



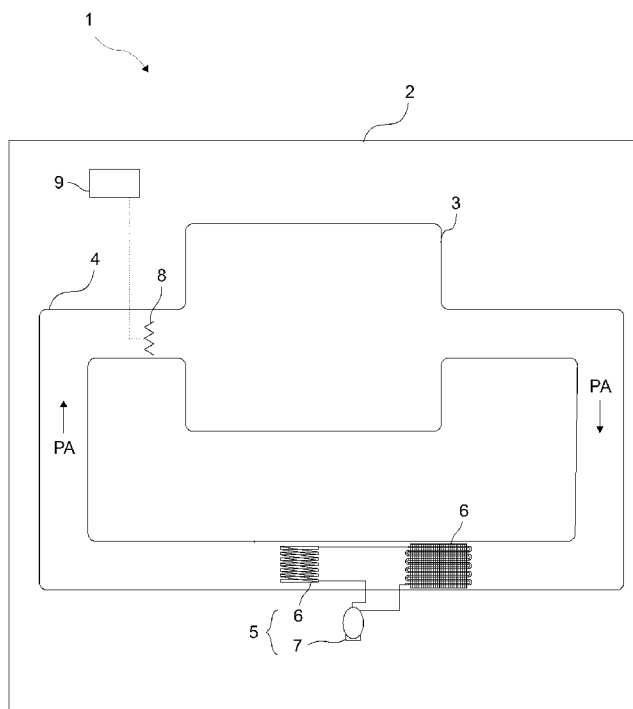
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- (71) Applicant: ARCELIK ANONIM SIRKETI [TR/TR]; E5
Ankara Asfalti Uzeri, Tuzla, 34950 Istanbul (TR).
- (72) Inventors: TUTKAK, Erman; E5 Ankara Asfalti Uzeri,
Tuzla, 34950 Istanbul (TR). BALIOGLU, Onder; E5
Ankara Asfalti Uzeri, Tuzla, 34950 Istanbul (TR). SIR,
Gokhan; E5 Ankara Asfalti Uzeri, Tuzla, 34950 Istanbul
(TR).

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[Continued on next page]

- (54) Title: A HEAT PUMP LAUNDRY DRYER COMPRISING A HEATER

Figure 2



- (57) Abstract: The present invention relates to a laundry dryer (1) comprising a body (2), a tub (3) that is disposed inside the body (2) and wherein the drying process is performed, an air channel (4) wherein the circulation of the process air (PA) is performed, a heat pump (5) that provides the dehumidification and/or the heating of the process air (PA) and that has at least one heat exchanger (6) and a compressor (7) that pumps the refrigerant fluid by pressurizing to the heat exchangers (6), and a heater (8) that is disposed on the air channel (4) and that provides the heating of the process air (PA).



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Description**A HEAT PUMP LAUNDRY DRYER COMPRISING A HEATER**

- [0001] The present invention relates to a laundry dryer wherein the laundry is enabled to be dried in a shorter time span by means of a heat pump and a heater.
- [0002] The heat pump laundry dryers have long drying durations along with low energy consumptions. Heaters are used in order to shorten the drying duration. In this type of hybrid dryers, the low energy consumption of the heat pump and the fast heating feature of the heater are utilized. However, keeping the heater open during the drying duration causes the temperatures inside the dryer to rise and the high temperature causes the compressor, one of the components of the heat pump, to shut down. The compressors shut down themselves at high temperatures for safety reason and can be activated again only after cooling down. The circulation of the refrigerant fluid cannot be performed in the time duration the compressor is deactivated and therefore the heat exchanger cannot perform its dehumidifying function. This situation prolongs the drying time and also shortens the life span of the compressor.
- [0003] In the state of the art European Patent Application No. EP2722432, a clothes laundry dryer is disclosed, wherein the heater is controlled depending on at least one physical parameter of the refrigerant fluid.
- [0004] In the state of the art European Patent Application No. EP2636787, a laundry dryer is disclosed, that controls the heater depending on the operating state of the compressor.
- [0005] In the state of the art American Patent Application No. US5245764, a laundry dryer is disclosed, that does not have a heat pump and wherein the heaters are controlled in a two heater system.
- [0006] The aim of the present invention is the realization of a laundry dryer wherein the compressor is used effectively and the drying duration is shortened.
- [0007] The laundry dryer realized in order to attain the aim of the present invention, explicated in the first claim and the respective claims thereof, comprises a control unit that calculates a limit temperature value by using

the value of the current drawn by the compressor, the temperature value of the refrigerant fluid and the temperature value of the process air and determines the temperature values whereat the heater is turned on and off by comparing the limit temperature value with the ambient temperature value.

- [0008] In the laundry dryer of the present invention, after the compressor starts operating at the beginning of the drying process, the value of the current drawn by the compressor is read by the respective sensor and transmitted to the control unit. Similarly, the temperature value of the refrigerant fluid and the temperature value of the process air are read by the respective sensors and transmitted to the control unit. The process air temperature measured just at the start of the drying process is almost equal to the ambient temperature. The control unit determines a limit temperature value by using the said three data. The calculated limit temperature value is at a level comparable to the ambient temperature. The control unit compares the limit temperature value with the ambient temperature value measured by the respective sensor. The control unit determines the operating temperatures of the heater as a result of the comparison and controls the heater by turning the same on and off at the said temperatures after the operating temperatures of the heater are determined. By means of the present invention, the cut-in and cut-out temperatures of the heater can be different for each drying cycle and the required conditions for the said drying cycle are taken into consideration. Thus, the heater is kept under control during the drying process and is operated at conditions where the compressor is not allowed to be closed. What is desired to be explained by the operating temperatures of the heater or the operating parameters of the heater are the cut-in temperature of the heater and the cut-out temperature of the heater and these terms are used for the aim of abbreviation.
- [0009] In an embodiment of the present invention, the control unit determines three different cut-in and cut-out temperatures for the heater depending on the limit temperature value and the ambient temperature value being equal, greater or smaller with respect to one another.

- [0010] In an embodiment of the present invention, the control unit uses the cut-in temperature of the heater and the cut-out temperature of the heater determined as a result of the experiments realized by the producer and saved in its memory when the ambient temperature is equal to the limit temperature. In the memory of the control unit, the operating temperatures of the heater predetermined for each limit temperature is recorded and the control unit determines the operational parameters of the heater from the table recorded in its memory.
- [0011] In another embodiment of the present invention, the control unit determines higher heater operating temperatures than the cut-in and cut-out temperature values determined when the ambient temperature and the limit temperature value are equal to one another and saved in its memory if the ambient temperature value is smaller than the limit temperature value. In this embodiment, in situations where the ambient temperature value is low, the heater is operated at higher operating temperatures by taking into consideration that the compressor will cool faster. Parallel to the above-explained embodiment, the control unit controls the heater by taking the operational parameters of the heater that have to be used from the chart recorded in its memory when the limit temperature is greater than the ambient temperature.
- [0012] In another embodiment of the present invention, the control unit determines lower operating temperatures for the heater than the cut-in and cut-out temperatures of the heater recorded in its memory and determined when the ambient temperature value and the limit temperature value are equal to one another if the ambient temperature value is greater than the limit temperature value. In this embodiment, if the environment where the laundry dryer is located is warmer than normal conditions, the temperature value of the compressor rises faster and naturally takes longer to cool down. Accordingly, the heater is operated at lower temperatures, thus preventing the compressor from shutting down itself due to overheating. Parallel to the above-explained embodiment, the control unit controls the heater by taking the operational parameters of the heater from the chart recorded in its memory that have to be used when the limit temperature is

smaller than the ambient temperature.

- [0013] In another embodiment of the present invention, the control unit calculates the operational parameters of the heater at the start of the drying process. By means of this embodiment, no operational parameter relating to the heater is saved in the memory of the control unit and the control unit calculates the operational parameters of the heater depending on the current conditions at the start of each drying process.
- [0014] In another embodiment of the present invention, the control unit calculates the operating values of the heater so as to be proportional with the difference between the limit temperature and the ambient temperature. By means of this embodiment, for example, if the ambient temperature is much colder than normal conditions, the heater is opened/closed at much higher temperatures or if the environment is very hot, the heater is operated at much lower temperatures. By means of this embodiment, it is not required to produce different laundry dryers for different regions (for example for cold northern countries and hot equatorial countries), and the control unit controls the heater most appropriately in accordance with the environmental conditions.
- [0015] In another embodiment of the present invention, the control unit determines the fixed operating range of a heater, in other words, difference between the cut-out temperature value of the heater and the cut-in temperature value of the heater independently from the comparison of the ambient temperature value and the limit temperature value. In this embodiment, the heater is operated at a constant operating range under every condition however the starting and ending points of the operating range are determined according to the result of the comparison realized by the control unit.
- [0016] In another embodiment of the present invention, when the ambient temperature value is greater than the limit temperature value, the control unit determines a wider operating range for the heater than the operating range determined when the ambient temperature value and the limit temperature value are equal to one another. If the ambient temperature value is higher than normal, cooling of the heater takes longer than

normal. Therefore, the heater provides the temperature that shortens the duration of the drying process without requiring being opened/closed frequently. In this situation, the control unit operates the heater in a wider operating range for the benefit of both the heater and the compressor.

- [0017] In another embodiment of the present invention, when the ambient temperature value is smaller than the limit temperature value, the control unit determines a narrower operating range for the heater than the operating range determined when the ambient temperature value and the limit temperature value are equal to one another. When the ambient temperature value is lower than normal, the heater, like the compressor, cools down faster after being shut down. Therefore, the heater is operated in a narrower operating range and the heater is enabled to be activated more frequently so that the drying duration is kept shorter.
- [0018] In another embodiment of the present invention, the control unit provides the measurement of the current drawn by the compressor, the temperature of the refrigerant fluid and the temperature of the process air at intervals predetermined by the producer during drying. By using the measured values, new limit temperature values are calculated in the same drying cycle. As a result of comparing the ambient temperature with the newly calculated limit temperature value, the opening/closing temperature values of the heater are determined again. Accordingly, during the drying cycle if an abnormal situation is encountered, like the mains voltage fluctuation, the operating conditions of the heater are changed. Thus, the compressor is enabled to operate almost without closing down during the drying cycle.
- [0019] In the laundry dryer of the present invention, the factors that affect the operation of the compressor are monitored and operation of the heater is determined by means of the factors affecting the compressor, and the compressor is prevented from shutting itself by making the operation of dehumidifying the process air continuous and the duration of the drying is shortened.
- [0020] The laundry dryer realized in order to attain the aim of the present invention is illustrated in the attached figures, where:
- [0021] Figure 1 – is the perspective view of a laundry dryer.

[0022] Figure 2 – is the sideways schematic view of the laundry dryer relating to an embodiment of the present invention.

[0023] The elements illustrated in the figures are numbered as follows:

[0024] 1. Laundry dryer

[0025] 2. Body

[0026] 3. Tub

[0027] 4. Air channel

[0028] 5. Heat pump

[0029] 6. Heat exchanger

[0030] 7. Compressor

[0031] 8. Heater

[0032] 9. Control unit

[0033] The following symbols are used for explicating the laundry dryer (1) of the present invention:

[0034] PA : Process air

[0035] I_{komp} : Compressor current

[0036] T_{PA} : Process air temperature

[0037] $T_{soğ}$: Refrigerant fluid temperature

[0038] T_{ortam} : Ambient temperature

[0039] T_{limit} : Limit temperature

[0040] $T_{aç}$: Heater cut-in temperature

[0041] $T_{aç1}$: Heater cut-in temperature when the ambient temperature is smaller than the limit temperature

[0042] $T_{aç2}$: Heater cut-in temperature when the ambient temperature is equal to the limit temperature

[0043] $T_{aç3}$: Heater cut-in temperature when the ambient temperature is greater than the limit temperature

[0044] T_{kapa} : Heater cut-out temperature

[0045] T_{kapa1} : Heater cut-out temperature when the ambient temperature is smaller than the limit temperature

[0046] T_{kapa2} : Heater cut-out temperature when the ambient temperature is equal to the limit temperature

[0047] T_{kapa3} : Heater cut-out temperature when the ambient temperature is

greater than the limit temperature

[0048] ΔT : Operating range of the heater

[0049] $\Delta T1$: Operating range of the heater when the ambient temperature is smaller than the limit temperature

[0050] $\Delta T2$: Operating range of the heater when the limit temperature is equal to the ambient temperature

[0051] $\Delta T3$: Operating range of the heater when the ambient temperature is greater than the limit temperature

[0052] The laundry dryer (1) comprises a body (2), a tub (3) that is disposed inside the body (2) and wherein the drying process is performed, an air channel (4) wherein the circulation of the process air (PA) is performed, a heat pump (5) that provides the dehumidification and/or the heating of the process air (PA) and that has at least one heat exchanger (6) and a compressor (7) that pumps the refrigerant fluid by pressurizing to the heat exchangers (6), and a heater (8) that is disposed on the air channel (4) and that provides the heating of the process air (PA).

[0053] In the laundry dryer (1) the user loads the items to be dried into the tub (3) and starts the drying process. The process air (PA) that provides drying enters the tub (3), dehumidifies the clothes in the tub (3) and leaves the tub (3). The process air (PA) leaving the tub (3) is dehumidified and heated by circulating in the air channel (4) and the drying cycle is performed thus. Heating of the process air (PA) is realized by means of the heat pump (5) and/or the heater (8). The process air (PA) is dehumidified by means of the heat exchanger (6) that forms a cold surface by the low temperature refrigerant fluid that is pumped by the compressor (7). When the humid process air (PA) passes over the heat exchanger (6) having the cold surface, the moisture contained in the process air (PA) condenses on the heat exchanger (6).

[0054] The laundry dryer (1) of the present invention comprises a control unit (9) that monitors the compressor current (I_{komp}), the temperature of the process air (T_{PA}) and the refrigerant fluid temperature ($T_{soğ}$) by the respective sensors (not shown in the figures), calculates a limit temperature (T_{limit}) by using the compressor current (I_{komp}), the

temperature of the process air (T_{PA}) and the refrigerant fluid temperature ($T_{soğ}$) and compares the limit temperature (T_{limit}) with the ambient temperature (T_{ortam}) and determines the heater cut-in temperature ($T_{aç}$) and the heater cut-out temperature (T_{kapa}).

- [0055] The current value (I_{komp}), drawn by the compressor (7), the temperature of the process air (T_{PA}) and the temperature of the refrigerant fluid ($T_{soğ}$) are measured by means of the sensors known in the technique. The sensors transmit the measured values to the control unit (9). The temperature of the process air (T_{PA}) is equal to the ambient temperature (T_{ortam}) at the start of the drying cycle and is heated when the heat pump (5) or the heater (8) operates thus becoming different from the ambient temperature (T_{ortam}). The refrigerant fluid temperature ($T_{soğ}$) can be measured from any point on the duct where circulation of the refrigerant fluid is realized and the measured value can be correlated with the temperature of the compressor (7).
- [0056] The control unit (9) calculates a limit temperature (T_{limit}) by using the compressor current (I_{komp}), temperature of the process air (T_{PA}) and the temperature of the refrigerant fluid ($T_{soğ}$) received from the sensors. Afterwards, the calculated limit temperature (T_{limit}) is compared with the ambient temperature (T_{ortam}). The control unit (9) determines at which temperature value the heater (8) is operated, in other words the heater cut-in temperature ($T_{aç}$) and at which temperature the heater (8) is deactivated, in other words the heater cut-off temperature (T_{kapa}) depending on the result of the comparison.
- [0057] The heater (8) is turned off when the surface of the heater (8) reaches the determined cut-off temperature (T_{kapa}). The heater (8) cools down when turned off since temperature values generated by the heat pump (5) are lower than that of the heater (8). When the surface of the heater (8) is lowered to the heater cut-in temperature ($T_{aç}$), the heater (8) is operated again and performs its function, i.e. heating the process air (PA). By using the compressor current (I_{komp}) and the temperature of the refrigerant fluid ($T_{soğ}$) in determining the heater cut-out temperature (T_{kapa}) and the heater cut-in temperature ($T_{aç}$), the compressor (7) is prevented from overheating

or drawing excessive current and shutting down. Moreover, by using the temperature of the process air (T_{PA}), cooling time of the heater (8) when not operating is predicted and thus the heater (8) is enabled to remain deactivated for a minimum amount of time. In summary, in the present invention, the compressor (7) is prevented from closing by overheating or drawing excessive current by taking into consideration the factors that affect operation of the compressor (7) and the drying duration is shortened by operating the heater (8) for as long a time as possible.

[0058] In an embodiment of the present invention, the control unit (9) determines three different heater cut-in temperatures ($T_{a\zeta}$) and heater cut-out temperatures (T_{kapa}) as a result of the comparison of the limit temperature (T_{limit}) with the ambient temperature (T_{ortam}), in other words, depending on the limit temperature (T_{limit}) and the ambient temperature (T_{ortam}) being equal, greater or smaller than one another. When the ambient temperature (T_{ortam}) is equal to the limit temperature (T_{limit}) ($T_{ortam} = T_{limit}$), the heater (8) is operated and closed at the heater cut-in temperature ($T_{a\zeta2}$) and the heater cut-out temperature (T_{kapa2}) and if the ambient temperature (T_{ortam}) is greater than the limit temperature (T_{limit}) ($T_{ortam} > T_{limit}$), the heater (8) is operated and closed between heater cut-in temperature ($T_{a\zeta3}$) and the heater cut-out temperature (T_{kapa3}). When the ambient temperature (T_{ortam}) is smaller than the limit temperature (T_{limit}) ($T_{ortam} < T_{limit}$), the heater (8) is operated and closed between heater cut-in temperature ($T_{a\zeta1}$) and the heater cut-out temperature (T_{kapa1}). When the different heater cut-in temperatures ($T_{a\zeta1}$, $T_{a\zeta2}$, $T_{a\zeta3}$) and the different heater cut-out temperatures (T_{kapa1} , T_{kapa2} , T_{kapa3}) are desired to be mentioned together, generally the heater cut-in temperature ($T_{a\zeta}$) and the heater cut-out temperature (T_{kapa}) will be used.

[0059] In a version of this embodiment, the control unit (9) operates the heater (8) between the heater cut-in temperature ($T_{a\zeta2}$) and the heater cut-out temperature (T_{kapa2}) that correspond to the respective limit temperature (T_{limit}) which is prerecorded in its memory by the producer when the ambient temperature (T_{ortam}) and the limit temperature (T_{limit}) are equal to one another. The heater cut-in temperature ($T_{a\zeta2}$) and the heater cut-out

temperature (T_{kapa2}) that correspond to a certain limit temperature (T_{limit}) obtained from the experiments performed by the producer are saved in the memory of the control unit (9) and when the ambient temperature (T_{ortam}) is equal to the limit temperature (T_{limit}), the control unit (9) controls the heater (8) by using the values saved in its memory. In this embodiment, the control unit (9) determines the heater cut-in temperature ($T_{a\zeta2}$) and the heater cut-out temperature (T_{kapa2}) by taking from a chart saved in its memory.

[0060] In another version of this embodiment, the control unit (9) operates the heater (8) between a heater cut-in temperature ($T_{a\zeta1}$) that is greater than the heater cut-in temperature ($T_{a\zeta2}$) and a heater cut-out temperature (T_{kapa1}) that is greater than the heater cut-out temperature (T_{kapa2}) that are saved in its memory when the ambient temperature (T_{ortam}) is smaller than the limit temperature (T_{limit}). In this embodiment, the heater (8) is operated at higher temperature values ($T_{a\zeta1} > T_{a\zeta2}$ and $T_{kapa1} > T_{kapa2}$) .since the heater (8) cools down faster when deactivated in low ambient temperature value (T_{ortam}). In this embodiment, as in the above-explained embodiment, the control unit (9) takes the respective values from the chart saved in its memory.

[0061] In another version of this embodiment, the control unit (9) operates the heater (8) between a heater cut-in temperature ($T_{a\zeta3}$) that is smaller than the heater cut-in temperature ($T_{a\zeta2}$) and the heater cut-out temperature (T_{kapa3}) that is smaller than the heater cut-out temperature (T_{kapa2}) that are saved in its memory when the ambient temperature (T_{ortam}) is greater than the limit temperature (T_{limit}). For example, when the ambient temperature (T_{ortam}) is equal to the limit temperature (T_{limit}), if the heater cut-in temperature ($T_{a\zeta2}$) is saved as 65°C and the heater cut-out temperature (T_{kapa2}) as 75°C in the chart, and when the ambient temperature (T_{ortam}) is greater than the limit temperature (T_{limit}), the heater cut-in temperature ($T_{a\zeta3}$) is saved as 60°C and the heater cut-out temperature (T_{kapa3}) as 70 °C in the chart in the memory of the control unit (9) ($T_{a\zeta3} < T_{a\zeta2}$ and $T_{kapa3} < T_{kapa2}$).

[0062] In another embodiment of the present invention, the control unit (9)

calculates the heater cut-in temperature ($T_{a\zeta 1}$, $T_{a\zeta 2}$, $T_{a\zeta 3}$) and the heater cut-out temperature (T_{kapa1} , T_{kapa2} , T_{kapa3}) at the start of the drying process depending on the values of the limit temperature (T_{limit}) and the ambient temperature (T_{ortam}) with respect to one another. In this embodiment, unlike the above-mentioned embodiments, the control unit (9) calculates the heater cut-in temperature ($T_{a\zeta}$) and the heater cut-out temperature (T_{kapa}) by its microprocessor (not shown in the figures) after calculating the limit temperature (T_{limit}) and comparing the same with the ambient temperature (T_{ortam}) at the start of the drying process. Thus, in the drying process, the operating parameters of the heater (8) are specially determined according to the current conditions.

- [0063] In a version of this embodiment, the control unit (9) calculates the heater cut-in temperature ($T_{a\zeta}$) and the heater cut-out temperature (T_{kapa}) in proportion to the difference between the limit temperature (T_{limit}) and the ambient temperature (T_{ortam}). Therefore, the heater (8) is controlled adaptively depending on the difference between the limit temperature (T_{limit}) and the ambient temperature (T_{ortam}).
- [0064] In another embodiment of the present invention, the control unit (9) determines the operating range (ΔT) of the heater (8), that is the difference between the heater cut-out temperature (T_{kapa}) and the heater cut-in temperature ($T_{a\zeta}$) ($\Delta T = T_{kapa} - T_{a\zeta}$) independently from the respective values of the ambient temperature (T_{ortam}) and the limit temperature (T_{limit}) and so as to be constant in all conditions ($\Delta T = T_{kapa} - T_{a\zeta} = T_{kapa1} - T_{a\zeta 1} = T_{kapa2} - T_{a\zeta 2} = T_{kapa3} - T_{a\zeta 3}$). In this embodiment, the control unit (9) determines only the heater cut-in temperature ($T_{a\zeta}$) or the heater cut-out temperature (T_{kapa}) with respect to the relation between the limit temperature (T_{limit}) and the ambient temperature (T_{ortam}) and calculates the undetermined value by using the constant operating range (ΔT) value.
- [0065] In another embodiment of the present invention, when the ambient temperature (T_{ortam}) is greater than the limit temperature (T_{limit}), the control unit (9) determines the operating-range (ΔT) of the heater (8) to be wider ($\Delta T_3 > \Delta T_2$) than the state when they are equal. When the ambient temperature (T_{ortam}) is greater than the limit temperature (T_{limit}), the

heater (8) is operated at lower temperature values and cooling of the heater (8) takes time. In this situation, the heater (8) is operated at a wider operating range (ΔT_3) so that the heater (8) is not activated frequently.

- [0066] In another embodiment of the present invention, when the ambient temperature (T_{ortam}) is smaller than the limit temperature (T_{limit}), the control unit (9) determines the operating range (ΔT) of the heater (8) to be narrower ($\Delta T_1 < \Delta T_2$) than the state when they are equal. Since the heater (8) and the compressor (7) cool down faster when the ambient temperature (T_{ortam}) is low, the heater (8) is operated at a narrower operating range (ΔT_1) so that the drying duration is not prolonged. For example, if the operating range of the heater (ΔT_2) is 20°C then the operating range of the heater (ΔT_1) is 10°C.
- [0067] In another embodiment of the present invention, during the drying process, the control unit (9) updates the limit temperature (T_{limit}) calculated by the data received previously from the respective sensors at certain intervals and accordingly the heater cut-in temperature (T_{ac}) and the heater cut-out temperature (T_{kapa}). By means of this embodiment, in the case of any abnormality during the drying process, the compressor (7) is enabled to continue to operate without shutting down by changing the operating parameters of the heater (8).
- [0068] In another embodiment of the present invention, the laundry dryer (1) has the function of washing clothes at the same time. In this embodiment, the laundry is both washed and dried in the desired dryness rate after washing.
- [0069] In the laundry dryer (1) of the present invention, the operating values of the heater (8), the heater cut-in temperature (T_{ac}) and the heater cut-out temperature (T_{kapa}) are determined adaptively depending on the state of the compressor (7). By means of the present invention, the heater (8) is controlled such that the process air (PA) temperature is so low that the compressor (7) does not shut off itself and high enough for the laundry to be dried in a short period of time, briefly, the operation of the heater (8) is optimized by using the current drawn by the compressor (I_{komp}), the process air (PA) temperature and the temperature of the refrigerant fluid (T

soğ).

Claims

1. A laundry dryer (1) **comprising** a body (2), a tub (3) that is disposed inside the body (2) and wherein the drying process is performed, an air channel (4) wherein the circulation of the process air (PA) is performed, a heat pump (5) that provides the dehumidification and/or the heating of the process air (PA) and that has at least one heat exchanger (6) and a compressor (7) that pumps the refrigerant fluid by pressurizing to the heat exchangers (6), and a heater (8) that is disposed on the air channel (4) and that provides the heating of the process air (PA), **characterized by** a control unit (9) that calculates a limit temperature (T_{limit}) by using the compressor current (I_{komp}), the temperature of the process air (T_{PA}) and the refrigerant fluid temperature ($T_{\text{soğ}}$) and determines the heater cut-in temperature ($T_{\text{aç}}$) and the heater cut-out temperature (T_{kapa}) by comparing the limit temperature (T_{limit}) with the ambient temperature (T_{ortam}) .
2. A laundry dryer (1) as in Claim 1, **characterized by** the control unit (9) that determines three different heater cut-in temperatures ($T_{\text{aç1}}$, $T_{\text{aç2}}$, $T_{\text{aç3}}$) and heater cut-out temperatures (T_{kapa1} , T_{kapa2} , T_{kapa3}) at the start of the drying process depending on the values of the limit temperature (T_{limit}) and the ambient temperature (T_{ortam}) with respect to one another.
3. A laundry dryer (1) as in Claim 2, **characterized by** the control unit (9) that operates the heater (8) between the heater cut-in temperature ($T_{\text{aç2}}$) and the heater cut-out temperature (T_{kapa2}) that correspond to the respective limit temperature (T_{limit}) in its memory when the limit temperature (T_{limit}) is equal to the ambient temperature (T_{ortam}) .
4. A laundry dryer (1) as in Claim 2, **characterized by** the control unit (9) that operates the heater (8) between a heater cut-in temperature ($T_{\text{aç1}}$) that is greater than the heater cut-in temperature ($T_{\text{aç2}}$) saved in its memory and the heater cut-out temperature (T_{kapa1}) that is greater than the heater cut-out temperature (T_{kapa2}) saved in its memory when the ambient temperature (T_{ortam}) is smaller than the limit temperature (T_{limit}) .
5. A laundry dryer (1) as in Claim 2, **characterized by** the control unit (9) that operates the heater (8) between a heater cut-in temperature ($T_{\text{aç3}}$) that is smaller than the heater cut-in temperature ($T_{\text{aç2}}$) saved in its memory and the

heater cut-out temperature (T_{kapa3}) that is smaller than the heater cut-out temperature (T_{kapa2}) saved in its memory when the ambient temperature (T_{ortam}) is greater than the limit temperature (T_{limit}).

6. A laundry dryer (1) as in Claim 2, **characterized by** the control unit (9) that calculates the heater cut-in temperatures (T_{ac1} , T_{ac2} , T_{ac3}) and the heater cut-out temperatures (T_{kapa1} , T_{kapa2} , T_{kapa3}) at the start of the drying process depending on the values of the limit temperature (T_{limit}) and the ambient temperature (T_{ortam}) with respect to one another.
7. A laundry dryer (1) as in Claim 6, **characterized by** the control unit (9) that calculates the heater cut-in temperature (T_{ac}) and the heater cut-out temperature (T_{kapa}) in proportion to the difference between the limit temperature (T_{limit}) and the ambient temperature (T_{ortam}).
8. A laundry dryer (1) as in Claim 2, **characterized by** the control unit (9) that enables the heater (8) to operate in the same heater operating range (ΔT) under all conditions.
9. A laundry dryer (1) as in Claim 5, **characterized by** the control unit (9) that determines the heater operating range ($\Delta T3$) to be wider than the heater operating range ($\Delta T2$) in the state where the ambient temperature (T_{ortam}) is equal to the limit temperature (T_{limit}), when the ambient temperature (T_{ortam}) is greater than the limit temperature (T_{limit}).
10. A laundry dryer (1) as in Claim 4, **characterized by** the control unit (9) that determines the heater operating range value ($\Delta T1$) to be narrower than the heater operating range ($\Delta T2$) in the state where the ambient temperature (T_{ortam}) is equal to the limit temperature (T_{limit}), when the ambient temperature (T_{ortam}) is smaller than the limit temperature (T_{limit}).
11. A laundry dryer (1) as in any one of the above claims, **characterized by** the control unit (9) that updates the limit temperature (T_{limit}) and accordingly the heater cut-in temperature (T_{ac}) and the heater cut-out temperature (T_{kapa}) obtained as a result of comparing the limit temperature (T_{limit}) with the ambient temperature (T_{ortam}) at certain intervals predetermined by the producer during the same drying process.

Figure 1

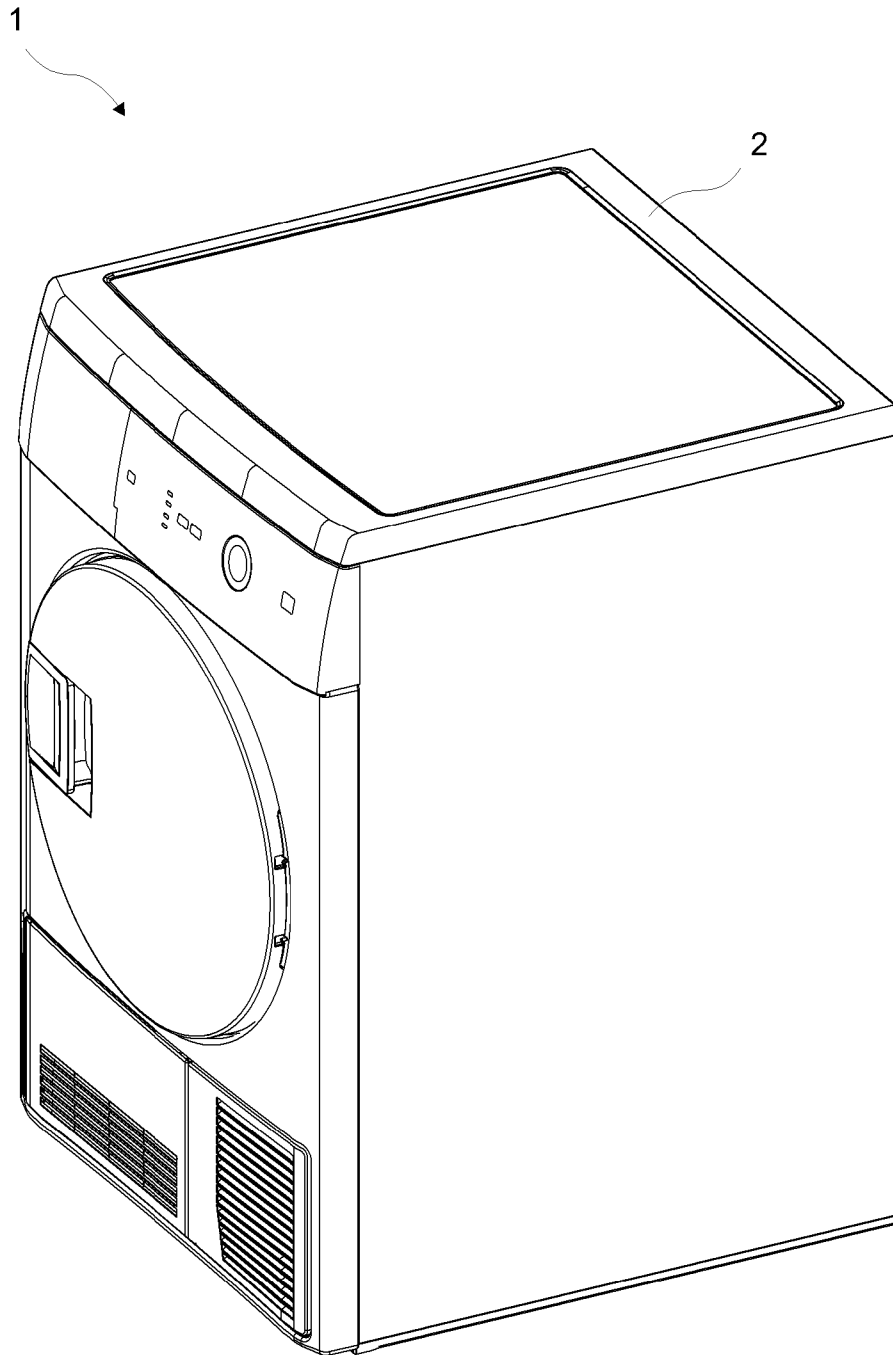
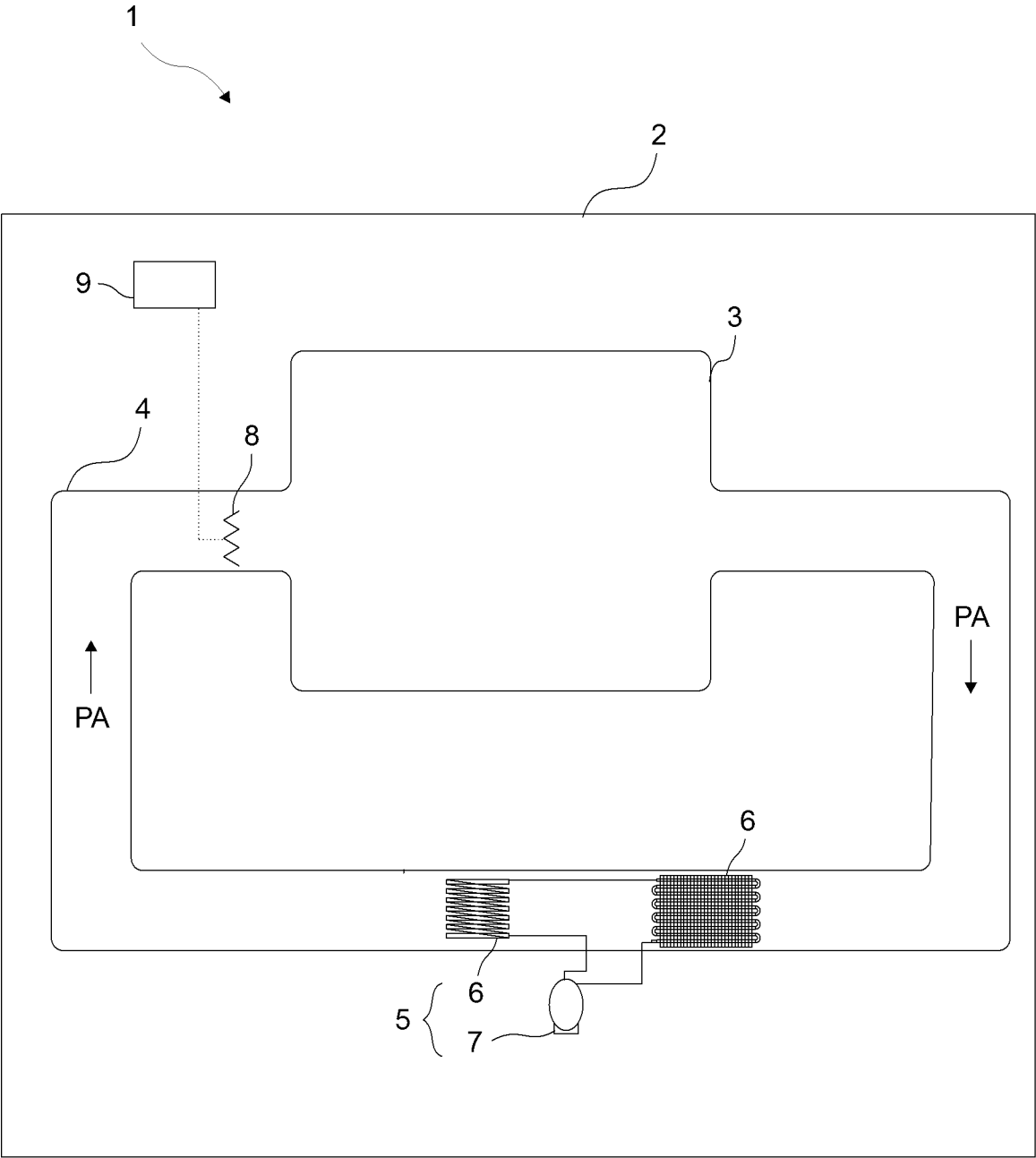


Figure 2



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/064917

A. CLASSIFICATION OF SUBJECT MATTER INV. D06F58/20 D06F58/26 D06F58/28 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	US 2014/020260 A1 (CAROW JAMES P [US] ET AL) 23 January 2014 (2014-01-23) the whole document -----	1-11
A	US 2012/017464 A1 (BEERS DAVID G [US] ET AL) 26 January 2012 (2012-01-26) the whole document -----	1-11
A	US 2015/082658 A1 (CONTARINI ANDREA [IT] ET AL) 26 March 2015 (2015-03-26) the whole document -----	1-11
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents :		
"A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 31 August 2016		Date of mailing of the international search report 14/09/2016
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Prosig, Christina

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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