the rear opening of the drum 32 where it enters the drum 32 and dries the laundry stored therein.

[0027] The blades of the process air blower 18 are supported on a shaft of drum driving motor 20. Motor 20 drives a belt (not shown) that is disposed around drum 32 to drive it. At the backside of the dryer in the depth range of the blower 18 a condensate unit 24 is arranged

for collecting and draining the condensate that was formed in or at the first heat exchanger 6 by cooling the process air. The bottom shell 4 has condensate channels on its bottom to collect and guide the condensate from the first heat exchanger 6 into a condensate reservoir 26 of unit 24 where it is temporally collected. The unit 24 has a level detector 28 sending a level signal to a control unit of the dryer (not shown) at a predetermined condensate water level and the control unit activates a condensate pump 30 of the condensate unit 24 to drain the condensate from the condensate reservoir 26 to a condensate drawer (not shown) which is arranged at a top section of the dryer.

[0028] As indicated in Fig. 1b by the dotted lines, the functional components arranged in the base section 2 can be grouped in three main zones, namely on the left side zone K comprising the filter compartment channel 12, the battery channel 10 including the first and second heat exchangers 6, 8 and most portion of rear channel 14. The right side zone L comprises the compressor 22 and the motor 20 (and a smaller portion of rear channel 14). The rear zone M comprises the blades of process blower 18, the lower section of rising channel 16, and the condensate unit 24. As in conventional dryers, the ground area of the dryer has a width W 1 of 60 cm and a depth D 1 of 60 cm.

[0029] Fig. 1c further indicates the basic air flow of the process air flow P1 through the drum 32, the front channel (only portion thereof shown by filter compartment channel 12), battery channel 10, rear channel 14, blower 18 and rear channel (only portion thereof shown by rising channel 16). The process air channel sections in the base section 2 are covered by a cover shell 34 which has roller supports 36 integrated therewith for rotatably supporting drum 32 on bearing reels.

[0030] Figs. 2a, 2b, 3a to 3c and 4 show embodiments of a base section 42, 42a and 42b according to the invention, respectively. The difference to the conventional base section 2 shown in Figs. 1a to 1c is the arrangement of the dryer components, in particular the heat pump components, in the base sections. Unless otherwise indicated, the operation and function of the components are similar or identical to the respective component described above in respect of the conventional dryer base section 2, wherein identical terms are used for the same components. This specifically relates to the order of components in the process air loop and in the refrigerant loop. Unless otherwise indicated, the features, elements and their interrelation as mentioned above applies for the following embodiments. The elements and features described above and in the following can be combined or arranged in different combinations and partial combinations which are all included in the disclosure.

[0031] Any technically meaningful combination and partial combination should be included. For simplicity, heat pump piping, the expansion device, mounting elements and electrical wiring is not shown in the following figures.

[0032] In the embodiment of a base section 42 shown in the top view of Fig. 2a and the perspective view of Fig. 2b, the groups or zones I, II, III of components of the dryer and its heat pump system are arranged different to the zones K, L, M shown in Fig. 1b. The first zone I forms a middle or center region of the base section 42 that extends from the front center region to the back center region of the base section, i.e. the front bottom center region to the bottom back center region of the dryer. Middle zone I comprises from front to back the filter compartment channel 52, the middle or battery channel 50 with the first and second heat exchangers 46, 48, most portion of the rear channel 54, and a portion of the rising channel 56. The left zone II is arranged at the left side of the base section 42 and comprises the compressor 62 and the condensate unit 64 having the condensate reservoir 66, the level detector 68 and the condensate pump 70. The right zone III is arranged on the right side of base section 42 and comprises the motor 60, the smaller portions of the rear channel 54 and portion of rising channel 56, and the blades of process air blower 58. The middle zone I, the left zone II and the right zone III extend from the very front to the very back of the base section 42 (which corresponds to the front to the back of the dryer - see also the following embodiments). The support, bottom and mounting structure of the base section 42 is mainly provided by a bottom shell 44a, in which for example the bottom walls and completely or at least partially the side walls of the filter compartment channel 52, the rear channel 54, the middle channel 50 and the rising channel 56 are formed, unless inlet or outlet openings between the channels or to the section of the dryer above the bottom section level are provided (e.g. inlet opening in filter compartment channel having also a fluff filter insertion opening or outlet opening in rising channel). In the following embodiments a similar structure is provided by bottom shells 44a and 44b for base sections 42a and 42b, respectively.

[0033] For illustrative purposes Fig. 2a shows a rectangle A which indicates the depth or ground area reduction that is achieved by the regrouping of components in the base section 42 (having depth D2) as compared to the conventional base section 2 (having depth D1). The following also applies for base sections 42a and 42b, wherein the base section dimension essentially or identically correspond to the base or ground dimensions of the dryer. Preferably the width W2 of base section 42 is identical to the conventional width W1, e.g. 60 cm. Preferably the depth D2 of base section 42 is about or less than 57 cm, 55 cm, 53 cm or 50 cm. Preferably the ratio of depth D2 to width W2 ($D2/W2$) is less than unity or less than or about 0.95, 0.90, 0.85, 0.80 or 0.70. Thereby the ground area requirement and in particular the installation depth of the dryer is reduced as compared to the conventional dryer and the inventive dryer is more convenient for single or two user apartments. Moreover as the drum volume can be reduced due to the reduced drum axial length (compare drums in Figs. 1c and 3c),

the components of the heat pump system can be dimensioned for lower maximum power, which reduces component's size and overall energy consumption.

[0034] Fig. 3a shows a perspective view of another embodiment of a base section 42a in which a cover shell 72 is shown in a lifted position. In Fig. 3c the cover shell 72 is in its final or mounting position where it is mounted the bottom shell 44a. Bottom shell together with cover shell 72 form the process air channel sections for the middle channel 50, the filter compartment channel 52, the rear channel 54a and portion of the rising channel 56a (see above). The blades of the process air blower 58a are enclosed by the two shell parts of the rising channel 56a wherein an inlet passage to the rear channel 54a is provided and an outlet passage to upper part of rising channel 56a towards the drum 76. Roller supports 74 are integrally formed at the cover shell 72 which have bearing rollers for rotatably supporting the drum 76 (Fig. 3c).

[0035] As compared to the embodiment of Fig. 2a, in the embodiment of Figs. 3a to 3c the blower is aligned to the process air flow direction in the battery channel 50. Rear channel 54 does not need to laterally deflect the process air output from the second heat exchanger 48 from zone I to zone III (compare Fig. 2a), but it has more a concentrating or hopper function and shape to guide the air flow from the battery channel 50 to the suction inlet of blower 58a. The blades of blower 58a are driven by motor 60 using a belt 59 guided between the shaft of motor 60 and the bearing shaft (not shown) of blower 58a. In an embodiment (not shown) the blower 58a and the drum 18 are each driven by separate motors. For example the drum 18 is driven by motor 60 as shown in the figures and the blower 58a is an integrated unit having the motor integrated and forming an independently driven blower, for example having radial or centrifugally conveying blades (as the blower 58a shown). The compressor 62 and the condensate unit 64 are arranged in the left zone II as in Fig. 2a with the difference that the components 62, 68 and 70 are slightly shifted or rotated without functional difference.

[0036] Fig. 3c further shows the process air flow path P2 through the drum 76, the front channel (only portion thereof shown by filter compartment channel 52), battery channel 50, rear channel 54a, blower 58a and rear channel (only portion thereof shown by rising channel 56a). As compared to process air flow P1 in Fig. 1c, the path length and the number of deflections and curves in the flow path P2 is significantly reduced. Flow path P2 is essentially in one plane in which the drum rotation axis lies. In this specific embodiment the second straight line for spanning the plane of the flow path P2 is the vertical direction of the dryer when positioned in its normal operation position. More deflections and a longer path length is required for flow path P1: From the drum rotation axis downward and from the center to the left side, from the left bottom rear side to the right bottom rear side and from there upward to the middle back to the drum rotation axis. For conveying the same process air volume in a

given time (flow rate), due to lower flow resistance, the blower 58 used in the embodiment of Fig. 3c requires a lower blowing capacity as compared to blower 18 used in the conventional dryer of Fig. 1c. Lower blowing capacity also facilitates to use blower 58 with smaller blade and/or drive motor dimensions and less power consumption (for the process air blowing operation). Thus the dimensional requirements (blower blade, housing for blower blade) are reduced assisting in providing a more compact dryer. Additionally as the flow path P2 length is reduced, the channel length is reduced - again providing a more compact design.

[0037] Although the embodiment of Fig. 2a and 2b provides a deflection of the process air path in the rear channel 54 from center bottom rear side to right bottom rear side and from there in the rising channel 56 from right bottom back side to higher center back side (at the drum rear inlet), the flow path at the front side is shorter and with reduced deflection locations as compared to flow path P1. Thus, although P2 has an optimized geometry, the flow path in the embodiment of Figs. 2a and 2b still has a reduced flow resistance and a shorter flow path as compared to the conventional dryer shown in Figs. 1a to 1c, such that the advantages of the embodiment of Figs. 3a to 3c at least partially applies.

[0038] The comparison of Fig. 1c and 3c shows that in the inventive embodiments the drum depth is reduced as compared to the drum depth of the conventional drum 32, while the diameter dimension is the same or essentially the same. Thus the drum volume and the laundry loading capacity are reduced. Parallel to this reduction the maximum drying power, i.e. the cooling/heating power, of the heat pump system is reduced. This enables using heat pump components of reduced dimensions as compared to the components of a conventional heat pump system. This results in an improved drying efficiency or energy reduction when normally smaller laundry loads or volumes have to be dried, e.g. laundry volumes that are typical for single household or couple households as compared to family households. The reduced dimensional requirement for the heat exchangers enables reducing the cross section area (cross to the process air flow) of the middle channel 50 which in turn allows providing the components on both channel sides.

[0039] Another embodiment of a base section 42b is shown in Fig. 4. In the base section 42b the middle or battery channel 50 with the first and second heat exchanger 46, 48 and most portion of the rear channel 54 are arranged at the middle zone I (compare embodiment in Fig. 2a). The bottom portion of the base section 42b is provided by a bottom shell 44b which comprises most of support, mounting and channel structure of the base section. The blower 58, blower motor 60, a compressor blower 86 and compressor 62 are arranged at the right side or third zone III. The compressor blower 86 is mounted on the shaft of drum drive motor 60 and blows cooling air towards the compressor 62. In an embodiment compressor blower 86 sucks cooling air from the compressor.

An auxiliary or first cooling air blower 80, an auxiliary heat exchanger 82, a compressor power converter 84 and the condensate unit 64 are arranged on a left side or second zone II. As before, the battery channel 50 is forming a center or middle section of the base section 5 running from a front region (filter compartment channel 52) to the back region (rear channel 54) of the base section 42b. In an embodiment (not shown) the compressor blower 86 may have its own driving motor so that blower 58 and 86 can be independently driven. This has the advantage that blower 86 is started only when the steady state of operation of the heat pump system is reached or is approached. Also the speed of blower 86 can be adapted by the control unit in dependency of need to remove excess heat from the heat pump system.

[0040] The compressor blower 86 cools the compressor and removes excessive heat from the heat pump system as soon as the heat pump system has achieved a steady state after the warm-up period. The auxiliary heat exchanger 82 in combination with cooling air blower 80 serves the same purpose, wherein the auxiliary heat exchanger 82 is connected in the refrigerant loop of the heat pump system between the compressor 62 and the second heat exchanger 48 or between the second heat exchanger 48 and the expansion device. As depicted, cooling air blower 80 generates a cooling air flow A that is sucked in through front openings in the base section 42b, is blown through auxiliary condenser 82, through and/or over power converter 84 and is deflected by the side wall of the condensate unit 64 to the outside of the base section through openings formed therein. The cooling air flow is sucked in by blower 80 through openings in the front region of the base section 42b, is pushed by the blower 80 through the heat exchanger 82 towards power converter 84, is deflected by the outer case of the condensate unit 64 to the side and exits the base section through openings at a side wall thereof. In further embodiments of Fig. 4 the cooling air flow is reversed and/or the blower 80 is arranged on the rear side of heat exchanger 82 (when seen from the front of the dryer).

[0041] In embodiments only blower 86 or only blower 80 and auxiliary heat exchanger 82 are used to remove excessive heat. Preferably blower 80 is activated by the control unit as soon as the refrigerant temperature at a predefined location of the refrigerant loop has reached or exceeded a predefined temperature.

[0042] Optionally the compressor blower 86 is provided in the embodiments of Figs. 2a and 3a. Optionally instead of or in addition to the power converter 84 other power electronics (like a drum motor 60 power converter) is arranged in the flow path of the cooling air in the first zone II.

Reference Numeral List:

[0043]

2 basement section

4	bottom shell	64	condensate unit
6	first heat exchanger	66	condensate reservoir
8	second heat exchanger	5 68	level detector
10	battery channel	70	condensate pump
12	filter compartment channel	72	cover shell
14	rear channel	10 74	roller support
16	rising channel	76	drum
18	process air blower	15 80	cooling air blower
20	motor	82	auxiliary heat exchanger
22	compressor	84	power converter
24	condensate unit	20 86	compressor blower
26	condensate reservoir	I, II, III	zones area
28	level detector	25 A A	area
30	condensate pump	C	cooling air flow
32	drum	K, L, M	zones
34	cover shell	30 W1, W2	width
36	roller support	D1, D2	depth
42, 42a, 42b	basement section	35 P1, P2	process air flow
44, 44a, 44b	bottom shell		
46	first heat exchanger		
48	second heat exchanger		
50	middle channel		
52	filter compartment channel	45	
54, 54a	rear channel		
56, 56a	rising channel	50	
58, 58a	process air blower		
59	belt		
60	motor	55	
62	compressor		

Claims

- 40 1. Laundry treatment apparatus, in particular dryer or washing machine having drying function, comprising:
- 45 a laundry storing chamber (76) for treating laundry using process air,
a process air loop (P2) for circulating the process air through the laundry storing chamber (76),
a motor (60) for driving the rotatably supported laundry storing chamber (76) and/or for driving
50 a process air blower (58, 58a) arranged in the process air loop (P2), and
a heat pump system for dehumidifying and heating the process air, the heat pump system having a refrigerant loop comprising:
- 55 a first heat exchanger (46) for heating a refrigerant and cooling the process air,
a second heat exchanger (48) for cooling

the refrigerant and heating the process air,
a refrigerant expansion device arranged in
the refrigerant loop, and
a compressor (62) arranged in the refrigerant loop,

wherein the first and second heat exchangers (46, 48) are arranged in a process air duct section (50) of the process air loop (P2) which is located in a base section (42, 42a, 42b) of the apparatus,

characterized in that

the process air duct section (50) is arranged in a middle region (I) of the base section (42, 42a, 42b), a first region (II/III) of the base section (42, 42a, 42b) is provided at a first side of the process air duct section (50), wherein the first region is adapted to receive or supports at least one component of the apparatus and/or the heat pump system, and a second region (III/II) of the base section (42, 42a, 42b) is provided at a second side of the process air duct section (50), wherein the second region is adapted to receive or supports at least one component of the apparatus and/or the heat pump system, wherein the process air duct section (50) is arranged between the first and second region (II, III).

2. The apparatus of claim 1,
wherein at least a portion of the base section (42, 42a, 42b) is formed by a bottom shell, and
wherein the bottom shell (44, 44a, 44b) and a cover shell (72), when arranged over the bottom shell, form together the process air duct section (50).
3. The apparatus of claim 1 or 2,
wherein the compressor (62) is arranged at a first side region (II/III) of the base section (42, 42a, 42b), and
one or more of the following are arranged at a second side region (III/II) of the base section (42, 42a, 42b) opposite to the first side region (II/III):
 - the motor (60),
 - one or more power electronic components (84) of the apparatus, and
 - an auxiliary heat exchanger (82) connected to the refrigerant loop.
4. The apparatus of any of the previous claims, wherein a condensate collection unit (64) is arranged at the first side region (II/III).
5. The apparatus of claim 4, wherein the condensate collection unit (64) comprises one or more of: a condensate collection reservoir (66), a condensate level detector (68), a condensate pump (70) and a condensate siphon providing a fluid connection to the interior of the process air duct section (50).

6. The apparatus of claim 4 or 5, wherein the condensate collection unit (64) is arranged at the first side region (II/III) opposite to or approximately opposite to the fan blades of the process air blower (58), with respect to the middle region (I).
7. The apparatus according to any of claims 1 to 5, wherein at least the fan blades of the process air blower (58a) are arranged in the middle region (I).
8. The apparatus according to any of the previous claims, wherein a process air duct (50, 54, 54a, 56, 56a) including the process air duct section (50) is aligned or essentially aligned in a plane or a vertical plane that intersects the rotatable laundry storing chamber (76) being a drum.
9. The apparatus according to any of the previous claims, wherein the laundry storing chamber (76) is a drum and the process air duct section (50) is arranged below the drum aligned or essentially aligned to a vertical plane running through the drum axis.
10. The apparatus according to any of the previous claims, wherein the fan blades of the process air blower (58) are connected to and driven by the motor (60) or wherein the fan blades of the process air blower (58a) are connected to the motor (60) via a transmission belt (59) or gear elements.
11. The apparatus according to any of the previous claims, wherein the compressor (62) is arranged at the first side region (II) opposite to or approximately opposite to the motor (60), with respect to the middle region (I).
12. The apparatus according to any of the previous claims, wherein a compressor cooling blower (86) is provided at the first side region (II) adapted to blow cooling air to or suck cooling air from the compressor (62).
13. The apparatus of claim 12, wherein the blades of the compressor cooling blower (86) are connected to and driven by the motor (60).
14. The apparatus of any of the preceding claims, wherein the cover shell (72) comprises one, two three or four roller elements (74), each adapted to provide a support for the rotatable laundry storing chamber (76) being a drum.
15. The apparatus according to any of the previous claims, wherein an apex to back distance or the depth (D2) of the apparatus is less than or is approximately 57 cm, 55 cm, 53 cm, 51 cm, 50 cm or 45 cm.
16. The apparatus according to any of the previous

claims, wherein the auxiliary heat exchanger (82) is arranged in the refrigerant loop between the compressor (62) and the second heat exchanger (48) or between the second heat exchanger (48) and the refrigerant expansion device with respect to the refrigerant flow direction. 5

17. The apparatus according to any of the previous claims, wherein a cooling air blower (80) is arranged at the second side region (III/II) adapted to blow cooling air to or suck cooling air from the auxiliary heat exchanger (82). 10

18. The apparatus according to any of the previous claims, wherein a or the cooling air blower (80) is arranged at the second side region (III/II) adapted to blow cooling air to or suck cooling air from the one or more power electronic components (84) and/or the motor (60). 15

19. The apparatus according to any of the previous claims, wherein the one or more power electronic components (84) comprise at least one of: a compressor power module and a motor power module. 20

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Fig. 1a
(Prior Art)

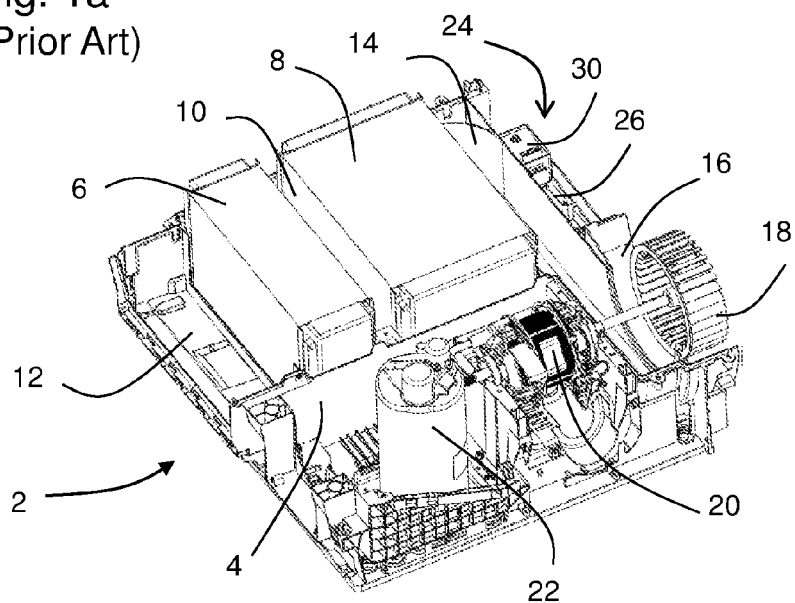


Fig. 1b
(Prior Art)

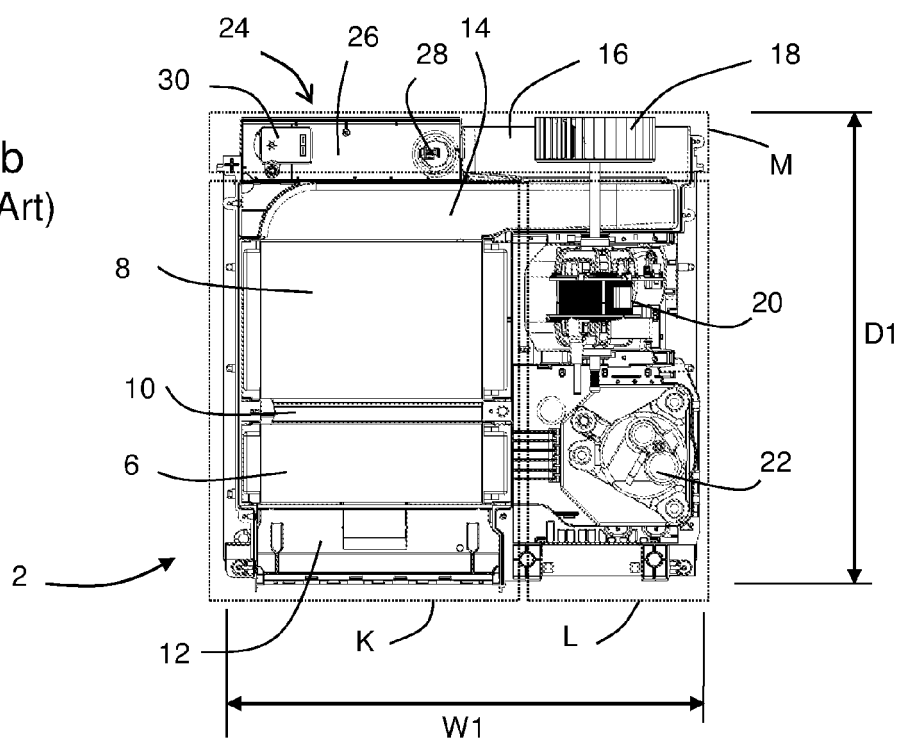


Fig. 2a

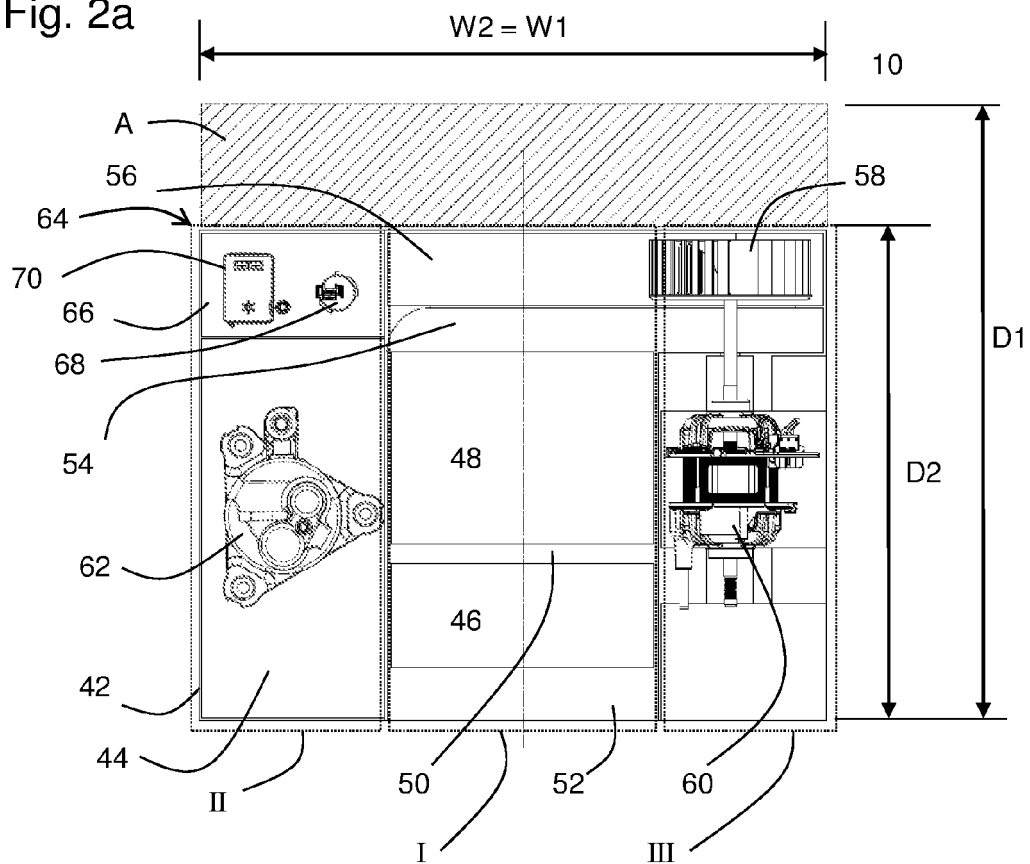


Fig. 2b

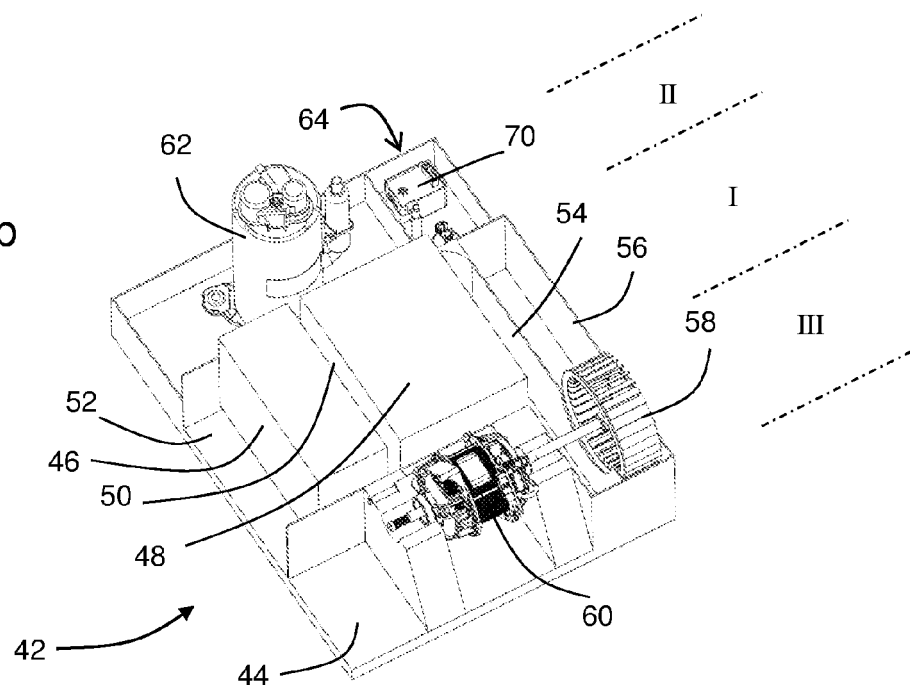


Fig. 3a

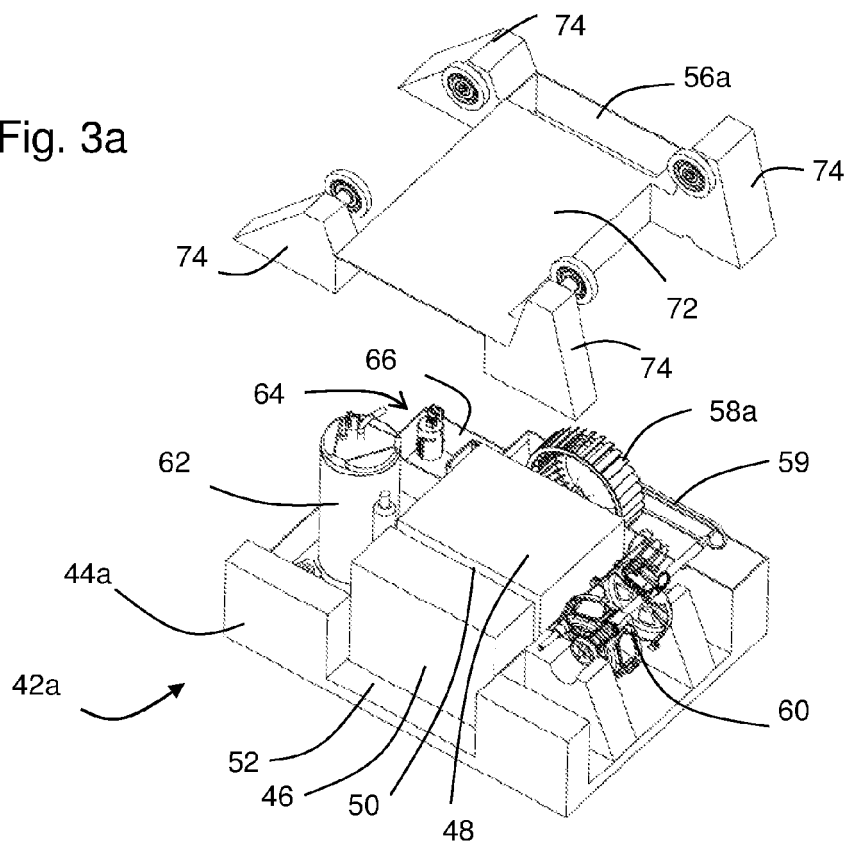
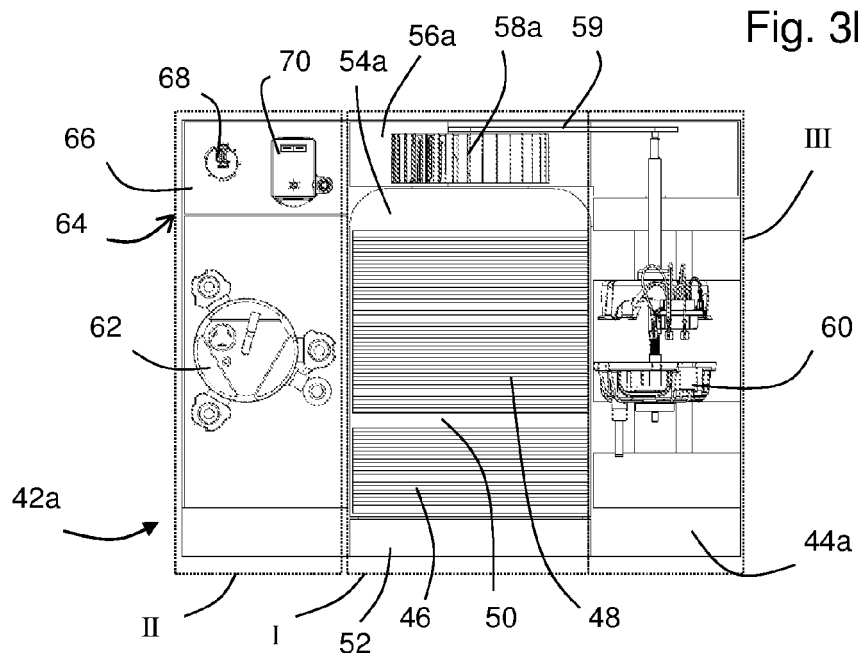


Fig. 3b



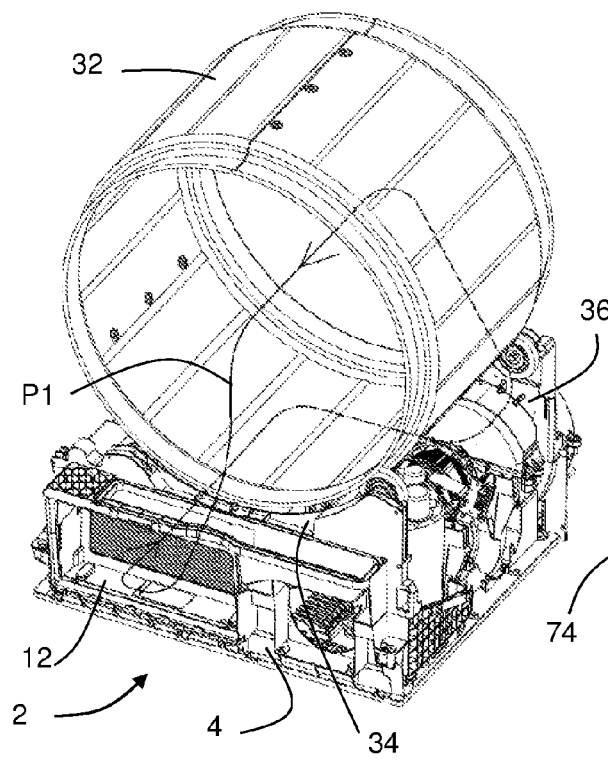


Fig. 1c (Prior Art)

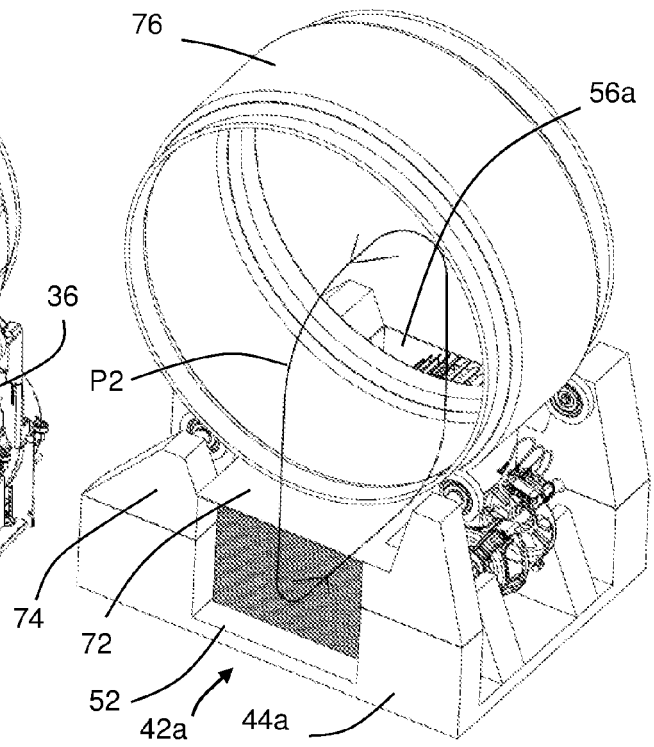


Fig. 3c

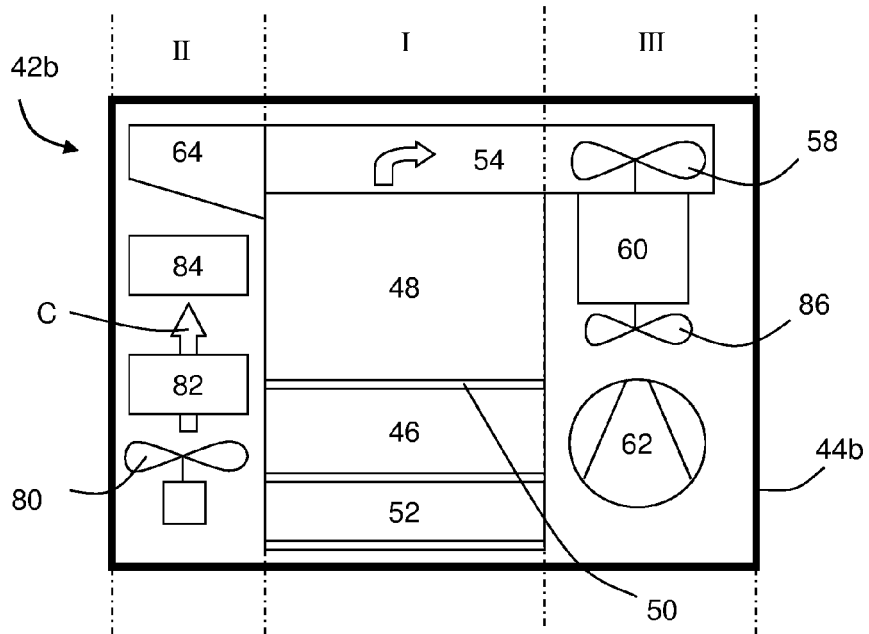


Fig. 4



EUROPEAN SEARCH REPORT

Application Number
EP 11 17 4986

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			D06F
Place of search		Date of completion of the search	Examiner
Munich		15 February 2012	Stroppa, Giovanni
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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15-02-2012

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