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(54) Title: LAUNDRY WASHER-DRYER

(57) Abstract: The present invention relates to a laundry washer-dryer (1) comprising a drum (2) wherein the laundry is washed and dried; a tub (3) wherein the drum (2) moves; a circulation duct (4); a heater (5) which is disposed into the air duct (4) and which provides the heating of the process air; a fan (6); a condenser (7); a condenser inlet (8) which allows the passage of the process air from the drum (3) to the condenser (7), and wherein the drying process is performed by carrying out the first phase drying step (I), the second phase drying step (II) and the aeration step (III).

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LAUNDRY WASHER-DRYER

The present invention relates to a washer-dryer wherein the load is detected in the drying process after the washing process.

In the drying process in laundry washer-dryers, the air heated and passed over the laundry gets humid and then is condenser in the condenser. The air which is dehumidified and thus dried is heated and then delivered back onto the laundry through the process air duct. The drying program is performed in three steps which are the first phase drying step, the second phase drying step and the aeration step. In the first step the heater heating the process air and the fan circulating the process air are generally operated continuously and thus the air in the drum is heated. The heated air gets in contact with the laundry and then is passed through the condenser to be dehumidified. The dehumidified air is passed over the heater to be heated and delivered back into the drum. In the first step of the drying program the temperature of the process air increases. The first step ends when the process air temperature detected by the temperature sensor, for example an NTC thermistor, reaches a certain value. In the second step, similar to the first step, the heater and the fan are operated; however, the heater can be intermittently (turn on/turn off) operated under the control of a second temperature sensor. The process air temperature is kept constant and the drying process continues in the steady state. In the last step of the drying process the heater is turned off and the fan is operated, thus the laundry is aerated to decrease the temperature thereof suitable for the contact of the user. In the state of the art different drying programs are performed for different amounts of laundry (load) and since load detection is not part of the drying program, it becomes difficult to provide savings in time and energy. For energy efficiency and for drying different loads of same type of laundry with a single drying program, the amount of load must be detected and the program must automatically make relevant changes.

In the Patent Application No. WO2008077968 (A1), in a laundry washer-dryer the process air temperature is measured by the temperature sensor and the control unit calculates the rate of increase in the temperature values detected by the temperature sensor.

The aim of the present invention is the realization of a laundry washer-dryer wherein the laundry load is detected in the drying program after the washing process, thus performing the suitable drying process and decreasing energy consumption.

In the laundry washer-dryer realized in order to attain the aim of the present invention, in the first step of the drying program the process air temperature is measured by means of a temperature sensor, for example an NTC thermistor. By means of a timer the time required for the process air to reach a predetermined limit temperature is measured. The control unit calculates the rate of increase in the process air temperature according to the data received from the temperature sensor and the timer and calculates the amount of laundry depending on the rate of increase in temperature. If the time to reach the limit temperature is low, meaning if the temperature rapidly increases, it is understood that the laundry load is lower than a threshold value. Similarly, if the time to reach the limit temperature is high, meaning if the temperature slowly increases, it is understood that the laundry load is higher than a threshold value. After determining the laundry load, the control unit regulates the following steps of the drying program according to the load, for example if the load is lower than the threshold value, the drying time is shortened, thus decreasing the energy consumption.

The laundry washer-dryer realized in order to attain the aim of the present invention is illustrated in the attached figures, where:

Figure 1 - is the schematic view of a laundry washer-dryer.

Figure 2 - is the graphic showing the change in power drawn by the heater with respect to time in the drying program where the heater is operated in the turn on/turn off mode in the second phase drying step.

Figure 3 - is the graphic showing the change in power drawn by the heater with respect to time in the drying program where the heater is operated in continuous mode in the second phase drying step.

The elements illustrated in the figures are numbered as follows:

1. Laundry washer-dryer
2. Drum

3. Tub
4. Air duct
5. Heater
6. Fan
7. Condenser
8. Condenser inlet
9. Control unit
10. Temperature sensor
11. Timer
12. Voltmeter

I: First phase drying step

II: Second phase drying step

III: Aeration step

W: Power

T: Time

The laundry washer-dryer (1) comprises a drum (2) wherein the laundry is washed and dried; a tub (3) wherein the drum (2) moves; a circulation duct (4) wherein the process air circulation, providing the drying of the laundry, is performed after the washing process; a heater (5) which is disposed into the air duct (4) and which provides the heating of the process air; a fan (6) which provides circulation of the process air in the circulation duct (4); a preferably water-cooled or air-cooled condenser (7) which is connected to the circulation duct (4) and wherein the process air (PA) passing therethrough is condensed; a condenser inlet (8) which is provided at the part of air duct (4) connected to the tub (3) and which allows the passage of the process air from the drum (3) to the condenser (7), and a control unit (9) which performs the drying process by carrying out, after the washing process and from the beginning of the drying step with the process air, the first phase drying step (I) wherein the heater (5) is operated and the load is detected, the

second phase drying step (II) wherein the heater (5) is intermittently (turn on/turn off) operated or continuously operated if needed and the time changes depending on the load and lastly the aeration step (III). The graphic in Figure 2 shows the change in power (W) drawn by the heater (5) with respect to time (T) in the drying program wherein the first phase drying step (I), the second phase drying step (II) and the aeration step (III) are carried out.

The laundry washer-dryer (1) of the present invention comprises

- a temperature sensor (10), for example an NTC (Negative Temperature Coefficient) thermistor which is disposed at the condenser inlet (8) of the air duct (4) and which detects the temperature of the process air dehumidifying the laundry and entering the condenser (7) to be condensed, and

- a timer (11) which measures the time (T-ölçülen: measured time) required for the process air to reach a predetermined limit temperature in the first phase drying step (I).

The control unit (9) calculates the rate of increase in the process air temperature according to the data received from the temperature sensor (10) and the timer (11) and calculates the amount of laundry (laundry load) depending on the rate of increase in temperature.

The control unit (9) decides that the rate of increase in the process air temperature is high and the laundry load is low with respect to the predetermined threshold loads if the time measured (T-ölçülen) to reach the limit temperature in the first phase drying step (I) is low with respect to the predetermined threshold time values.

The control unit (9) decides that the rate of increase in the process air temperature is low and the laundry load is high with respect to the predetermined threshold loads if the time measured (T-ölçülen) to reach the limit temperature in the first phase drying step (I) is high with respect to the predetermined threshold time values.

In sum, the control unit (9) decides that the laundry load is low if the measured time (T-ölçülen) is low and that the laundry load is high if the measured time (T-ölçülen) is high.

Upon determining the laundry load in the first phase drying step (I), the control unit (9) determines the temperature and time values of the second phase drying step (II) according to said load. If the laundry load in the first phase drying step (I) is lower than the predetermined threshold values, the cut-in times of the heater (5) and the total drying program time in the second phase drying step (II) are decreased. If the laundry load in the first phase drying step (I) is higher than the predetermined threshold values, the cut-in times of the heater (5) and the total drying program time in the second phase drying step (II) are increased.

In the laundry washer-dryer (1), after the washing process and before the drying process with the process air, the preheating and the thermal spin-drying steps are performed and the laundry is prepared for the drying process. These steps are carried out in the same time period for all the declared laundry loads. The laundry load is determined by the control unit (9) in the first phase drying step (I) and the second phase drying step (II) is performed according to the load. In the first phase drying step (I) if the laundry load is low the process air temperature increases more quickly and if the laundry load is high the process air temperature increases slowly due to the dense humidity. According to the data received from the temperature sensor (10) and the timer (11), the control unit (9) decides that the laundry load is low if the process air temperature increases "quickly" and that the laundry load is high if the process air temperature increases "slowly". Upon determining the laundry load, the control unit (9) determines again the temperature and time values of the second phase drying step (II) according to said laundry load detected.

In an embodiment of the present invention, the control unit (9) compares the time measured (T-ölçülen) in the first phase drying step (I), hence the rate of increase in the process air, with the lower and higher threshold time values (T-alt eşik, T-üst eşik) for different laundry loads and determines the laundry load amount as "quarter load", "half load" and "full load".

The control unit (9) determines the laundry load as "quarter load" if the measured time of the first phase drying step (I) is lower than the lower threshold time value (T-ölçülen < T-alt eşik).

The control unit (9) determines the laundry load as "half load" if the measured time of the first phase drying step (I) is between the lower threshold time value and the higher threshold time value (T-alt eşik < T-ölçülen < T-üst eşik).

The control unit (9) determines the laundry load as "full load" if the measured time of the first phase drying step (I) is higher than the higher threshold time value (T-ölçülen > T-üst eşik).

In another embodiment of the present invention, the laundry washer-dryer (1) comprises a voltmeter (12) measuring the mains voltage and the control unit (9) calculates the laundry load according the data received from the voltmeter (12), that is according to the fluctuations in the mains voltage.

If the mains voltage measured by the voltmeter (12) in the first phase drying step (I) is in the 220-240 volt range, which is considered "normal", the control unit (9) carries out the second phase drying step (II) according to the laundry load determined by the temperature sensor (10) and the timer (11).

If the mains voltage measured by the voltmeter (12) in the first phase drying step (I) is lower than the normal value, the control unit (9) decides that the laundry load is "lower" than the laundry load determined by the temperature sensor (10) and the timer (11). If the mains voltage is lower than the normal value, the heater (5) heats up late, the measure time (T-ölçülen) increases and the laundry load determined by the temperature sensor (10) and the timer (11) is calculated "erroneously as high". The control unit (9) revises the laundry load as "lower" according to the lower voltage data received from the voltmeter (12).

If the mains voltage measured by the voltmeter (12) in the first phase drying step (I) is higher than the normal value, the control unit (9) decides that the laundry load is "higher" than the laundry load determined by the temperature sensor (10) and the timer (11). If the mains voltage is higher than the normal value, the heater (5) heats up quicker, the measure time (T-ölçülen) decreases and the laundry load determined by the temperature sensor (10) and the timer (11) is calculated "erroneously as low". The control unit (9)

revises the laundry load as "higher" according to the higher voltage data received from the voltmeter (12).

In the laundry washer-dryer (1), the drying process is performed in a manner suitable to the laundry load thanks to the detection of the load. Consequently, the drying time and the energy consumption are decreased.

CLAIMS

1 - A laundry washer-dryer (1) **comprising** a drum (2); a tub (3); a circulation duct (4); a heater (5) which provides the heating of the process air; a fan (6) which provides circulation of the process air; a condenser (7) which is connected to the circulation duct (4) and wherein the process air passing therethrough is condensed; a condenser inlet (8) which allows the passage of the process air from the drum (3) to the condenser (7), and a control unit (9) which carries out the first phase drying step (I) wherein the load is detected and the second phase drying step (II) wherein the time changes depending on the load, **characterized by**

- a temperature sensor (10) which is disposed at the condenser inlet (8) of the air duct (4) and which detects the temperature of the process air dehumidifying the laundry and entering the condenser (7) to be condensed,

- a timer (11) which measures the time required for the process air to reach a predetermined limit temperature in the first phase drying step (I), and

- the control unit (9) which calculates the rate of increase in the process air temperature according to the data received from the temperature sensor (10) and the timer (11) and calculates the laundry load depending on the rate of increase in temperature.

2 - A laundry washer-dryer (1) as in Claim 1, **characterized by** the control unit (9) which decides that the laundry load is low with respect to the predetermined threshold loads if the time measured to reach the limit temperature in the first phase drying step (I) is low with respect to the predetermined threshold time values.

3 - A laundry washer-dryer (1) as in Claim 1 or 2, **characterized by** the control unit (9) which decides that the laundry load is high with respect to the predetermined threshold loads if the time measured to reach the limit temperature in the first phase drying step (I) is high with respect to the predetermined threshold time values.

4 - A laundry washer-dryer (1) as in Claim 1, **characterized by** the control unit (9), upon determining the laundry load in the first phase drying step (I), determines the temperature and time values of the second phase drying step (II) according to said load.

5 - A laundry washer-dryer (1) as in Claim 1, **characterized by** the control unit (9) which compares the time measured in the first phase drying step (I) with the lower and higher threshold time values for different laundry loads and determines the laundry load amount as "quarter load", "half load" and "full load".

6 - A laundry washer-dryer (1) as in Claim 5, **characterized by** the control unit (9) which determines the laundry amount as "quarter load" if the measured time of the first phase drying step (I) is lower than the lower threshold value.

7 - A laundry washer-dryer (1) as in Claim 5, **characterized by** the control unit (9) which determines the laundry amount as "half load" if the measured time of the first phase drying step (I) is between the lower threshold value and the higher threshold value.

8 - A laundry washer-dryer (1) as in Claim 5, **characterized by** the control unit (9) which determines the laundry amount as "full load" if the measured time of the first phase drying step (I) is higher than the higher threshold value.

9 - A laundry washer-dryer (1) as in Claim 1, **characterized by** a voltmeter (12) which measures the mains voltage, and by the control unit (9) which calculates the laundry load according to the data received from the voltmeter (12).

10 - A laundry washer-dryer (1) as in Claim 9, **characterized by** the control unit (9) which carries out the second phase drying step (II) according to the laundry load determined by the temperature sensor (10) and the timer (11) if the mains voltage measured by the voltmeter (12) in the first phase drying step (I) is within the normal range.

11 - A laundry washer-dryer (1) as in Claim 9, **characterized by** the control unit (9) which detects that the laundry load is lower than the laundry load determined by the temperature sensor (10) and the timer (11) if the mains voltage measured by the voltmeter (12) in the first phase drying step (I) is lower than the normal range.

12 - A laundry washer-dryer (1) as in Claim 9, **characterized by** the control unit (9) which detects that the laundry load is higher than the laundry load determined by the temperature sensor (10) and the timer (11) if the mains voltage measured by the voltmeter (12) in the first phase drying step (I) is higher than the normal range.

Figure 1

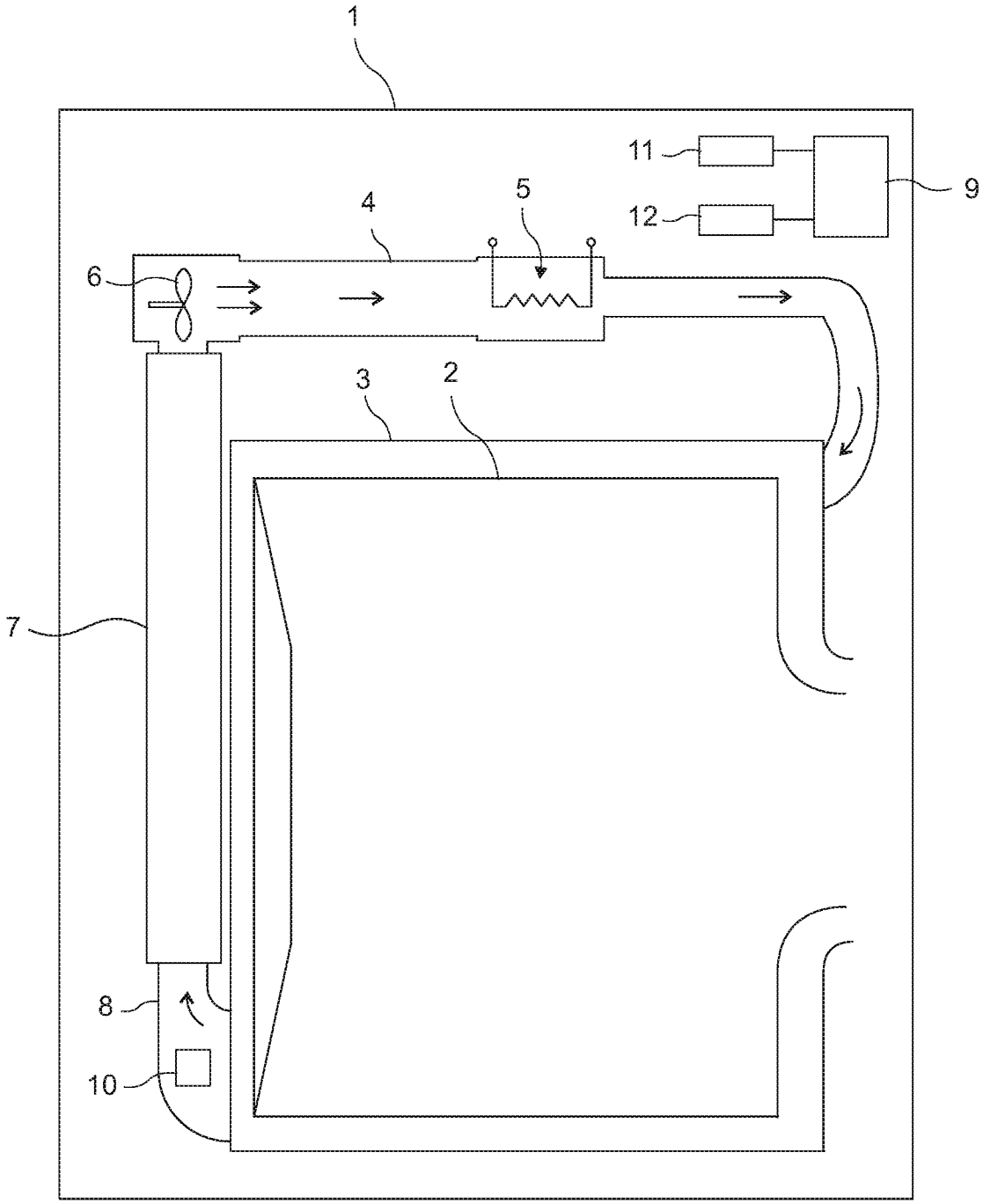

Figure 2

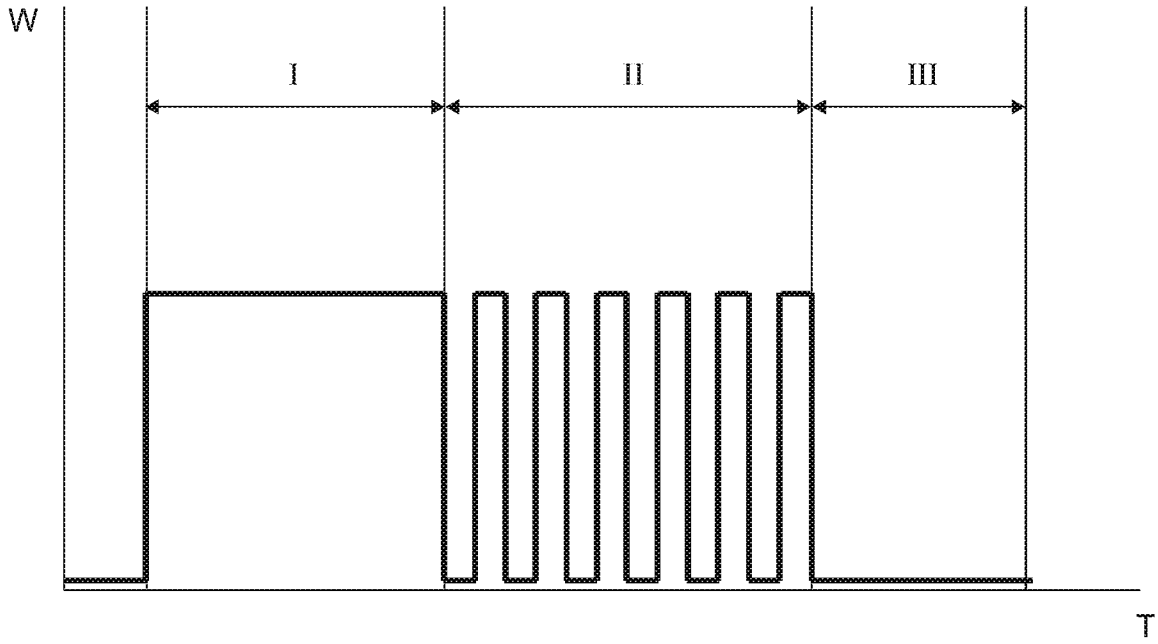

Figure 3