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(54) Title: A METHOD OF CONTROLLING A ROTATABLE-DRUM LAUNDRY DRYER AND A ROTATABLE-DRUM LAUNDRY DRYER IMPLEMENTING THE METHOD

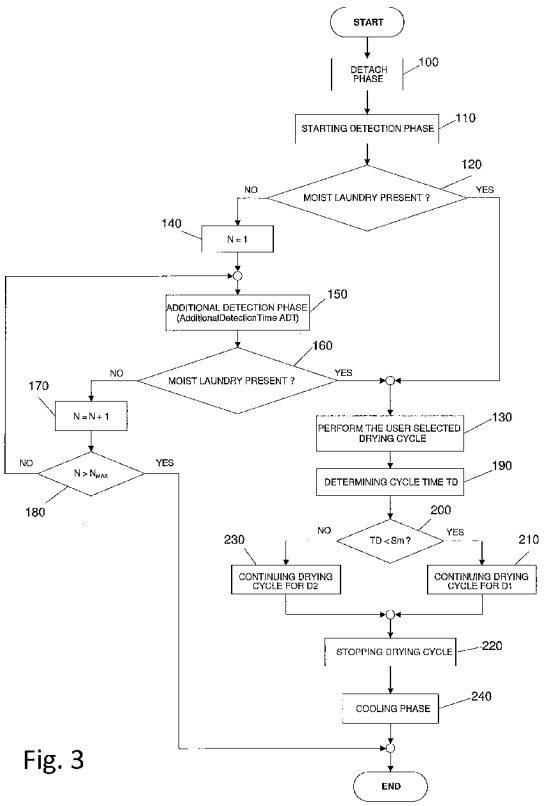


Fig. 3

(57) Abstract: A method of controlling a drying operation of a rotatable-drum laundry dryer (1) comprising a rotatable drum (3) for loading laundry (5) and at least an electrode sensor (22) for sensing dryness of the laundry (5). The method comprises the steps of: detecting the presence/absence of moist laundry (5) inside the rotatable drum (3) by the electrode sensor (22); if presence of moist laundry inside the rotatable drum (3) is detected, starting a drying cycle; sensing dryness of the laundry (5) during the drying cycle; measuring a cycle time (TD) at which the sensed dryness reaches a preset dryness threshold; if the cycle time (TD) is lower than a preset dryness threshold time (Sm), continuing the drying cycle for a first additional time (D1), and stopping the drying cycle at the end of the first additional time (D1).

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A METHOD OF CONTROLLING A ROTATABLE-DRUM LAUNDRY DRYER AND A ROTATABLE-DRUM LAUNDRY DRYER IMPLEMENTING THE METHOD

DESCRIPTION

The present invention relates to a method of controlling a rotatable-drum laundry dryer and a rotatable-drum laundry dryer implementing the method.

Methods of controlling rotatable-drum laundry dryers are known, in which: hot air is fed into the rotatable drum so as to flow over the laundry inside the drum; an electric parameter associated with the laundry moisture is measured by means of an electrode sensor arranged in order to contact with the laundry when drum rotates; the dryness of the laundry is determined according to the measured electric parameter; and the drying cycle is stopped when the measured electric parameter reaches a preset value associated with a prefixed final dryness.

More specifically, laundry dryers are known comprising an electronic control unit which receives a plurality of voltage signals having an amplitude and/or a frequency associated with the electric parameter of the laundry, i.e. impedance or resistance, or conductance, and measured a prefixed number of times; the electronic control unit determines the dryness of the laundry according to the measured voltage signals, and controls the drying cycle according to determined laundry dryness. For example the electrode sensor may be configured to output a voltage signal which is proportional to the dryness of the laundry. Thus, more dried is the laundry, higher is its electric parameter and consequently bigger is the voltage signal outputted from the electrode sensor.

The technical problem of the above-described prior-art laundry dryer is that when contacts between laundry and electrode sensor, during the drying cycle, are very

few, an incomplete dryness condition of the laundry may be performed, since the electronic control unit may erroneously conclude (or determine, resolve) that the few number of contacts between the laundry and the electrode corresponds to a dry condition of the laundry.

As a matter of the fact, research by the Applicant shows that when the above control method is performed in a rotary-drum home laundry dryer in which the electrode sensor is arranged outside the drum, i.e. in a position facing the opening in the drum, the frequency with which the laundry contacts the electrode sensor is reduced, or tends towards zero, when, for example, the laundry corresponds to a small load quantity, i.e. a single T-shirt, or when, for example, a "special" kind of laundry (e.g. a pillow), is loaded in the laundry dryer in such a way that it gets stuck inside the drum in such a position that it doesn't contact or only rarely contacts the electrode sensor.

In such cases, because the number of contacts laundry-electrode is very few and/or the electric signals outputted from electrode sensor are affected by high electric noise, the electronic control unit determines a high average value and, as a consequence, calculates a high electric parameter (impedance or resistance or conductance), and erroneously associate the latter with a dryness condition. Thus, electronic control unit may incorrectly conclude (or determine, resolve) that an expected drying condition of the laundry has been reached, and it may and stop the drying cycle too early, even if the laundry is still wet.

JP2000229200 discloses a clothes drying machine in which drying operation are controlled in the case of a small amount of laundry into the rotating drum. In particular, the drying machine is configured to start a drying course by measuring the number of contacts between electrode and laundry; to determine whether the laundry is a high load or small load based on the measured number of contacts; and if the determined laundry is a small load, to set the drying cycle period for twenty-five minutes, independently of the moisture of the laundry.

JP6312095 discloses a clothes drying machine which dries laundry independently of the its quantity, by executing the drying operation by a drying time setting timer when a small quantity signal is outputted from a clothes quantity judging device, while executing the drying operation, monitoring the dried state if the small quantity signal is not outputted. In detail, the clothes are agitated, and each time when the clothes come to an electrode which operates as clothes detector, is detected repeatedly. When the clothes detection signal which is detected up to the time-up of a clothes quantity judging timer is less than a standard value, a microcomputer incorporated in a control circuit outputs a small quantity signal from a clothes quantity judging device and forcibly executes the drying operation without monitoring the dried state of the clothes up to the time-up of a drying time setting timer. Under the condition that it is considered that the contact frequency of the clothes with the electrode is high and the reliability of the signal of the electrode is high, the drying operation is executed, judging the degree of dryness by the electrode.

Clothes drying machines disclosed in JP2000229200 and in JP6312095 have the problem that systems starts the drying cycle selected by the user and maintains operating the same in any case for a preset time, even if the drum is empty or the laundry is already dry, causing a useless wastage of electric energy.

It is therefore an object of the present invention to provide a solution designed to obviate one or more problems due to limitations and disadvantages of the related art, and in particular a solution which guarantees the user to control the rotatable-drum laundry dryer in order to assure a uniform laundry dryness, even if the laundry inside of the drum is few and/or is arranged inside the rotatable-drum so that number of contacts with the electrode sensor is very low, and at the same time strongly reducing the wastage of electric energy, in particular in case no laundry or already dry laundry is loaded in the rotatable drum.

According to the present invention, there is provided a method of controlling a

drying operation of a rotatable-drum laundry dryer comprising a rotatable drum for loading laundry and at least an electrode sensor for sensing dryness of the laundry. The method comprises: detecting the presence/absence of moist laundry inside the rotatable drum by the electrode sensor; if presence of moist laundry inside the rotatable drum is detected, starting a drying cycle; sensing dryness of the laundry during the drying cycle; measuring a cycle time at which the sensed dryness reaches a preset dryness threshold; if the cycle time is lower than a preset dryness threshold time, continuing the drying cycle for a first additional time, and stopping the drying cycle at the end of the first additional time.

Preferably the first additional time is such that the time elapsed from the beginning of the drying cycle and the stopping of the drying cycle is a preset minimum dryness time.

More preferably the first additional time is set as the difference from the preset minimum dryness time and the cycle time.

Advantageously the method comprises: if the cycle time is not lower than the preset dryness threshold time, continuing the drying cycle for a preset second additional time; and stopping the drying cycle at the end of the second additional time.

Preferably the second additional time is between zero and ten seconds.

Preferably determining the presence/absence of moist laundry inside the rotatable-drum comprises: performing a starting detection phase for a starting detection time; if no moist laundry has been detected during the starting detection time, performing one or more additional detection phases, each of which lasts an additional detection time; if no moist laundry has been detected during the additional detection phase/s, ending operation of rotatable-drum laundry dryer.

Advantageously the additional detection time is lower than the starting detection time.

The invention regards also a rotatable-drum laundry drier comprising: a rotatable

drum for loading laundry, a least an electrode sensor for sensing dryness of the laundry; feeding drying air means for feeding drying air into the drum, and rotating means for rotating the drum about an axis of rotation. The rotatable-drum dryer comprises electronic control means configured to: detect presence/absence of moist laundry inside the rotatable drum by the electrode sensor; if presence of moist laundry inside rotatable drum is detected, start a drying cycle; sense dryness of the laundry during the drying cycle; measure a cycle time at which the sensed dryness reaches a preset dryness threshold; if the cycle time is lower than a preset dryness threshold time, continue to perform the drying cycle for a first additional time, and stop the drying cycle at the end of the first additional time.

Advantageously the first additional time is such that the time elapsed from the beginning of the drying cycle and the stopping of the drying cycle is a preset minimum dryness time.

Preferably the first additional time is set as the difference from the preset minimum dryness time and the cycle time.

Opportunely the electronic control means are further configured to: continue to perform the drying cycle for a preset second additional dryness time if the cycle time is not lower than the preset dryness threshold time; and stop the drying cycle at the end of the preset second increased cycle time.

Advantageously the second additional time is between zero and ten seconds.

Preferably the electronic control means are further configured to: perform a starting detection phase for a starting detection time; if no moist laundry has been detected during the starting detection time, perform one or more additional detection phases; and if moist laundry have been detected during the additional detection phase/s, end operation of rotatable-drum laundry drier.

Advantageously each of the one or more additional detection phases lasts an additional detection time lower than the starting detection time.

A non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a schematic lateral cross section of a rotatable-drum laundry drier implementing the laundry drying control method according to the present invention;

Figure 2 shows an inner lateral wall of the Figure 1 rotatable-drum laundry drier; while

Figure 3 shows an operation flow chart of the control method implemented according to the present invention.

Number 1 in Figure 1 indicates as a whole a rotatable-drum laundry dryer comprising an outer casing 2, which preferably rests on the floor on a number of feet.

Casing 2 supports a rotatable laundry drum 3, which defines a drying chamber 4 for laundry 5 and rotates about a preferably, though not necessarily, horizontal axis of rotation 6. In an alternative embodiment not shown, axis of rotation 6 may be vertical or inclined.

Drying chamber 4 has a preferably frontal access opening 7 closable by a door 8 preferably hinged to casing 2.

Drum 3 may be rotated about axis of rotation 6 by an electric motor, schematically represented in Figure 1 and indicated with reference number 9, is fed with hot air heated by a heating device, schematically represented in Figure 1 and indicated with reference number 10, and is fed into drum 3 preferably by a fan schematically represented in Figure 1 and indicated with reference number 11. Fan 11 may preferably, though not necessarily, be driven by electric motor 9 or, in an alternative embodiment (not shown), by an auxiliary electric motor (not shown) independent of electric motor 9.

In the Figure 1 example, one opened side of the drum 3 of the laundry drier 1 is advantageously associated, in a rotatable and substantially air-tight way, to a perforated inner wall 12 fixed to a lateral wall of casing 2 and through which hot air flows into

drum 3; the other opened side of the drum 3 is advantageously associated, in a rotatable and substantially air-tight way, to a flange 13 associated to casing 2 and interposed between door 8 and front access opening 7 of drum 3.

In the Figures 1 and 2 example, flange 13 is fixed firmly to casing 2, and is positioned at front access opening 7 so as to project at least partly inside drum 3, so that its inner surface faces the laundry 5 when the latter is loaded into the drum 3.

Heating device 10 may advantageously comprise one or more electric heating components, such as electric resistors (not shown) or, in an alternative embodiment, a heat pump.

In actual use, fan 11 blows a stream of drying air (represented by the white arrows in Fig.1), produced by heating device 10, preferably through perforated inner wall 12 into drum 3. After contacting laundry 5 inside drum 3, the moisture-laden drying air flows out of drum 3 and it is preferably directed to a condensing device 15, which cools the drying air to condense the moisture inside it. For this purpose, condensing device 15 may be supplied with cold air from outside the drier, and feeds the moisture-free air to fan 11. It should be pointed out that condensing device 15 as described above applies, purely by way of example, to one possible embodiment of the present invention, and may be omitted in the case of an exhaust-type rotatable-drum laundry drier 1 (i.e. in which the hot and moisture-laden drying air from the rotatable laundry drum 3 is expelled directly out of rotatable-drum laundry drier 1).

The rotatable-drum laundry drier 1 also comprises an electronic control system 16, which is configured to control the rotatable-drum laundry drier 1, advantageously on the basis of a drying cycle selected by a user via a user control interface 18.

The electronic control system 16 advantageously comprises an electrode sensor 22 for detecting dryness of the laundry.

According to a preferred embodiment, the electrode sensor 22 is a contact electrode sensor type and comprises two metal plates 23 arranged on the flange 13 in a

position facing the inside of the drum 3, for sensing the dryness of laundry by using impedances generated at opposite ends of the metal plates 23 according to moisture content of the laundry 5 when the later is brought into contact with the opposite metal plates 23, and forwards the dryness as a electrical signal, i.e. a voltage signal. Nevertheless, it is obvious that electrical signal outputted by the electrode sensor 22 could be associated, for example, with the resistance and/or conductance of the laundry 5 sensed between the metal plates 23.

Preferably the electrode sensor is configured to generate an oscillating electrical signal and vary the frequency of oscillation of the electrical signal according to the laundry moisture/dryness.

The electronic control system 16 further comprises an electronic control unit 14, which is configured to control the electric motor 9, heating device 10 and/or fan 11 in order to regulate the rotation speed of the drum 3, the temperature and/or the flow rate of hot air entering the drum 3 according to preset temperatures and flow rates specified for the laundry drying cycle selected by the user.

Preferably, selectable laundry cycles may comprise for example, a “cotton laundry drying cycle”, a “synthetic fabric laundry drying cycle”, a “wool laundry drying cycle”, and a “delicate laundry drying cycle”.

The electronic control unit 14 is further configured to:

- detect the presence/absence of moist laundry 5 inside the rotatable drum 3 by the electrode sensor 22;

- if presence of moist laundry 5 inside the rotatable drum 3 is detected, start a drying cycle that user selected.

Advantageously, if presence of moist laundry 5 inside the rotatable drum 3 is not detected, the electronic control unit 14 stops operation of the rotatable-drum laundry dryer 1.

It should be pointed out that “detecting the presence/absence of moist laundry 5

inside the rotatable drum 3" comprises both simply detecting the presence/absence of laundry inside the drum 3 (i.e. independently on the moisture of the laundry), and detecting the presence/absence of laundry having a prefixed degree of moisture (or in other words having a prefixed degree of dryness).

In other words the electronic control unit 14 is configured to sense (by using the electric signals coming from the electrode sensor 22) both if there is laundry or not inside the drum, and if the laundry is moist or not, i.e. if the dryness of the laundry sensed by the electrode sensor 22 is below or above a threshold value (DRL) which may preferably depend on the drying cycle selected by the user.

If laundry is not sensed at all, or if laundry is sensed, but its dryness is above a prefixed threshold (DRL), i.e. if moist laundry has not been detected inside the drum 3, the drying cycle is not started, while if laundry is sensed, and its dryness is below a prefixed threshold (DRL), i.e. if moist laundry has been detected inside the drum 3, electronic control unit 14 starts the drying cycle that user selected.

The electronic control unit 14 is further configured to:

- sense dryness of the laundry 5 during the drying cycle;

- measure (or calculate, determine, estimate, detect) the cycle time TD at which the sensed dryness reaches a preset dryness threshold (which preferably depends on the specific laundry cycle selected by the user);

- if the cycle time TD is lower than a preset dryness threshold time (Sm), continue the drying cycle for a first additional time D1,

- stop the drying cycle at the end of this first additional time D1.

Preferably the first additional time D1 is such that the time elapsed from the beginning of the drying cycle and the stopping of the drying cycle is a preset minimum dryness time Tmin (e.g. 30 minutes).

More preferably the first additional time D1 is set as the difference from the preset minimum dryness time Tmin and the cycle time TD at which the sensed dryness

reaches a preset dryness threshold (e.g. if TD is 10 minutes, and Tmin is 30 minutes, then D1 is 20 minutes).

It should be pointed out that in the present application "drying cycle" indicates the part of the cycle starting when the heating device 10, i.e. electric resistor or heat pump, is switched-on for the first time, and ending when the heating device 10 is permanently switched-off.

During the "drying cycle" the heating device 10 may be continuously switched on, or it may be repeatedly switched on and off according to a time pattern depending on the laundry cycle selected by the user.

Advantageously the above mentioned preset dryness threshold depends on the laundry cycle selected by the user.

In other words, the electronic control unit 14 is configured to:

- determine the presence/absence of moist laundry 5 inside the rotatable drum 3 by using electric signal coming from electrode sensor 22;

- start a selected drying cycle if the rotatable drum 3 is not empty and if the dryness of the loaded laundry is below a certain prefixed threshold value (DRL) (or in other words if the laundry moisture is above a certain prefixed threshold);

- sense, preferably continuously, the dryness of the laundry, i.e. based on the frequency of the electric signal outputted from the electrode sensor 22;

- compare sensed dryness with a preset dryness threshold, and measure (or calculate, estimate, detect, determine) the cycle time TD when sensed dryness reaches the preset dryness threshold.

The electronic control unit 14 compares the cycle time TD when sensed dryness reaches the preset dryness threshold with a preset dryness threshold time Sm, and if the measured cycle time TD is lower than a the dryness threshold time Sm, electronic control unit 14 continues to perform the drying cycle for a certain time (first additional time D1), preferably for a period of time such that the time elapsed (e.g. measured) from

the beginning of the drying cycle, reaches a preset minimum dryness time Tmin.

It is underlined that the phase of "detecting the presence/absence of moist laundry 5 inside the rotatable drum 3 and starting a drying cycle if presence of moist laundry 5 inside the rotatable drum 3 is detected" (while don't starting the drying cycle if presence of moist laundry 5 inside the rotatable drum 3 is not detected) has a sort of synergic effect with the phases of "measuring (or calculating, determining, estimating, detecting) the cycle time TD at which the sensed dryness reaches a preset dryness threshold and, if the cycle time TD is lower than a preset dryness threshold time (Sm), continuing the drying cycle for a first additional time D1"; in fact if the phase of "detecting the presence/absence of moist laundry 5 inside the rotatable drum 3 and starting a drying cycle only if presence of moist laundry 5 inside the rotatable drum 3 is detected" weren't comprised in the method, and if the user erroneously started a drying cycle without loading any piece of laundry in the drum or loading already dry laundry, the drying cycle would start and (for the reasons explained above with reference to the problems of the prior art solutions) the sensed dryness would reach a preset dryness threshold very quickly, and therefore the drying cycle would continue for a first additional time D1, with a further useless energy consumption.

Therefore the combination of the phases of "detecting the presence/absence of moist laundry 5 inside the rotatable drum 3 and starting a drying cycle only if presence of moist laundry 5 inside the rotatable drum 3" and of "measuring (or calculating, determining, estimating, detecting) the cycle time TD at which the sensed dryness reaches a preset dryness threshold and, if the cycle time TD is lower than a preset dryness threshold time (Sm), continuing the drying cycle for a first additional time D1" is very effective in solving the above mentioned problems of the prior art (i.e. obtaining a uniform laundry dryness even if the laundry inside of the drum is few and/or is arranged inside the rotatable-drum so that number of contacts with the electrode sensor is very low, and at the same time strongly reducing the wastage of electric energy).

With reference to Figure 3, an example of the operations implemented by the control method performed by the electronic control system 16 made according to the principles of the present invention shall now be described.

In the initial phase (block 100), heating device 10 is turned-off, the electronic control unit 14 recognises the selected drying cycle/program and preferably performs a detach phase, wherein it turns-on and controls the electric motor 9 to rotate the rotatable laundry drum 3 for a preset detaching time so as to detach the laundry 5 from the inner surface of the rotatable laundry drum 3 for increasing the probability that laundry 5 is brought into contact with the electrode sensor 22. According to the preferred embodiment, the preset detaching time could be set between ten and twenty seconds, preferably about fifteen seconds.

The electronic control unit 14 performs a starting detection phase (block 110) for a starting detection time, during which it controls the electric motor 9 to rotate the rotatable laundry drum 3 with preset rotation speed/s, and determines the presence/absence of the moist laundry 5 inside the drum 3 based on the electric signal outputted from the electric sensor 22.

Preferably, electronic control unit 14 determinates (i.e. concludes or resolves) presence of moist laundry based on the impedance of the laundry 5 sensed between the metal plates 23 and/or according to the frequency of the electric signal outputted from the electrode sensor 22.

The electronic control unit 14 advantageously checks whether moist laundry is present or absent inside of the drum 3 (block 120) based on presence or absence condition is detected and in positive case (YES output from block 120) controls the rotatable-drum laundry dryer 1 in order to perform the user selected drying cycle (block 130). In that case, electronic control unit 14 controls the electric motor 9, the heating device 10 and the fan 11 according to preset control-parameters/control program associated with the drying cycle that user selected.

In negative case (NO output from block 120), the electronic control unit 14 preferably sets a counter N=1 (block 140), performs an additional detection phase for an additional detection time ADT, e.g. thirty seconds, during which it determinates, preferably by impedance sensed by the electrode sensor 22 and/or according to the frequency of the electric signal outputted from the electrode sensor 22 (block 150) if moist laundry is present or absent inside of the drum 3 (block 160).

Advantageously the additional detection time (ADT) is lower than the starting detection time of the starting detection phase (block 110).

In negative case (NO output from block 160), the electronic control unit 14 advantageously increases the counter N=N+1 (block 170), and checks if increased counter N=N+1 is equal or greater than a preset maximum threshold N_{MAX}, i.e. $N>N_{MAX}$ (block 180).

In negative case (NO output from block 180), the electronic control unit 14 performs again the additional detection phase for the additional detection time ADT (block 150), whereas in positive case (YES output from block 180), the electronic control unit 14 confirms absence of moist laundry inside of the rotatable laundry drum 3 (i.e. according to the electronic control unit 14 there is no moist laundry in the drum) and advantageously stops operation of the rotatable-drum laundry dryer 1.

If the electronic control unit 14 detects a moist laundry presence condition during the starting detection phase (YES output from block 120) or one of the additional detection phases (YES output from block 160), it controls the rotatable-drum laundry dryer 1 to perform the selected drying cycle (block 130).

In that case, electronic control unit 14 starts drying cycle by switching-on/controlling the electric motor 9, the heating device 10 and the fan 11.

During the drying cycle, the electrode sensor 22 provides voltage signals associated with the moisture contents of the laundry 5 so as to sense the dryness of the laundry 5, the electronic control unit 14 receives the electric signals from the electrode

sensor 22 and measures the cycle time TD at which the sensed dryness reaches a preset dryness threshold (block 190).

Advantageously, after starting the drying cycle, electronic control unit 14 repeatedly senses the dryness of the laundry and compares, preferably continuously, sensed laundry dryness with the preset dryness threshold; the electronic control unit 14 measures (calculates, detects, obtains) the cycle time TD corresponding to the time at which sensed dryness reaches the preset dryness threshold.

The electronic control unit 14 checks if the cycle time TD is lower than a preset minimum dryness threshold time Sm (i.e. if TD<Sm) (block 200).

In positive case (YES output from block 200), i.e. the cycle time TD is lower than the preset minimum dryness threshold time Sm, the electronic control unit 14 concludes (or determines, resolves) an insufficient dryness condition, and continues to perform the drying cycle for a first additional time D1 (block 210), after which the drying cycle is stopped (block 220).

Preferably electronic control unit 14 sets the first additional time D1 in such a way that the drying cycle ends when the time elapsed from the beginning of the drying cycle reaches a preset minimum dryness time Tmin.

Advantageously the electronic control unit 14 sets the first additional time D1 as the difference between the preset minimum dryness time Tmin and the cycle time TD at which sensed dryness reaches the preset dryness threshold.

Regarding what has been described above, it should be pointed out that during the first additional time D1, the electronic control unit 14 continues to keep switched on the electric motor 9, the fan 11 and the heating device 10 according to the selected drying cycle.

According to a preferred embodiment, the preset minimum dryness time Tmin may vary according to the selected drying cycle or may be a preset value, preferably comprised between twenty and thirty-five minutes, preferably about thirty minutes.

In negative case (No output from block 200), i.e. whether cycle time TD at which sensed dryness reaches the preset dryness threshold is equal or greater than preset minimum dryness threshold time Sm, the electronic control unit 14 concludes (or determines, resolves) an admissible dryness condition, and continues to perform the drying cycle for a preset second additional time D2 (block 230). In other words, if admissible dryness condition is detected, the electronic control unit 14 continues to perform the drying cycle, after the cycle time TD, for the preset additional time D2, after which the drying cycle is stopped (block 230).

Preferably the preset additional time D2 depends on the selected drying cycle.

Preferably, the preset additional time D2 is between 0 and ten seconds; if D2 is 0 seconds, the drying cycle is stopped immediately or substantially immediately after the electronic control unit 14 concludes (or determines, resolves) that it has been reached the admissible dryness condition.

According to the preferred embodiment, after stopping of the drying cycle, electronic control unit 14 may preferably perform a final cooling phase (block 240), wherein drum 3 may be kept turning, and non-heated air (since the heating device 10 has been permanently switched-off) may be fed into drum by the fan 11 so as to lower the high temperature to a predetermined low temperature (e.g. 30°C) at which laundry 5 can be handled by the user.

Regarding what has been described above, it should be pointed out that the above-described control method may advantageously be encoded in software that can be loaded in the electronic control unit 14 of the rotatable-drum laundry drier 1 and designed to ensure that, when executed, the electronic control unit 14 becomes configured for controlling the rotatable-drum laundry drier 1 according to the provisions of the method.

The laundry dryer of the present invention has the following advantages.

The additional detecting phases permit the laundry dryer to improve detecting

the condition of empty-drum or of already-dry laundry loaded, and in this case to immediately stop operating the laundry dryer, so as to decrease wastage of electric energy.

Moreover, increasing of cycle time in case of detection of an insufficient dryness condition assures uniform laundry dryness, even in case of small load/quantity of laundry, and/or when the latter is arranged inside the rotatable-drum so that number of contacts with the electrode sensor is very low.

Clearly, changes may be made to the method and the rotatable-drum laundry dryer as described and illustrated herein without, however, departing from the scope of the present invention.

CLAIMS

1) A method of controlling a drying operation of a rotatable-drum laundry dryer (1) comprising a rotatable drum (3) for loading laundry (5) and at least an electrode sensor (22) for sensing dryness of the laundry (5);

the method being **characterized by** comprising:

- detecting the presence/absence of moist laundry (5) inside the rotatable drum (3) by said electrode sensor (22);
- if presence of moist laundry inside the rotatable drum (3) is detected, starting a drying cycle;
- sensing dryness of the laundry (5) during said drying cycle;
- measuring a cycle time (TD) at which the sensed dryness reaches a preset dryness threshold;
- if said cycle time (TD) is lower than a preset dryness threshold time (Sm), continuing the drying cycle for a first additional time (D1), and stopping the drying cycle at the end of said first additional time (D1).

2) Method according to Claim 1, wherein said first additional time (D1) is such that the time elapsed from the beginning of said drying cycle and the stopping of the drying cycle is a preset minimum dryness time (Tmin).

3) Method according to Claim 1 or 2, wherein said first additional time (D1) is set as the difference from said preset minimum dryness time (Tmin) and said cycle time (TD).

4) Method according to Claim 1 or 2 or 3, comprising:

- if said cycle time (TD) is not lower than said preset dryness threshold time (Sm), continuing the drying cycle for a preset second additional time (D2); and
- stopping the drying cycle at the end of said second additional time (D2).

5) Method according to Claim 4, wherein said second additional time (D2) is between zero and ten seconds.

6) Method according to one or more of the previous Claims, wherein determining the presence/absence of moist laundry inside the rotatable-drum comprises:

- performing a starting detection phase for a starting detection time;
- if no moist laundry has been detected during said starting detection time, performing one or more additional detection phases, each of which lasts an additional detection time (ADT);
- if no moist laundry has been detected during said additional detection phase/s, ending operation of rotatable-drum laundry dryer (1).

7) Method according to Claim 6, wherein said additional detection time (ADT) is lower than said starting detection time.

8) Rotatable-drum laundry drier (1) comprising:

a rotatable drum (3) for loading laundry (5),

a least an electrode sensor (22) for sensing dryness of the laundry (5);

feeding drying air means (11) for feeding drying air into the drum (3), and

rotating means (9) for rotating the drum (3) about an axis of rotation;

the rotatable-drum dryer (1) being **characterized by** comprising electronic control means (14) configured to:

- detect presence/absence of moist laundry (5) inside the rotatable drum (3) by said electrode sensor (22);
- if presence of moist laundry inside rotatable drum (3) is detected, start a drying cycle;
- sensing dryness of the laundry (5) during said drying cycle;
- measure a cycle time (TD) at which the sensed dryness reaches a preset dryness threshold;
- if said cycle time (TD) is lower than a preset dryness threshold time (Sm), continue to perform the drying cycle for a first additional time (D1), and stop the drying cycle at the end of said first additional time (D1).

9) Dryer according to Claim 8, wherein said first additional time (D1) is such that the time elapsed from the beginning of said drying cycle and the stopping of the drying cycle is a preset minimum dryness time (Tmin).

10) Dryer according to Claim 8 or 9, wherein said first additional time (D1) is set as the difference from said preset minimum dryness time (Tmin) and said cycle time (TD).

11) Dryer according to Claim 8 or 9 or 10, wherein said electronic control means (14) are further configured to:

- continue to perform said drying cycle for a preset second additional dryness time (D2) if said cycle time (TD) is not lower than said preset dryness threshold time (Sm); and
- stop the drying cycle at the end of said preset second increased cycle time (D2).

12) Dryer according to Claim 11, wherein said second additional time (D2) is

between zero and ten seconds.

13) Dryer according to Claim 9 or 10 or 11 or 12, wherein said electronic control means (14) are further configured to:

- perform a starting detection phase for a starting detection time;
- if no moist laundry has been detected within said starting detection time, perform one or more additional detection phases; and
- if no moist laundry has been detected during said additional detection phase/s, end operation of rotatable-drum laundry drier (1).

14) Dryer according to Claim 13, wherein, each of said one or more additional detection phases lasts an additional detection time (ADT) lower than said starting detection time.

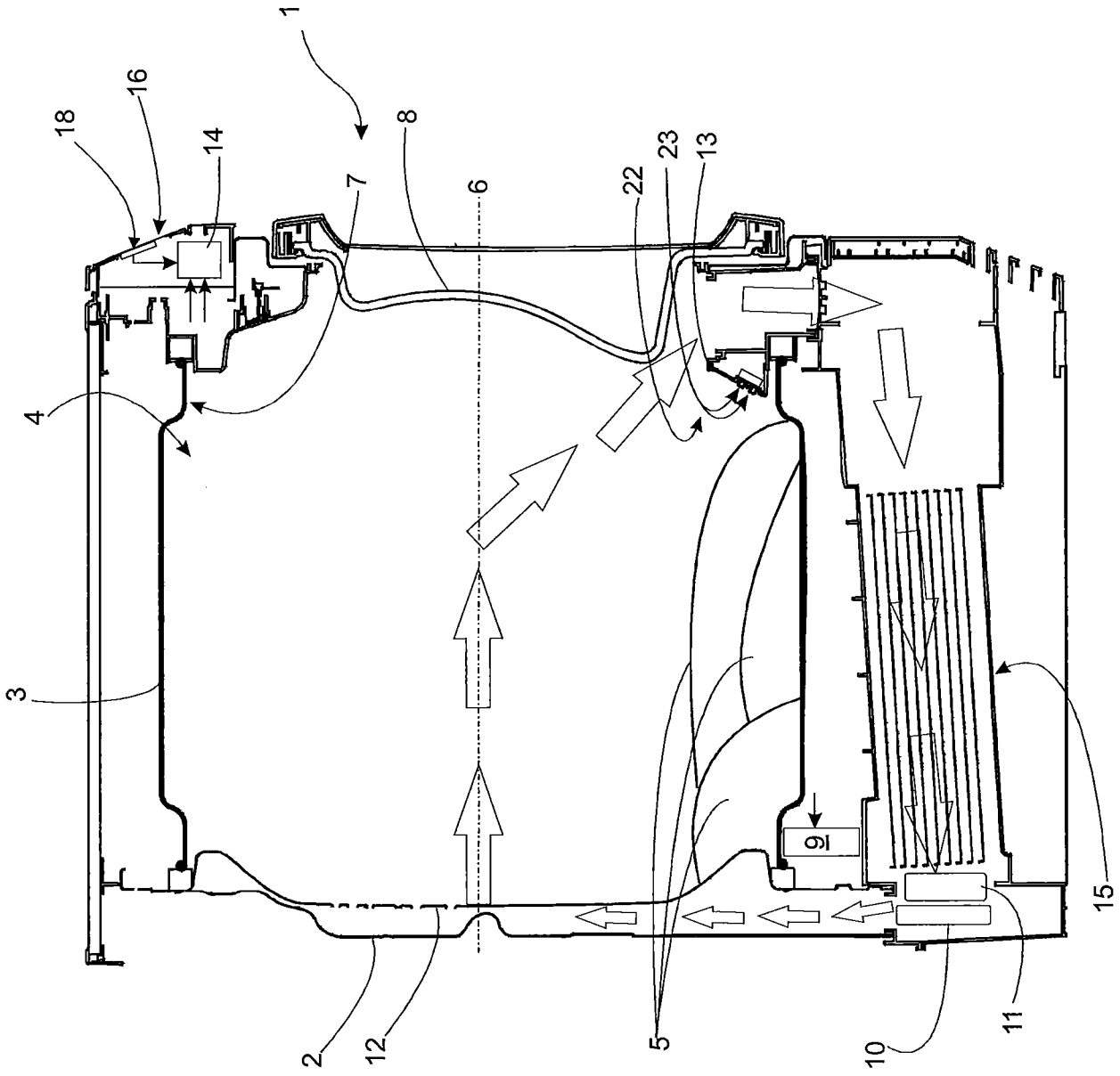


Fig. 1

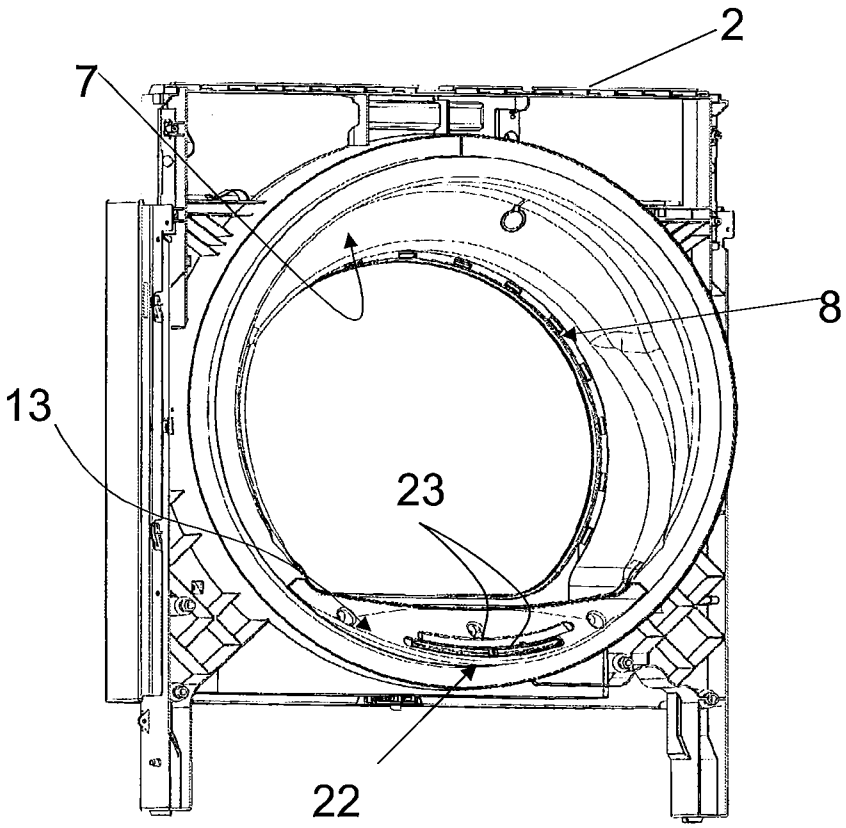


Fig. 2

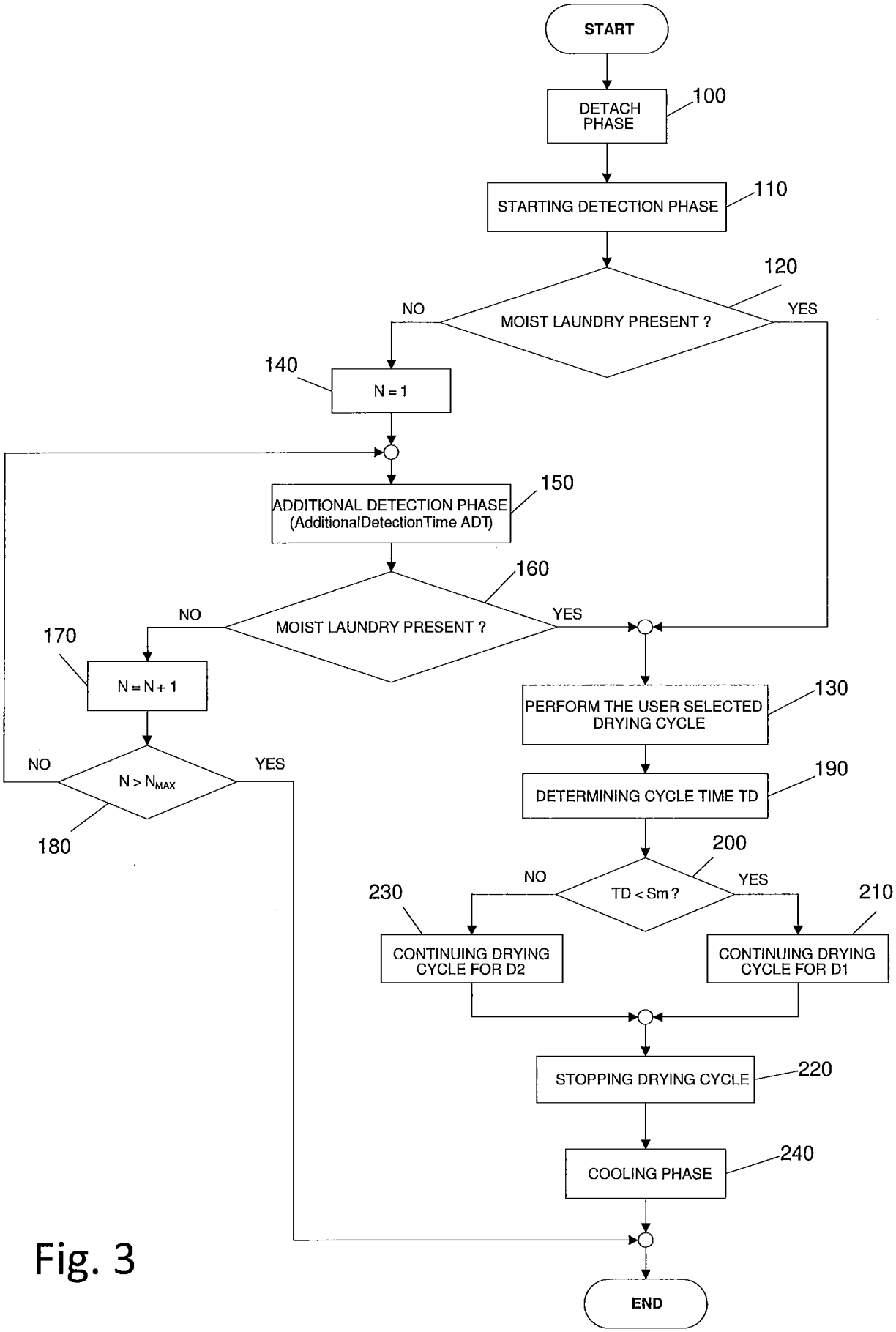

START
DETACH PHASE
100
STARTING DETECTION PHASE
110
120
MOIST LAUNDRY PRESENT ?
NO
YES
140
N = 1
ADDITIONAL DETECTION PHASE (AdditionalDetectionTime ADT)
150
160
MOIST LAUNDRY PRESENT ?
NO
YES
170
N = N + 1
NO
N > N_MAX
YES
180
PERFORM THE USER SELECTED DRYING CYCLE
130
DETERMINING CYCLE TIME TD
190
200
TD < Sm ?
NO
YES
230
210
CONTINUING DRYING CYCLE FOR D2
CONTINUING DRYING CYCLE FOR D1
STOPPING DRYING CYCLE
220
COOLING PHASE
240
END

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/062033

A. CLASSIFICATION OF SUBJECT MATTER
INV. D06F58/20 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	JP 2000 229200 A (TOSHIBA CORP) 22 August 2000 (2000-08-22) cited in the application the whole document	1-14
A	WO 2007/105908 A2 (LG ELECTRONICS INC [KR]; HAN JONG HYE [KR]) 20 September 2007 (2007-09-20) the whole document	1-14
A	DE 37 03 671 A1 (BOSCH SIEMENS HAUSGERAETE [DE]) 18 August 1988 (1988-08-18) the whole document	1-14
A	US 2005/091876 A1 (YANG JAE S [KR] YANG JAE SUK [KR]) 5 May 2005 (2005-05-05) the whole document	1-14

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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"E" earlier application or patent but published on or after the international filing date

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"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	Date of mailing of the international search report
3 September 2012	10/09/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Spitzer, Bettina

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/062033

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2012/062033

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