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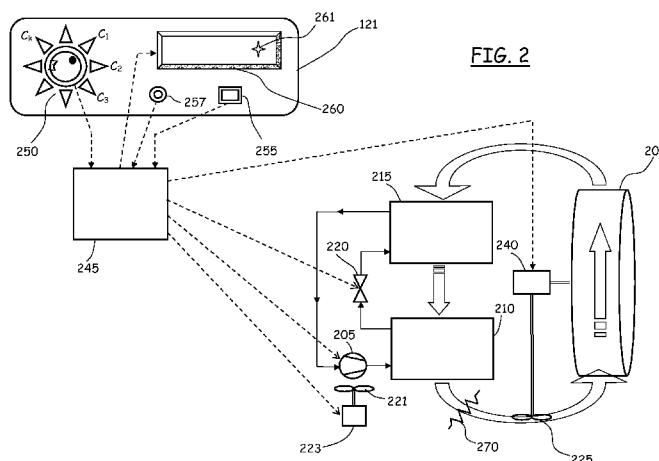
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(54) Title: HEAT PUMP LAUNDRY DRYING APPLIANCE WITH ENHANCED OPERATION FLEXIBILITY



(57) **Abstract:** An appliance for drying laundry (100) comprising an appliance cabinet (110), a laundry treatment chamber (105) inside the cabinet, a drying air recirculation path for causing recirculation of the drying air into/out from the laundry treatment chamber, a drying air propeller (225) driven by a drying air propeller motor (240; 340f) for causing the drying air to recirculate along the drying air recirculation path, a drying air moisture condensing and heating system (205-220, 270) located in the drying air recirculation path for dehydrating the moisture-laden drying air leaving the laundry treatment chamber and heating the dehydrated drying air before it re-enters into the laundry treatment chamber, wherein the drying air moisture condensing and heating system comprises a heat pump operating with a refrigerant fluid, the heat pump comprising a refrigerant fluid compressor (205) and a refrigerant fluid expansion device (220). The refrigerant fluid compressor is a variable-output compressor, capable of being driven to work at different compressor working modes, each compressor working mode corresponding to a respective compressor power consumption course and/or compressor rotational speed course and/or frequency course of the supply current/voltage of the compressor. The refrigerant fluid expansion device is a variable expansion device, controllable to provide different refrigerant fluid mass-flow rates. The appliance has a user interface (121) comprising a laundry drying cycle selector (205) operable

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by a user for selecting one out of a number of default laundry drying cycles (C1, C2, C3,..., Ck), and a control unit (245) adapted to control the machine operation, comprising commanding the compressor to work at a default output corresponding to the selected default laundry drying cycle, controlling the expansion device to provide a default refrigerant fluid mass-flow rate corresponding to the selected default laundry drying cycle, and commanding the drying air propeller motor to work at a default average speed corresponding to the selected default laundry drying cycle. The user interface comprises a command input means (255) operable by the user for imparting to the appliance a command in response to which the control unit: commands the compressor to work at a changed compressor output course with respect to the default output; controls the expansion device to provide a correspondingly changed refrigerant fluid mass-flow rate with respect to the default refrigerant fluid mass-flow rate corresponding to the selected default laundry drying cycle, and commands the drying propeller motor to work at a changed average speed with respect to the default average speed corresponding to the selected drying cycle.

HEAT PUMP LAUNDRY DRYING APPLIANCE WITH ENHANCED OPERATION FLEXIBILITY**Background of the invention****Field of the invention**

The present invention generally relates to the field of household appliances for laundry, clothes and garments treatment. In particular, the present invention relates to appliances for drying laundry, such as laundry dryers and laundry washers also having laundry drying capability.

Discussion of the related art

Appliances for drying laundry are adapted to dry clothes, garments, laundry in general, by circulating hot and dry air (also referred to as "process air") within a tumbler or drum. The drum is rotatable within a machine external casing or cabinet, and is designed to contain the items to be dried. The rotation of the drum causes agitation (tumbling) of the items to be dried, while they are hit by the drying air flow.

Also known are laundry washer&dryer appliances, which are laundry washers that also have laundry drying capability, thereby combining the functionalities of a laundry washing machine with those of a laundry dryer. In a laundry washer&dryer, the drum is rotatable within a washing tub which is accommodated within a machine external casing or cabinet.

In a known type of laundry dryers and washers&dryers, also referred to as "condenser dryer", the drying air flow is typically caused to pass through the drum, exiting therefrom through a drying air outlet, then it passes through a moisture condensing system, where the humid, moisture-laden air is at least partially dehydrated, dried, and the dried air flow is heated up by means of a heating arrangement; the heated drying air flow then re-enters into, and passes again through the drum, and repeats the cycle.

While in some known condenser laundry dryers and washers/dryers the moisture condensing system comprises an air-air heat exchanger, exploiting cooling air taken in from the outside the appliance for cooling down the drying air (and thus cause the condensation of the moisture), other known dryers and washers&dryers exploit a heat pump to dehydrate the drying air flow. In these "heat pump dryers", the heating of the drying air may be performed by the heat pump itself. An example of heat pump laundry dryer can be found in EP 2270276.

Heat pump dryers embed a refrigerant fluid circuit that comprises a refrigerant fluid

compressor, a first heat exchanger, e.g. a refrigerant fluid evaporator, for cooling the drying air by transferring heat to the refrigerant fluid, a second heat exchanger, e.g. a refrigerant fluid liquefier, for heating the drying air by having the refrigerant fluid release heat. The refrigerant fluid, after exiting the first heat exchanger and before entering the second heat exchanger, passes through a
5 refrigerant fluid expansion device, e.g. a capillary tube. A fan is provided for promoting the circulation of the process air. The drying air fan is usually coupled to the shaft of the motor that drives the drum, so that the drying air fan is driven alongwith the drum at a fixed speed.

CH 701466 discloses a clothes dryer in which the volume flow in the drying air circuit is changed within a single drying process: the volume flow is set higher in a starting phase of the
10 drying process than in an end phase thereof, based on a solely time-controlled selection of the volume flow or on a measure of the moisture of the laundry of the drying air using a moisture sensor. If the clothes dryer is equipped with a heat pump, the performance of the heat pump is preferably set as a function of the volume flow, i.e. the performance can be reduced with decreasing volume flow: the motor of the compressor is designed as a "brushless DC" (BLDC)
15 motor, whose speed can be varied. The clothes dryer can have a program selection in a known way, via which the user can select one of multiple drying programs having different operating parameters. At least two drying programs are provided, in which the drying air is conveyed using different volume flows (a first drying program generates a lower volume flow than a second drying program).

20 EP 2586906 discloses a laundry dryer with a heat pump system having variable expansion means, in which a control unit is provided to adjust the variable expansion means in response to at least a compressor quantity representative of the operation of the compressor and/or in response to the drying cycle selected by the user.

Summary of the invention

25 The Applicant has observed that known heat pump dryers usually operates as "on/off" systems: the (motor of the) refrigerant fluid compressor can only operate at a fixed speed, thus the compressor can only be either on or off, so that the heat pump operation can not be more finely regulated. The performance of the heat pump thus mainly depends on the overall design of the appliance, especially of the refrigerant fluid circuit, and the appliances are scarcely flexible, since
30 they do not offer to the user other options over the selection of default operating modes.

The use of variable speed compressors in heat pumps is known in general, and it is

proposed in CH 701466. Variable speed compressors enable optimizing the heat pump operation during a laundry drying cycle, and making the appliance more flexible in terms of options offered to the user to depart from default, standardized laundry drying cycles. For example, options can be provided for allowing the user selecting "fast" drying cycles, for which a shorter drying time is privileged over energy consumption reduction). And/or, options can be provided for allowing the user selecting "Eco" drying cycles, which at the price of a longer drying time bring about a substantial power saving.

The Applicant has observed that, however, the use of a variable speed compressor alone is not sufficient to efficiently exploit the heat pump functionalities.

Usually, the refrigerant fluid expansion device has a static nature, i.e. it has a predetermined and fixed working point, and provide a fixed refrigerant fluid mass-flow rate. The static nature of the refrigerant fluid expansion device limits or jeopardizes the performance improvements that could be attained by using a variable speed refrigerant fluid compressor, and thus penalizes the heat pump performance.

For example, if, in order to run a "fast" laundry drying cycle, the compressor rotational speed is significantly increased, a static expansion device with fixed working point can lead to a decrease of the heat pump performance, jeopardizing the expected advantages in terms of reduction of drying time.

In fact, the increase in the refrigerant fluid mass-flow rate that would result from an increase in the compressor rotational speed would mean being able to exchange more thermal energy with the drying air and consequently shortening the drying time.

But the refrigerant fluid mass-flow rate can actually be increased provided that the density condition of the refrigerant fluid at the inlet of the compressor does not change in switching from the lower-speed to the higher-speed compressor operation. This because the refrigerant fluid mass-flow rate M is given by the formula:

$$M = \rho * V * n$$

where ρ is the refrigerant fluid density at the entrance of the compressor (suction condition), V is the volume of the refrigerant processed during a single rotation of the compressor, and n is the rotational speed of the compressor.

If the compressor rotational speed n is increased and the refrigerant fluid density ρ remains constant, the refrigerant fluid mass-flow rate M increases, and this is beneficial for the reduction of the drying time. However, if the increase in the compressor rotational speed n is badly matched due to the lack of flexibility of the expansion device, which is optimized for a lower compressor rotational speed, no really significant increase in the mass-flow rate M of the refrigerant fluid is attained.

If the expansion device is not capable of adapting to the changed compressor rotational speed, a too high pressure drop for the refrigerant fluid in the refrigerant fluid circuit is created. As a consequence, the refrigerant fluid evaporation pressure decreases, and the refrigerant fluid density decreases as well. It may thus happen that despite the increase in the compressor rotational speed, the refrigerant fluid mass-flow rate does not increase, rather it decreases, and this is disadvantageous because the compressor power consumption increases but without any advantage in the heat-pump performance.

In other words, having a refrigerant fluid expansion device that operates at a fixed working point, set to correspond to a certain, predefined compressor speed, and irrespective of any possible change in the compressor rotation speed, jeopardizes any possible improvement brought about by varying the compressor rotation speed.

Moreover, as mentioned in the foregoing, the drying air fan is usually coupled to the shaft of the motor that drives the drum, so that the drying air fan is driven alongwith the drum at a fixed (average) speed. The Applicant has observed that having a drying air fan that rotates at fixed (average) speed, that is usually selected by the appliance designer based on a trade-off between the appliance performance and an appliance level of noise constraint (in order to avoid excessive airborne noise in the appliance).

However, the drying air flow rate that results from such a noise level constraint is often far from being the best under the viewpoint of the drying performance, in terms of energy saving and drying time, which could be drastically reduced by having higher drying air flow rates.

The Applicant has found that establishing a priori a level of noise to be considered acceptable, and designing the drying air flow rate to comply with such acceptable noise level established a priori, jeopardizing the drying performance, is not the best approach.

The noise level that is to be considered "acceptable" may vary depending on several

factors, like the time of the day, the user premises, the tolerance of the user to noise, etc.

The Applicant has faced the problem of providing a heat pump laundry drying appliance featuring an enhanced flexibility of operation in terms of choices made available to the user for the selection of laundry drying cycles.

5 According to the present invention, an appliance for drying laundry is provided, comprising an appliance cabinet, a laundry treatment chamber inside the cabinet, a drying air recirculation path for causing recirculation of the drying air into/out from the laundry treatment chamber, a drying air propeller driven by a drying air propeller motor for causing the drying air to recirculate along the drying air recirculation path, a drying air moisture condensing and heating system located in the
10 drying air recirculation path for dehydrating the moisture-laden drying air leaving the laundry treatment chamber and heating the dehydrated drying air before it re-enters into the laundry treatment chamber. The drying air moisture condensing and heating system comprises a heat pump operating with a refrigerant fluid, the heat pump comprising a refrigerant fluid compressor and a refrigerant fluid expansion device.

15 The refrigerant fluid compressor is a variable-output compressor, capable of being driven to work at different compressor working modes, each compressor working mode corresponding to a respective compressor power consumption course and/or compressor rotational speed course and/or frequency course of the supply current/voltage of the compressor.

 The refrigerant fluid expansion device is a variable expansion device, controllable to
20 provide different refrigerant fluid mass-flow rates.

 The appliance has a user interface comprising a laundry drying cycle selector operable by a user for selecting one out of a number of default laundry drying cycles, and a control unit adapted to control the machine operation, said control the machine operation comprising commanding the compressor to work at a default output corresponding to the selected default laundry drying cycle,
25 controlling the expansion device to provide a default refrigerant fluid mass-flow rate corresponding to the selected default laundry drying cycle, and commanding the drying air propeller motor to work at a default average speed corresponding to the selected default laundry drying cycle.

 The user interface comprises a command input means operable by the user for imparting to the appliance a command in response to which the control unit:

30 - commands the compressor to work at a changed compressor output course with respect

to the default output;

- controls the expansion device to provide a correspondingly changed refrigerant fluid mass-flow rate with respect to the default refrigerant fluid mass-flow rate corresponding to the selected default laundry drying cycle, and

- 5 - commands the drying propeller motor to work at a changed average speed with respect to the default average speed corresponding to the selected drying cycle.

For example, said changed compressor output course corresponds to an increased compressor output course, increased with respect to the default compressor output course, said changed refrigerant fluid mass-flow rate is an increased refrigerant fluid mass-flow rate with respect
10 to the default refrigerant fluid mass-flow rate, and said changed speed is an increased speed with respect to the default speed.

The appliance may comprise a compressor cooling fan for cooling the compressor, and the control unit may control a compressor cooling fan motor so as to control the activation and/or speed of the compressor cooling fan in dependence of a default limit temperature of a sensed refrigerant
15 fluid temperature. In response to the user imparting said command through said command input means the control unit preferably changes the default limit temperature so that the activation period of the compressor cooling fan and/or the speed of the compressor cooling fan is/are changed, particularly reduced.

Said command input means may comprise a pushbutton or a touchbutton on a touch
20 screen, said pushbutton or touchbutton being distinct from the drying cycle selector.

The laundry treatment chamber may comprise a rotatable drum caused to rotate by a drum motor. The drying air propeller motor and the drum motor may be a selfsame motor. The increased speed preferably does not exceed an average drum rotation speed that may cause laundry to get stuck on the drum inner walls. Alternatively, the drying air propeller motor may be
25 distinct and distinctly operated with respect to the drum motor.

The user interface may comprise display means for displaying relevant information to the user. When the control unit receives the user command imparted by the user through the command input means, the control unit preferably causes the appliance to give a confirmation to the user by displaying on the display means an indication. The user interface may also comprise
30 acoustic means, and when the control unit receives the user command imparted by the user

through the command input means, the control unit causes the appliance to give a confirmation to the user by causing the acoustic means emit an acoustic signal.

The variable expansion device may comprise a first capillary and a second capillary providing different mass-flow rates, and a valve, controlled by the control unit, to cause the refrigerant fluid selectively pass through either the first or the second capillary.

The variable expansion device may comprise a first capillary and a second capillary arranged in series, and a valve, controlled by the control unit, to selectively cause one of the first and second capillaries being bypassed.

The variable expansion device may comprise an electronic expansion valve capable of self-adjusting the provided mass-flow rate to a detected refrigerant fluid temperature detected by a temperature sensor based on settings provided thereto by the control unit, and the control unit may control the variable expansion device to provide said correspondingly changed refrigerant fluid mass-flow rate with respect to the default refrigerant fluid mass-flow rate corresponding to the selected default laundry drying cycle by providing to the electronic expansion valve changed settings, different from default settings.

The variable expansion device may comprise a variable expansion valve, and the control unit may control the variable expansion valve to set the opening thereof.

Said command input means may be configured so as to allow the user to select more than one changed compressor output course, changed refrigerant fluid mass-flow of the expansion device and changed average speed of the drying air propeller.

The change in the compressor output course, refrigerant fluid mass-flow rate provided by the variable expansion device and average working speed of the drying air propeller may depend on the selected laundry drying cycle.

When the control unit receives the command imparted by the user through the command input means, the refrigerant fluid compressor may be power-controlled or rotation speed-controlled by the control unit.

Brief description of the drawings

These and other features and advantages of the present invention will be better understood

by reading the following detailed description of some embodiments thereof, provided merely by way of non-limitative examples, description that, for its better intelligibility, should be read in conjunction with the attached drawings, wherein:

Figure 1 is a perspective view from the front of an appliance for drying laundry according to an embodiment of the present invention;

Figure 2 schematically shows an arrangement of relevant components of the appliance according to an embodiment of the present invention;

Figure 3 schematically shows another arrangement of relevant components of the appliance according to another embodiment of the present invention;

Figures 4A – 4D schematically show some exemplary embodiments of variable expansion device;

Figure 4E schematically shows another exemplary embodiment of variable expansion device;

Figure 5 is a time diagram of an exemplary, default laundry drying cycle, and

Figure 6 is a time diagram of an exemplary user-imparted change of the default laundry drying air cycle.

Detailed description of embodiments of the invention

With reference to the drawings, a laundry drying appliance according to an embodiment of the present invention, for example a laundry dryer or a laundry washer&dryer, is depicted in **Figure 1** in perspective from the front. The laundry drying appliance, globally denoted as **100**, comprises a laundry treatment chamber **105** for accommodating the items to be dried or washed and dried, such as clothes, garments, linen, and similar laundry items. Preferably the laundry treatment chamber **105** includes a drum rotatably mounted inside the machine casing or cabinet **110**, and in case the appliance is a laundry washer&dryer the drum is arranged within a tub housed in the machine casing or cabinet **110**. The drum is not visible in **Figure 1**, being inside the cabinet **110**, but in **Figures 2-5** the drum is schematically depicted, and denoted **200**.

The cabinet **110** is generically a parallelepiped in shape, and has a front wall **113**, two side walls **117**, a rear wall, a basement and a top **119**. The front wall **113** is provided with an opening for accessing the laundry treatment chamber **105** and loading/unloading the laundry, and a door

115 is hinged to the front wall **113** for closing the loading/unloading opening. In the upper part of the front wall **113**, an appliance control panel (user interface) **121** is located. The top **119** closes the cabinet **110** from above, and may also define a worktop.

In the laundry drying appliance **100**, in order to dry laundry, drying air (process air) is caused to flow through the laundry treatment chamber **105**, where the items to be dried are contained, and, in the preferred case the laundry treatment chamber **105** includes the rotatable drum **200**, the items to be dried are caused to tumble by the drum rotation. After exiting the laundry treatment chamber **105**, the flow of moisture-laden drying air passes through a moisture condensing system, where the humid, moisture-laden drying air is (at least partially) dried, dehydrated. The dehydrated air flow is then heated and caused to pass again through the laundry treatment chamber **105**, repeating the cycle.

The schematic drawings of **Figures 2** and **3** show some of the components of the laundry drying appliance **100** which are useful for understanding the invention embodiments described herein by way of example.

Referring to **Figure 2**, the laundry drying appliance **100** has a moisture condensing system comprising a heat pump operating with a refrigerant fluid. The heat pump comprises a refrigerant fluid circuit. The refrigerant fluid circuit comprises a refrigerant fluid compressor **205**; a first heat exchanger **210**, e.g. a refrigerant fluid liquefier, for heating the drying air by having the refrigerant fluid release heat; a second heat exchanger **215**, e.g. a refrigerant fluid evaporator, for cooling the drying air by transferring heat to the refrigerant fluid. The refrigerant fluid, after exiting the first heat exchanger **210** and before entering the second heat exchanger **215**, passes through a refrigerant fluid expansion device **220** (e.g., capillary tube, expansion valve), to undergo an expansion process. The refrigerant fluid circuit of the heat pump is subdivided in a high pressure portion and a low pressure portion: the high pressure portion extends from the outlet of the compressor **205** via the first heat exchanger **210** to the inlet of the expansion device **220**, whereas the low pressure portion extends from the outlet of the expansion device **220** via the second heat exchanger **215** to the inlet of the compressor **205**. Additional heat exchangers can be provided in the refrigerant fluid circuit, along the high pressure portion and/or the low pressure portion.

Advantageously, the compressor **205** is a variable-output compressor, i.e. a compressor that can be driven to work at different compressor working modes, wherein a generic compressor working mode is characterized by a respective compressor power consumption course and/or

compressor rotational speed course and/or frequency course of the supply current/voltage of the compressor.

For the purposes of the present invention, by “course” there is meant a trend over time; thus, for example, “compressor power consumption course” means a trend over time of the compressor power consumption; “compressor rotational speed course” means a trend over time of the compressor rotational speed; “frequency course of the supply current/voltage of the compressor motor” means the trend over time of the frequency of the current or voltage supplied to the compressor electric motor by an inverter (or other type of compressor control system) adapted to vary the speed of the compressor electric motor.

A compressor cooling fan **221** is preferably provided for cooling the compressor **205**. The compressor cooling fan **221** can be driven by a dedicated motor **223**. The motor **223**, e.g. an electric motor, can be a fixed-speed motor or a variable-speed motor, capable of operating at different speeds.

Advantageously, the expansion device **220** is or comprises a variable expansion device, controllable to vary the provided refrigerant fluid mass-flow rate so as to adjust it according to the variation of the rotational speed of the compressor.

The thick arrows in **Figure 2** schematize the drying air recirculation path. The drying air is propelled by a drying air propeller **225**, that causes the drying air to pass through the drum **200** where the items to be dried are contained. In the drum **200**, the drying air subtracts moisture from the items to be dried and becomes moisture-laden. After exiting the drum **200**, the moisture-laden drying air passes through the second heat exchanger **215**, where the drying air is cooled down and dehydrated by releasing moisture. Then the dehydrated drying air passes through the first heat exchanger **210**, where the drying air is heated up. Thereafter, the heated drying air enters again into the drum **200**.

A Joule-effect drying air heater **270**, for example one (or, possibly, more than one) electric resistor can be provided in the drying-air recirculation path, being for example arranged downstream the first heat exchanger **210**, for boosting the drying air heating, e.g. during an initial transitory part of a drying cycle, during which the drying air temperature and the refrigerant fluid temperature are increased up to respective operating levels (after the initial transitory part of a drying cycle, the Joule-effect drying air heater **270** is preferably deactivated).

In the embodiment of **Figure 2**, a single motor **240** (e.g., an electric motor) is provided for driving both the drum **200** and the drying air propeller **225**. Advantageously, the motor **240** is a variable-speed motor, capable of operating at different speeds. In an embodiment of the present invention, the motor **240** is an inverter electric motor.

5 Block **245** schematizes an appliance control unit, for example an electronic control board, which governs the appliance operation, and *inter alia* controls the drum and drying air propeller motor **240**, the compressor **205** output (e.g., the compressor power consumption and/or the compressor rotational speed and/or the frequency of the supply current/voltage of the compressor), the compressor cooling fan motor **223** (so as to control the activation and/or speed of the
10 compressor cooling fan **221** in dependence of the temperature of the refrigerant fluid sensed for example at the inlet of the expansion device **220**), the expansion device **220** (so as to cause the expansion device vary the provided refrigerant fluid mass-flow rate to adapt to the changed compressor output), the energization of the Joule-effect drying air heater **270**, and which receives drying air temperature readings from drying air temperature sensors or probes (e.g., a probe may
15 be arranged to sense the drying air temperature at the entrance of the laundry treatment chamber **105**), and refrigerant fluid temperature readings from refrigerant fluid temperature sensors or probes.

The control unit **245** may be a programmable electronic control unit, for example comprising a microcontroller or a microprocessor, which is adapted to execute a program stored in
20 a program memory thereof.

Exemplary embodiments of the variable expansion device **220** are schematized in **Figures 4A – 4D**.

Referring to **Figure 4A**, the variable expansion device **220** includes a three-way valve **405**, a first capillary tube **410** and a second capillary tube **415**. The three-way valve **405** comprises
25 three ports. A first port is connected to the outlet of the first heat exchanger **210**. A second port is connected to the inlet of the first capillary tube **410**. A third port is connected to the inlet of the second capillary tube **415**. The three-way valve **405** is provided to change over between the first capillary tube **410** and the second capillary tube **415**, so that the refrigerant fluid flows either through the first capillary tube **410** or through the second capillary tube **415**. The first capillary tube
30 **410** and the second capillary tube **415** have different geometric properties, so that the first capillary tube **410** and the second capillary tube **415** provide different refrigerant fluid mass-flow rates. For

example, the provided refrigerant fluid mass-flow rate decreases as the length of the capillary tubes **410** and **415** increases, assuming that the cross-section of the tubes is the same. The first capillary tube **410** is longer than the second capillary tube **415**. Thus, the second capillary tube **415** provides a higher mass-flow rate than the first capillary tube **410**. However, in a similar manner the provided refrigerant fluid mass-flow rate increases as the cross-section of the capillary tubes **410** and **415** increases, assuming that the length of the capillary tubes is the same. In an alternative embodiments, the three-way valve **205** can be arranged downstream of first capillary tube **410** and the second capillary tube **415**.

In **Figure 4B**, the variable expansion device **220** includes the first capillary tube **410**, the second capillary tube **415**, a first on-off valve **420** and a second on-off valve **425**. The inlets of the first capillary tube **410** and the second capillary tube **415** are connected to the outlet of the first heat exchanger **210**. The outlet of the first capillary tube **410** is connected to the inlet of the first on-off valve **420**. In a similar way, the outlet of the second capillary tube **415** is connected to the inlet of the second on-off valve **425**. Thus, the on-off valves **420** and **425** are arranged downstream the corresponding capillary tubes **410** and **415**, respectively. The outlets of the first on-off valve **420** and the second on-off valve **425** are connected to the inlet of the second heat exchanger **215**. The first on-off valve **420** and the second on-off valve **425** are provided to select one of the capillary tubes **410** or **415**. The first capillary tube **410** and the second capillary tube **415** have different geometric properties, so that the first capillary tube **410** and the second capillary tube **415** provides different refrigerant fluid mass-flow rates. Since the first capillary tube **410** is longer than the second capillary tube **415**, the second capillary tube **415** provides a higher refrigerant fluid mass-flow rate than the first capillary tube **410** (assuming that the respective cross sections are the same). Additionally, when both the on-off valves **420** and **425** are in open position, the first and second capillary tubes **410** and **415** provide a cumulative refrigerant fluid mass-flow rate higher than the one provided by the first capillary tube **410** when only the first on-off valve **420** is open and by the second capillary tube **415** when only the second on-off valve **425** is open.

In the embodiment of **Figures 4C**, the variable expansion device **220** includes the first capillary tube **410**, the second capillary tube **415** and a bypass on-off valve **430**. The inlet of the first capillary tube **410** is connected to the outlet of the first heat exchanger **210**. The inlet of the second capillary tube **415** is connected to the outlet of the first capillary tube **410**. The outlet of the second capillary tube **415** is connected to the inlet of the second heat exchanger **215**. Thus, the first capillary tube **410** and the second capillary tube **415** are connected in series. The bypass on-

off valve **430** is connected in parallel to the first capillary tube **410**. Preferably, the bypass on-off valve **430** is provided along a bypass line comprising a bypass line inlet arranged between the inlet of the first capillary tube **410** and the outlet of the first heat exchanger **210** and a bypass line outlet arranged between the outlet of the first capillary tube **410** and inlet of the second capillary tube **415**.

5 When the bypass on-off valve **430** is closed, then the refrigerant fluid flows in the first capillary tube **410** and the second capillary tube **415**. When the bypass on-off valve **430** is open, then the first capillary tube **410** is bypassed, and the refrigerant flows only in the second capillary tube **415**. When the bypass on-off valve **430** is open, the refrigerant fluid mass-flow rate that is provided by the expansion means **220** increases.

10 In the embodiment of **Figure 4D** the variable expansion device **220** includes the first capillary tube **410**, the second capillary tube **415** and the bypass on-off valve **430**. The inlet of the first capillary tube **410** is connected to the outlet of the first heat exchanger **210**. The inlet of the second capillary tube **415** is connected to the outlet of the first capillary tube **410**. The outlet of the second capillary tube **415** is connected to the inlet of the second heat exchanger **215**. Thus, the
15 first capillary tube **410** and the second capillary tube **415** are connected in series. The bypass on-off valve **430** is connected in parallel to the second capillary tube **415**. Preferably, the bypass on-off valve **430** is provided along a bypass line comprising a bypass line inlet arranged between the outlet of the first capillary tube **410** and the inlet of second capillary tube **415** and a bypass line outlet arranged between the outlet of the second capillary tube **415** and the inlet of the second heat
20 exchanger **215**. When the bypass on-off valve **430** is closed, then the refrigerant flows in the first capillary tube **410** and the second capillary tube **415**. When the bypass on-off valve **430** is open, then the second capillary tube **415** is bypassed, and the refrigerant flows only in the first capillary tube **410**. When the bypass on-off valve **430** is open, the refrigerant fluid mass-flow rate that is provided by the expansion device **220** increases.

25 In the above described embodiments the variable expansion device **220** includes two capillary tubes **410** and **415** in each case, wherein two (in the embodiments of **Figures 4A, 4C** and **4D**) or three (in the embodiment of **Figure 4B**) different provided refrigerant fluid mass-flow rates can be selected. In general, the variable expansion device **220** may include more capillary tubes and/or more valves, so that more than two or three different provided refrigerant fluid mass-flow
30 rates can be selected.

In the embodiments of **Figures 4A - 4D**, the control unit **245** controls the variable expansion device **220** by directly controlling the valves **405, 420, 425, 430** of the variable

expansion device **220**, so that the refrigerant fluid mass-flow rate that can be provided by the variable expansion device **220** can be varied, as discussed later on.

Other types of variable expansion device **220** can be used. In particular, other types of variable expansion devices can be used which are directly controlled by the control unit **245**, whereby the control unit **245** directly commands the expansion device to set the proper working point, i.e. the proper opening of the expansion device such that the provided refrigerant fluid mass-flow rate matches the output of the compressor **205**. Also, it is possible to use self-adjusting variable expansion devices: for example, the variable expansion device **220** may comprise an electronic expansion valve. An electronic expansion valve is a device that is capable of self-adjusting the refrigerant fluid mass-flow rate it can provide, based on device settings that are for example in the form of a look-up table provided thereto by the control unit **245**. In this case, the control operated by the control unit **245** on the variable expansion device **220** may consist in providing thereto the (new) device settings.

For example, as schematically depicted in **Figure 4E**, the control unit **245** provides settings **405** to the variable expansion device **220** comprising an electronic expansion valve **406**. The settings provided by the control unit **245** are stored **407** at the electronic expansion valve **406**. Then, the variable expansion device **220** comprising the electronic expansion valve **406** adjusts the provided refrigerant fluid mass-flow rate (e.g., the valve opening) to a certain value based on a detected refrigerant fluid temperature sensed by sensors **410** along the refrigerant fluid circuit. By having the control unit **245** change the settings **405** provided to the variable expansion device **220** comprising the electronic expansion valve **406**, the latter can adjust the provided refrigerant fluid mass-flow rate to a different value, still based on the detected refrigerant fluid temperature.

The control unit **245** receives inputs from the control panel (user interface) **121**, by means of which the user may e.g. set the desired laundry drying program or cycle, as well as set options for the operation of the machine.

The control panel **121** comprises a laundry drying cycle selector **250**, e.g. a rotary selector, through which the user can select a desired laundry drying cycle out of a number of pre-defined, default laundry drying cycles **C₁**, **C₂**, **C₃**, ..., **C_k**. The generic default laundry drying cycle is characterized by certain respective default parameters, and particularly by a certain default compressor output (compressor power consumption, compressor rotational speed, frequency of the supply current/voltage of the compressor of the variable-output compressor **205**) and a certain

default speed of the motor **240** (and, consequently, of the drying air propeller **225**). For example, all the default laundry drying cycles are characterized by a value of compressor output that the appliance designer has selected using a criterion based on a trade-off between the appliance performance and the reduction of the energy consumption, despite the (longer) duration of the drying cycles. Also, all the default laundry drying cycles may be characterized by a value of drying air propeller (average, averaged over time) rotation speed that the appliance designer has selected based on a trade off between the appliance performance and an appliance noise level requirement, such that the level of the noise produced by the appliance is not above a noise level that is regarded by the designer as admissible, tolerable.

The control panel **121** further comprises user command input means **255**, preferably distinct from said default laundry treatment cycle selector **250**, through which the user is allowed to impart to the appliance (control unit **245**) a command to change the default parameters that characterize the selected default laundry drying cycle, e.g. to change the output of the compressor **205** and, possibly, the default (average, averaged over time) rotation speed of the drying air propeller **225**, as described in detail in the following. The user command input means **255** comprise for example a pushbutton or slider or rotary knob, either physical or virtual.

The control panel **121** may also comprise a cycle start button (a pushbutton or a touchbutton) **257**, that the user can push to start the machine operation.

The control panel **121** preferably comprises display means **260** for displaying to the user relevant or useful information about the appliance settings and operation. The display means **260** may comprise a touch screen, and the virtual user command input means **255** may be a displayed icon. In the case of a touch screen, also the laundry drying cycle selector **250** and/or the cycle start button **257** can be virtual, touch buttons displayed in the form of icons on the display means **260**.

Referring to **Figure 5**, in operation the user puts the laundry to be dried in the drum **200**, he/she closes the door **115**, then through the laundry drying cycle selector **250** he/she selects a desired one of the default laundry drying cycles **C₁, C₂, C₃, ..., C_k** for example according to the nature of the textiles to be treated, and pushes the start button **257** to start the appliance **100**. The appliance starts performing the default drying cycle selected by the user under the control of the control unit **245**, which, among other things, commands the compressor **205** to work at the default output level **C-out_{def}**, commands the variable expansion device **220** to provide a default refrigerant fluid mass-flow rate **m_{def}** (matching the default compressor output level **C-out_{def}**), and the drum and

drying air propeller motor **240** to work at the default (average) rotation speed ω_{def} . The sawtooth waveform shown in **Figure 5** means that the working speed of motor **240** may oscillate around the default average value. Also, the sense of rotation of the drum **200** (and, consequently, of the drying air propeller **225**) may be periodically reversed. In case the variable expansion device **220** is an electronic expansion valve, the control operated by the control unit **245** comprises the provision to the variable expansion valve of default expansion valve settings **405** based on which the electronic expansion valve **406** is then capable of self-adjusting the provided refrigerant fluid mass-flow rate based on the detected refrigerant fluid temperature. The execution of the default drying cycle proceeds while the control unit **245** maintains these default values.

Let now reference be made to **Figure 6**. Let it be assumed that, at any time during the ongoing default drying cycle, e.g. at instant t_1 (but, possibly, from the very beginning, e.g., before starting the appliance), the user decides to change the parameters of the selected default drying cycle in execution (or to be executed).

To do so, the user acts on the user command input means **255**. In response, the control unit **245** commands the compressor **205** to change, e.g. to increase its output level from the default output level $C\text{-out}_{\text{def}}$ to an increased compressor output level $C\text{-out}_1$ (e.g. by increasing the compressor power consumption and/or the compressor motor rotational speed and/or the frequency of the supply current/voltage of the compressor). The control unit **245** also commands the variable expansion device **220** to change, e.g. increase the provided refrigerant fluid mass-flow rate from the default refrigerant fluid mass-flow rate m_{def} to an increased refrigerant fluid mass-flow rate m_1 (e.g., in case the expansion device is an electronic expansion valve **406**, this corresponds to an increased variable expansion device opening **Set point**₁ compared to the default variable expansion device opening **Set point**_{def}). In case the variable expansion device **220** is an electronic expansion valve, the control operated by the control unit **245** comprises providing to the variable expansion valve new expansion valve settings **405** based on which the expansion valve is then capable of self-adjusting to provide the changed, e.g. increased refrigerant fluid mass-flow rate.

In this way, the increase in the compressor **205** output is properly matched by the increase in the refrigerant fluid mass-flow rate that is provided by the expansion device **220**. The refrigerant fluid mass-flow rate in the refrigerant fluid circuit thus increases, so that the exchange of thermal energy with the drying air is enhanced and consequently the laundry drying time is shortened.

When the user imparts the command through the command input means **255** to change,

e.g. increase, the compressor output, and to consequently adjust the refrigerant fluid mass-flow rate provided by the variable expansion device **220**, the control unit **245** may change the set limit refrigerant fluid temperature, e.g. increasing it from 65 °C to 75 °C, so that the activation period of the compressor cooling fan **221**, and/or the speed of the compressor cooling fan **221**, is/are reduced.

Advantageously, when the user acts on the user command input means **255**, the control unit **245** also commands the (time-averaged) speed of the drying air propeller **225** to change, e.g. to increase. The control unit **245** commands the drum and drying air propeller motor **240** to work at an increased (time-averaged) rotation speed ω_1 compared to the default (time-averaged) rotation speed ω_{def} . In this way, both the drying air propeller **225** and the drum **200** are caused to rotate (on average) faster than the default (time-averaged average) speed. Faster rotation of the drying air propeller **225** increases the drying air flow rate and consequently further reduces the drying time. The increased drying air flow rate also helps the heat pump reaching a higher efficiency working point than that reached with the default drying air flow rate. Overall, by increasing the drying air flow rate, not only is the drying time reduced, also a saving of electric power is achieved.

Faster rotation of the drum **200**, although being a consequence of having just a single motor **240**, is of no detriment: experimental tests have shown that there are no relevant negative effects due to the laundry sticking on the drum surface as long as the drum rotation speed is kept below approximately 80 RPM. The sawtooth waveform shown in **Figures 5** and **6** is intended to show such periodical oscillation of the drum and drying air propeller rotation speed around an average rotation speed (**Figure 5**) and that the change, e.g. increase, in the average rotation speed of the motor **240** that drives both the drum **200** and the drying air propeller **225** is compatible with a periodical oscillation of the rotation speed around the increased average rotation speed ω_1 : the average value of the motor **240** rotation speed over the time period after the control unit **245** has commanded the drum and drying air propeller motor **240** to increase the rotation speed is different, e.g. higher than the average value of the motor **240** rotation speed over the time period before the control unit **245** has commanded the increase of the rotation speed. Similarly, the change, e.g. increase, in the (average) rotation speed of the motor **240** is also compatible with a periodical reversal in the rotation sense of the drum **200**, which is beneficial for enhancing the tumbling of the laundry to be dried, for making the drying of the laundry more uniform.

Preferably, when the control unit **245** receives the user command imparted through the command input means **255**, the control unit **245** causes the appliance to give a confirmation to the

user, e.g. by displaying on the display means **260** an indication or an icon **261** (and/or by lighting a dedicated light provided on the control panel **121**), and/or by emitting an acoustic signal, e.g. a buzz.

5 The user needs not to be aware of the fact that, by acting on the command input means **255**, a different (e.g., increased) compressor **205** output, a different refrigerant fluid mass-flow rate provided by the expansion device **220** and, preferably, a different drying air propeller (average) speed are set: the user may for example just be aware of the fact that the command input means **255** correspond to a "fast drying cycle" selection, and that by selecting such option the appliance can execute any one of the default drying cycles faster, possibly with an increased noise level.

10 As mentioned above, when performing a default drying cycle the control unit **245** preferably activates the Joule-effect drying air heater **270** in the initial phases of a drying cycle, when the heat pump has not yet reached its proper working point, to assist the heating of the drying air, and thereafter the control unit **245** may deactivate the Joule-effect drying air heater **270**. Advantageously, when the user imparts the command through the command input means **255** to
15 change, e.g. increase the compressor **205** output, the refrigerant fluid mass-flow rate provided by the variable expansion device **220** and the drying air propeller speed, the control unit **245** may command the Joule-effect drying air heater **270** to stay activated for a prolonged period of time, to boost the drying air heating, and thus contributing to the reduction of the drying time.

The changed, e.g. increased, compressor output, changed mass-flow rate provided by the
20 variable expansion device mass-flow rate sustainability, and drying air propeller speed can be maintained for the whole remaining part of the drying cycle after the user has imparted the command through the command input means **255** (which command, as mentioned in the foregoing, can be imparted at any time during the ongoing drying cycle, as well as possibly from the very beginning, e.g., before starting the appliance, or after a while the execution of the drying cycle has
25 begun, e.g. at the instant t_1), or for at least a fraction of the remaining part of the drying cycle, for example until the heat pump (i.e., the compressor **205**) is deactivated.

The appliance **100** can be configured so that, through the command input means **255**, the user is allowed to select more than one, e.g. two or more, different output levels for the compressor **205**, different levels of mass-flow rate provided by the variable expansion device **220**, and different
30 speeds for the drying air propeller **225**. For example, it may be provided that by pushing the command input means (pushbutton) **225** once, the user selects a first increased compressor output

level, increased mass-flow rate provided by the expansion device and increased drying air propeller (average) speed, higher than the default values; by pushing the command input means (pushbutton) **225** twice, the user selects a second increased compressor output level, increased mass-flow rate provided by the expansion device and increased drying air propeller (average) speed, higher than the first increased values, etc. Alternatively, the command input means may comprise two or more pushbuttons, the actuation of either of which causes a different increase in the compressor output level, mass-flow rate provided by the expansion device and drying air propeller (average) speed over the corresponding default values. The current compressor output level, mass-flow rate provided by the expansion device and drying air propeller (average) speed corresponding to the user selection can be signaled to the user on the display means **260**, e.g. by means of an indicator bar like a bar with segments that are selectively highlighted.

The embodiment schematized in **Figure 3** is similar to that of **Figure 2**, with the difference that instead of a single motor **240** for driving both the drum **200** and the drying air propeller **225**, two distinct motors **340d**, for driving the drum **200**, and **340f**, for driving the drying air propeller **225** are provided. In such a case, then the control unit **245**, upon receiving from the user the command to change, e.g. increase the compressor **205** output, the mass-flow rate provided by the expansion device **220** and the drying air propeller (average) speed, commands to the drying air propeller motor **340f** to increase its working speed, without affecting the drum rotation speed (i.e., drum motor **340d** continues to operate at the default average working speed). Referring again to **Figures 5** and **6**, while the default drying air propeller average rotation speed for a default drying cycle would be $\omega\text{-}f_{\text{def}}$, when the user imparts the command through the command input means **255** the average rotation speed of the drying air propeller is increased to $\omega\text{-}f_1$.

The provision of a dedicated motor **340f** for driving the drying air propeller **225**, distinct from the drum motor **340d** enhances the flexibility of the appliance. For example, in such a case the drying air propeller **225** rotation speed has not to be limited by concerns of laundry getting stuck on the drum walls.

§ § § §

Thanks to the solution disclosed herein, the laundry drying appliance has an improved operation flexibility, that allows the appliance user to decide whether to vary the laundry drying time irrespective of design constraints that are e.g. focused on the level of noise generated by the appliance while working.

In embodiments of the present invention, the change, e.g. increase in the compressor output course, refrigerant fluid mass-flow rate provided by the expansion device and (average) speed of the drying air propeller commanded by the control unit upon receiving the user command may differ depending on the default laundry drying cycle selected by the user / being executed by the appliance, for example for taking into account that different default drying cycles are designed for different types of textiles. Also, said changes may be inhibited by the control unit if the user has selected certain drying cycles (which are designed for particular types of textiles).

Nothing prevents that, in alternative embodiments of the invention, the command input means **255** are a peculiar position (physical or virtual) of the drying cycle selector **250** that is interpreted by the control unit **245** as meaning that the user wants that a generic one of the default laundry drying cycles **C₁, C₂, C₃, ..., C_k** is executed with a compressor output course, refrigerant fluid mass-flow rate provided by the expansion device and drying air propeller **225** (average) working speed different from the default (average) levels specified for that drying cycle. Also, in other embodiments of the invention, an additional laundry drying cycle may be provided, in addition to the default laundry drying cycles **C₁, C₂, C₃, ..., C_k**, by selecting which the user can command the appliance to work at a compressor output course, refrigerant fluid mass-flow rate provided by the expansion device and drying air propeller average speed different, particularly the drying air propeller speed can be higher than the noise-limited drying air propeller speed of the default drying cycles.

20

CLAIMS

1. An appliance for drying laundry (**100**) comprising an appliance cabinet (**110**), a laundry treatment chamber (**105**) inside the cabinet, a drying air recirculation path for causing recirculation of the drying air into/out from the laundry treatment chamber, a drying air propeller (**225**) driven by
 5 a drying air propeller motor (**240;340f**) for causing the drying air to recirculate along the drying air recirculation path, a drying air moisture condensing and heating system (**205-220,270**) located in the drying air recirculation path for dehydrating the moisture-laden drying air leaving the laundry treatment chamber and heating the dehydrated drying air before it re-enters into the laundry treatment chamber, wherein the drying air moisture condensing and heating system comprises a
 10 heat pump operating with a refrigerant fluid, the heat pump comprising a refrigerant fluid compressor (**205**) and a refrigerant fluid expansion device (**220**), wherein:

- the refrigerant fluid compressor is a variable-output compressor, capable of being driven to work at different compressor working modes, each compressor working mode corresponding to a respective compressor power consumption course and/or compressor rotational speed course
 15 and/or frequency course of the supply current/voltage of the compressor, and

- the refrigerant fluid expansion device is a variable expansion device, controllable to provide different refrigerant fluid mass-flow rates,

wherein the appliance has a user interface (**121**) comprising a laundry drying cycle selector (**205**) operable by a user for selecting one out of a number of default laundry drying cycles (**C₁, C₂, C₃,..., C_k**), and a control unit (**245**) adapted to control the machine operation, said control the machine operation comprising commanding the compressor to work at a default output corresponding to the selected default laundry drying cycle, controlling the expansion device to provide a default refrigerant fluid mass-flow rate corresponding to the selected default laundry drying cycle, and commanding the drying air propeller motor to work at a default average speed corresponding to the
 20 selected default laundry drying cycle,
 25

and wherein the user interface comprises a command input means (**255**) operable by the user for imparting to the appliance a command in response to which the control unit:

- commands the compressor to work at a changed compressor output course with respect to the default output;

30 - controls the expansion device to provide a correspondingly changed refrigerant fluid

mass-flow rate with respect to the default refrigerant fluid mass-flow rate corresponding to the selected default laundry drying cycle, and

- commands the drying propeller motor to work at a changed average speed with respect to the default average speed corresponding to the selected drying cycle.

5

2. The appliance of claim 1, wherein said changed compressor output course corresponds to an increased compressor output course, increased with respect to the default compressor output course, said changed refrigerant fluid mass-flow rate is an increased refrigerant fluid mass-flow rate with respect to the default refrigerant fluid mass-flow rate, and said changed speed is an increased speed with respect to the default speed.

10

3. The appliance of any of claims 1 or 2, comprising a compressor cooling fan (**221**) for cooling the compressor, the control unit controlling a compressor cooling fan motor (**223**) so as to control the activation and/or speed of the compressor cooling fan in dependence of a default limit temperature of a sensed refrigerant fluid temperature, and wherein in response to the user imparting said command through said command input means the control unit changes the default limit temperature so that the activation period of the compressor cooling fan and/or the speed of the compressor cooling fan is/are changed, particularly reduced.

15

4. The appliance of any one of the preceding claims, wherein said command input means (**255**) comprise a pushbutton or a touchbutton on a touch screen, said pushbutton or touchbutton being distinct from the drying cycle selector.

20

5. The appliance of any one of the preceding claims, wherein the laundry treatment chamber comprises a rotatable drum (**200**) caused to rotate by a drum motor (**240**), and wherein said drying air propeller motor and said drum motor are a selfsame motor.

25

6. The appliance of claim 5 as depending on claim 2, wherein said increased speed does

not exceed an average drum rotation speed that may cause laundry to get stuck on the drum inner walls.

5 7. The appliance of any one of claims 1 to 4, wherein the laundry treatment chamber comprises a rotatable drum (205) caused to rotate by a drum motor, and wherein said drying air propeller motor (340f) is distinct and distinctly operated with respect to said drum motor (340d).

10 8. The appliance of any one of the preceding claims, wherein the user interface comprises display means (260) for displaying relevant information to the user, and wherein when the control unit (245) receives the user command imparted by the user through the command input means, the control unit causes the appliance to give a confirmation to the user by displaying on the display means an indication (261).

15 9. The appliance of claim 8, wherein the user interface comprises acoustic means, and wherein when the control unit (245) receives the user command imparted by the user through the command input means, the control unit causes the appliance to give a confirmation to the user by causing the acoustic means emit an acoustic signal.

20 10. The appliance of any one of the preceding claims, wherein said variable expansion device comprises a first capillary and a second capillary providing different mass-flow rates, and a valve, controlled by the control unit, to cause the refrigerant fluid selectively pass through either the first or the second capillary.

25 11. The appliance of any one of claims 1 to 9, wherein said variable expansion device comprises a first capillary and a second capillary arranged in series, and a valve, controlled by the control unit, to selectively cause one of the first and second capillaries being bypassed.

12. The appliance of any one of claims 1 to 9, wherein said variable expansion device

comprises an electronic expansion valve capable of self-adjusting the provided mass-flow rate to a detected refrigerant fluid temperature detected by a temperature sensor (410) based on settings (405) provided thereto by the control unit, and wherein the control unit controls the variable expansion device to provide said correspondingly changed refrigerant fluid mass-flow rate with
5 respect to the default refrigerant fluid mass-flow rate corresponding to the selected default laundry drying cycle by providing to the electronic expansion valve changed settings, different from default settings.

13. The appliance of any one of claims 1 to 9, wherein said variable expansion device
10 comprises a variable expansion valve, the control unit controlling the variable expansion valve to set the opening thereof.

14. The appliance of any one of the preceding claims, wherein said command input means (255) are configured so as to allow the user to select more than one changed compressor output
15 course, changed refrigerant fluid mass-flow of the expansion device and changed average speed of the drying air propeller.

15. The appliance of any one of the preceding claims, wherein the change in the compressor output course, refrigerant fluid mass-flow rate provided by the variable expansion
20 device and average working speed of the drying air propeller depends on the selected laundry drying cycle.

16. The appliance of any one of the preceding claims, wherein when the control unit receives the command imparted by the user through the command input means, the refrigerant
25 fluid compressor is power-controlled or rotation speed-controlled by the control unit.

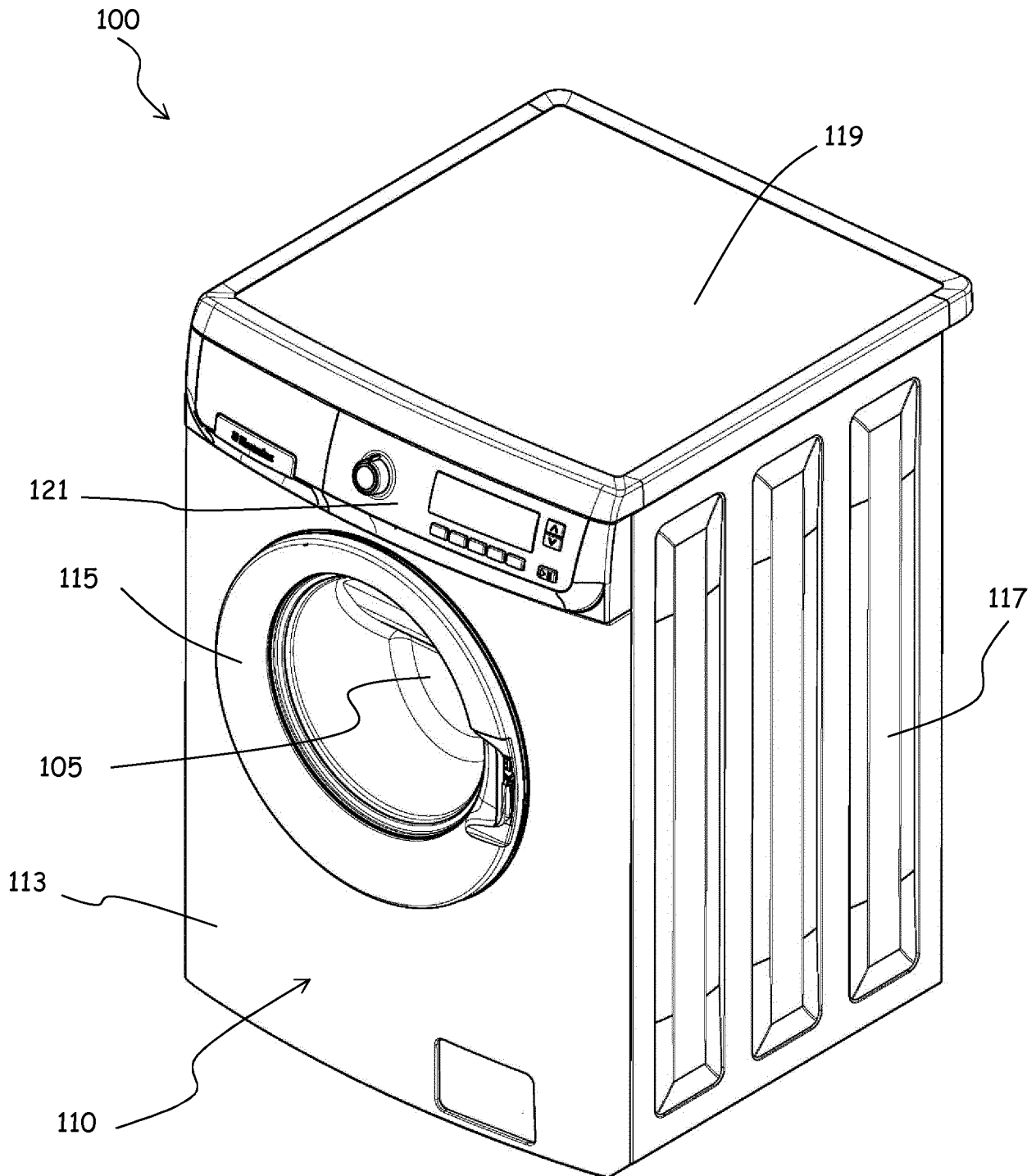
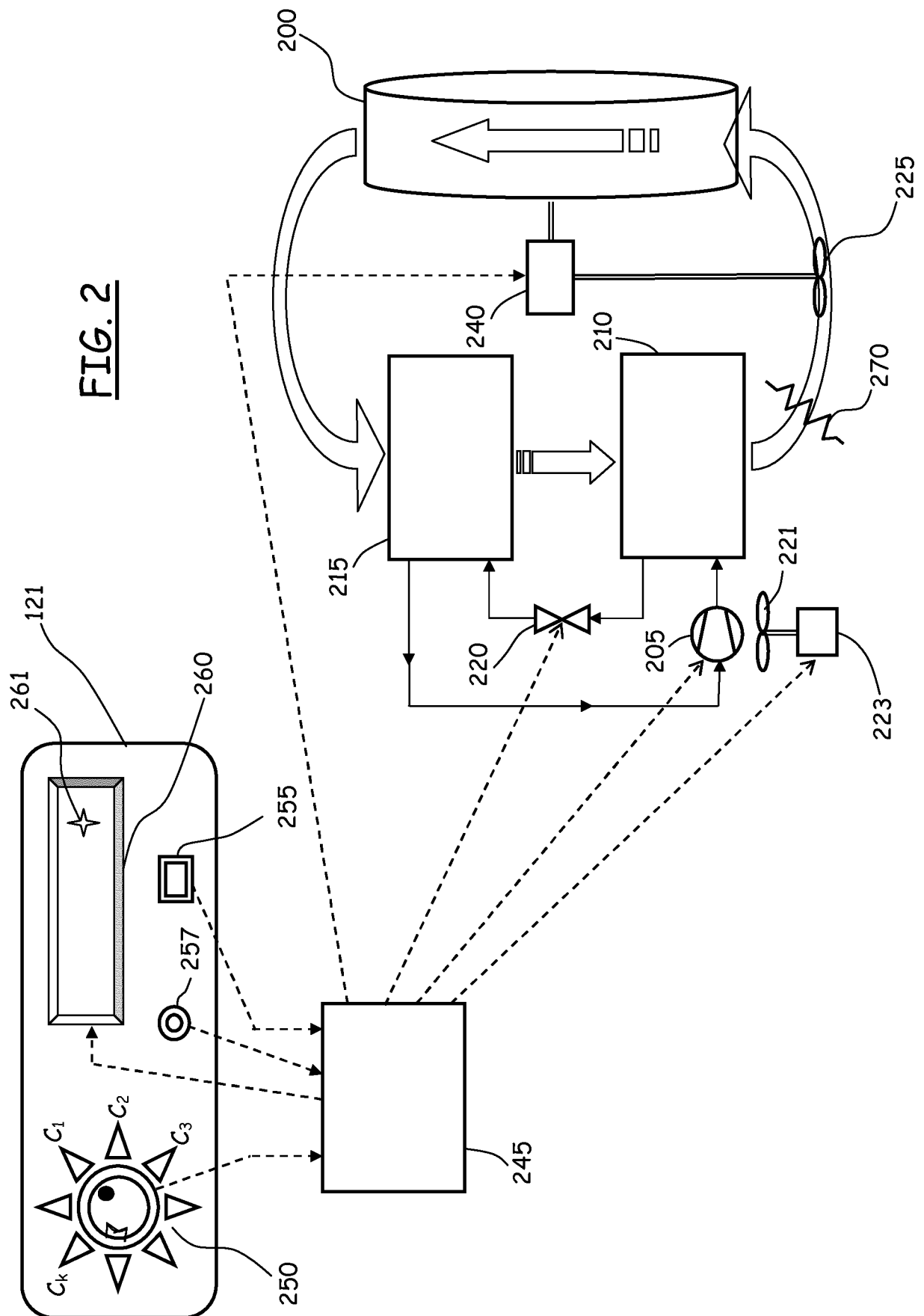
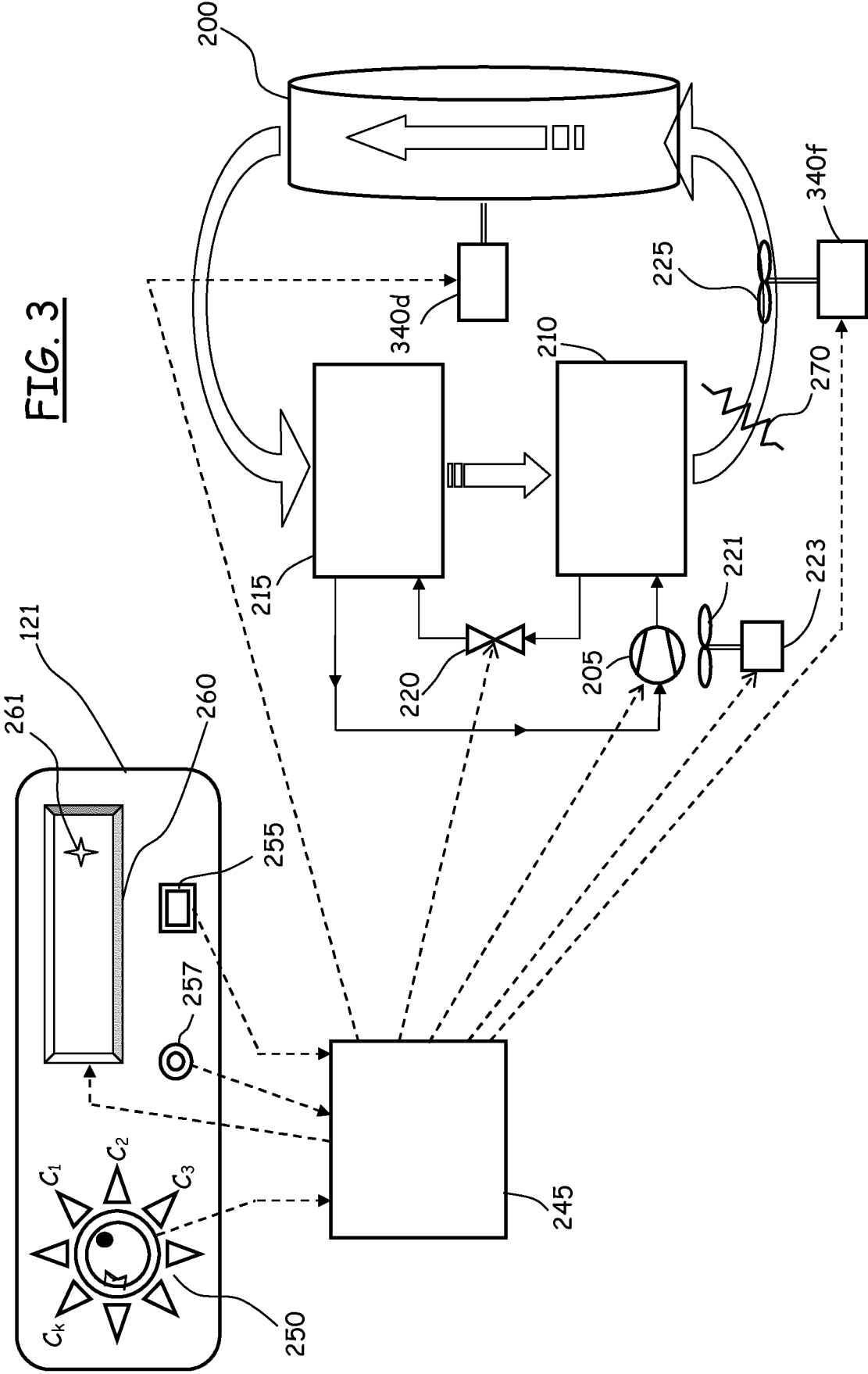
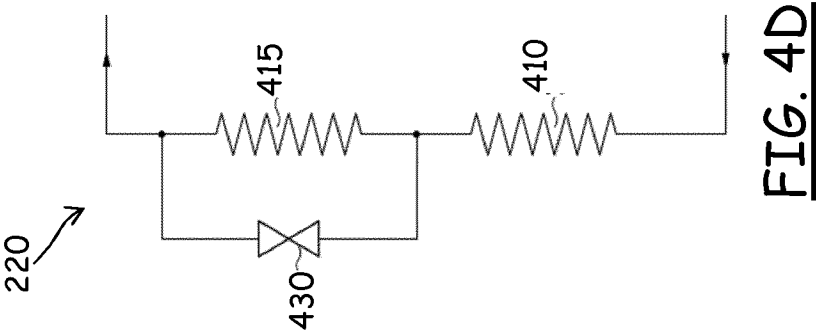
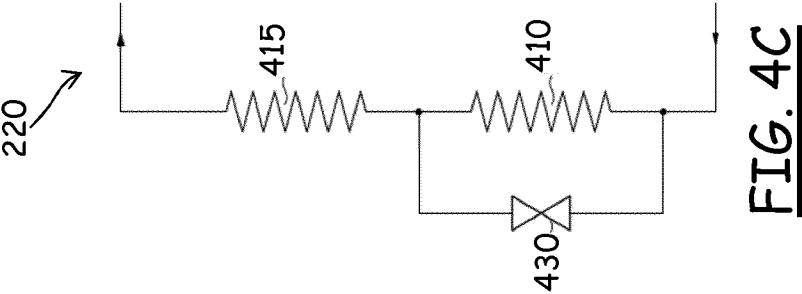
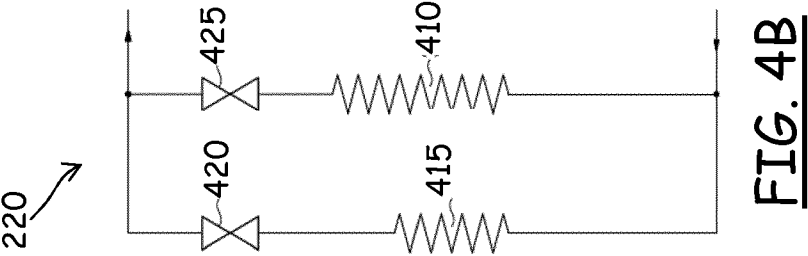
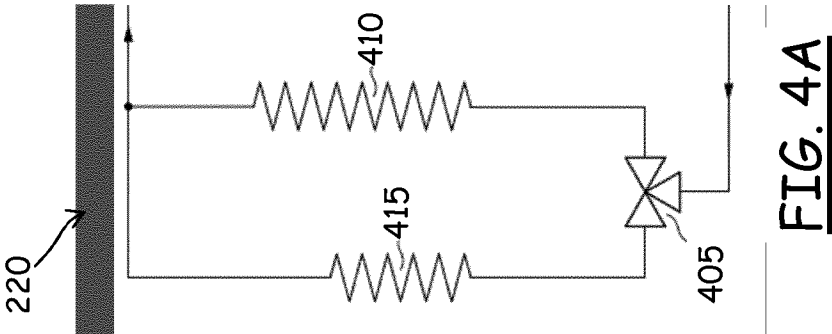


FIG. 1

FIG. 2







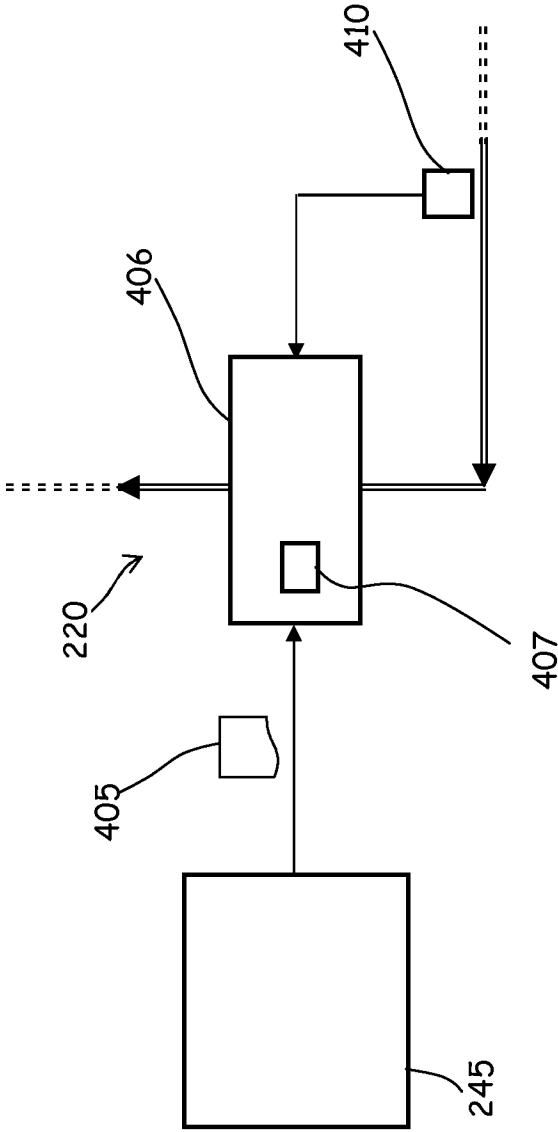


FIG. 4E

FIG. 5

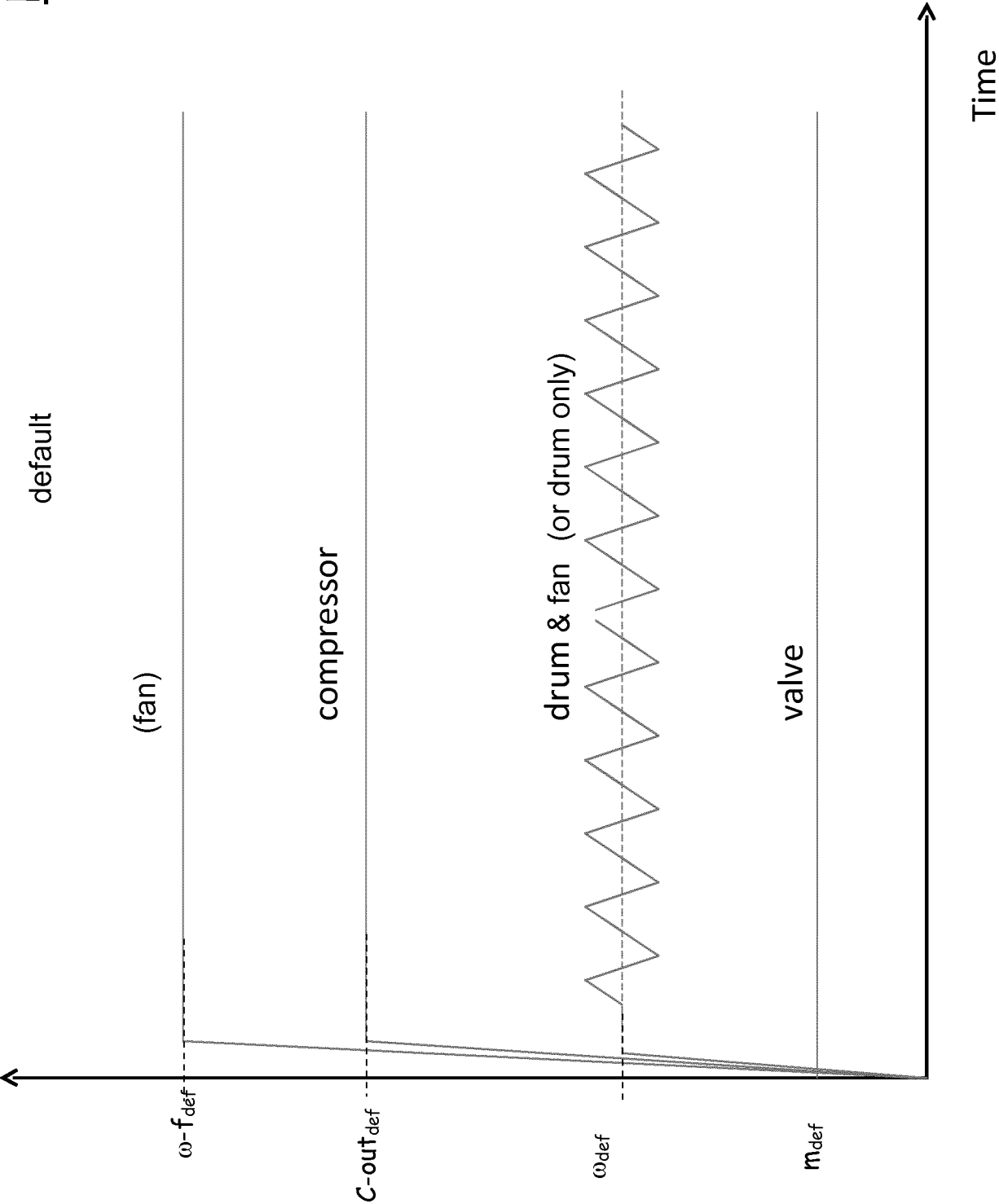
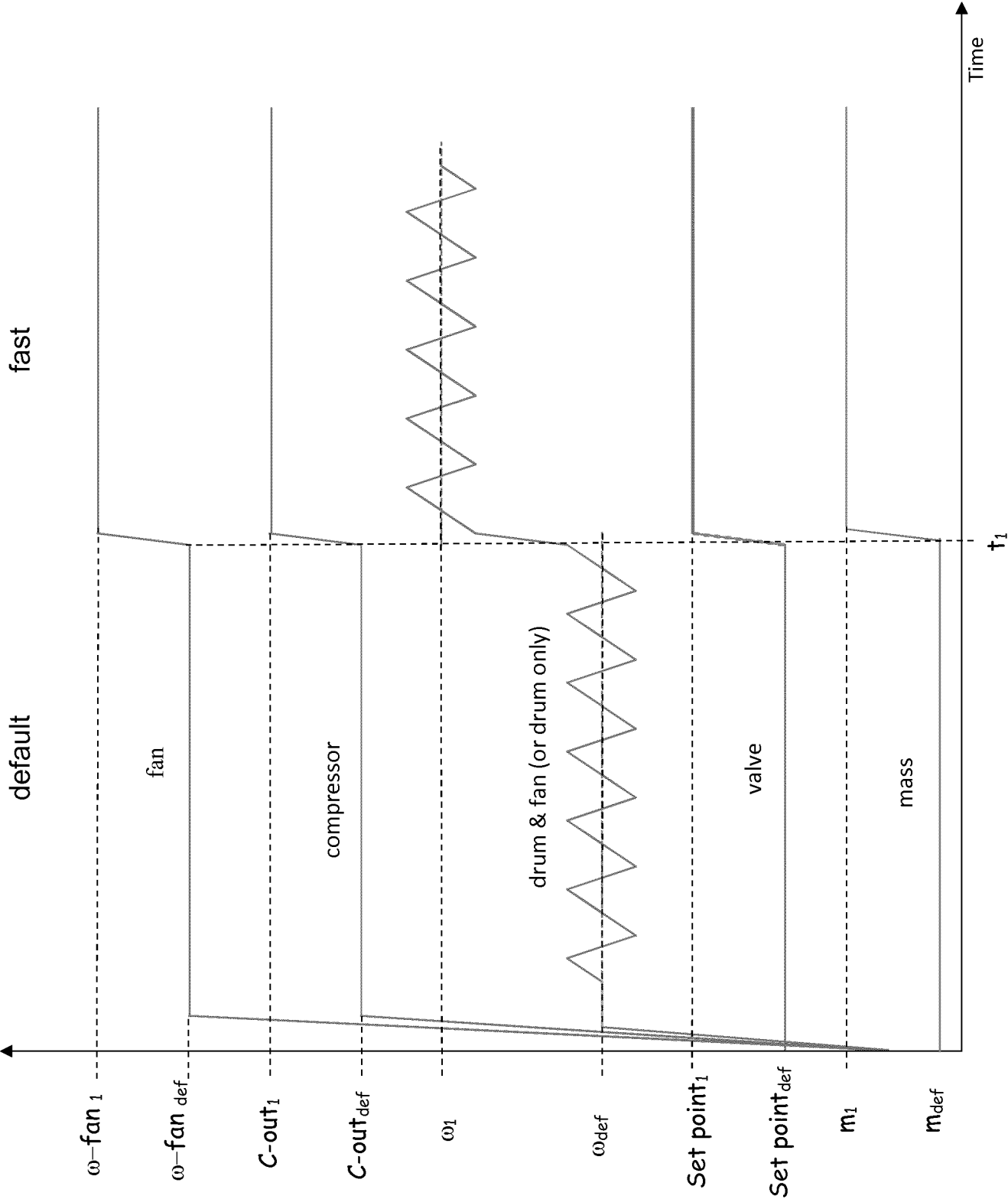


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2013/064499

A. CLASSIFICATION OF SUBJECT MATTER
 INV. D06F58/20
 ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 D06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CH 701 466 A2 (V ZUG AG [CH]) 15 December 2010 (2010-12-15) cited in the application the whole document -----	1-16
A	EP 2 586 906 A1 (ELECTROLUX HOME PROD CORP [BE]) 1 May 2013 (2013-05-01) cited in the application the whole document -----	1-16
A	EP 2 270 276 A1 (ELECTROLUX HOME PROD CORP [BE]) 5 January 2011 (2011-01-05) cited in the application the whole document -----	1-16
A	EP 2 527 521 A1 (ELECTROLUX HOME PROD CORP [BE]) 28 November 2012 (2012-11-28) the whole document -----	1-16



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

3 April 2014

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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