



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
24.09.2014 Bulletin 2014/39

(51) Int Cl.:
D06F 58/20 (2006.01)

(21) Application number: **13160567.7**

(22) Date of filing: **22.03.2013**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(72) Inventor: **Artico, Gianpiero**
33080 Porcia (PN) (IT)

(74) Representative: **Petrucelli, Davide et al**
Electrolux Italia S.p.A.
Corso Lino Zanussi 30
33080 Porcia (PN) (IT)

(71) Applicant: **Electrolux Appliances Aktiebolag**
105 45 Stockholm (SE)

(54) **Laundry treatment apparatus with heat pump**

(57) The invention relates to a laundry treatment apparatus having a heat pump system, comprising: a cabinet 40 having a front wall 44, a rear wall 43, side walls 42 and top cover 49, a laundry storing chamber 18 arranged inside the cabinet for treating laundry 19 using process air A, a process air loop for circulating the process air through the laundry storing chamber, and a heat pump system 4 for dehumidifying and heating the proc-

ess air, the heat pump system having a refrigerant loop 6. The refrigerant loop comprises a first heat exchanger 10 for heating a refrigerant and cooling the process air, a second heat exchanger 12 for cooling the refrigerant and heating the process air, a refrigerant expansion device 16, a compressor 14, and an auxiliary heat exchanger 13; wherein the auxiliary heat exchanger is arranged at the external side of the rear wall 43.

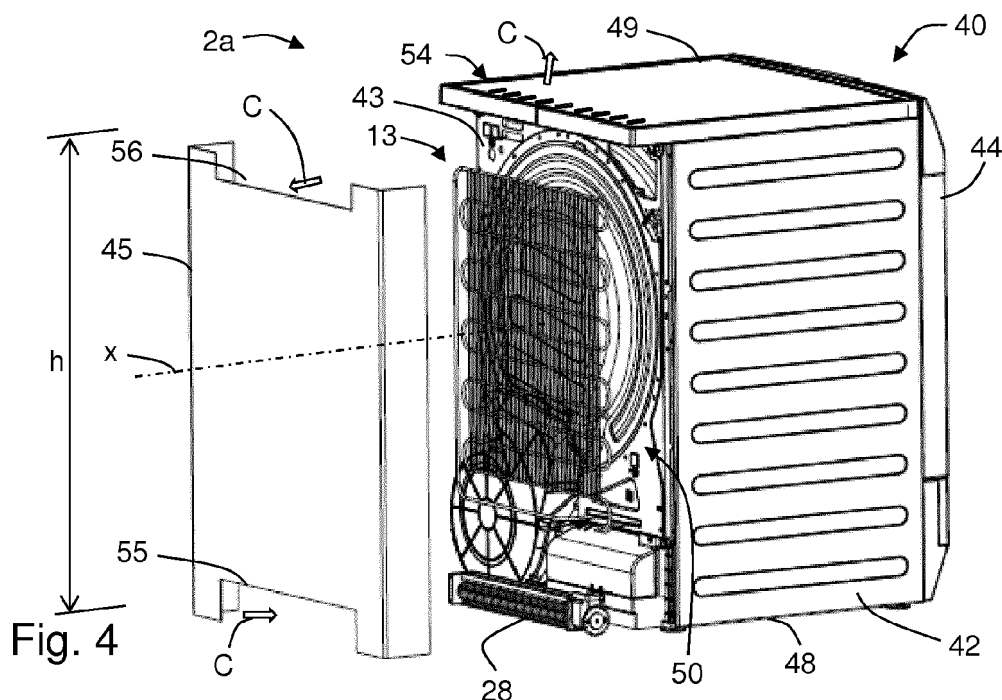


Fig. 4

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] In driers using a heat pump system for dehumidifying and heating the process air in a closed process air loop, excess energy has to be removed from the heat pump system as soon as the system is run through a warm-up period. In the following 'normal' operation mode, an optimum operation state is to be controlled such that the dehumidifying capacity of the evaporator and the heating capacity of the condenser are optimized in view of laundry drying efficiency and energy consumption of the heat pump system. In the normal operation mode the excess energy is the heat loss power introduced to the system by the compressor and which over the time would drive the system to an over-temperature and less-optimum operation, if not removed. From prior art different approaches are known to remove the excess energy when reaching the normal operation mode.

[0003] A dryer having a heat pump system for dehumidifying and heating process air is known from WO 2008/086933 A1. An auxiliary condenser cooled by ambient air is used to remove heat from the refrigerant loop in the heat pump system.

[0004] In a dryer of EP 2 034 084 A1 an auxiliary condenser of the heat pump system is arranged in the bottom section between an ambient air blower and a compressor such that the ambient air cools and removes excessive heat from both, the auxiliary condenser and the compressor.

[0005] In a laundry dryer of EP 1 884 586 A2 a heat pump system is arranged in the bottom section. The heat pump system has refrigerant loop comprising a first heat exchanger for heating a refrigerant and cooling the process air, a second heat exchanger for cooling the refrigerant and heating the process air, a refrigerant expansion device, a compressor, and an auxiliary heat exchanger. The auxiliary heat exchanger is arranged in the refrigerant loop between the second heat exchanger and the first heat exchanger for additional cooling of the refrigerant.

[0006] It is an object of the invention to provide a laundry treatment apparatus having a heat pump system in which an auxiliary heat exchanger is integrated in a compact manner providing good cooling functionality.

[0007] The invention is defined in claim 1. Particular embodiments are set out in the dependent claims.

[0008] According to claim 1 a laundry treatment apparatus, in particular dryer or washing machine having drying function, comprises a cabinet having a front wall, a rear wall, side walls and top cover, a laundry storing chamber arranged inside the cabinet for treating laundry using process air, a process air loop for circulating the process air through the laundry storing chamber, and a heat pump system for dehumidifying and heating the process air, the heat pump system having a refrigerant loop. The refrigerant loop comprises a first heat exchanger for heating the refrigerant and cooling the process air, a second heat exchanger for cooling the refrigerant and heating the process air, a refrigerant expansion device and a compressor. For removing at least a portion of the excessive energy (e.g. excessive heat power and/or temperature) from the heat pump system an auxiliary heat exchanger is provided which is arranged at the external side of the rear wall.

[0009] The auxiliary heat exchanger is provided such that it removes heat (energy) from the refrigerant circulated in the refrigerant loop and may function as an auxiliary condenser or as gas cooler especially working as refrigerant cooler in a transcritical or totally supercritical refrigerant cycling process. Preferably the heat is transferred from the refrigerant to ambient air which is available in the operating surroundings of the laundry treatment apparatus.

[0010] The laundry treatment apparatus has a cabinet comprising a front wall, a rear wall, side walls, a top cover or cover shell, and a base section. The front wall may comprise a front top panel with an operation section and/or a front bottom panel providing an outer front cover of the base section. The cabinet defines the limit or outer envelope/cabinet between the internal side of the apparatus and the external side of the apparatus. The cabinet may include protruding sections of one or more of the walls. The base section representing or comprising a part of the cabinet thus also has an external side and an internal side with respect to the apparatus. In conventional laundry treatment apparatus having a heat pump system, like heat pump dryers or washing machines, all components of the apparatus - in particular the components of the heat pump system - are arranged in the internal side of the apparatus.

[0011] According to the invention, the auxiliary heat exchanger is arranged at an external side of the rear wall and may be covered by a channel wall. Preferably the other components of the heat pump system are arranged completely or substantially in and/or at a basement of the apparatus, preferably in the base section portion of the apparatus. Then providing the auxiliary heat exchanger at or adjacent to (an outer surface of) a rear wall results in the advantage that inlet and outlet tubes of the auxiliary heat exchanger may be arranged near or in the base section close to other elements of the heat pump system. The other components of the heat pump system are e.g. a first and a second heat exchanger, a compressor, and preferably an expansion device. The main components of the heat pump system or refrigerant loop are preferably arranged in or on a bottom shell forming part of the bottom base section of the apparatus, wherein the bottom shell preferably forms the lower cover or cabinet element of the apparatus.

[0012] By arranging the auxiliary heat exchanger in this way on or at the outer side of the rear wall of the apparatus, a compact overall layout or design of the heat pump system can be provided. This can for example be used to provide the apparatus with smaller outer total dimension and/or to provide more internal space in the apparatus cabinet for other

components, for example to enable a larger drum diameter in case of a laundry storing compartment of the apparatus being a rotatable drum.

[0013] The auxiliary heat exchanger may be connected in the refrigerant loop especially between the compressor and the second heat exchanger or between the second heat exchanger and the refrigerant expansion device. The first heat exchanger may operate as evaporator or gas heater in a transcritical or totally supercritical refrigerant cycling process and/or the second heat exchanger may operate as condenser or gas cooler in a transcritical or totally supercritical refrigerant cycling process.

[0014] In an embodiment the base section forms or comprises at the internal side thereof at least a portion of a battery channel. The battery channel is a section of the process air channel which houses or at least partially houses the first and second heat exchangers. Alternatively or additionally the base section supports the first and second heat exchangers and/or the compressor of the heat pump system.

[0015] Preferably the base section comprises a bottom shell that is forming the bottom cabinet part of the laundry treatment apparatus. The bottom shell may be formed by a monolithic part, preferably a single plastic mold part. In an embodiment thereof the base section further comprises a cover or upper shell which is covering at least some of the components of the heat pump system that are arranged or mounted in the bottom shell. For example the cover shell forms portion of the process air channel, in particular the portion of the process air channel forming the battery channel in which the first and second heat exchangers are arranged.

[0016] In a preferred embodiment the rear wall, in particular a rear wall shell forming part of the outer walls of the cabinet, comprises a recess and/or mounting structure for receiving and/or fixing the auxiliary heat exchanger. The recess is arranged especially at the external side of the rear wall for receiving the auxiliary heat exchanger completely or at least partially retracted from the rear maximum extension of the apparatus at the outer face of the cabinet for mechanical protection of the auxiliary heat exchanger. By the mounting structure, which may comprise snap-fits, screwing holes and/or alignment elements, mounting the auxiliary heat exchanger is simplified.

[0017] Preferably, the auxiliary heat exchanger is a wire-type and/or wire-tube heat exchanger and/or the auxiliary heat exchanger is oriented at the backside of the rear wall such that a cooling air flow is induced by natural convection. In particular, the natural convection is a free convection without blower assistance. Warming up the cooling air results in upwardly moving of the air because the warmed air has reduced density compared with the ambient air at same height. A wire-type auxiliary heat exchanger is essentially flat and/or planar and/or has restricted extension in vertical direction and/or is oriented upright.

[0018] Preferably, the tube-type auxiliary heat exchanger has a tube for containing and passing the refrigerant, wherein the tube is guided at the backside of the rear wall in a curved manner or in serpentines or meandering from a lower region or a base unit level vertically upward. The tube of the auxiliary heat exchanger preferably starts from the lower region to an upper region at the backside of the rear wall. Thus, it consumes only little space and assists the natural convection of the cooling air. Preferably the resulting flow path of the refrigerant is from the upper region of the auxiliary heat exchanger to the lower region thereof for higher efficiency in heat exchange. Alternatively the net refrigerant flow may be from left to right or right to left or from below upwards.

[0019] Preferably, the auxiliary heat exchanger and/or the tube of the auxiliary heat exchanger and/or a tube-type auxiliary heat exchanger is extending and/or is essentially extending from the left side of the apparatus or from the left side wall to the right side of the apparatus or to the right side wall. Such arrangement consumes little space by providing high cooling efficiency.

[0020] Preferably, the top cover is protruding at the backside of the apparatus cabinet beyond the rear wall or a portion of the rear wall, wherein the auxiliary heat exchanger is arranged vertically below the protruding portion of the top cover. Thus, the top cover is protruding such as to form a top shield for the auxiliary heat exchanger. Preferably the cover shell extends in backside direction beyond the rear wall and/or beyond the auxiliary heat exchanger. Thus, the auxiliary heat exchanger is arranged in a usually empty room or dead volume between the dryer and a wall of a room in a building where the apparatus is placed by the user.

[0021] Preferably, the top cover comprises one or more openings for passing through cooling air that passed over the auxiliary heat exchanger. The openings may also be used for sucking in and/or blowing out cooling air driven by a and/or the blower. Preferably one or more cooling air passages or openings are provided at or in the protruding portion of the top cover.

[0022] Preferably, the rear wall has or forms a recessed portion, the auxiliary heat exchanger is arranged completely or at least partially in the recessed portion, and the top cover has an extension which covers the horizontal cross-section area of the recessed portion combining several of such advantages in one embodiment.

[0023] Preferably, the horizontal back edge or extension of the top cover protrudes beyond the backside extension of the auxiliary heat exchanger. In particular, the worktop protrudes from the cabinet back wall more than the distance between the outer portion of the heat exchanger and the outer cabinet back wall. When arranging the dryer at a vertical wall of a building the back edge or extension of the top cover abuts against the vertical wall and the auxiliary heat exchanger does not come in contact with the vertical wall. In this way the worktop protects the auxiliary condenser from

being damaged. In addition, there is formed a small dimensioned space accommodating the auxiliary heat exchanger between the room wall and the rear wall assisting a natural convection of the cooling air. Preferably, such backward protrusion or extension of top cover in horizontal direction is at least 0.3, 0.5, 0.8, 1, 1.5 or 2 cm more than maximum backward extension of auxiliary heat exchanger.

[0024] Preferably, the auxiliary heat exchanger is arranged such as to be cooled by forcedly driven ambient air and/or the apparatus comprises a blower for blowing and/or sucking cooling air over the auxiliary heat exchanger. Especially, the blower is a radial blower or tangential blower. The blower may be the blower that conveys cooling air through the inner volume of the cabinet (e.g. blower that cools the compressor and/or the power electronics arranged inside cabinet) and/or sucks ambient air through openings in the cabinet wall.

[0025] Preferably the blower, more preferably the blower dedicated to cool the auxiliary heat exchanger, is operated under the control of a control unit such that the start, the stop, the operation duration, the flow rate and/or the flow direction of the cooling air can be controlled. For example the cooling air flow is started only when a predefined refrigerant temperature and/or pressure is detected in the refrigerant loop. Actively driving the cooling air flow also provides the advantage to adapt the auxiliary heat exchanger design and the path of the cooling air according to the place and technical requirements related to location where the auxiliary heat exchanger is provided.

[0026] In an embodiment the blower is arranged at the rear wall or at the external side of the rear wall and/or at an external side of a base unit. For example the rear wall shell provides outside supporting structure and/or portions of side walls or of the case of the blower and/or auxiliary heat exchanger. Thereby a cost efficient assembly structure is implemented. Preferably the outer maximum dimensions are not extended by providing the blower and/or auxiliary heat exchanger in or at the outside recess(es) or compartment(s).

[0027] In an embodiment the blower is arranged at or in close proximity to a cooling air inlet or outlet provided for the auxiliary heat exchanger. In an embodiment the blower is directly connected to the inlet or outlet of the auxiliary heat exchanger to have a compact design and/or the blower is arranged below a fluff filter compartment provided in the process air channel.

[0028] In an embodiment an air guiding means is provided to guide the air flow over or along the auxiliary heat exchanger. In an embodiment a or the blower is arranged at an inlet or outlet of the air guiding means. In an embodiment the air guiding means is a channel wall extending at the backside of the rear wall and/or is extending between the base unit and the top cover and/or is extending between the left side wall and the right side wall of the cabinet. Especially, when the blower is arranged laterally or vertically downward or upward offset to the auxiliary heat exchanger, preferably a cooling air guiding element or means is provided that guides the cooling air pushed or sucked by the blower towards or from the auxiliary heat exchanger. The cooling air guiding element is or comprises for example one or more of: a channel, a deflector, a fin, a nozzle, a baffle or a combination thereof. By the air guiding means (element) the efficiency of heat exchange of the blown cooling air is increased. The air guiding means preferably is adapted to concentrate the air flow to the surface of the auxiliary heat exchanger and/or to evenly distribute it over the (inlet or outlet) area of the auxiliary heat exchanger. Preferably the air guiding means is or comprises one or more of: a portion of a or the rear wall, a rear channel wall, a bottom shell and/or a cover shell of the apparatus, in particular of the apparatus base section. Thus, a double function is provided by the air guiding means.

[0029] Preferably, a or the blower sucks in or blows out the cooling air through at least one opening at the bottom side of the cabinet and/or at the back side of the cabinet and/or at least one opening to the inner side of the cabinet.

[0030] Preferably, the apparatus comprises flow path means for guiding the cooling air from the auxiliary heat exchanger to one or more of the following or from one or more of the following to the auxiliary heat exchanger: the compressor, a drum drive motor of the apparatus and power electronics of the apparatus. Thus, the cooling air conveyed by the blower is additionally passed over or through other components of the apparatus by directing it thereto or therefrom by cooling air guiding means, like a cooling air channel or partition and/or deflection walls or elements. Thus, other heating components can be cooled down before or after guiding the cooling air to the auxiliary heat exchanger.

[0031] In an embodiment a or the blower sucks in or blows out the cooling air through at least one opening or recess in the front wall of the apparatus or through at least one opening or recess in a front bottom panel of the cabinet. The air is guided from or to front side for air intake or exhaust. Preferably, the inlet opening(s) are directed to the apparatus front and/or are arranged at the apparatus front to enable sucking in of ambient air. Additionally or alternatively the outlet opening(s) of the auxiliary heat exchanger and/or blower are directed to the apparatus back side and/or are arranged at the apparatus back side or bottom side, e.g. to prevent a circulation loop for the cooling air between cooling air inlet and outlet.

[0032] According to a preferred embodiment the base section of the apparatus forms, at the internal side, at least a portion of a battery channel of the process air loop for housing the first heat exchanger and the second heat exchanger. In another preferred embodiment the internal side of the base section supports the first heat exchanger and the second heat exchanger. It is a preferred embodiment that the internal side of the base section forms a seat for the compressor.

[0033] Also a preferred embodiment is an apparatus, wherein the base section comprises a bottom shell and a cover shell forming together the battery channel, wherein the auxiliary heat exchanger is arranged at the bottom shell, especially

arranged at the back section of the bottom shell making possible high extension of the auxiliary heat exchanger. A preferred embodiment of an apparatus is that the apparatus cabinet has ventilation openings at a bottom shell, at the cabinet side wall or at the cabinet rear wall.

[0034] Several other advantageous embodiments are possible. Preferably the heat exchanging surface(s) of the auxiliary heat exchanger is(are) increased by using one or more thermally conductive elements like: a corrugated metal plate, a heat radiator element, a heat exchanger rip, a heat exchanger fin or combinations thereof. One or more of these may be provided on or at a surface being in contact with the cooling air (i.e. to the outside of the refrigerant piping).

[0035] The process air loop is preferably a closed loop in which the process air is continuously circulated 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 short section of the total processing time) to have an open loop discharge - which e.g. may be used to remove smell from the laundry treated.

[0036] The auxiliary heat exchanger may have a 'flat' design and the cooling air is flown in and exhausted out at a 'flat' side or edge, respectively. Flat means for example that the area of the cooling air inlet and outlet (in particular the cross section area of the auxiliary heat exchanger in a sectional plane perpendicular to the cooling air flow path through the auxiliary heat exchanger) is smaller than the cross section area of the auxiliary heat exchanger along a main axis (i.e. the largest cross section area of a sectional plane parallel to the cooling air flow path). As a result, the cross sections of air channels (as far as applicable) for guiding cooling air from and to the auxiliary heat exchanger and a blower for blowing the cooling air is smaller as compared to conventional auxiliary heat exchangers. Thus the overall space or volume requirement for integrating the auxiliary heat exchanger in the apparatus is significantly reduced.

[0037] The cooling capacity of the auxiliary heat exchanger is not provided by a large cross section for passing the cooling air, but by an extended cooling air path length through the auxiliary heat exchanger. Preferably the cooling air path length through the auxiliary heat exchanger is longer than at least the shortest inlet or outlet cross section dimension.

[0038] Due to the flat design, the auxiliary heat exchanger can be sandwiched between other components or elements of the apparatus or at the gap between the outer surface of a rear shell and the vertical wall before which the apparatus is placed or between a process air channel wall and the inside wall section of the apparatus cabinet (e.g. rear or side shell thereof). For example the auxiliary heat exchanger is arranged before a section of the process air channel at the rear shell of the apparatus.

[0039] Reference is made in detail to preferred embodiments of the invention, examples of which are illustrated in the accompanying figures, which show:

Fig. 1 a schematic view of a dryer with a heat pump system,

Fig. 2 a perspective side view to an auxiliary heat exchanger as integrated in or at a base unit,

Fig. 3 a perspective side view of a preferred embodiment of a dryer having components according to Fig. 1 and shown with detached side cabinet wall and rear channel wall,

Fig. 4 the dryer of Fig. 2 with attached side cabinet wall during a mounting step for the rear channel wall, and

Fig. 5 the dryer of Fig. 2 with attached rear channel wall.

[0040] In the following detailed embodiments an auxiliary heat exchanger 13 is described which is provided at a backside and/or external of a cabinet 40 of a laundry treatment apparatus 2, 2a. Ambient air is used to take heat from the auxiliary heat exchanger 13 by flowing or passing the ambient air in the form of a cooling air flow C, C' and/or Cn along or over the auxiliary heat exchanger. Cooling air flow C is conveyed by a blower 28 which is dedicated (exclusively) for cooling the auxiliary heat exchanger; cooling air flow C' is conveyed by a blower 28a which is normally arranged within the cabinet 40 of the apparatus 2, 2a and cools components of the apparatus arranged within the apparatus or exchanges internally heated air by cooler ambient air; cooling air flow Cn is a flow generated by natural convection without a mechanical conveying force and which results from heating the air surrounding the auxiliary heat exchanger. All cooling air flows can contribute to auxiliary heat exchanger cooler at different phases of operating the heat pump system of the apparatus. For example Cn may assist C and/or C' at any time of a laundry treatment process (e.g. laundry drying process). C' may be started by activating the internal blower 28a some time after starting the dryer when the compressor or any other internal component has warmed up. Additionally or alternatively C may be started by activating blower 28 when the heat pump system approaches the normal operation state or mode.

[0041] Fig. 1 depicts in a schematic representation a laundry treatment apparatus as a home appliance 2 which in this embodiment is a heat pump tumble dryer. The tumble dryer comprises a heat pump system 4, including in a closed refrigerant loop in this order of refrigerant flow B: a first heat exchanger 10 acting as evaporator for evaporating the

refrigerant and cooling process air, a compressor 14, a second heat exchanger 12 acting as condenser for cooling the refrigerant and heating the process air, an auxiliary heat exchanger 13 acting as auxiliary condenser and transferring heat to cooling air (C, C' and/or Cn), and an expansion device 16 from where the refrigerant is returned to the first heat exchanger 10. Together with the refrigerant pipes connecting the components of the heat pump system 4 in series, the heat pump system forms a refrigerant loop 6 through which the refrigerant is circulated by the compressor 14 as indicated by arrow B. If the refrigerant in the heat pump system is operated in the transcritical or totally supercritical state, according to an embodiment the first heat exchanger 10 can act as gas heater and the second and auxiliary heat exchanger 12, 13 can act as gas cooler. The main components of the heat pump system 4 are arranged in a base section 5 or basement of the dryer 2, an embodiment of which is shown in the following figures.

[0042] The expansion device 16 is 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 4. In alternative embodiments the expansion device 16 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 a predefined one of the components, in thermal contact with the refrigerant).

[0043] The process air flow within the home appliance 2 is guided through a compartment 18 of the home appliance 2, i.e. through a compartment being a laundry storing chamber 18 for receiving articles to be treated, e.g. a drum 18. The articles to be treated are textiles, laundry 19, clothes, shoes or the like. In the embodiments here these are preferably textiles, laundry or clothes. The process air flow is indicated by arrows A in the Figures and is driven by a process air blower 8. The process air channel 20 guides the process air flow A outside the drum 18 and includes different sections, including the section forming the battery channel 20a in which the first and second heat exchangers 10, 12 are arranged. The process air exiting the second heat exchanger 12 flows into a rear channel 20b in which the process air blower 8 is arranged. The air conveyed by blower 8 is guided upward in a rising channel 20c to the backside of the drum 18 and into the drum 18. In particular, the air exiting the drum 18 through the drum outlet, which is especially the loading opening 46 of the drum 18, is filtered by a fluff filter 22 which is here arranged close to the drum outlet in or at a front channel 20d. The fluff filter 22 is arranged in the front channel 20d forming another section of channel 20 which is arranged behind and adjacent the front cover of the dryer 2.

[0044] The auxiliary heat exchanger 13 acts as an additional condenser (or gas cooler in case of transcritical or totally supercritical operation of the refrigerant cycle) and is connected in the refrigerant loop as indicated by refrigerant piping 6 in Fig. 1. In embodiments not shown, the sequence of the components in the refrigerant loop 6 can be modified in that the auxiliary heat exchanger 13 is not placed between the second heat exchanger 12 and the expansion device 16 with respect to refrigerant flow, but between the compressor 14 and the second heat exchanger 12. This modification is applicable to all embodiments herein.

[0045] During operation of the dryer 2, the auxiliary heat exchanger 13 transfers heat from the process air to ambient air, which is also denoted as cooling air (C, C' and/or Cn) in the following. By transferring heat to the cooling air, during the above mentioned normal operation mode of the heat pump system 4, excess heat is removed from the heat-exchanging closed loops of the process air loop and the refrigerant loop 6 (which are closed loops under ideal consideration). Thereby the electrical power consumed by the compressor 14, which is not transformed to work power by compressing the refrigerant, i.e. loss heat power of the compressor, is removed from the closed loops of refrigerant and process air. This means that in the normal operation mode of heat pump system operation, in which maximum or nearly maximum operation condition or efficiency is achieved after the warm-up period, the heat deposited by the compressor in the refrigerant loop 6 has to be removed by the auxiliary heat exchanger 13 to prevent overheating.

[0046] In an embodiment an internal blower 28a is mounted in the dryer 2, preferably in the dryer cabinet 40, such that it sucks the air from at least one inlet opening from outside of the dryer, flows the air over one or more internal components to be cooled and/or blows the cooling air C' over one or more internal components to be cooled to at least one outlet opening and from there over the auxiliary heat exchanger 13. In an embodiment the blower 28a sucks in cooling air from the front side through one or more inlets to convey the cooling air towards the compressor 14 and/or to the inside of the cabinet. From there the cooling air may exit through air outlets (not shown) at the rear wall 43 towards the auxiliary heat exchanger 13. The air flow C' can be exclusively used to cool the auxiliary heat exchanger 13. Cooling air C can be advantageously guided to and from the blower 28a by air guide channels or air guide components formed and arranged within the cabinet 40. Outlet openings and the exhausting direction of these outlets for exhausting the cooling air C' conveyed by the internal blower 28a may be designed such that a cooling air flow C is induced (even without providing below blower 28) or the convection flow Cn is amplified. For example in connection with or without the channel wall 45 the exhausted air flow C may result in a Venturi-effect inducing the forced air flow C.

[0047] Fig. 3 shows an embodiment with the auxiliary heat exchanger 14 arranged at the rear side of the rear wall 43 without providing a blower 28 dedicated for the auxiliary heat exchanger. In this case the heat transferred from the hot refrigerant in the auxiliary heat exchanger 14 to the ambient air induces the convective air flow Cn which accelerates

heat exchange. Still without providing the blower 28, the channel wall 45 may be provided which additionally accelerates heat exchange due to the chimney effect of the rising cooling air Cn.

[0048] In another embodiment (shown in Figs. 4 and 5) or in combination with internal blower 28a, downstream or upstream (with respect to the flow direction and the auxiliary heat exchanger) a blower 28 dedicated for the auxiliary heat exchanger 13 is provided that conveys a flow of cooling air C. With respect to the auxiliary heat exchanger the flow direction may be forward or backward, i.e. sucking from or blowing to the auxiliary heat exchanger. Preferably, the blower 28 is operating as soon as the normal operation mode is achieved or is approached. Preferably, the blower 28 operates continuously when normal operation mode once has been achieved or is approached during the running drying cycle.

[0049] Or the blower 28 is operated according to cooling needs interruptedly and/or with varying conveyance speed. In the embodiment shown in Figs. 4 and 5, the complete air is exhausted at the rear upper side and/or at the upper rear side of the dryer 2. Other embodiments can provide one or more outlet openings to exhaust the warmed up cooling air C, Cn at other positions of a dryer, too.

[0050] At least when the heat pump system 4 is operating in the normal operation mode (i.e. normal mode after the warm-up period, i.e. after starting the heat pump system 4 from low refrigerant pressure and low temperature state), the first heat exchanger 10 transfers heat from the process air A to the refrigerant. By cooling the process air to lower temperatures, humidity from the process air condenses at the first heat exchanger 10, is collected there and the collected condensate is drained to a condensate collector 30. The process air cooled and dehumidified when passing the first heat exchanger passes then through the second heat exchanger 12 where heat is transferred from the refrigerant to the process air. The process air is sucked from exchanger 12 by the blower 8 and is driven into the drum 18 where it heats up the laundry 19 and receives the humidity therefrom. The process air exits the drum 18 and is guided in front channel 20d back to the first heat exchanger 10.

[0051] The auxiliary heat exchanger 13 is arranged in a rear section 7 of the dryer 2. In particular, the auxiliary heat exchanger 13 extends in an upward direction such that cooling air C making possible an air flow by natural convection Cn along the surface of the auxiliary heat exchanger 13 and/or through the auxiliary heat exchanger 13. The air flow by natural convection Cn is induced by heating up the cooling air C so that the warmed up air rises upside against the gravity.

[0052] According to a preferred embodiment the auxiliary heat exchanger 13 extends upwardly starting at the bottom of the dryer 2 or in the base section 5. According to other embodiments the auxiliary heat exchanger 13 can extend upwardly starting from a position higher than the base section 5. Preferably, the auxiliary heat exchanger 13 or a heat exchanging part thereof is arranged in a height within or approximately in the height range of the drum 18. Especially, the auxiliary heat exchanger 13 or a heat exchanging part thereof is arranged in a height of the middle height of the drum 18. Preferably the auxiliary heat exchanger 13 extends or is arranged higher than the rotation axis x of the drum 18. In case of a front load household appliance the rotation axis x of the drum 18 is especially arranged as a horizontal rotation axis x.

[0053] Fig. 2 shows a perspective side view and an enlarged section view of one embodiment of the auxiliary heat exchanger 13. The auxiliary heat exchanger 13 comprises an inlet tube 60 and an outlet tube 61. The inlet tube 60 and the outlet tube 61 are parts of the refrigerant loop 6 or connected to tubes of the refrigerant loop 6. Especially, the inlet tube 60 is connected to an outlet of the second heat exchanger 12 and the outlet tube 61 is connected to an inlet of the expansion device 16. The inlet tube 60 and the outlet tube 61 are connected to one end of a heat exchanging tube or are the end sections of a heat exchanging tube extending in especially serpentine through the auxiliary heat exchanger 13. The shown heat exchanging tube is formed by elongated extending tubes which are connected by curved tubes to form together the meandering tubes 62.

[0054] Wires 64 or cooling ribs are in heat transfer connection with the tubes 62 and enlarge the heat exchanging surface of the auxiliary heat exchanger 13 around which the cooling air C, C' and/or Cn flows. Heat exchanger 18 extends with side dimension 'a' and in a height dimension 'b' parallel to the or a portion of the rear wall 43 of the dryer. According to other embodiments the auxiliary heat exchanger can be embodied in any other form or type of heat exchanger suitable to transfer especially residual heat from the refrigerant to the cooling air. For example, the piping of the auxiliary heat exchanger 13 can be provided with heat exchanger surfaces for enlarging the heat exchanging surface area, for example ribs, heat radiators a grid structure or the like.

[0055] Figs. 3 to 5 show a perspective side view of a preferred embodiment dryer 2a to show some more exemplary details. The main components of the heat pump system 4 (except the control electronics which is arranged at a top section of dryer) are arranged in or at a bottom shell 48 (partially shown) which also forms part of the process air channel 20, including the battery channel (in which the first and second heat exchanger 10, 12 are encased), the rear channel 20b, portion of the rising channel (not shown) and portion of the front channel. Further the cabinet is formed by two side covers (only one cabinet side wall 42 shown in Fig. 4), a front cabinet wall 44 (partially shown) and a cabinet top cover 49. In Figs. 3 to 5 the loading opening in the front cabinet wall 44 for loading laundry into and out of drum 18 is not shown.

[0056] The auxiliary heat exchanger 13 preferably extends in a sideward dimension 'a' little bit less than the horizontal extension of the rear wall 43 between the side walls 42 and preferably extends in height dimension 'b' less than a height 'h' of the rear wall 43. The rear wall 43 of the cabinet 40 extends between the two side cabinet walls 42 and the height

h of the dryer 2a and in parallel to the front cabinet wall 44 as shown in Figs. 4 and 5. The rear wall 43 has a recess 50 to accommodate the auxiliary heat exchanger 13 and a cooling air passage for the upwardly flowing cooling air C, C' and/or Cn.

[0057] According to a preferred embodiment and as shown in Figs. 4 and 5, the dryer comprises a rear channel wall 45 extending at the backside of the dryer 2, 2a and essentially parallel or parallel to the auxiliary heat exchanger 13. The channel wall 45 protects the auxiliary heat exchanger 13 and serves as guide for the cooling air C by forming portion of an air passage between the channel wall 45 and the rear wall 43 accommodating the auxiliary heat exchanger 13. The rear wall 43 and/or the channel wall 45 can form a recess and/or mounting structure for receiving the auxiliary heat exchanger 13.

[0058] Preferably, a lower section of the channel wall 45 comprises one or more cooling air inlet openings 55 letting in ambient air. Alternatively or additionally an upper section of the channel wall 45 comprises one or more cooling air outlet openings 56 letting cooling air out to the ambient of the dryer 2a.

[0059] Additionally or instead of the outlet opening 56, in the preferred embodiment there are provided one or more cooling air outlet openings 54 in the top cover 49 for passing the cooling air C, Cn out to and/or in from the dryer ambient. Additionally or instead of the inlet opening 55, in the preferred embodiment there are provided one or more cooling air inlet openings 53 at the lower front section of the dryer 2a letting cooling air C from the ambient into the dryer 2a and pass along and/or through the other components of the heat pump system 4 arranged in the base section (for example passing first the compressor 14 and then the auxiliary heat exchanger 13).

[0060] In this embodiment the auxiliary heat exchanger 13 has cooling air inlets towards the bottom side of the dryer 2a and cooling air outlet towards the upper side of the dryer 2a. The cooling air exhausted from auxiliary heat exchanger 13 distributes in the gap between the rear upper side of shell 48 and the rear wall 43 and flows from there mainly to the upper rear side and upper side out of the dryer. The auxiliary heat exchanger 13 is housed between a portion of the rear wall 43, the rear channel wall 45, and a top cover 49 forming the top wall of cabinet 40. These define the outlines of the inlet and the outlet each with a corresponding cross section area. When providing blower 28 dedicated for the auxiliary heat exchanger, the flow direction of the cooling air C can be controlled by the (fixed or invertable) conveying direction of blower 28.

[0061] The blower 28 may be arranged at the lower rear side of the cabinet 40 and below the auxiliary heat exchanger 13. Alternatively, the blower 28 can be arranged at other positions, especially other positions at the base section, too.

[0062] Preferably the flow path length b (or height) of the auxiliary heat exchanger 13 is larger than the exchanger width dimension 'a' cross to the flow path C. Preferably, the ratio between flow path length b to the width dimension a is or is at least e.g. 1.5, 2, 3, 4, 5, 6, 8 or 10. In particular, the area of sides spanning the plane of the auxiliary heat exchanger 13 is larger than the area of the inlets 53, 55 or outlets 54, 56 preferably the ratio of the plane area to inlet and/or outlet areas is or is at least 1.5, 2, 3, 4, 5, 6, 8 or 10. Thereby a 'flat' auxiliary heat exchanger 13 is provided that can be interlaced or inserted in gaps between elements, at wall niches of the rear wall 43 or the like. Of course in embodiments the auxiliary heat exchanger 13 can be oriented to have its inlet section and outlet section in a horizontal plane. Or the inlet and outlet may be inclined with respect to the horizontal and/or a vertical plane.

[0063] Individual components or group of components shown and described for the above embodiments can be combined among each other in any convenient way.

Reference Numeral List:

[0064]

2	laundry treatment apparatus	40	cabinet
2a	tumble dryer	42	side cabinet wall
4	heat pump system	43	rear wall
5	base section	44	front cabinet wall
6	refrigerant loop	45	channel wall / air guiding means
7	rear section	46	loading opening
8	blower	48	bottom shell
10	first heat exchanger (evaporator)	49	top cover
		50	recess
12	second heat exchanger (condenser)	53	front inlet opening (area)
		54	outlet opening (area)
13	auxiliary heat exchanger (auxiliary condenser)	55	inlet opening
		56	outlet opening

(continued)

	14	compressor	60	inlet tube
	16	expansion device	61	outlet tube
5	18	drum (laundry compartment)	62	curved/meandering tube
	19	laundry	64	wire / blades
	20	process air channel		
	20a	battery channel	A	process air flow
10	20b	rear channel	B	refrigerant flow
	20c	rising channel	C	cooling air flow
	20d	front channel	Cn	air flow by natural convection
	22	first fluff filter	a, b	outer dimensions of auxiliary heat exchanger
	28	blower		
15	28a	internal blower	h	dryer height
	30	condensate collector	x	drum axis

Claims

- 20 1. Laundry treatment apparatus, in particular dryer (2; 2a) or washing machine having drying function, comprising:
- 25 a cabinet (40) having a front wall (44), a rear wall (43), side walls (42) and a top cover (49),
a laundry storing chamber (18) arranged inside the cabinet (40) for treating laundry (19) using process air (A),
a process air loop (A) for circulating the process air (A) through the laundry storing chamber (18), and
a heat pump system (4) for dehumidifying and heating the process air, the heat pump system having a refrigerant
loop (6) comprising:
- 30 a first heat exchanger (10) for heating a refrigerant and cooling the process air (A),
a second heat exchanger (12) for cooling the refrigerant and heating the process air (A),
a refrigerant expansion device (16),
a compressor (14), and
an auxiliary heat exchanger (13);
characterized in that
- 35 the auxiliary heat exchanger (13) is arranged at the external side of the rear wall (43).
2. Apparatus according to claim 1, wherein the external side of the rear wall (43) comprises a recess (50) and/or
mounting structure for receiving the auxiliary heat exchanger (13).
- 40 3. Apparatus according to claim 1 or 2, wherein the auxiliary heat exchanger (13) is a tube-type, wire-type or wire-tube
heat exchanger or wherein the auxiliary heat exchanger (13) is oriented at the backside of the rear wall (43) such
that a cooling air flow (Cn) is induced by natural convection.
- 45 4. Apparatus according to any of the previous claims, wherein the auxiliary heat exchanger (13) has a tube (62) for
containing and passing the refrigerant and wherein the tube (62) is guided at the backside of the rear wall (43) in a
curved manner or in serpentes from a lower region or a base unit level vertically upward.
- 50 5. Apparatus according to any of the previous claims, wherein the auxiliary heat exchanger (13) or the tube of the
auxiliary heat exchanger (13) or a tube-type auxiliary heat exchanger is extending or is essentially extending from
the left side of the apparatus or from the left side wall (42) to the right side of the apparatus or to the right side wall.
- 55 6. Apparatus according to any of the previous claims, wherein the top cover (49) is protruding at the backside of the
apparatus cabinet (40) beyond the rear wall (43) or a portion of the rear wall (43) and wherein the auxiliary heat
exchanger (13) is arranged vertically below the protruding portion of the top cover (49).
7. Apparatus according to any of the previous claims, wherein the top cover (49) comprises one or more openings
(54) for passing through cooling air (C) that passed over the auxiliary heat exchanger (13) or for sucking in cooling
air (C) driven by a or the blower (28; 28a).

8. Apparatus according to any of the previous claims, wherein the rear wall (43) has or forms a recessed portion (50), the auxiliary heat exchanger (13) is arranged completely or at least partially in the recessed portion (50) and the top cover (49) has an extension which covers the horizontal cross-section area of the recessed portion.

5 9. Apparatus according to any of the previous claims, wherein the horizontal back edge or extension of the top cover (49) protrudes beyond the backside extension of the auxiliary heat exchanger (13).

10 10. Apparatus according to any of the previous claims, wherein the auxiliary heat exchanger (13) is arranged such as to be cooled by forcedly driven ambient air, or wherein the apparatus comprises a blower (28; 28a) for blowing or sucking cooling air (C) along the auxiliary heat exchanger (13).

15 11. Apparatus according to claim 10, wherein the blower (28; 28a) is arranged at the rear wall (43) or at the external side of the rear wall (43) or at a base unit (48).

12. Apparatus according to claim 10 or 11, wherein the blower (28; 28a) is arranged at or in close proximity to a cooling air inlet (55) or cooling air outlet (54, 56) provided for the auxiliary heat exchanger (13).

20 13. Apparatus according to any of the previous claims, wherein an air guiding means (45) is provided to guide the air flow (C) over or along the auxiliary heat exchanger (13).

14. Apparatus according to claim 13, wherein a or the blower (28; 28a) is arranged at an inlet or outlet of the air guiding means (45).

25 15. Apparatus according to claim 13 or 14, wherein the air guiding means (45) is a channel wall extending at the backside of the rear wall (43) or is extending between the base unit (48) and the top cover (49) or is extending between the left side wall (42) and the right side wall of the cabinet (40).

30

35

40

45

50

55

Fig. 1

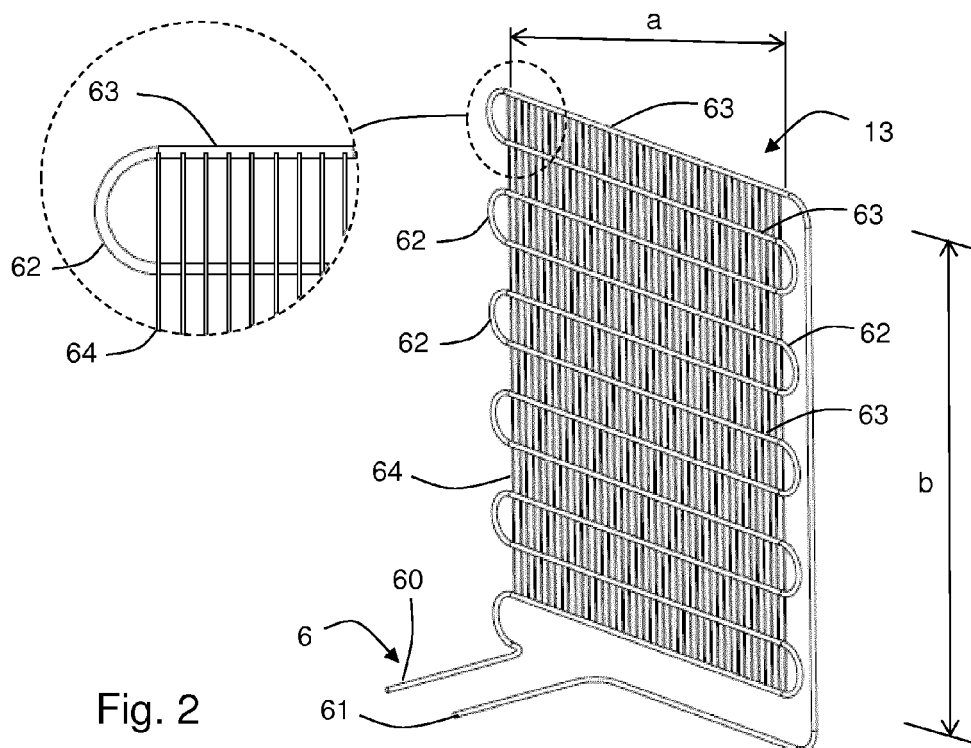
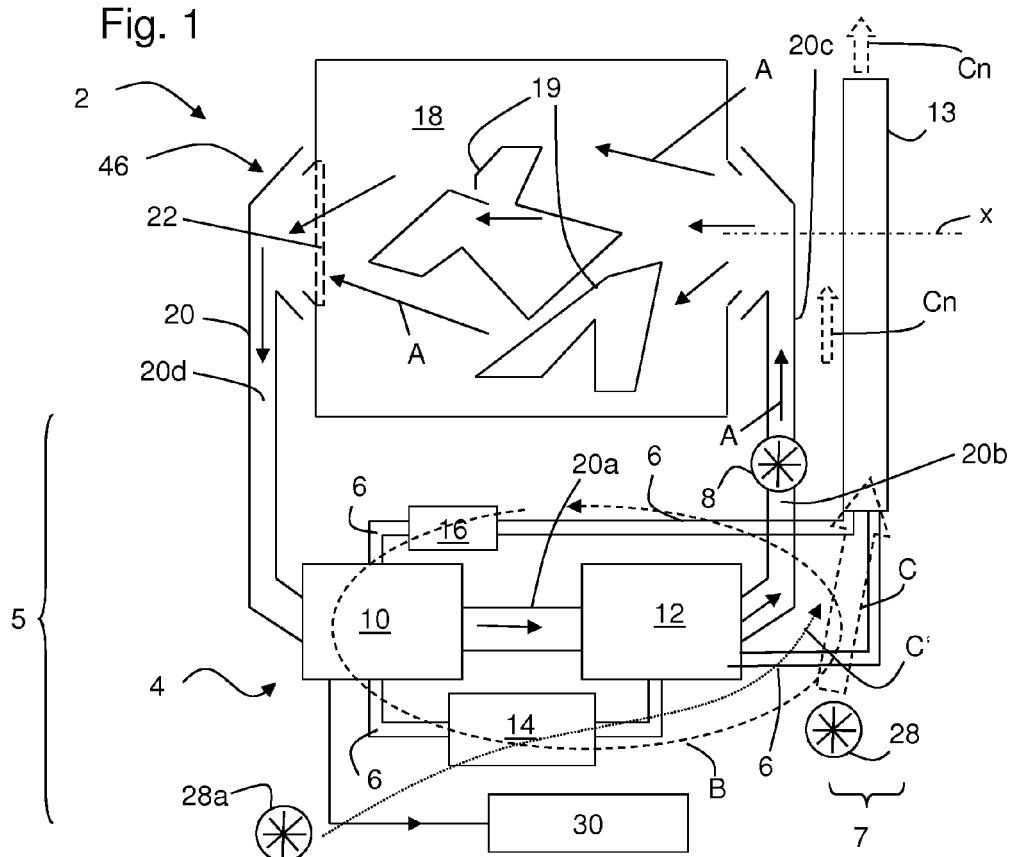
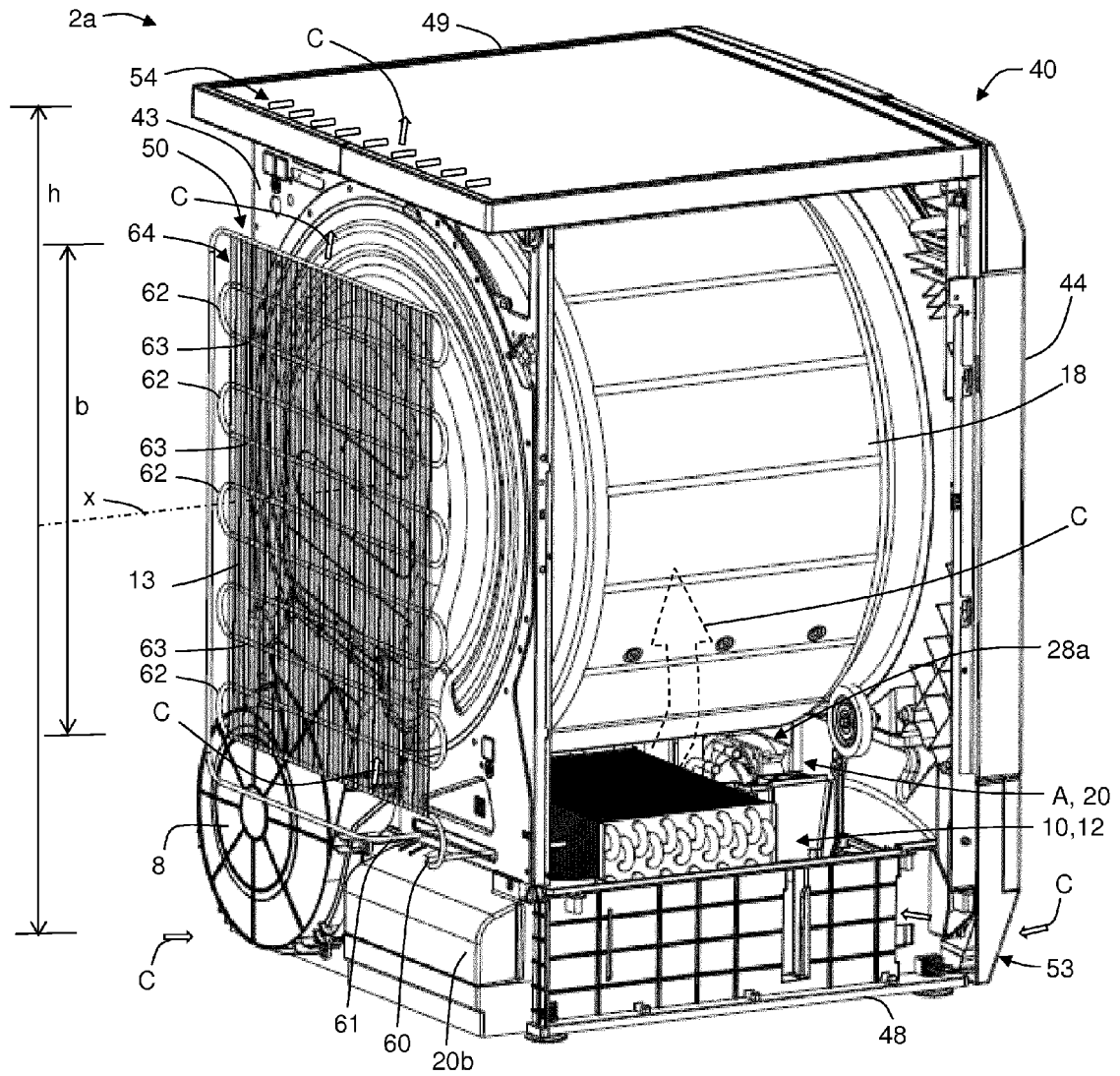
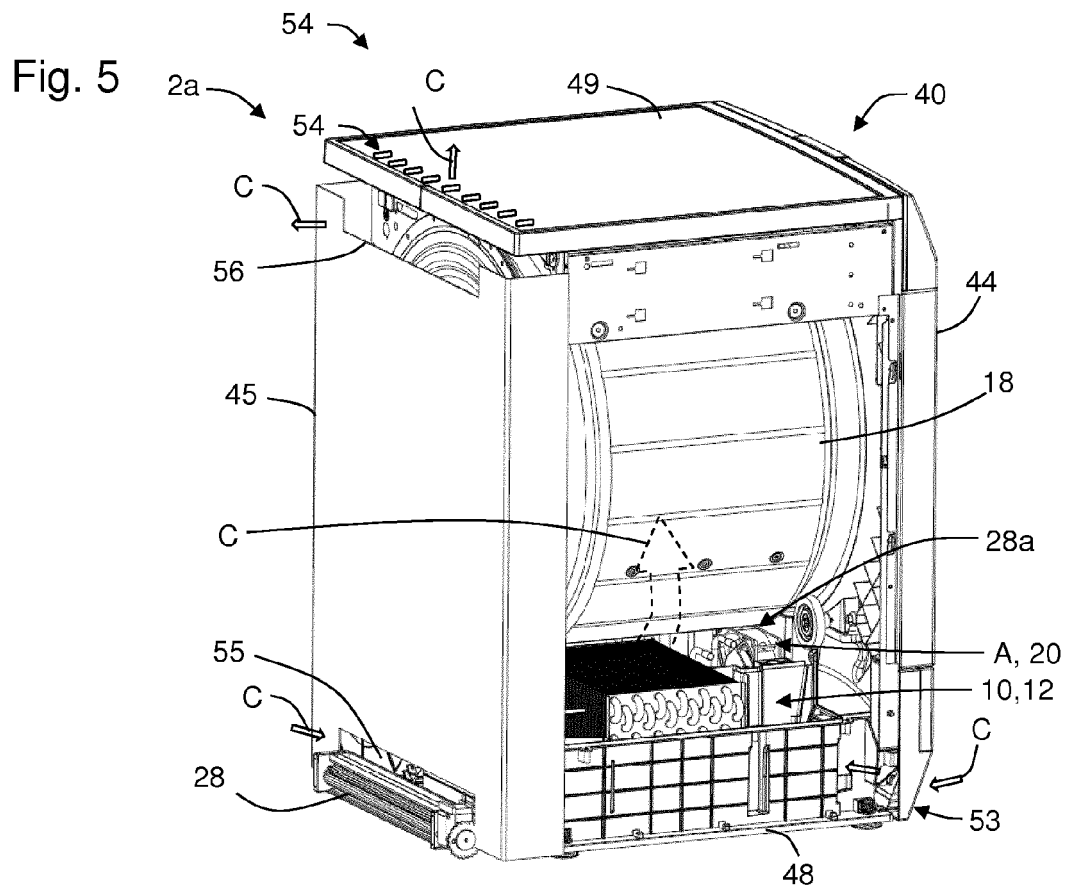
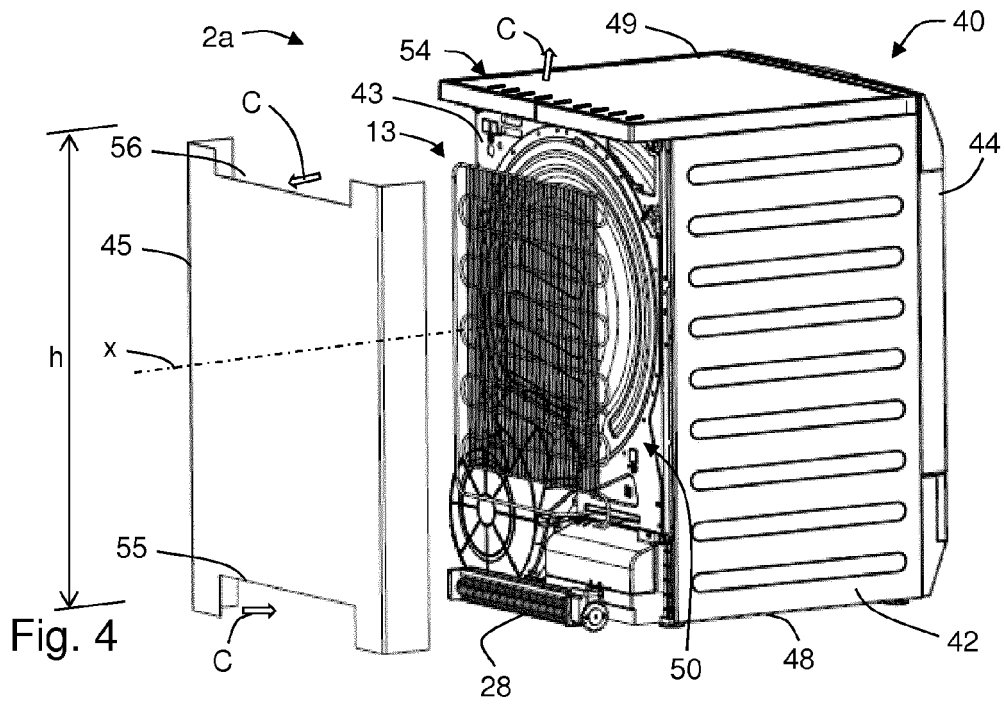


Fig. 2

Fig. 3







EUROPEAN SEARCH REPORT

Application Number
EP 13 16 0567

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP H01 212599 A (MITSUBISHI HEAVY IND LTD) 25 August 1989 (1989-08-25) * abstract; figures 1,2 *	1-15	INV. D06F58/20
X	EP 1 811 077 A1 (SANYO ELECTRIC CO [JP]) 25 July 2007 (2007-07-25) * paragraphs [0023] - [0034] * * paragraphs [0062] - [0063] * * paragraphs [0070] - [0072], [0077] * * figures 1-14 *	1,3,10	
A	DE 196 38 865 A1 (MIELE & CIE [DE]) 27 March 1997 (1997-03-27) * column 3, lines 8-51; figure 1 *	1-15	
A	FR 1 439 185 A (RICHALET PAUL [FR]) 20 May 1966 (1966-05-20) * page 1, column 1, line 19 - page 1, column 2, line 9 * * figures 1,2 *	1,2	
A	FR 1 557 616 A (MARTIN RENÉ [MC]) 21 February 1969 (1969-02-21) * page 1, column 1, line 38 - page 2, column 1, line 22 * * figure 1 *	1,2	TECHNICAL FIELDS SEARCHED (IPC) D06F
A	EP 0 163 265 A2 (MIELE & CIE) 4 December 1985 (1985-12-04) * page 3, line 14 - page 5, line 30 * * figures 1-5 *	1,2	
A	DE 20 2008 002641 U1 (BSH BOSCH SIEMENS HAUSGERÄTE [DE]) 8 May 2008 (2008-05-08) * paragraphs [0018] - [0026]; figures 1-3 * ----- -/--	6-9	
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 27 August 2013	Examiner Weinberg, Ekkehard
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	

EPO FORM 1503 03.82 (P04C01)



EUROPEAN SEARCH REPORT

Application Number
EP 13 16 0567

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 2 460 926 A1 (ELECTROLUX HOME PROD CORP [BE]) 6 June 2012 (2012-06-06) * paragraphs [0006] - [0013] * * paragraphs [0046], [0052] - [0053] * * figures 1,7 * -----	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 27 August 2013	Examiner Weinberg, Ekkehard
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	

1
EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 13 16 0567

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

27-08-2013

10

15

20

25

30

35

40

45

50

55

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP H01212599 A	25-08-1989	NONE	
EP 1811077 A1	25-07-2007	CN 101004319 A EP 1811077 A1 JP 4386895 B2 JP 2007190257 A US 2007169367 A1	25-07-2007 25-07-2007 16-12-2009 02-08-2007 26-07-2007
DE 19638865 A1	27-03-1997	NONE	
FR 1439185 A	20-05-1966	NONE	
FR 1557616 A	21-02-1969	NONE	
EP 0163265 A2	04-12-1985	DE 3419743 A1 EP 0163265 A2	28-11-1985 04-12-1985
DE 202008002641 U1	08-05-2008	DE 202008002641 U1 EP 2092870 A2	08-05-2008 26-08-2009
EP 2460926 A1	06-06-2012	AU 2011334932 A1 EP 2460926 A1 WO 2012072693 A2	11-04-2013 06-06-2012 07-06-2012

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 2008086933 A1 [0003]
- EP 2034084 A1 [0004]
- EP 1884586 A2 [0005]