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(54) **Laundry drying machine and operating method therefor**

(57) Disclosed is a method to operate a laundry drying machine 1, wherein the laundry drying machine 1 comprises: a control device 12, an accommodation chamber 3 for accommodating laundry, an air circulation channel 7 in communication with the accommodation chamber 3, and a condensation valve 14 for supplying water into the air circulation channel 7 to condense humidity from air coming from the accommodation chamber 3; the method which comprises executing a preheating step S1; in the preheating step S1, providing heated air in the accommodation chamber 3 and turning off the con-

densation valve 14; the method further comprising: performing a detecting step S2 for detecting condensation water after the preheating step S1; in the detecting step S2, stopping providing heated air in the accommodation chamber 3, turning on the condensation valve 14, and determine, according to a temperature change at a specific position in the air circulation channel 7, a quantity of water supplied by the condensation valve 14. Also disclosed is a laundry drying machine 1 that can implement such method.

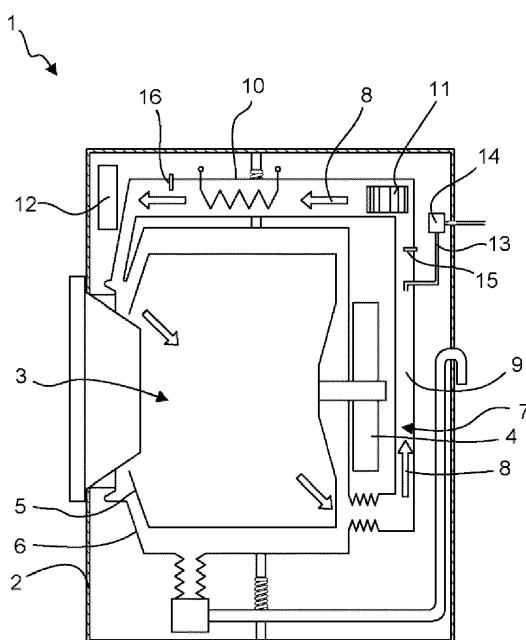


FIG. 1

Description

[0001] The present invention relates to a method to operate a laundry drying machine, wherein the laundry drying machine comprises: a control device, an accommodation chamber for accommodating laundry, an air circulation channel in communication with the accommodation chamber, and a condensation valve for supplying water into the air circulation channel to condense humidity from air coming from the accommodation chamber; the method which comprises executing a preheating step; in the preheating step, providing heated air in the accommodation chamber and turning off the condensation valve, and to a laundry drying machine that can implement such method.

[0002] The existing laundry drying machines such as a laundry dryer and a laundry drying machine integrating the washing and drying functions and termed "washer-dryer" usually have the following drying process: Under the action of a heating device, dry air is heated in a heating tube or heating channel into dry hot air, then enters a laundry accommodating chamber to perform heat exchange with wet laundry, to take away moisture in the laundry, forms relatively humid hot air, and then enters a condensing device through an outlet disposed on the accommodating chamber; after the condensation action of the condensing device, the moisture in the relatively humid hot air is condensed into water, and then the water is discharged through a drainpipe; the condensed air becomes relatively dry cold air, is re-guided into the heating pipe under the action of a fan or blower, and forms dry hot air through heating to enter a next cycle, which is repeated until the end of the drying process.

[0003] A relatively common condensing device in the laundry drying machine, in particular in such machine as embodied in a washer-dryer, is a spray head connected with a water inlet pipe disposed in an air channel connected with the laundry accommodating chamber, and the water inlet pipe is provided with a condensation valve. The water, after being sprayed from the spray head, encounters water vapor in the channel from the laundry accommodating chamber. As the temperature of the water is low, the water vapor is cooled and condensed into water.

[0004] During drying, if there is no water, or the water pressure is too low, or the water tap is not turned on, or the quantity of the condensation water is too little or no condensation water is supplied due to damage to the condensation valve, the water vapor evaporated from the laundry cannot be effectively cooled. Then it is difficult to achieve the dew point temperature to be condensed, and the drying performance of the machine may be greatly reduced. In the meantime, no cooling water or too little cooling water may cause that the machine has a too high temperature during drying, rendering aging and deformation of some plastic parts inside the machine, thereby damaging the machine or shortening the service life of the machine.

[0005] The known method of detecting whether the water valve supplies water or whether the flow of the supplied water is normal is implemented by using a flow sensor or by detecting the water pressure of the laundry accommodating chamber. However, the flow of the condensation water is generally very small, approximately in a range of 0.25 liter/min to 1 liter/min, and the flow sensor for small flow on the current market often has low detection accuracy, and is expensive. Determining whether the condensation valve supplies water or the magnitude of the water supplying quantity is too low by detecting the water pressure of the laundry accommodating chamber within a period after the condensation valve is turned on has the following disadvantages: under the influence of factors such as mechanical system precision and user water pressure magnitude, water inflowing time and pressure rise are inconsistent; if the water inflowing time is set too long, the situation may occur that the cooling water enters the inner barrel and soaks laundry, and if the water inflowing time is set too short and the pressure parameter is set too low, the detection precision is not high, and it is prone to misjudgment. Additionally, the water supply detected through additional water inflow before the drying begins, and at this time, the machine is in the cold-state waiting stage, wastes the water supplied so, and also wastes the running time of the drying procedure.

[0006] An objective of the present invention is to provide a method for operating a laundry drying machine that alleviates or overcomes the above shortcomings, and to provide a laundry drying machine that can implement the method.

[0007] Solutions to these objectives are defined in the independent claims attached. Preferred embodiments of the invention are defined in dependent claims attached, the drawing attached and the subsequent description, with preferred embodiments of the method always constituting preferred embodiments of the machine and vice versa, even if not explained in detail herein.

[0008] With respect to the above objectives, the present invention accordingly provides a method to operate a laundry drying machine, wherein the laundry drying machine comprises: a control device, an accommodation chamber for accommodating laundry, an air circulation channel in communication with the accommodation chamber, and a condensation valve for supplying water into the air circulation channel to condense humidity from air coming from the accommodation chamber; the method which comprises executing a preheating step; in the preheating step, providing heated air in the accommodation chamber and turning off the condensation valve; the method further comprising: performing a detecting step for detecting condensation water after the preheating step; in the detecting step, stopping providing heated air in the accommodation chamber, turning on the condensation valve, and determine, according to a temperature change at a specific position in the air circulation channel, a quantity of water supplied by the con-

densation valve.

[0009] Preferably, in the preheating step, heated air is provided in the accommodation chamber by supplying heated air from the air circulation channel into the accommodation chamber.

[0010] Preferably, the specific position in the air circulation channel is located at a downstream of a position of the condensation valve in an air flow direction, and a temperature detection device is provided at the specific position.

[0011] Preferably, in the step of detecting condensation water, if the temperature of a specific position in the air circulation channel within a period before the condensation valve is turned on or after the condensation valve is turned on reduces, it is determined that the condensation valve has supplied water to the air circulation channel; if the temperature increases or remains unchanged, it is determined that the condensation valve has not supplied water to the air circulation channel.

[0012] Preferably, in the step of detecting condensation water, if the temperature of a specific position in the air circulation channel within a period before the condensation valve is turned on or after the condensation valve is turned on reduces and a reduction value is greater than or equal to a specific value, it is determined that the condensation valve has supplied a normal quantity of water to the air circulation channel; if the temperature reduction value is less than the specific value, it is determined that the condensation valve has supplied water of a quantity less than the normal water supplying quantity to the air circulation channel.

[0013] Preferably, if it is determined that the quantity of water supplied by the condensation valve is zero, prompt information is displayed by the control device.

[0014] Preferably, if it is determined that the quantity of water supplied by the condensation valve is zero, the control device stores information indicating that the condensation valve has no water.

[0015] Preferably, the method further includes performing a drying step after the step of detecting condensation water.

[0016] Preferably, if it is determined that the quantity of water supplied by the condensation valve is zero or less than a normal water supplying quantity, in the drying step, the heating temperature of the air in the accommodation chamber or the heating temperature of the air to be supplied to the accommodation chamber is reduced.

[0017] With respect to the above objective, the present invention further provides a laundry drying machine, comprising: a control device, an accommodation chamber for accommodating laundry, an air circulation channel in communication with the accommodation chamber, and a condensation valve for supplying water into the air circulation channel to condense humidity from air coming from the accommodation chamber, wherein the control device is set so that the laundry drying machine is capable of implementing the method according to the invention.

[0018] Compared with the prior art, the present invention has the following advantages: Addition and use of an expensive an imprecise flowmeter is avoided, and precision of measurement attained by resorting to a measurement of temperature to determine an amount of water entered into the machine; use of a temperature detecting device necessary in the laundry drying machine present for any other purpose does not increase additional costs of the machine; the detecting result is more accurate, and is little affected by the mechanical structure, and accurate detection can be performed in a variety of load weight, ambient temperature, or cooling water temperature fluctuation environments; the step of detecting condensation water is performed after the preheating step, and the accommodation chamber and the air circulation channel are full of evaporated water vapor, so the condensation water in the step of detecting condensation water can directly play the condensation role, and therefore, a waste of water and drying time may be kept at a minimum; as prompt information may be sent if it is determined that the quantity of water supplied by the condensation valve is zero, it facilitates the user or maintenance personnel to check the water supply system; as the control device stores information indicating that the condensation valve has no water if it is determined that the quantity of water supplied by the condensation valve is zero, the maintenance personnel can quickly determine whether the condensation valve is damaged according to the stored information and the frequency; in addition, the laundry drying machine of the present invention can still dry the laundry in the case of detecting that the quantity of water supplied by the condensation valve is zero or less than a normal water supplying quantity, and related parts may not be damaged by high temperature as the heating temperature of the air is reduced.

[0019] Preferred embodiments of the invention are now described in detail with reference to the drawing attached. In the drawing:

FIG. 1 is a schematic structural view of a laundry drying machine; and

FIG. 2 is a schematic view of a correspondence relationship between a temperature curve detected by a temperature sensor at a condenser outlet in an air circulation channel and opening/closing of a condensation valve.

[0020] As shown in FIG. 1, a laundry drying machine 1 has a laundry accommodation chamber 3 in a case 2, which includes an inner barrel 5 or drum 5 driven by a motor 4 to be rotatable and an outer barrel 6 or tub 6 sleeved outside the inner barrel 5. The outer barrel 6 is connected with two ends of an air circulation channel 7, so that dried air 8 can circularly flow in the laundry accommodation chamber 3 and the air circulation channel 7. The air circulation channel 7 includes a condensing channel 9 and a heating channel 10, and the air circula-

tion channel 7 is also provided with a blowing device 11 to make the dried air 8 circularly flow in the laundry accommodation chamber 3 and the air circulation channel 7. The laundry drying machine 1 further has a control device 12, which controls running of devices in the machine according to procedure setting. Under control of the control device 12, in the drying procedure, the heating channel 10 heats the dried air 8 flowing therethrough; the high-temperature dried air 8 after being heated enters the laundry accommodation chamber 3 under the action of the blowing device 11, to heat wet laundry in the inner barrel 5, to evaporate moisture in the laundry; the dried air 8 carries the evaporated moisture and enters the condensing channel 9, in which the moisture in the dried air 8 is condensed and becomes liquid again, and is separated from the dried air 8, and the dried air 8 again becomes air at a low temperature and dry, and re-enters the heating channel 10 with the driving of the blowing device 11; a new round of circulation begins, which is repeated to finally dry the laundry in the inner barrel 5.

[0021] To condense the dried air 8 in the condensing channel 9, the condensing channel 9 is provided with a water supply pipe 13. The water supply pipe 13 is provided with a condensation valve 14 connected with a water source.

[0022] A first temperature sensor 15 is disposed between the condensing channel 9 and the blowing device 11. The heating channel 10 is provided with a second temperature sensor 16.

[0023] FIG. 2 shows a correspondence relationship among a first temperature curve C1 measured by the first temperature sensor 15 when there is normally supplied condensation water, a second temperature curve C2 measured by the first temperature sensor 15 when there is no condensation water and a curve C3 of opening/closing of the condensation valve 14.

[0024] As shown in FIG. 2, when a drying procedure is selected and executed, under control of the control device 12, the laundry drying machine 1 first performs a preheating step S1. In this step, the dried air 8 is constantly heated in the heating channel 10, the heated air is supplied into the accommodation chamber 3, and the condensation valve 14 is in a closed state. In other embodiments, the air in the accommodation chamber 3 may be directly heated through a heating device located in the accommodation chamber 3. In the preheating step S1, the air temperature measured by the first temperature sensor 15 gradually increases.

[0025] A detecting step S2 of detecting condensation water is performed after the preheating step S1 has ended.

[0026] In this step, the heating channel 10 stops heating the air supplied to the accommodation chamber 3. In other embodiments, if the device heating the air is located in the accommodation chamber 3, stop heating the air of the accommodation chamber 3. The condensation valve 14 is turned on for a period of time, for example, 120 seconds. After 120 seconds, the condensation valve 14

is turned off. Turning on or off the condensation valve 14 means a circuit connected to the condensation valve 14 is switched on or off under the action of the control device 12, and if the condensation valve 14 is damaged, the condensation water cannot be supplied even if the condensation valve 14 is turned on. Therefore, turning on the condensation valve 14 is only an action executed by the control device 12.

[0027] The control device 12 records a first temperature value T1 (T11, T21) measured by the first temperature sensor 15 once at the 20th second when the condensation valve 14 is turned on, the control device 12 records a second temperature value T2 (T12, T22) measured by the first temperature sensor 15 at the 120th second when the condensation valve 14 is turned on, a temperature difference $T_{\Delta} = T2 - T1$ is calculated, and then the temperature difference T_{Δ} is compared with a first temperature change threshold T_{b1} and a second temperature change threshold T_{b2} which are predetermined. Generally, the first temperature change threshold T_{b1} may be set as 0, and the second temperature change threshold T_{b2} is a temperature change value in a normal water supply condition, which can be obtained in advance through experiments. If $T_{\Delta} \geq T_{b1}$, the control device 12 determines that no condensation water is supplied; if $T_{b2} < T_{\Delta} < T_{b1}$, the control device 12 determines that condensation water is supplied, but the flow of the condensation water is less than the normal water supplying flow; if $T_{\Delta} < T_{b2}$, the control device 12 determines that the condensation water in a normal flow is supplied.

[0028] It can be seen from FIG. 2 that, when the condensation valve 14 is turned on by the control device 12 but does not supply condensation water, in the step S2 of detecting condensation water, the second temperature curve C2 measured by the first temperature sensor 15 still slowly ascends, and a difference between the temperature T22 measured by the first temperature sensor 15 at the 120th second when the condensation valve 14 is turned on and the temperature T21 measured by the first temperature sensor 15 at the 20th second when the condensation valve 14 is turned on is greater than 0, that is, the temperature increases. When the condensation valve 14 is turned on by the control device 12 and supplies condensation water of a normal flow, in the step S2 of detecting condensation water, the first temperature curve C1 measured by the first temperature sensor 15 tends to descend, and a difference between the temperature T12 measured by the first temperature sensor 15 at the 120th second when the condensation valve 14 is turned on and the temperature T11 measured by the first temperature sensor 15 at the 20th second when the condensation valve 14 is turned on is less than 0, that is, the temperature decreases.

[0029] By understanding the above specific embodiments, persons skilled in the art could understand that it is also feasible to select another two suitable time points in a period when the condensation valve 14 is turned on to measure and determine two temperature values re-

quired, or to respectively select two suitable time points before and after the condensation valve 14 is turned on to measure and determine two temperature values required, both of which can achieve the objective of the present invention.

[0030] Besides, the position of the first temperature sensor 15 is not unique. In other embodiments, the first temperature sensor 15 also may be located at another position in the air circulation channel 7, which can achieve the objective of the present invention, and thus also falls within the protection scope defined by the claims of the present invention.

[0031] In the step S2 of detecting condensation water, if the control device 12 determines that no condensation water is supplied, that is, if it determines that a quantity of water supplied by the condensation valve 14 is zero, prompt information is sent through a display, a signal lamp or an audio device, to inform the user, and meanwhile, the control device 12 stores information indicating that the condensation valve 14 has no water. If it is found that there are errors of having no water constantly and it is determined that the water tap is in an opened state, the maintenance personnel can quickly check whether the condensation valve or the circuit thereof is damaged according to the information stored by the control device 12.

[0032] A drying step S3 is performed after the step S2 of detecting condensation water has ended.

[0033] If it is determined in the step S2 of detecting condensation water that the quantity of water supplied by the condensation valve 14 is zero or less than a normal water supplying quantity, in the drying step S3, reduce the heating temperature of the air in the accommodation chamber 3 or reduce the heating temperature of the air to be supplied to the accommodation chamber 3. For example, if, in the normal drying step, a target temperature of the second temperature sensor 16 in the heating channel 10 is controlled at 100°C, in the case that the quantity of the condensation water is zero or less than a normal water supplying quantity, reduce the heating power of the heating channel 10 if the temperature measured by the first temperature sensor 15 reaches or exceeds 80°C, to make the target temperature of the second temperature sensor 16 to be at about 80°C. In this case, the drying time may be long, which may not cause damage to the laundry drying machine 1.

[0034] The above embodiments are merely preferred embodiments of the present invention, and the present invention may have many other embodiments. For persons of ordinary skill in the art, equivalent variations made with respect to the present invention with the teachings of the present invention still should be included in the scope defined by the claims of the present invention.

LIST OF REFERENCE NUMERALS

[0035]

1	laundry drying machine
2	case
3	laundry accommodation chamber
4	motor
5	5 inner barrel, drum
6	6 outer barrel, tub
7	7 air circulation channel
8	8 dried air
9	9 condensing channel
10	10 heating channel
11	11 blowing device
12	12 control device
13	13 water supply pipe
14	14 condensation valve
15	15 first temperature sensor
16	16 second temperature sensor
C1	C1 first temperature curve
C2	C2 second temperature curve
C3	C3 curve of opening/closing the condensation valve
20	S1 preheating step
	S2 condensation water detecting step
	S3 drying step
	T1 first temperature value
	T2 second temperature value
25	T _Δ T2-T1
	T _{b1} first temperature change threshold
	T _{b2} second temperature change threshold

Claims

1. A method to operate a laundry drying machine (1), wherein the laundry drying machine (1) comprises: a control device (12), an accommodation chamber (3) for accommodating laundry, an air circulation channel (7) in communication with the accommodation chamber (3), and a condensation valve (14) for supplying water into the air circulation channel (7) to condense humidity from air coming from the accommodation chamber (3); the method which comprises executing a preheating step (S1); in the preheating step (S1), providing heated air in the accommodation chamber (3) and turning off the condensation valve (14); the method **characterized by** further comprising: performing a detecting step (S2) for detecting condensation water after the preheating step (S1); in the detecting step (S2), stopping providing heated air in the accommodation chamber (3), turning on the condensation valve (14), and determine, according to a temperature change at a specific position in the air circulation channel (7), a quantity of water supplied by the condensation valve (14).
2. The method according to claim 1, **characterized in that** in the preheating step (S1), heated air is provided in the accommodation chamber (3) by supplying heated air from the air circulation channel (7) into the accommodation chamber (3).

3. The method according to one of claims 1 and 2, **characterized in that:** the specific position in the air circulation channel (7) is located at a downstream of a position of the condensation valve (14) in an air flow direction, and a temperature detection device (15, 16) is provided at the specific position. 5

4. The method according to any preceding claim, **characterized in that:** in the detecting step (S2), if the temperature of the specific position in the air circulation channel (7) reduces, it is determined that the condensation valve (14) has supplied water to the air circulation channel (7); if the temperature increases or remains unchanged, it is determined that the condensation valve (14) has not supplied water to the air circulation channel (7). 10 15

5. The method according to claim 4, **characterized in that:** in the detecting step (S2), if the temperature of the specific position in the air circulation channel reduces and a reduction value is greater than or equal to a specific threshold, it is determined that the condensation valve (14) has supplied a normal quantity of water to the air circulation channel (7); if the temperature reduction value is less than the specific threshold, it is determined that the condensation valve (14) has supplied a quantity of water less than the normal water supplying quantity to the air circulation channel (7). 20 25 30

6. The method according to any preceding claim, **characterized in that:** if it is determined that the quantity of water supplied by the condensation valve (14) is zero, prompt information is displayed by the control device (12). 35

7. The method according to any preceding claim, **characterized in that:** if it is determined that the quantity of water supplied by the condensation valve (14) is zero, the control device (12) stores information indicating that the condensation valve (14) has no water. 40

8. The method according to any preceding claim, **characterized by** further comprising: performing a drying step (S3) after the detecting step (S2). 45

9. The method according to claim 8, **characterized in that,** if it is determined that the quantity of water supplied by the condensation valve (14) is zero or less than a normal water supplying quantity, in the drying step (S3), a temperature of heated air provided in the accommodation chamber (3) is reduced. 50

10. A laundry drying machine (1), comprising: a control device (12), an accommodation chamber (3) for accommodating laundry, an air circulation channel (7) in communication with the accommodation chamber (3), and a condensation valve (14) for supplying wa- 55

ter into the air circulation channel (7) to condense humidity from air coming from the accommodation chamber (3), **characterized in that:** the control device (12) is set so that the laundry drying machine (1) is capable of implementing the method according to any one of claims 1 to 9.

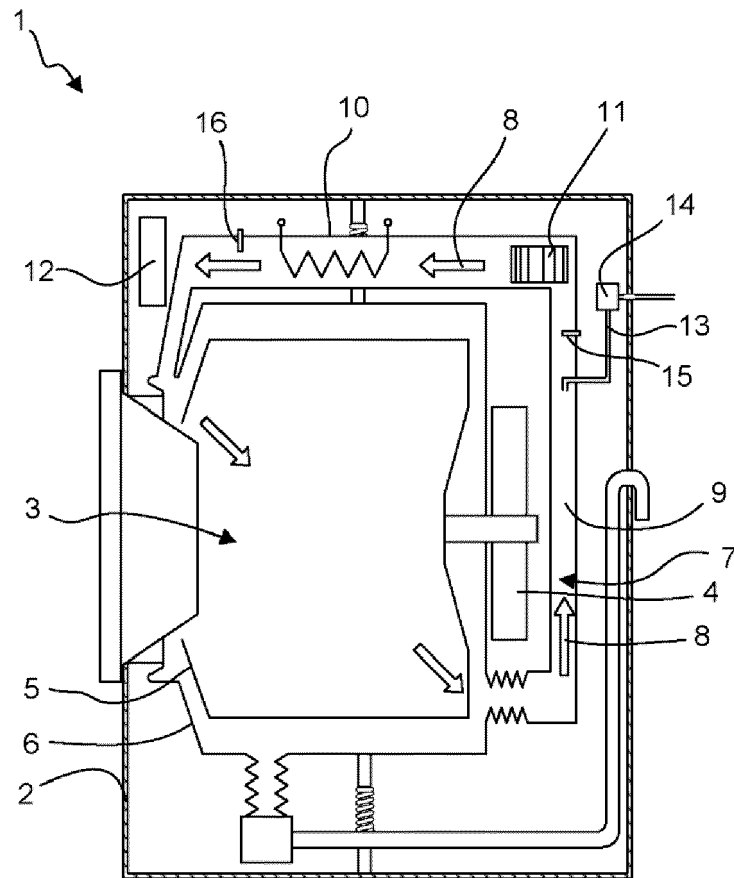


FIG. 1

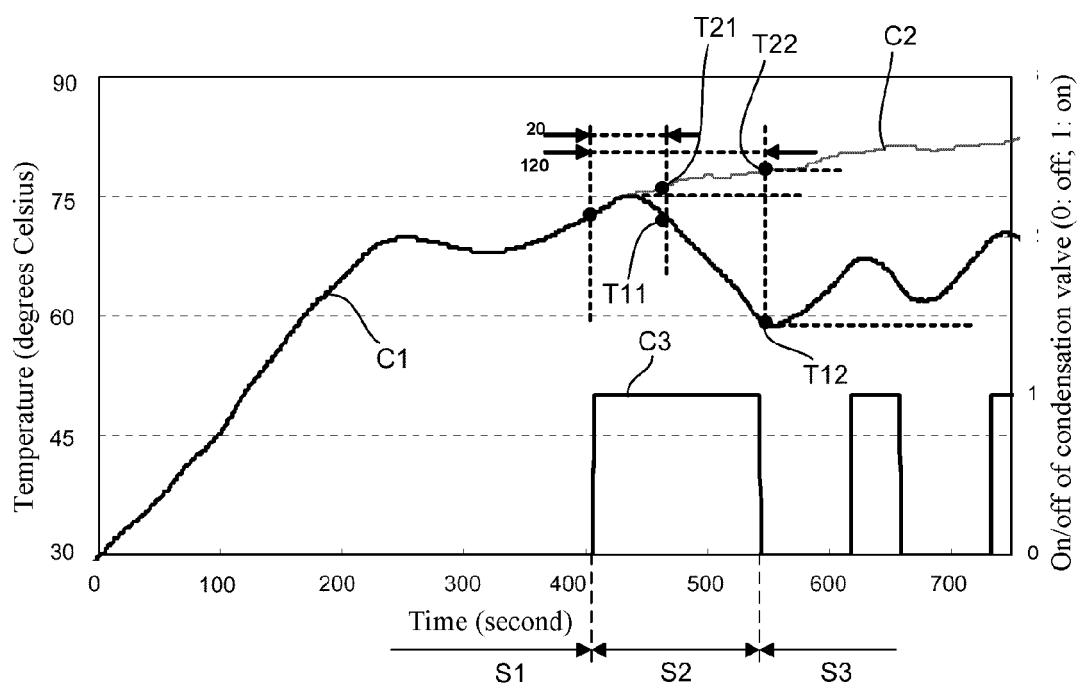


FIG. 2