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(54) **Dryer and method to control a drying cycle**

Trockner und Verfahren zur Steuerung eines Trocknungszyklus

Appareil de séchage et procédé de contrôle d'un cycle de séchage

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Description

Field of the invention

[0001] The present invention relates to a dryer according to claim 1 and a method to control a drying cycle in an efficient manner, according to claim 10. The dryer and the method of the invention reduce the duration of "non-cotton" cycles and effectively control the working temperature of the same.

Background art

[0002] A dryer is an appliance used to remove moisture from a load, such as clothing and other textiles, generally shortly after they are cleaned in a washing machine.

[0003] Most dryers consist of a rotating drum called a tumbler, thus called tumble dryer, through which heated air is circulated to evaporate the moisture from the load. The tumbler is rotated around its axis.

[0004] The temperature of the heated air is generally changeable, depending on the size and nature of the load. The user can select a predetermined laundry cycle among a plurality depending on the type of fabric(s) in which the clothes forming the laundry is made. For example, among the possible available cycles, a cotton cycle is generally present, also called "normal" or "standard" cycle. Cotton fibers, as well as linen ones, are natural fibers that can withstand heat, thus generally the normal cycle is performed at a relatively high temperature in order to quickly dry the clothes. This cycle is used for natural resistant fibers. Additionally, a synthetic cycle may be present, also called permanent press. At this setting, the dryer maintains a warm but not hot temperature in order not to damage synthetic fabrics such as nylon, polyester, acrylic and other synthetic blends, which are easily damaged by high temperature. This setting can also work for natural fiber clothes at risk of shrinking. In addition, a delicate cycle can also be present, in which a cooler temperature than in the synthetic cycle is maintained. This delicate setting can be used for example for items labeled as "hand wash," woolen fabrics that can be machine washed and dried, heat-sensitive garments labeled as "tumble dry low", lingerie and other fragile clothing.

[0005] As mentioned above, it is therefore very important to dry synthetic or delicate clothes at a lower temperature than the cotton/linen fibers. In order to achieve this result, several methods have been proposed in the prior art.

[0006] Most commonly, the heater that heats the air flowing within the dryer includes two heating elements. During the cotton cycle, both heating elements heat the air raising its temperature in order to dry the clothes, and to avoid overheating, one of the two heating elements is switched on and off during the cycle. On the other hand, during the synthetic or delicate cycle, only one of the heating elements is heating the air to keep a lower temperature; the only working heating element is then switched on and off depending to the temperature present into the dryer during the cycle to keep a substantially constant, but lower, temperature.

[0007] European patent application EP 0362676 discloses a laundry drying control device for a clothes drier comprising an electrical heating element divided into two portions (5, 6), portion (5) being adapted to be short-circuited by a driver (16) controlled by an electronic comparator (14) or by a logical AND gate (15). The device is adapted to control the run of "acrylic" drying cycles by switching on the maximum power of only the portion (6) of the heating element until the operating drying temperature is reached, and then switching on a reduced heating power via the two portions (5, 6) of the heating element. The device is adapted to control the run of "extra dry" drying cycles by switching on the maximum heating power and then the reduced heating power for a supplementary period after the end of drying.

[0008] US patent application US 2008/0210769 describes a heating system and a method of controlling the heating system. When a heating unit and a switch are turned on and off repeatedly by the predetermined number of times or more, only some of heaters of the heating unit are turned on, thereby increasing service life of the heating unit and the switch.

European patent application EP 1076128 is relative to a tumble dryer having an electric heating element 10 switched between first and second states in a regular repetitive cycle. In the preferred embodiment the heating element 10 is switched either fully on or fully off by a relay 24 according to a pulse width modulation control by a microprocessor 21. Advantageously, the effective heater output is continuously variable to any desired level.

UK patent application GB 2296793 describes a domestic tumbler drier with a fan which blows air through a heater. The drier has temperature and moisture sensors as well as a programmable electronic controller which can store measured values and process variables. At the start (t0) of the drying process the air temperature (delta 4s) at the drum exit is measured and during a time interval (t0-t2) part or all of the heater is periodically switched ON and OFF. At the end of the start-up period (t0-t2), which covers one to three switching cycles, temperature measurements at the heater inlet (delta 2), at the drum inlet (delta 3) and at the drum exit (delta 4) are used to calculate temperature differences which are stored together with the time elapsed. Temperatures and laundry moisture contents are measured continuously or with a frequency of several times per second. When limiting values (A1, A2) according to previously input laundry parameters have been reached, one of several stored process sequences are fed to the controller. Preferably, the controller uses a fuzzy logic processor to estimate the drying time from the temperature differentials in the start-up period and the time taken to reach a critical outlet temp. or intermediate laundry moisture content. The controller has a number of algorithms for various input conditions, e.g. different degrees of required dryness, laundry type,

etc. GB 2296793 discloses the features of the preamble of claims 1 and 10.

Summary of the invention

[0009] The present invention relates to a dryer and a method to control a drying cycle according to claims 1 and 10. In particular, with the dryer and the method of the invention, the time required to perform a "non cotton" cycle, compared with the time required to perform the same cycle by dryers according to the prior art, is reduced. Reducing the drying time of a cycle is desired not only for a practical convenience of the user that has his/her laundry quickly ready, but also for environmental consciousness in order to consume as less energy as possible.

[0010] At the same time, the method of the invention, and the dryer operating according to said method, are relatively simple and do not require expensive modifications to dryers according to the prior art in order to achieve the goals of the invention, therefore the dryer according to the invention is not more costly due to sophisticate components.

[0011] In the following, with the term "dryer" both clothes dryer only and washer dryer are meant.

[0012] Most dryers comprise a rotating drum called a tumbler through which heated air is circulated to evaporate the moisture from the load. The tumbler is rotated to maintain space between the articles in the load. In case of washer dryers, the drum is located inside a tub for the washing cycles.

[0013] Known laundry dryer includes two categories: condense laundry dryers and vented laundry dryers. Dryers of the first category circulate air exhausted from the drum through a heat exchanger/condenser to cool the air and condense the moisture; they subsequently recirculate the air back through the drum. Dryers of the second category draw air from the surrounding area, heat it, blow it into the drum during operation and then exhaust it through a vent into the outside. The present invention is applicable, not only to washer-dryer and dryers, but also to dryers belonging to both of the above mentioned categories.

[0014] In order to dry the clothes, a dryer includes a fan, preferably a blower, to force air into the drum, and a heater to heat the air that flows through the dryer. The dryer of the invention can be operated in various modes, i.e. different types of "drying cycles" can be selected, for example through an input panel or user interface located on the casing of the dryer and accessible to the user. Among the available cycles, a "non cotton" drying cycle is present. In the following, with the term "non cotton cycle", any cycle in which the drying temperature is set lower than the "cotton cycle" is meant, such as a synthetic fiber drying cycle or a delicate drying cycle. In other words, the cotton cycle is the cycle used to dry natural fibers such as cotton and/or linen, and the air forced into the drum is at a relatively high temperature. In a non-cotton cycle, the air which is forced into the drum has a lower temperature than the one used during the cotton cycle before defined.

[0015] The dryer in addition includes an air circulation system for the circulation of the air heated by the heater and forced by the fan through the drum to dry the items therein located. The heater in turn includes a first heating element and a second heating element, preferably electrical heating elements, such as resistors. It is to be understood that each of the first and second heating element can be further divided in additional "smaller" elements, without changing the teaching of the invention. Moreover, additional heating elements can also be provided in the heater of the invention. First and second heating elements are preferably connected electrically and a variable power supply which can switch on and off alternatively one or both of the first and/or second heating element commands the same.

[0016] A controller supervises the operation of the dryer.

[0017] Applicants have considered the teaching of the prior art and operated the above described dryer accordingly. In detail, having selected a "non-cotton" drying cycle, they have used the known teaching according to which only one of the heating elements (either the first or the second) is used to heat air, and the same is switched on and off depending on the temperature reached inside the drum. With reference to the graphs of figs. 5a and 5b, the results achieved using the method of the prior art is shown: during a non-cotton drying cycle, only one of the heating elements is heating the air flowing into the air circulation system (in the graph of fig. 5a a first heating element having a power of 900 W is operated, the second heating element being non activated) and in this way the desired working temperature to heat the laundry is reached in approximately 1 hour, as clearly seen from the temperature curves displayed in the graph of fig. 5b (each curve represents a different test). When the desired working temperature is reached, the single heating working element is switched off, and switched on again when the temperature lowers below a certain pre-set threshold (see the sudden drop(s) in emitted power in graph of fig. 5a and the corresponding temperature fall(s)in fig. 5b, with the subsequent rise(s) in both curves).

[0018] Applicants have realized that there is a much more efficient way of modulating the temperature during a non cotton cycle, in order to reach the desired working temperature faster and thus reducing the overall time of the drying cycle itself.

[0019] The invention relates to a dryer, according to claim 1.

[0020] The invention further relates to a method to control a drying cycle of a dryer, according to claim 10.

[0021] Applicants have realized that modulating the heating elements during the non-cotton cycle so that they are either both on or both off shortens the cycle duration: the working temperature is reached faster and in addition

the time to restore the working temperature is reduced.

[0022] Preferably, when both heating elements are switched on the heater is at full power, when the heating elements are both switched off, the heater is wholly off.

[0023] According to any of the above aspects, the following characteristics can also be comprised.

[0024] Preferably, the variable power supply is apt to switch on again both first and second heating elements when a second threshold temperature has been subsequently reached.

[0025] Indeed, when the two heating elements have been switched off, the temperature lowers and the heating elements might have to be switched on again in order to keep the working temperature substantially stable. As said, due to the fact that both heating elements are again switched on, the working temperature is reached more quickly again, with respect to the cycle performed according to the prior art.

[0026] Preferably, these actions of switching on and off again the heaters, always both of them, are performed till the end of the drying cycle which has been selected. In detail, said controller includes an end of cycle device to signal the end of the selected cycle , and wherein said variable power supply is apt to repeat the actions of

- ◦ switching on both heating elements, when a non-cotton cycle has been selected, till a first threshold temperature has been reached;
- ◦ switching off both said first and second heating elements afterwards, and
- ◦ switching on again both first and second heating elements when a second threshold temperature has been subsequently reached,

till the end of the drying cycle as signaled by said end of the cycle device.

[0027] Preferably, said non cotton drying cycle is a synthetic drying cycle.

[0028] However, the non cotton cycle can also be a delicate cycle, a wool cycle, etc.

[0029] According to a preferred embodiment, said heater is an electrical heater.

[0030] Preferably, said end of cycle device includes a humidity sensor for example one or more electrodes to monitor the conductivity of the laundry .

[0031] Preferably, said first and said second threshold temperature are the substantially the same temperature.

[0032] Indeed, when the heater is switched off, the temperature takes a certain while before it lowers; therefore the first threshold temperature is not the maximum temperature and can be considered a threshold in both directions, i.e. when the temperature rises and when it lowers.

[0033] The first and second threshold temperature are measured via at least one temperature sensor, preferably said temperature sensor is located downstream of said heater in proximity of the entrance of the heated air into the drum.

[0034] According to an embodiment, said first and said second heating elements have the same heating power capacity.

[0035] Preferably, the dryer of the invention is a washer dryer.

[0036] Said plurality of drying cycles includes also a cotton cycle and said variable power supply is adapted, when said cotton cycle has been selected, to switch on both said first and said second heating elements till a third threshold temperature has been reached, and to switch off only one of said first and second heating elements afterwards.

[0037] Differently from the non cotton cycle, during the cotton cycle there is always one of the heating elements which is switched on.

[0038] Preferably, also during the cotton cycle, both first and second heating elements are again switched on when a fourth threshold temperature has been subsequently reached.

[0039] Preferably, the heater variable power supply is part of the controller of the machine or the controller integrally provides the heater variable power supply

[0040] These and other features and advantages of the invention will better appear from the following description of some exemplary and non-limitative embodiments, to be read with reference to the attached drawings, wherein:

- Fig. 1 is a cross-sectional schematic lateral view, where some elements have been removed for clarity, of a laundry dryer according to the invention;
- Fig. 2 is a schematic diagram of some of the components of the laundry dryer of fig. 1;
- Fig. 3 is a flow chart of the method of the invention;
- Fig. 4 is a graph showing the power consumed vs. time in a drying cycle of the laundry dryer according to the invention;
- Figs. 5a and 5b are graphs representing the power consumed vs. the time and the temperature vs. the time, respectively, of a non cotton drying cycle according to the prior art;
- Fig. 6a and 6b are graphs representing the power consumed vs. the time and the temperature vs. the time of the same non cotton drying cycle of the graphs according to figs. 5a and 5b, respectively, but according to the method of the invention.

Preferred embodiments of the invention

[0041] With initial reference to fig. 1, a laundry dryer according to the present invention is globally indicated with 100.

[0042] Laundry dryer 100 is in the depicted drawing a

washer dryer, however - as mentioned - the present invention is applicable to all types of dryers. Dryer 100 comprises an outer box casing 2, preferably but not necessarily parallelepiped-shaped, and a drum 3, for example having the shape of a hollow cylinder, for housing the laundry and in general the clothes and garments to be dried. Drum 3 therefore defines a drying chamber for items to be dried. In the depicted drawing, in the drum 3, clothes are also washed. The drum 3 is preferably rotatably fixed to the casing 2, so that it can rotates around a preferably horizontal axis X (in alternative embodiments, not shown, rotation axis may be vertical or tilted). Access to the drum 3 is achieved via a door 4, preferably hinged to casing 2, which can open and close an opening 4a realized on the casing 2 itself. Opening 4a preferably faces drum 3 and it can be sealed by door 4.

[0043] Drum 3 defines a lateral surface 3c and two opposite ends 3a,3b, one of which 3a, called front end, includes an opening which faces opening 4a of casing 2. Laundry dryer 100 also comprises an electrical motor assembly 5 for rotating, on command, revolving drum 3 along its axis X inside casing 2. The coupling between the motor assembly 5 and drum 3 can be for example via a belt and a drive pulley (also not shown). Preferably, motor 5 is fixed to the dryer 100 below drum 3.

[0044] Casing 2, revolving drum 3, door 4 and motor 5 are common parts in the technical field and are considered to be known; therefore they will not be described in details.

[0045] Dryer 100 additionally includes an air delivery system, schematically depicted in fig. 1 as a plurality of arrows F showing the path flow of the air through the dryer 100. The air delivery system includes a fan or blower 11, generally driven by motor 5 in case of a dryer and having an independent servomotor (not shown) in case of a washer-dryer, a heater 9 and pathways for directing air along an air path better detailed below..

[0046] More specifically, depending on the type of dryer under consideration, either air enters into dryer 100 through one or more air vents realized in the casing 2, or the air delivery system is a closed circuit, the latter being preferred in case of a washer dryer. In all cases, the relatively cold air travels through an inlet duct 10 reaching the heater 9, where it is heated as it passes through, and it is then introduced in the rotatable drum 3 via the through holes 7 located in correspondence to drum 3. During operation, the heated air dries the laundry present inside drum 3.

[0047] Preferably, heater 9 is located inside casing 2 above drum 3 within the duct 10, such as a metal pipe included in the air delivery system, as better detailed below.

[0048] Air passes the whole drum 3 and it exits the same through an exhaust duct (not shown. The air then travels through an internal exhaust tube and it is either vented outside the casing or passes a heat exchanger and then restarts the described path in the dryer 100. According to a different embodiment, In a washer-dryer, a closed-loop drying circuit is present including a suction unit, i.e. the fan 11, driven by an electric motor, and a heat exchanger connected to the heater 9 via a drying duct.

[0049] With now reference to fig. 2, dryer 100 also includes a user interface 8 for the user to enter various inputs relative to the dryer's 100 working parameters. For example, among others, the user can insert via interface 8 the desired drying cycle from a plurality of available cycles. This plurality preferably includes one or more of:

- Cotton cycle (or regular or heavy cycle) for items realized in resistant natural fibers, the air heated by heater reaches a relatively high temperature;
- Synthetic cycle (or permanent press or acrylic cycle) for items realized in synthetic fibers, the temperature of the heated air is lower than the temperature in the cotton cycle;
- Delicate cycle (or wool cycle or knit cycle) for items realized in delicate fabric, the temperature is only slightly above room temperature;
- Air fluff for softening or refreshing any garment, the air is not heated or only very mildly.

[0050] All the above cycles, and others which can be available, with the exception of the cotton cycle, are called in the following "non cotton" cycles.

[0051] It has to be understood that additional inputs can be entered using the user interface 8 by the user. For example information about the amount of load (full load or half load) or the desired dryness "extra dry", "easy ironing", etc) can be inputted as well.

[0052] The user interface 8 is preferably mounted on casing 2, more preferably in proximity of aperture 3a, and it can be of any type, i.e. it can include push buttons, knobs, touch screens, touch buttons or a combination thereof. A display may also be present to visualize the chosen setting.

[0053] The dryer 100 includes a controller 20 in which the programs for controlling the drying cycles are stored, for example in a memory. The controller 20 selects the program to be executed depending on the inputs received by the user interface 8 which is electrically connected to it. For example, for each drying cycle, the controller stores the cycle duration or maximum humidity allowed in the dryed clothes and temperature. Controller 20 includes for example a microcontroller.

[0054] Each of these programs is called in the following "drying module" 30 in which all instructions for the correct execution of the chosen drying cycle made by the user are present. When the user select a program, the corresponding drying module 30 is then executed by controller 20.

[0055] The controller 20 is also in communication with the fan 11 and with the heater 9 for controlling the same, i.e. for sending command signals in order to switch on/switch off or modulate the same, as better detailed below.

[0056] In addition, referring now back to fig. 1, dryer 100 includes a temperature sensor 40, located inside casing 2 and preferably within the air delivery system, in particular inside duct 10, downstream heater 9 and just before the inlet duct 10 enters drum 3. Preferably, temperature sensor 40 is a thermistor, such as a negative temperature coefficient (NTC) thermistor, however any other sensor can be used as well. The signal coming from the temperature sensor 40 is also sent to controller 20. Temperature sensor 40 detects the temperature of the heated air which enters the drum 3 to dry clothes.

[0057] Heater 9, which is preferably an electrical heater, includes a first and a second heating element 9a and 9b, depicted in fig. 1 as resistors. Heating elements 9a and 9b preferably have the same heating capacity, i.e. they dissipate the same power, in particular the same electrical power. However heating elements 9a,9b having different heating capacity can be considered as well. Heating elements 9a and 9b are preferably electrically connected in parallel Each of the heating element 9a,9b can - in turn - include more heating sub-elements, for example each resistor 9a,9b can include a plurality of resistors in series.

[0058] Heater 9 is controlled by a heater variable power supply 50, which is in turn controlled by controller 20, that selectively energizes the heater 9, for example switching on or off any of the two heating elements 9a and 9b as better detailed below.

[0059] Controller 20, which moreover preferably includes an end of cycle device 21 better detailed below, thus receives input(s) from the user via interface 8 and it is operatively coupled to motor 5 that rotates drum 3, and to the motor that drives fan 11 (motor that drives fan 11 and motor that rotates drum 3 might coincide in some preferred embodiments), and to the heater variable power supply 50 that activates and deactivates the heater 9 to execute the drying cycle selected by the user according to the parameters stored in the cycle module 30 corresponding to the user's selected cycle.

[0060] Heater variable power supply 50 preferably includes one or more switches (not shown), such as relays or triacs, to selectively energizes or de-energizes one or both heating elements 9a,9b, for example the switches can activate one or both of the heating elements 9a, 9b according to the controller's 20 instruction signals.

[0061] According to the invention, the heater variable power supply 50, when a non cotton cycle has been selected, is apt to energize both heating elements 9a,9b till a first threshold temperature is reached and to de-energize both heating elements, i.e. switching off the heater 9, afterwards. In detail, when a non-cotton cycle is selected, and both heating elements 9a,9b are energized, the heater 9 is at full power. Conversely, when both heating elements 9a,9b are de-energized, the heater 9 is globally switched off. Moreover, when a second threshold temperature is reached, i.e. the temperature lowers due to the absence of heated air, the heater variable power supply 50 is apt to energize again both elements 9a,9b till the first threshold temperature is reached another time and repeats this switching on/switching off activity till the end of the drying cycle. The duration of the drying cycle is determined by the type of selected cycle and may also depend by additional parameters, such as the weight of the load, etc. The drying cycle is terminated when the end of cycle device 21 of controller 20 signals it: the end of cycle device 21 sends to the controller 20 a signal when the drying cycle is to be terminated. The end of cycle device 21 can include for example a timer, so the cycle is endend when the timer reaches the selected cyle duration (i.e. the wool drying cycle is set in the drying module 30 to last 50 minutes and after 50 min the timer sends to the controller a signal to interrupt the cycle), or it can include a humidity/moisture sensor (not visible in the appended figures) which measures the desired humidity of the laundry in the drum 3. When the humidity of the laundry has reached a desired level, i.e. it equal or below a certain humidity threshold (which might be different depending on the cycle), the sensor sends a signal to the controller 20 in order to terminate the drying cycle. The humidity/moisture sensor can be for example a thermistor such as a NTC thermistor and it translates a value of humidity into an electronic signal. In all these cases, the end of cycle device 21 is activated when the selected pre-determined humidity (and this pre determined value can be stored for example in module 30) of the laundry is detected.

[0062] Alternatively, a combination of the two is possible: a pre-determined cycle duration might be set in the controller 20, but this duration can be changed during the cycle itself depending on the output of the humidity/moister sensor.

[0063] The first and second threshold temperatures depend preferably on the user's selected drying cycle. Selecting the cycle may also select the cycle duration and velocity of rotation of the drum. Other parameters can be fixed as well, and they are all stored in the cycle module 30 of the respective selected cycle.

[0064] Referring to fig. 3, the method of the invention to control a drying cycle operates as follows. The dryer 100 is switched on (phase 1) or anyhow activated and loaded with the garments to be dried. Alternatively, in case of a washer-dryer, the dryer is already loaded with the just washed items.

[0065] The selected cycle is imputed by the user via the interface 8 and read by the controller 20 (phase 2). According to the input, the chosen drying cycle module 30 is then selected by the controller 20 and the various parameters, i.e. cycle duration or desired clothes' dryness (i.e. maximum humidity), cycle working temperature, etc, are then loaded from the memory (all these parameters can be for example included in the cycle module 30).

[0066] Then, regardless of the inputted cycle, preferably the controller 20 activates heater 9 at the maximum available power ("full power"), i.e. it commands heater variable power supply 50 to energize both heating ele-

ments 9a, 9b and consequently current flows through the two resistors (phase 3).

[0067] In phase 4, it is then checked whether the inputted cycle is a cotton cycle. In case it is not a cotton cycle, a first threshold temperature T_1 is set and it is then checked whether this first threshold temperature has been reached (phase 5). As said, T_1 depends on the selected non cotton cycle and can vary depending on the chosen cycle. It is to be noted that during this checking phase, both heating elements 9a, 9b are energized, i.e. both heating elements 9a, 9b are switched on (see previous phase 3). If the first threshold temperature is not reached yet, then the two elements 9a,9b remain both energized in order to heat air and the temperature checking via sensor 40 is also performed at regular intervals, for example every 10 milliseconds. T_1 is the air temperature read by the controller via sensor 40 and it is preferably measured downstream of the heater and substantially at the entrance of the drum 3 where sensor 40 is present. It is the "working temperature" of the cycle, i.e. the desired temperature to be kept during this specific drying cycle.

[0068] When the first threshold temperature is reached, according to phase 6, the controller 20 commands the heater variable power supply 50 to switch off the heater 9 in its entirety, i.e. both heating elements 9a,9b are de-energized, i.e. the heater 9 is switched off. The temperature of the air starts then to slowly lower; at the entrance of the drum this temperature is continuously checked by sensor 40 and, when the controller 20 receives from sensor 40 a signal indicating a temperature lower than a second threshold temperature T_2 (phase 7), i.e. the temperature is too cold, it sends a command to heater variable power supply 50 so that both heating elements are energized again (back to phase 3) and the heater 9 is again at full power.

[0069] The first and the second threshold temperatures T_1 and T_2 can also be substantially identical: when the heater 9 is switched off there is still a transient time period in which, due to hysteresis effects, the temperature within the drum still raises, therefore T_1 is not the maximum reached temperature and can thus be considered also a suitable temperature below which the heater 9 has to be switched on again. A possible first/second threshold temperature for a synthetic cycle is for example 65° C. The results of the method of the invention are depicted in figs. 6a and 6b, where in the first graph of fig. 6a the power dissipated versus time is shown. In the preferred embodiment, each heating element 9a, 9b produces a thermal power of 900 Watt and thus the total power with both heating elements on is equal to circa 1800 Watt. The abrupt valleys of the curve are due to the switching off of the two heating elements when the second threshold temperature T_2 has been reached, thus the power switches from 1800 Watt to 0 Watt. This can be seen from the graph of fig. 6b: when a temperature of circa 95° C (this temperature is higher than the temperature of the air in the drum which should be as said of about 65°C)is reached, the heater is switched off. The temperature still rises and then lowers, and then when the same temperature of circa 95° C is reached, both heating elements are switched on again and the graph of fig. 6a rises consequently. Comparing the graphs of fig. 6b with the graph of fig. 5b, it is evident that the working temperature of the air in the drum is reached in a quicker way using the method and the dryer of the invention. This allows shortening the whole drying cycle. A non-cotton drying cycle up to 20% shorter can be achieved.

[0070] The dryer of the invention also includes preferably a standard normal cotton cycle stored in the controller 20. Therefore, if in phase 4 the answer is "yes", then a different third threshold temperature T_3, higher than the first threshold temperature T_1 of the non-cotton cycle, is set using the corresponding drying module 30 of the cotton cycle and it is checked whether this higher third threshold temperature is reached (phase 8).

[0071] In case the third threshold temperature has been reached, in phase 9 then a command from the controller 20 is sent to the heater variable power supply 50 so that the latter switches off one of the two heating elements 9a,9b. The working temperature is thus kept keeping more or less constant switching on one of the two heating elements 9a,9b.

[0072] If a fourth threshold temperature T_4 is then reached, which is the minimum acceptable working temperature, the second heating element is switched on again, going back to phase 4 of the method of the invention. During the cotton cycle, therefore, there is always a heating element 9a or 9b which is switched on, while during the non- cotton cycle they are either both on or both off.

[0073] A graph of the result of this cycle is given in fig. 4. Comparing this graph with graph 6a, it is clear that in the non-cotton cycle either the power is "full power" or it is equal to zero, while in the cotton cycle there is always power consumed.

[0074] Phases 5-8 and phases 9-11 are repeated for all the duration of the drying cycle. As already mentioned, the total duration of a cycle can be a parameter which is stored in the memory of the controller 20 and set when the drying module 30 has been selected by the user, or it can be determined during the cycle itself. Example

[0075] In a washer dryer a synthetic drying cycle has been selected and 3 kg of synthetic fabric has been washed and then dried. The threshold temperatures are $T_1 = T_2 = 65$ °C. The synthetic drying cycle according to the teaching of the prior art has lasted 130 minutes (see graphs of figs. 5a and 5b), while the same cycle according to the teaching of the invention has lasted 115 minutes.

Claims

1. A dryer (100) for drying fabric items according to a plurality of drying cycles, said plurality including at least a non-cotton cycle and a cotton cycle, compris-

ing:

- A drying chamber (3) for receiving fabric items to be dried;
- An air circulation system to force air through the drying chamber (3);
- A heater (9) to heat the air in the air circulation system, said heater including a first and a second heating element (9a,9b);
- A user interface (8) apt to receive input from a user to select a drying cycle from said plurality;
- A temperature sensor (40) located within said dryer (100) to sense the temperature of said heated air;
- A controller (20) operably coupled to the heater (9), to the user interface (8), and to the temperature sensor (40), said controller being apt to receive from the user interface (8) an input relative to the selected drying cycle and from said temperature sensor (40) a temperature value;
- wherein it also comprises a heater variable power supply (50) controlled by said controller (20),

characterized by said variable power supply (50) being adapted, when a non-cotton cycle has been selected, to switch on both said first and said second heating elements (9a,9b) till a first threshold temperature (T_1) has been reached, and to switch off both said first and second heating elements (9a,9b) afterwards; and said variable power supply (50) being adapted, when said cotton cycle has been selected, to switch on both said first and said second heating elements (9a,9b) till a third threshold temperature (T_3) has been reached, and to switch off only one of said first and second heating elements (9a,9b) afterwards.

2. The dryer (100) of claim 1, wherein said variable power supply (50) is apt to switch on again both first and second heating elements (9a,9b) when a second threshold temperature (T_2) has been subsequently reached.

3. The dryer according to claim 1 or 2, wherein said heater (9) is at full power when said first and said second heating elements (9a,9b) are switched on.

4. The dryer according to any of the preceding claims, wherein said heater (9) is wholly switched off when said first and said second heating elements (9a,9b) are switched off.

5. The dryer (100) of any of the preceding claims, wherein said controller (20) includes an end of the cycle device(21) to signal the end of the selected cycle, and wherein said variable power supply (50) is apt to repeat the actions of

- switching on both heating elements (9a,9b), when a non-cotton cycle has been selected, till a first threshold temperature (T_1) has been reached;
- switching off both said first and second heating elements (9a,9b) afterwards, and
- switching on again both first and second heating elements (9a,9b) when a second threshold temperature (T_2) has been subsequently reached,

till the end of the drying cycle as indicated by said end of the cycle device (21).

6. The dryer (100) of any of the preceding claims, wherein said non cotton drying cycle is a synthetic drying cycle.

7. The dryer (100) of claims 2 or 5 or of any of the preceding claims when dependent on claims 2 or 5, wherein said first (T_1) and said second threshold temperature (T_2) are substantially the same temperature.

8. The dryer (100) of any of the preceding claims, wherein said temperature sensor (40) is located in said air circulation system downstream of said heater (9) in proximity of the entrance of the heated air into the drum (3).

9. The dryer (100) of any of the preceding claims, wherein said first and said second heating element (9a,9b) have the same heating power capacity.

10. A method to control a drying cycle of a dryer (100), said dryer (100) including

- A drying chamber (3) for receiving fabric items to be dried;
- An air circulation system to force air through the drying chamber (3);
- A heater (9) to heat the air in the air circulation system, said heater including a first and a second heating element (9a,9b);

Said method comprising:

- Selecting a drying cycle from a plurality of drying cycles, said plurality including at least a non-cotton cycle and a cotton cycle;

characterized in that

- If said non-cotton drying cycle has been selected, switching on both first and second heating element (9a,9b) till a first threshold temperature (T_1) is reached; and switching off both first and second heating element (9a,9b) after the first threshold temperature (T_1) has been reached;

◦ If said cotton cycle has been selected, switching on both said first and said second heating elements (9a,9b) till a third threshold temperature (T_3) has been reached, and switching off only one of said first and second heating elements (9a,9b) afterwards.

11. The method of claim 10, including, after switching off both said first and said second heating elements:
◦ Switching on both said first and said second heating elements after a second threshold temperature (T_2) is reached.

12. The method of claims 10 or 11, including repeating the actions of:

◦ switching on both heating elements (9a,9b) till a first threshold temperature (T_1) has been reached;
◦ switching off both said first and second heating elements (9a,9b) afterwards, if a non-cotton drying cycle has been selected, and
◦ switching on again both first and second heating elements (9a,9b) when a second threshold temperature (T_2) has been subsequently reached,

till the end of the selected cycle.

13. The method according to any of claims 10-12, including:
◦ switching on again both first and second heating elements (9a,9b) when a fourth threshold temperature (T_4) has been subsequently reached.

Patentansprüche

1. Trockner (100) zum Trocknen von Textilartikeln in Übereinstimmung mit mehreren Trocknungsprogrammen, wobei die mehreren Programme wenigstens ein NichtbaumwollProgramm und ein Baumwollprogramm umfassen, wobei der Trockner Folgendes umfasst:

◦ eine Trocknungskammer (3) zum Aufnehmen von zu trocknenden Textilartikeln;
◦ ein Luftzirkulationssystem, um Luft durch die Trocknungskammer (3) zu drängen;
◦ eine Heizung (9) zum Heizen der Luft in dem Luftzirkulationssystem, wobei die Heizung ein erstes und ein zweites Heizelement (9a, 9b) umfasst;
◦ eine Benutzerschnittstelle (8), die ausgelegt ist, eine Eingabe von einem Benutzer zu empfangen, um ein Trocknungsprogramm aus den mehreren Programmen auszuwählen;
◦ einen Temperatursensor (40), der in dem Trockner (100) angeordnet ist, um die Temperatur der geheizten Luft zu messen;
◦ eine Steuerung (20), die mit der Heizung (9), der Benutzerschnittstelle (8) und dem Temperatursensor (40) betriebstechnisch gekoppelt ist, wobei die Steuerung ausgelegt ist, von der Benutzerschnittstelle (8) eine Eingabe in Bezug auf das ausgewählte Trocknungsprogramm und von dem Temperatursensor (40) einen Temperaturwert zu empfangen;
◦ wobei er außerdem eine einstellbare Leistungsquelle (50) für die Heizung umfasst, die durch die Steuerung (20) gesteuert wird,

dadurch gekennzeichnet, dass
die einstellbare Leistungsquelle (50) ausgelegt ist, dann, wenn ein Nichtbaumwollprogramm ausgewählt worden ist, das erste und das zweite Heizelement (9a, 9b) einzuschalten, bis eine erste Schwellenwerttemperatur (T_1) erreicht worden ist, und das erste und das zweite Heizelement (9a, 9b) danach auszuschalten; und wobei die einstellbare Leistungsquelle (50) ausgelegt ist, dann, wenn das Baumwollprogramm ausgewählt worden ist, das erste und das zweite Heizelement (9a, 9b) einzuschalten, bis eine dritte Schwellenwerttemperatur (T_3) erreicht worden ist, und nur das erste oder das zweite Heizelement (9a, 9b) danach auszuschalten.

2. Trockner (100) nach Anspruch 1, wobei die einstellbare Leistungsquelle (50) ausgelegt ist, das erste und das zweite Heizelement (9a, 9b) erneut einzuschalten, wenn danach eine zweite Schwellenwerttemperatur (T_2) erreicht worden ist.

3. Trockner nach Anspruch 1 oder 2, wobei die Heizung (9) auf Nennleistung ist, wenn das erste und das zweite Heizelement (9a, 9b) eingeschaltet sind.

4. Trockner nach einem der vorhergehenden Ansprüche, wobei die Heizung (9) vollständig ausgeschaltet ist, wenn das erste und das zweite Heizelement (9a, 9b) ausgeschaltet sind.

5. Trockner (100) nach einem der vorhergehenden Ansprüche, wobei die Steuerung (20) eine Programmende-Vorrichtung (21) umfasst, um das Ende des ausgewählten Programms zu signalisieren, und wobei die einstellbare Leistungsquelle (50) ausgelegt ist, die folgenden Vorgänge bis zum Ende des Trocknungsprogramms, das durch die Programmende-Vorrichtung (21) angezeigt wird, zu wiederholen:

◦ Einschalten beider Heizelemente (9a, 9b), wenn ein Nichtbaumwollprogramm ausgewählt worden ist, bis eine erste Schwellenwerttemperatur (T_1) erreicht worden ist;
◦ danach Ausschalten des ersten und des zwei-

ten Heizelements (9a, 9b), und
◦ erneutes Einschalten des ersten und des zweiten Heizelements (9a, 9b), wenn eine zweite Schwellenwerttemperatur (T_2) anschließend erreicht worden ist.

6. Trockner (100) nach einem der vorhergehenden Ansprüche, wobei das Nichtbaumwoll-Trocknungsprogramm ein Synthetik-Trocknungsprogramm ist.

7. Trockner (100) nach Anspruch 2 oder 5 oder einem der vorhergehenden Ansprüche, wenn dieser von Anspruch 2 oder 5 abhängt, wobei die erste (T_1) und die zweite Schwellenwerttemperatur (T_2) im Wesentlichen die gleiche Temperatur sind.

8. Trockner (100) nach einem der vorhergehenden Ansprüche, wobei sich der Temperatursensor (40) in dem Luftzirkulationssystem stromabwärts der Heizung (9) direkt bei dem Eintritt der geheizten Luft in die Trommel (3) befindet.

9. Trockner (100) nach einem der vorhergehenden Ansprüche, wobei das erste und das zweite Heizelement (9a, 9b) die gleiche Heizleistungskapazität haben.

10. Verfahren zum Steuern eines Trocknungsprogramms eines Trockners (100), wobei der Trockner (100) Folgendes umfasst:

◦ eine Trocknungskammer (3) zum Aufnehmen von zu trocknenden Textilartikeln;
◦ ein Luftzirkulationssystem, um Luft durch die Trocknungskammer (3) zu drängen;
◦ eine Heizung (9) zum Heizen der Luft in dem Luftzirkulationssystem, wobei die Heizung ein erstes und ein zweites Heizelement (9a, 9b) umfasst;

wobei das Verfahren den folgenden Schritt umfasst:
◦ Auswählen eines Trocknungsprogramms aus mehreren Trocknungsprogrammen, wobei die mehreren Programme wenigstens ein Nichtbaumwollprogramm und ein Baumwollprogramm umfassen;
gekennzeichnet durch:

◦ wenn das Nichtbaumwollprogramm ausgewählt worden ist, Einschalten des ersten und des zweiten Heizelements (9a, 9b), bis eine erste Schwellenwerttemperatur (T_1) erreicht worden ist; und Ausschalten des ersten und des zweiten Heizelements (9a, 9b), nachdem die erste Schwellenwerttemperatur (T_1) erreicht worden ist;
◦ wenn das Baumwollprogramm ausgewählt worden ist, Einschalten des ersten und des zweiten Heizelements (9a, 9b), bis eine dritte Schwellenwerttemperatur (T_3) erreicht worden ist, und danach Ausschalten nur des ersten oder des zweiten Heizelements (9a, 9b).

11. Verfahren nach Anspruch 10, das nach dem Ausschalten des ersten und des zweiten Heizelements den folgenden Schritt umfasst:
◦ Einschalten des ersten und des zweiten Heizelements, nachdem eine zweite Schwellenwerttemperatur (T_2) erreicht worden ist.

12. Verfahren nach Anspruch 10 oder 11, das das Wiederholen der folgenden Vorgänge umfasst:

◦ Einschalten beider Heizelemente (9a, 9b), bis eine erste Schwellenwerttemperatur (T_1) erreicht worden ist;
◦ danach Ausschalten des ersten und des zweiten Heizelements (9a, 9b), falls ein Nichtbaumwoll-Trocknungsprogramm ausgewählt worden ist, und
◦ erneutes Einschalten des ersten und des zweiten Heizelements (9a, 9b), wenn eine zweite Schwellenwerttemperatur (T_2) danach erreicht worden ist,

bis zum Ende des ausgewählten Programms.

13. Verfahren nach einem der Ansprüche 10-12, das den folgenden Schritt umfasst:
◦ erneutes Einschalten des ersten und des zweiten Heizelements (9a, 9b), wenn danach eine vierte Schwellenwerttemperatur (T_4) erreicht worden ist.

Revendications

1. Appareil de séchage (100) destiné à sécher des articles textiles selon une pluralité de cycles de séchage, ladite pluralité incluant au moins un cycle pour articles sans coton et un cycle pour articles en coton, comprenant :

une chambre de séchage (3) permettant de recevoir des articles textiles à sécher ;
un système de circulation d'air pour refouler de l'air dans la chambre de séchage (3) ;
un chauffage (9) pour chauffer l'air dans le système de circulation d'air, ledit chauffage comprenant un premier et un second élément chauffant (9a, 9b) ;
une interface d'utilisateur (8) permettant de recevoir une entrée d'un utilisateur pour sélectionner un cycle de séchage parmi ladite pluralité ;
un capteur de température (40) situé dans ledit appareil de séchage (100) pour détecter la température dudit air chauffé ;
un contrôleur (20) couplé de manière fonction-

nelle au chauffage (9), à l'interface d'utilisateur (8) et au capteur de température (40), ledit contrôleur permettant de recevoir, en provenance de l'interface d'utilisateur (8), une entrée relative au cycle de séchage sélectionné et, en provenance dudit capteur de température (40), une valeur de température,
l'appareil de séchage comprenant en outre une alimentation variable de chauffage (50) contrôlée par ledit contrôleur (20),
l'appareil de séchage étant **caractérisé en ce que** :
ladite alimentation variable (50) est conçue, quand un cycle pour articles sans coton a été sélectionné, pour allumer lesdits premier et second éléments chauffants (9a, 9b) jusqu'à atteindre une première température de seuil (T_1), et pour éteindre ensuite lesdits premier et second éléments chauffants (9a, 9b) ; et ladite alimentation variable (50) est conçue, quand ledit cycle pour articles en coton a été sélectionné, pour allumer lesdits premier et second éléments chauffants (9a, 9b) jusqu'à atteindre une troisième température de seuil (T_3), et pour éteindre ensuite seulement un desdits premier et second éléments chauffants (9a, 9b).

2. Appareil de séchage (100) selon la revendication 1, dans lequel ladite alimentation variable (50) permet de rallumer les premier et second éléments chauffants (9a, 9b) quand une deuxième température de seuil (T_2) a ensuite été atteinte.

3. Appareil de séchage selon la revendication 1 ou 2, dans lequel ledit chauffage (9) est à pleine puissance quand lesdits premier et second éléments chauffants (9a, 9b) sont allumés.

4. Appareil de séchage selon l'une quelconque des revendications précédentes, dans lequel ledit chauffage (9) est totalement éteint quand lesdits premier et second éléments chauffants (9a, 9b) sont éteints.

5. Appareil de séchage (100) selon l'une quelconque des revendications précédentes, dans lequel ledit contrôleur (20) inclut une fin du dispositif de cycle (21) pour signaler la fin du cycle sélectionné, et dans lequel ladite alimentation variable (50) permet de répéter les actions consistant à :

allumer les deux éléments chauffants (9a, 9b), quand un cycle pour articles sans coton a été sélectionné, jusqu'à atteindre une première température de seuil (T_1) ;
éteindre ensuite lesdits premier et second éléments chauffants (9a, 9b) ; et
rallumer les premier et second éléments chauffants (9a, 9b) quand une deuxième température de seuil (T_2) a ensuite été atteinte,
jusqu'à la fin du cycle de séchage, comme indiqué par ladite fin du dispositif de cycle (21).

6. Appareil de séchage (100) selon l'une quelconque des revendications précédentes, dans lequel ledit cycle de séchage pour articles sans coton est un cycle de séchage pour articles synthétiques.

7. Appareil de séchage (100) selon la revendication 2 ou 5 ou selon l'une quelconque des revendications précédentes lorsqu'elles dépendent de la revendication 2 ou 5, dans lequel ladite première (T_1) et ladite deuxième température de seuil (T_2) sont sensiblement la même température.

8. Appareil de séchage (100) selon l'une quelconque des revendications précédentes, dans lequel ledit capteur de température (40) est situé dans ledit système de circulation d'air en aval dudit chauffage (9) à proximité de l'entrée de l'air chauffé dans le tambour (3).

9. Appareil de séchage (100) selon l'une quelconque des revendications précédentes, dans lequel lesdits premier et second éléments chauffants (9a, 9b) ont la même capacité de puissance de chauffage.

10. Procédé de contrôle d'un cycle de séchage d'un appareil de séchage (100), ledit appareil de séchage (100) comprenant :

une chambre de séchage (3) permettant de recevoir des articles textiles à sécher ;
un système de circulation d'air pour refouler de l'air dans la chambre de séchage (3) ;
un chauffage (9) pour chauffer l'air dans le système de circulation d'air, ledit chauffage comprenant un premier et un second élément chauffant (9a, 9b) ;
ledit procédé consistant à :

sélectionner un cycle de séchage parmi une pluralité de cycles de séchage, ladite pluralité incluant au moins un cycle pour articles sans coton et un cycle pour articles en coton ;
ledit procédé étant **caractérisé par** les étapes consistant à :

si ledit cycle de séchage pour articles sans coton a été sélectionné, allumer les premier et second éléments chauffants (9a, 9b) jusqu'à atteindre une première température de seuil (T_1) ; et éteindre les premier et second éléments chauffants (9a, 9b) après que la première température de seuil (T_1) a

été atteinte ;
si ledit cycle pour articles en coton a été sélectionné, allumer lesdits premier et second éléments chauffants (9a, 9b) jusqu'à atteindre une troisième température de seuil (T_3), et éteindre ensuite seulement un desdits premier et second éléments chauffants (9a, 9b).

11. Procédé selon la revendication 10, consistant, après l'extinction desdits premier et second éléments chauffants, à :
allumer lesdits premier et second éléments chauffants après qu'une seconde température de seuil (T_2) a été atteinte.

12. Procédé selon la revendication 10 ou 11, consistant à répéter les actions consistant à :

allumer les deux éléments chauffants (9a, 9b) jusqu'à atteindre une première température de seuil (T_1) ;
éteindre ensuite lesdits premier et second éléments chauffants (9a, 9b), si un cycle de séchage pour articles sans coton a été sélectionné ; et
rallumer les premier et second éléments chauffants (9a, 9b) quand une deuxième température de seuil (T_2) a ensuite été atteinte,
jusqu'à la fin du cycle sélectionné.

13. Procédé selon l'une quelconque des revendications 10 à 12, consistant à :
rallumer les premier et second éléments chauffants (9a, 9b) quand une quatrième température de seuil (T_4) a ensuite été atteinte.

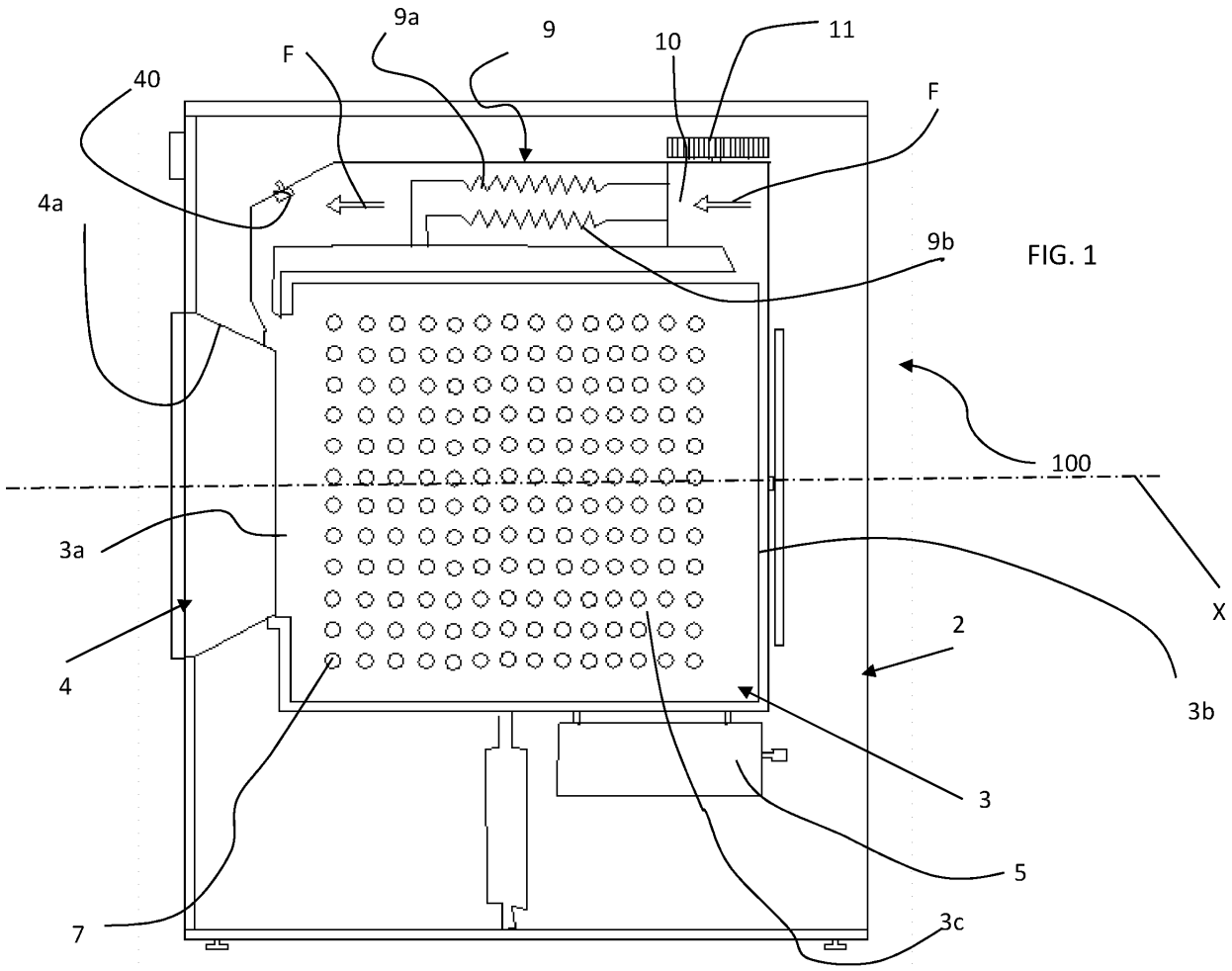


FIG. 1

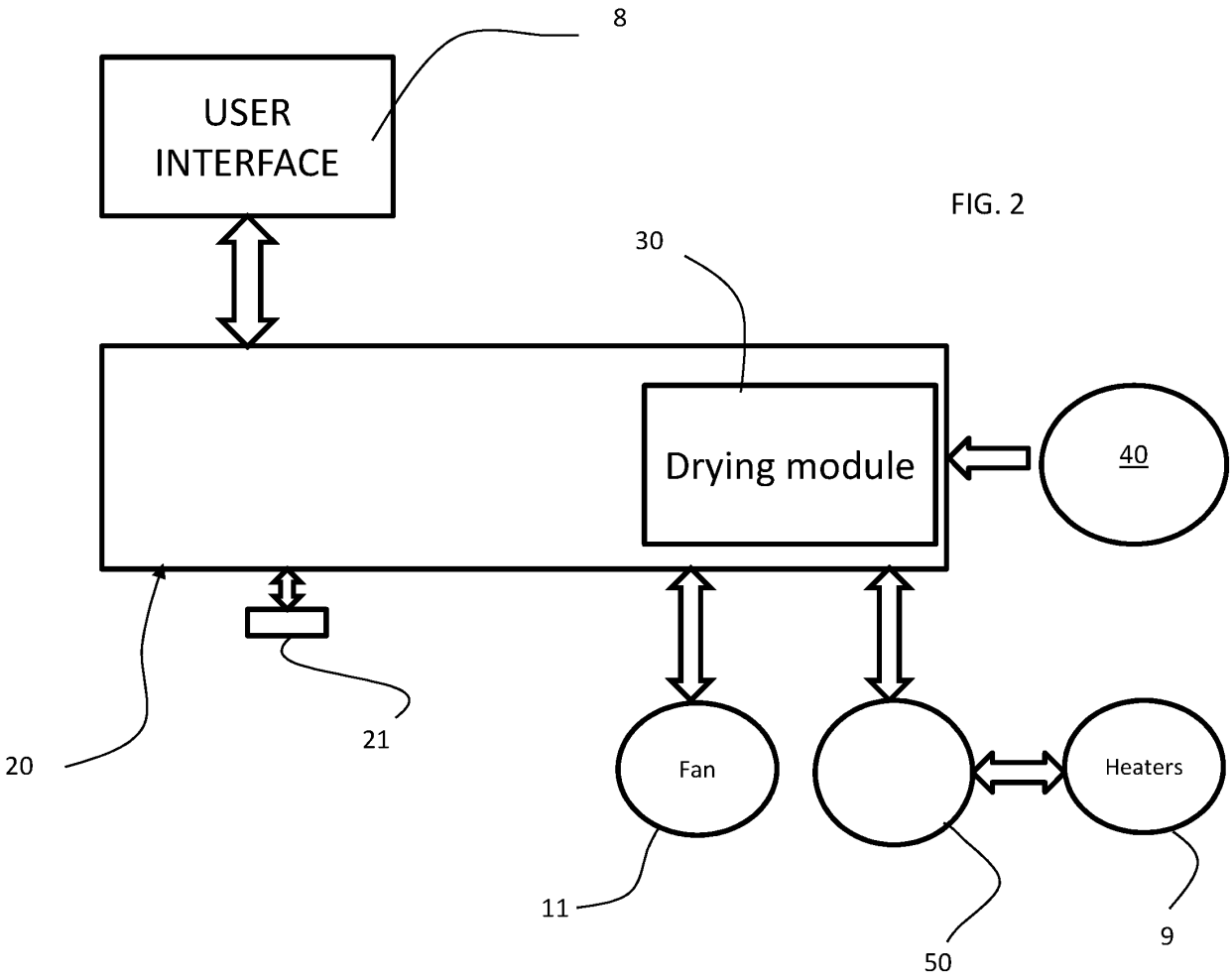


FIG. 2

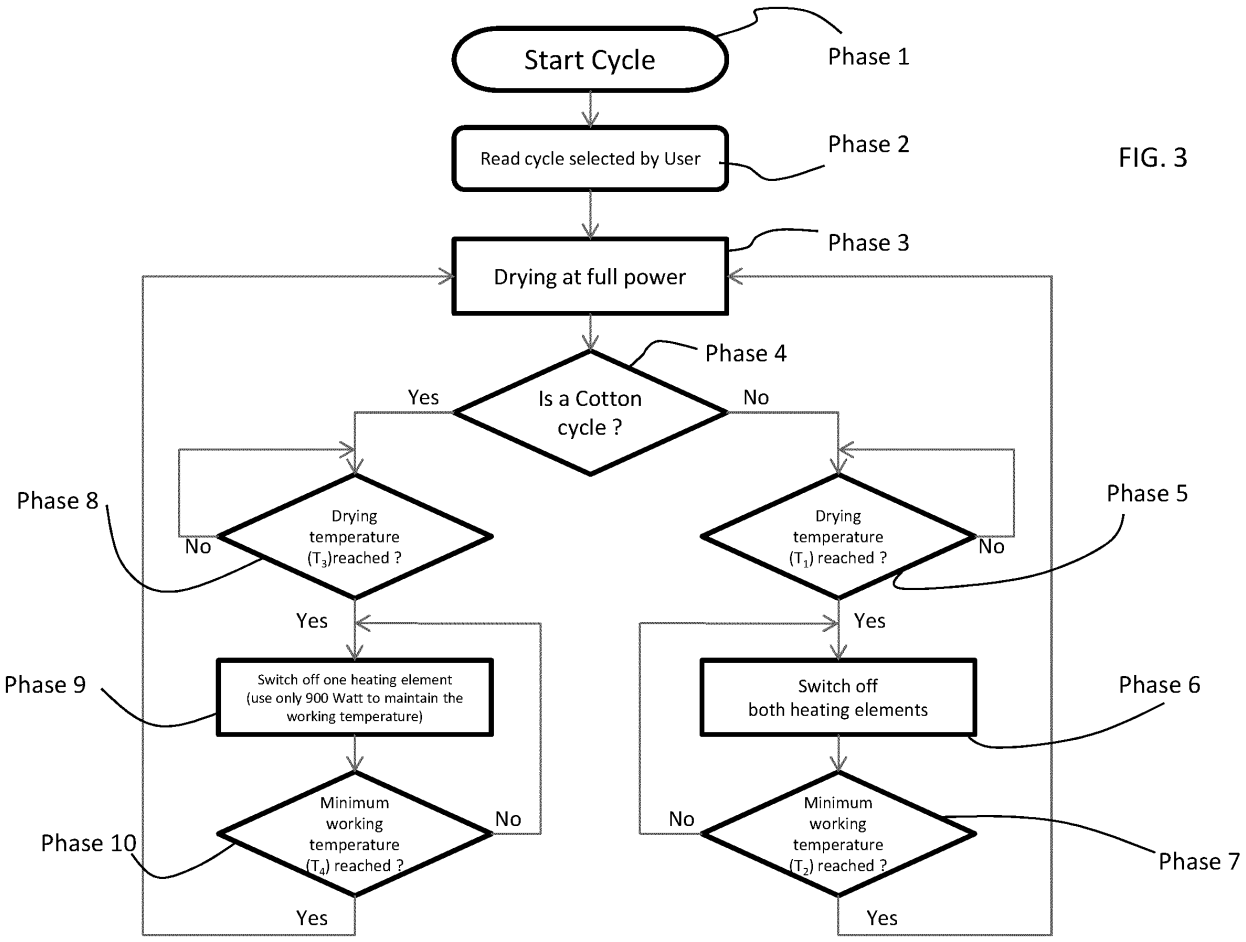

Start Cycle
Phase 1
Read cycle selected by User
Phase 2
Drying at full power
Phase 3
Phase 4
Is a Cotton cycle ?
Yes
No
Drying temperature (T_3)reached ?
No
Yes
Phase 8
Switch off one heating element (use only 900 Watt to maintain the working temperature)
Phase 9
Minimum working temperature (T_4) reached ?
No
Yes
Phase 10
Drying temperature (T_1) reached ?
No
Yes
Phase 5
Switch off both heating elements
Phase 6
Minimum working temperature (T_2) reached ?
No
Yes
Phase 7

FIG. 3

FIG. 4

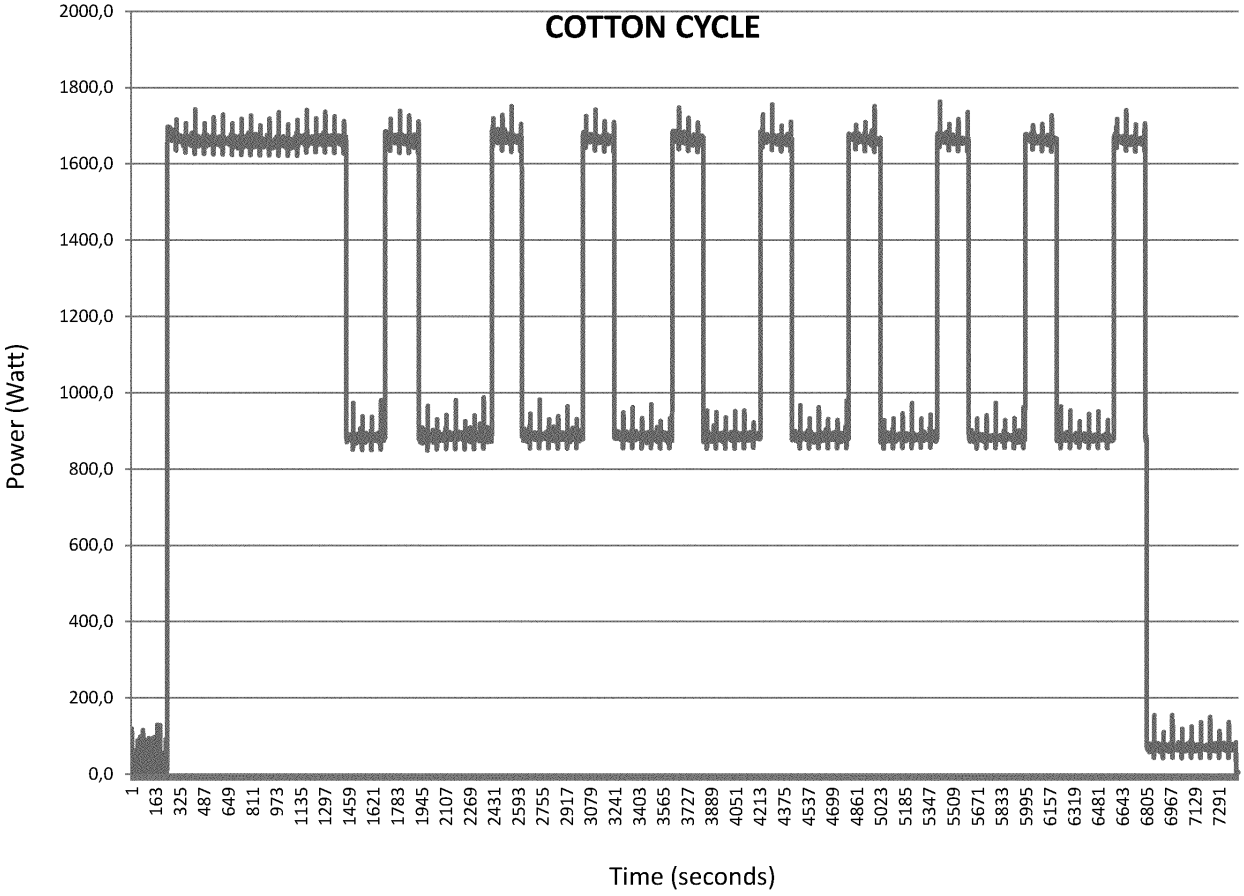
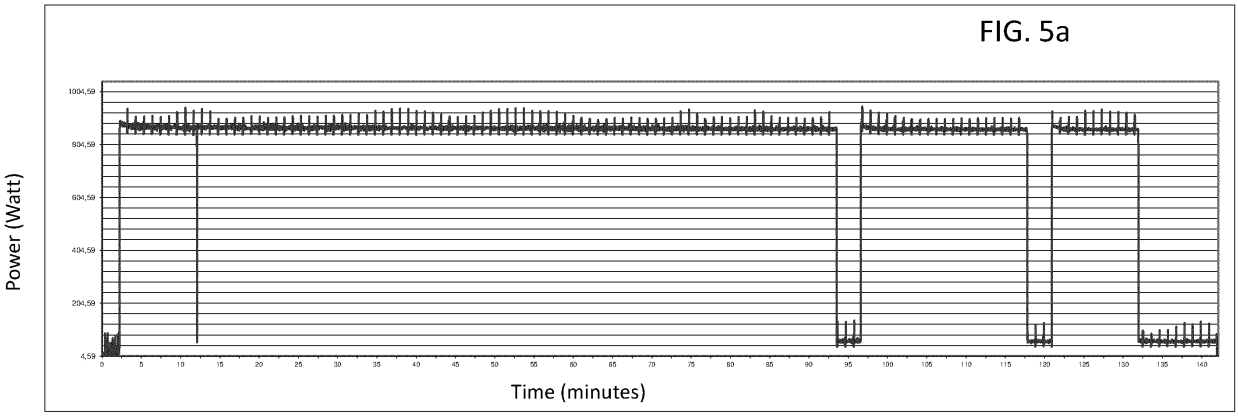

COTTON CYCLE
Power (Watt)
2000,0
1800,0
1600,0
1400,0
1200,0
1000,0
800,0
600,0
400,0
200,0
0,0
1
163
325
487
649
811
973
1135
1297
1459
1621
1783
1945
2107
2269
2431
2593
2755
2917
3079
3241
3403
3565
3727
3889
4051
4213
4375
4537
4699
4861
5023
5185
5347
5509
5671
5833
5995
6157
6319
6481
6643
6805
6967
7129
7291
Time (seconds)

FIG. 5a


Power (Watt)
1004,59
804,59
604,59
404,59
204,59
4,59
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140
Time (minutes)

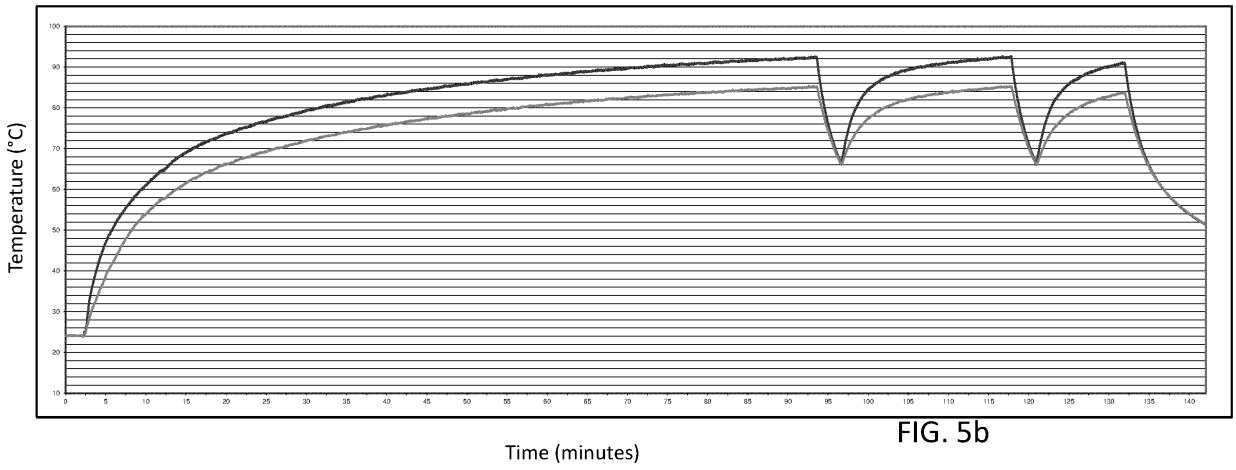
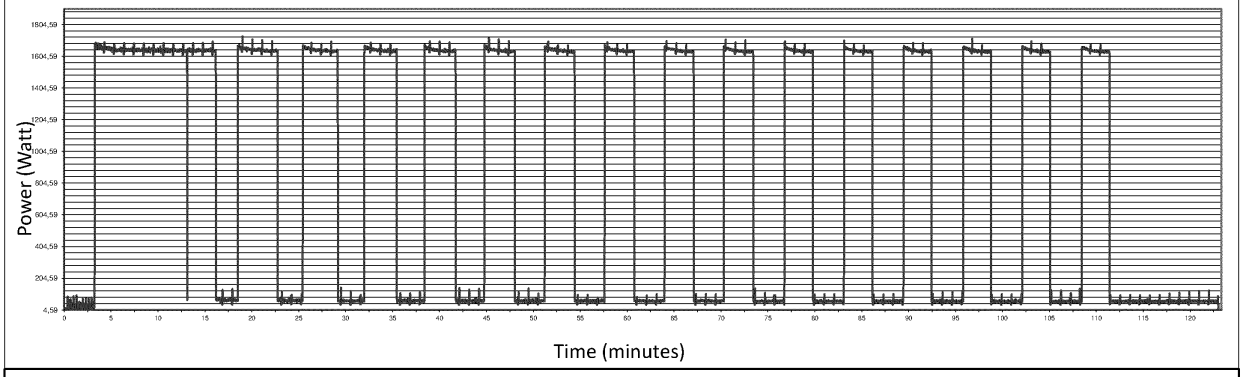

Temperature (°C)
100
90
80
70
60
50
40
30
20
10
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140
Time (minutes)

FIG. 5b

FIG. 6a



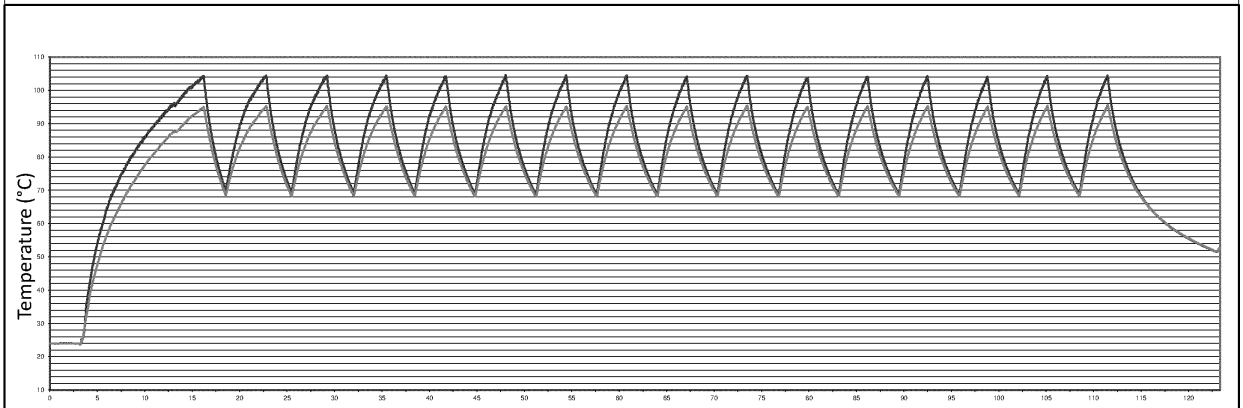


FIG. 6b

REFERENCES CITED IN THE DESCRIPTION

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