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(54) **METHOD TO CONTROL OPERATION OF A WASHING MACHINE**

VERFAHREN ZUR STEUERUNG DES BETRIEBS EINER WASCHMASCHINE

PROCÉDÉ DE COMMANDE DU FONCTIONNEMENT D'UNE MACHINE À LAVER

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(73) Proprietor: **Electrolux Appliances Aktiebolag**
105 45 Stockholm (SE)

(72) Inventors:
- **BONDI, Martino**
  33080 Porcia (PN) (IT)
- **DE MICHIELI, Enrico**
  33080 Porcia (PN) (IT)
- **STABON, Elisa**
  33080 Porcia (PN) (IT)

(74) Representative: **Electrolux Group Patents**
AB Electrolux
Group Patents
S:t Göransgatan 143
105 45 Stockholm (SE)

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Description

[0001] The present invention relates to a method to control a washing machine, in particular in a washing machine having a rotatable drum inside a tub.

[0002] Commonly, a washing machine includes a tub where water is introduced, a drum which is rotatably mounted inside the tub to receive laundry, such as clothes, shoes, accessories etc., and a motor which generates a drive force to rotate the drum, thereby allowing washing to be performed via tumbling of laundry in the drum. For example, the laundry is tumbled along an inner wall of the drum during rotation of the drum.

[0003] Further, in such washing machines, a plurality of washing programs or washing cycles is generally available. Commonly, washing programs or cycles include a washing step to eliminate stains on laundry using water and preferably also a detergent, and a rinsing step to rinse the laundry.

[0004] Among the washing programs, a delicate program is often present. In the delicate program, delicate fabrics, such as wool, silk or even cashmere may be washed. In order not to damage such delicate fabrics, the program needs to be realized so that causes of such potential damage are minimized or avoided. Indeed, high temperature, water and/or detergent presence, mechanical compression due to the rotation of the drum and others can all cause undesired consequences on the fabric.

[0005] At the same time, the delicate program preferably refreshes the laundry properly, that is, without leaving stains or odors in the same. The balance of the two requirements, proper cleaning and care of the delicate fabrics, is not always easy to achieve.

[0006] There is therefore a need for a method to control operation of a washing machine, preferably but not exclusively during execution of a delicate program, which may overcome one or more of the problems listed above.

[0007] DE102013104075 discloses a method for operating a washing machine with a tub for holding washing liquid for treating laundry, which has a rotatable drum for holding the laundry and a device for generating steam. The method provides for carrying out a washing phase and / or at least one rinsing phase and for determining an application speed at which the laundry lies against the drum and a space is formed in the center of the drum, and adjusting a drum speed of the drum to the application speed at least temporarily while the laundry is exposed to steam.

[0008] According to an aspect, the invention is relative to a method to control operation of a washing machine, the washing machine including a rotatable drum having an inner surface, a tub housing the drum and connected to an external water source, the method comprising:

- o supplying water into the tub from the external water source till a level at which water does not enter into the drum;
- o heating the water supplied in the tub to a temperature between 60°C and 95°C to produce steam;
- o supplying steam to the drum while keeping the water temperature between 60°C and 95°C; and
- o rotating the drum at a speed at which laundry inserted in the drum at least partially remains attached to the inner wall of the drum for the majority of the time during which the steam is supplied to the drum.

[0009] In the present context, a washing machine may indicate a "simple" washing machine where the washing of laundry is performed, or a combined washer dryer, where, in addition to the washing, drying of the laundry is performed.

[0010] The washing machine includes a drum where laundry is located, which can rotate around an axis by means of a motor. The axis of rotation of the drum can be horizontal, that is, substantially parallel to a surface where the appliance is located or slightly tilted to it, or vertical. Therefore, the washing machine might be a front loading washing machine or a top loading washing machine as well.

[0011] The drum is rotatable inside a tub, where it is housed. Preferably, the drum is perforated so that liquid exchange between the drum and the tub is possible. On the other hand, preferably the tub is water tight so that water cannot leave it if undesired.

[0012] The washing machine further preferably comprises a casing, preferably but not necessarily parallelepiped-shaped, on which a door is advantageously hinged to access and close the drum in order to load or unload the laundry to be washed. The door is preferably hinged on a front wall of the casing in case of a front loading washing machine, while it is hinged on a top wall of the casing in case of a top loading washing machine.

[0013] Further, the washing machine is connected to a water supply, that is, an external water source, for example to the water mains, by means of suitable pipes which can be opened or closed, for example by a valve, in order to introduce water to the drum and/or in the tub. One or more discharge pipes can be present as well in order to discharge water from the drum.

[0014] A drawer or other container is also preferably present and fluidly connected to the drum in order to introduce detergent into the drum or in the tub itself, if needed during the laundry washing. The drawer may contain also softeners, products for cleaning the tub and/or drum and scents or perfumes.

[0015] The washing machine may further include a control panel, for example located in an upper portion of the casing, where inputs or commands can be selected by an user, and/or information about the status of the washing machine can be displayed, for example by means of a display or one or more light indicators.

[0016] In operation, the washing machine preferably includes a plurality of washing programs or cycles (cycle or program are used interchangeably in the present context). Some washing programs preferably include a washing step where the laundry is washed, such as tum-

bled, and a rinsing step, where the laundry is rinsed. The washing program may also include a spinning step where the drum is rotated at relatively high velocity. Further steps may be present as well, for example prewashing or others. Other washing programs may include no tumbling and/or no spinning.

[0017] The various cycles may differ one from the others for the duration of the same, for the number or rinsing steps, for the temperature of the washing water, for the amount of detergent and so on.

[0018] The washing programs are preferably designed to treat laundry made of a specific textile type or composition or type of dirt or stain. For example, in a washing machine, a cotton cycle program at high temperature is generally present, as well as a delicate cycle program for delicate textiles (e.g. silk) at lower temperatures. Preferably, among the available selectable programs, a delicate or cashmere program is present, to be selected when particularly delicate fabrics is to be washed.

[0019] According to the invention, a washing program or cycle is preferably selected. The washing program or cycle is generally selected either by a user operating on the control panel, for example by means of a switch, button, knobs and the like, or automatically, that is, a predefined washing program is stored on a memory of the washing machine and automatically selected when the appliance is switched on. Alternatively, the washing machine may "auto-select" the washing program among the available ones, for example all stored in a memory, depending on one or more characteristics of the laundry inserted in the drum, which are automatically detected.

[0020] The selection of a washing cycle predefines one or more of a plurality of parameters, that is, given the washing program, for example the duration of the same may be predefined, as well as the type and quantity of detergent to be used, the temperature of the water, the amount of water to be used in washing, the amount of water to be used in rinsing, the revolution per minute of the drum, the duration of the washing cycle and others.

[0021] According to the invention, preferably after the washing program's selection, the water is introduced in the tub till a pre-determined level. Such a pre-determined level is selected so that water does not enter inside the drum. Also, the path flown by the water entering into the tub is such that the water does not enter into the drum and thus avoids the laundry. In this way, there is no contact between the laundry located inside the drum (for example loaded in the drum via the door) and the water itself. For example, knowing the geometry of the tub, the water is introduced into the tub till a given amount of water has been reached. The know geometry of the tub allows a calculation of a level reached by the water given the amount of water entered in the tub. A space within the tub holds the amount of water introduced, for example, a bowl-shaped bulge formed in the tub below the drum could contain the desired amount of water.

[0022] The water located within the tub is then heated. The heating may take place for example via a heater positioned within the tub itself, for example immersed in the water. Alternatively or in addition, the heater can be placed in thermal contact with the water, such as outside the tub but close to the tub walls. The temperature reached by the water due to the heating is comprised between 60°C and 95°C, more preferably it is comprised between 65°C and 90°C, even more preferably it is comprised between 65°C and 85°C. At this temperature, water can evaporate and form steam at a sufficiently high rate to be used in a washing program. Because the tub houses the drum, which is in fluid communication with the tub, steam can enter inside the drum, for example via perforations present in the drum's wall. The steam can be therefore in contact with the laundry positioned in the drum. In the present invention therefore the steam is the "refreshing agent" of the laundry, instead of water. In the present context, the words "vapor" and "steam" are used as having the same meaning, that is, interchangeably: although the technical term in the present context of the evaporated water is "vapor", in the technical field of reference cycles which includes water evaporation - although below the boiling point - are named "steam cycles".

[0023] Further, while the steam is produced and introduced in the drum, the drum itself is brought into rotation. The rotation is for example obtained by means of a motor, more preferably an electric motor. The speed of rotation, and thus the speed of the motor, is preferably variable and tunable.

[0024] During the production of steam, and its consequent entrance into the drum, the drum is rotated at a speed which is at least enough to have a portion of the laundry attached to the inner wall of the drum. The speed is thus therefore "high" enough that there are some clothes or anyhow items positioned in the drum which remains attached to the inner wall of the drum during the complete rotations of the drum itself. This speed is maintained for the majority of the time interval during which steam is supplied to the drum.

[0025] Preferably, this speed for which at least part of the laundry remains attached to the inner wall of the drum for the complete rotations of the drum itself is maintained for the majority of the selected washing program. More preferably, the production of steam and the rotation of the drum at a speed which is high enough to maintain at least a portion of the laundry attached to the inner wall of the drum take place for the majority of the selected washing program. In other words, preferably the whole washing cycle includes the steam production and "high enough speed" drum rotation only, without other phases such as spinning or water introduction in the drum.

[0026] This "high enough" speed, that is, the speed at which at least a portion of the clothes are attached to the inner wall of the drum, is higher than or equal to a critical speed N where the centrifugal force and the force of gravity to be applied to the laundry are balanced. This critical speed N (rpm), without being bound by theory, is calculated with the following expression:

$$N = 30\sqrt{2g / \pi^2 d}$$

[0027] Provided that:

g: acceleration of gravity (cm/sec^2);

d: internal diameter of drum (cm)

[0028] The clothes located within the drum, if the speed at which the drum rotates is equal to this critical speed N, can still move (tumble) being the centrifugal force lower inside the drum that at its inner wall (i.e. at a smaller d, N needs to be higher).

[0029] Thus, the speed at which the drum rotates according to the invention is higher than or equal to the critical speed N at which centrifugal force and gravity force are identical at the inner wall of the drum.

[0030] This combination of characteristics, i.e. steam production at low temperature and "high enough" speed, allows having a good compromise between a proper care of delicate fabric and a good refreshing efficiency (e.g. good odor removal). The fact that the water does not touch the laundry avoids shrinkage or felting of laundry. Further, the relatively low temperature of the vapor or steam in contact with the laundry also limits possible damages to the laundry due to the temperature. However, the temperature is still high enough to have a good refreshing efficiency.

[0031] Further, the speed of the drum is high enough to avoid a continuous movement and shuffling of the laundry, which may cause mechanical damages, due for example to friction, to the fabric.

[0032] Combination of steam at "low temperature" and "high enough" rotational speed of the drum provides with a minimization of fabric damage and a good quality of the resulting "refreshed" laundry.

[0033] Preferably, the method includes the step of reversing a direction of rotation of the drum while supplying steam to the drum. More preferably, it includes the step of reversing the direction of rotation of the drum at least two times. The reversion of rotation allows to shuffle the laundry within the drum so that the whole laundry can be exposed to the steam (the laundry which might be sandwiched between two additional layers of laundry may be not very well soaked in steam), so that a proper good refreshing quality is achieved. The shuffle is performed few times so that it does not mechanically damage the fabric.

[0034] Preferably, the method includes:

- o selecting a washing cycle among a plurality of washing cycles, said washing cycle having a washing cycle duration; and
- o wherein steam is supplied to the drum for the majority of the washing cycle duration.

[0035] As mentioned, preferably the production of steam and the rotation of the drum above the critical N speed take place for the majority of the selected washing cycle or program. The speed is not always above or equal to the critical speed because, due to the reversion of rotation direction, there are short time intervals in which the rotation speed is equal to zero. The cycle or program is thus a "steam program", where there is no contact between water and laundry. In this way, proper care of delicate fabric is taken.

[0036] More preferably, selecting a washing cycle among a plurality of washing cycles includes selecting a cashmere washing cycle. This cycle is preferred for very sensitive fabric.

[0037] More preferably, said cycle duration is less than 45 minutes. Even more preferably, the cycle duration is of about 30 minutes. To preserve the delicate fabric, also the time of contact between the steam and the laundry is preferably limited. It has been found that this time gives a good compromise between fabric care and refreshing quality.

[0038] Preferably, rotating the drum at a speed at which laundry inserted in the drum at least partially remains attached to the inner wall of the drum includes: rotating the drum at a speed higher than a tumbling speed. The action of tumbling, where the laundry is continuously shuffled and agitated, falling from one side to the other of the drum's inner wall, may cause damages to delicate fabrics. For this reason, the speed of the drum in the method of the invention is high enough to avoid tumbling of at least a portion of the laundry. Preferably, the speed of the drum is high enough that all the laundry remains attached to the wall of the drum, so that no laundry experiences tumbling.

[0039] Preferably, rotating the drum at a speed at which laundry inserted in the drum at least partially remains attached to the inner wall of the drum includes: rotating the drum at a speed lower than a spinning speed. The speed of the drum has preferably not only a lower limit (the so called critical speed N), but also an upper limit. During spinning, the laundry is compressed against the wall of the drum because it is desired to remove water from the same. In the present cycle or program, there is no soaking of the laundry in water and therefore the spinning is not necessary. Furthermore, it could damage the delicate fabric due to the pressure exerted. Therefore, preferably the speed of the drum is lower than a spinning speed. Preferably the spinning speed is defined as a speed equal or higher than 400 rpm. A speed lower than the spinning speed is in this context a speed lower than 400 rpm.

[0040] Preferably, rotating the drum at a speed at which laundry inserted in the drum at least partially remains attached to the inner wall of the drum includes: rotating the drum at a speed lower than 300 rpm. More preferably, rotating the drum at a speed at which laundry inserted in the drum at least partially remains attached to the inner wall of the drum includes: rotating the drum

at a speed between 60 rpm and 200 rpm. In this speed range, the desired effect of having laundry at least in part attached to the inner wall of the drum is obtained. The preferred speed for a specific washing cycle may depend on the size of the drum (the limit speed depends on the diameter of the drum) and on the amount of laundry.

[0041] Preferably, the method includes heating the water supplied in the tub to a temperature between 65°C and 85°C to produce steam; and keeping the water temperature between 65°C and 85°C during the whole steam production. The relatively low temperature has been found to be gentle on the fabric and to provide at the same time a good refreshing effect . This relatively low temperature of the water and thus of the steam is preferably maintained for the whole selected washing cycle.

[0042] Preferably, the method includes: inserting a fragrance inside the tub. The production of steam may be used to transport other molecules, besides water, into the laundry without having water touching it. A possibility is to introduce a temperature of the water and thus of the steam is preferably maintained for the whole selected washing cycle.

[0043] Preferably, the method includes: inserting a fragrance inside the tub. The production of steam may be used to transport other molecules, besides water, into the laundry without having water touching it. A possibility is to introduce a fragrance inside the water in the tub so that a preferred fragrance is imparted to the laundry and/or possible odors present in the laundry can be masked. Preferably, a speed of rotation of the drum in one direction of rotation and a speed of rotation of the drum in the opposite direction of rotation is the same. Preferably, a rotating time interval during which the drum rotates in one direction of rotation is equal to a rotating time interval during which the drum rotates in the opposite direction of rotation. The cycle is substantially symmetric regardless of the direction of rotation. In this way, the steam may contact the whole laundry in a homogeneous manner.

[0044] Advantageously, the method includes the step of accelerating or decelerating the drum at an acceleration lower than 100 rpm/s. Preferably, the deceleration or deceleration of the drum is comprised between 10 rpm/s and 100 rpm/s. Preferably, the deceleration or acceleration of the drum is of about 35 rpm/s. A relatively low acceleration or deceleration allows to treat the laundry relatively "gently".

[0045] Preferably, the washing machine includes a heater positioned in the tub and wherein the step of supplying water into the tub from the external water source till a level at which water does not enter into the drum includes: supplying water into the tub from the external water source till a level at which water covers the heater. The water covering the heater prevents overheating of the same. Further, the transfer of heat from the heater to the water is efficient because the heater is directly in contact with the water. Preferably, the heater is an electric heater. The fabric in a relatively limited time, the amount of laundry introduced in the drum is preferably limited, below or even well below the limit set for the washing machine.

[0046] The present invention will now be described with reference to the accompanying drawings that illustrate non-limiting embodiments thereof, wherein:

- Fig. 1 is a isometric view of the washing machine of the invention;
- Fig. 2 is a further isometric view of the washing machine of figure 1 with the casing made transparent in order to show its inner components;
- Fig. 3 is an isometric view of the washing machine of figure 2;
- Fig. 4 is a flow chart of the various steps of the method of the invention; and
- Fig. 5 are two graphs showing the switching on and off of a heater and the speed of the drum and temperature of the water of the washing machine of figures 1 - 3 in a step of the method of figure 4.

[0047] The following description refers to an advantageous embodiment of the invention in which the washing machine 1 is a "standard washing machine" with no drying functionality (i.e. a washing machine which can only wash and rinse the laundry).

[0048] However, it is clear that the invention can be applied as well to washer - dryers (i.e. a washing machine which can also dry the laundry), not illustrated.

[0049] The washing machine 1 according to the invention which is schematically illustrated in the enclosed Figures is advantageously of the front-loading type; it is however clear that the invention is applicable, substantially without any crucial modification, to a top-loading washing machine.

[0050] With reference to Figures 1 to 3, the washing machine 1 comprises an external casing 2 in which frontal wall 2a an access opening 3 is obtained, provided with a loading/unloading door 4, which allows the access to a washing tub 5 contained in the external casing 2; the washing tub 5 contains a rotatable perforated drum 6 in which the laundry to be washed, not depicted in the drawings, can be loaded and unloaded. In this advantageous embodiment the drum 6 embodies, therefore, a treating chamber in which one or more items (pieces of laundry in this advantageous embodiment) can be loaded and treated with water and one or more additives (washing/rinsing products in this advantageous embodiment). The rotational axis of the drum 6 is preferably substantially horizontal. The drum defines an inner surface 6a, for example preferably cylindrical.

[0051] The washing tub 5 is connected to the external casing 2 preferably via a flexible bellows 3a connected between the frontal, opened, surface of the washing tub

5 facing the access opening 3, and the border of the latter.

[0052] In the example illustrated, the washing tub 5 is advantageously elastically supported by the external casing 2 via a suitable resilient support system, comprising, for example, springs 8; preferably the oscillations of the washing tub 5 are damped by suitable shock-absorbing devices or dampers 9, interposed between the washing tub 5 and the bottom of the casing 2.

[0053] Clearly, the washing tub 5 may be associated to the casing 2 in any other suitable way.

[0054] Washing tub 5 defines a housing for the drum 6 as well as a bowl-shaped container 16 positioned below drum 5.

[0055] Advantageously, the washing machine 1 comprises a water inlet circuit, not visible in the figures, adapted for feeding water and washing/rinsing products, into the washing tub 5; the water inlet circuit comprises, for example, a removable drawer 19, adapted to be filled with washing and/or rinsing products, e.g. liquid or concentrate or gel detergent, or powder detergent, or softener, an inlet duct, also not represented, connectable to water delivery means present outside the washing machine 1 and adapted to deliver fresh water to the drawer 19 and/or to the tub, and an outlet duct, fluidly connecting the drawer 19 and the washing tub 5 and adapted to deliver water and washing/rinsing products into the washing tub 5.

[0056] In the removable drawer, also perfumes and/or fragrances may be introduced, for example in a dedicated partition (not depicted in the drawings) of the removable drawer 19.

[0057] The washing machine 1 also advantageously comprise a draining circuit, fluidly connected to the bottom of the washing tub 5 and adapted to drain the washing/rinsing liquid from the washing tub 5; in a further embodiment, not illustrated, the draining circuit may be also provided with a recirculation circuit, adapted to drain the washing/rinsing liquid from the bottom of the washing tub 5, and to re-admit such liquid into an upper region of the washing tub 5, for improving the wetting of the laundry.

[0058] Water inlet circuit and draining circuit are considered standard and known in the art and therefore not further discussed.

[0059] The washing machine 1 also comprises some electric and/or electronic components, adapted for performing some specific functions; for example the washing machine comprises an electric motor 11 for rotating the rotatable drum 6, a valve (not shown) adapted to deliver the washing/rinsing liquid into the washing tub 5, an electric pump (not shown) adapted to drain and/or to re-circulate the washing/rinsing liquid from the washing tub 5, an electric heater 18 adapted to heat the washing/rinsing liquid, etc.

[0060] The drum 6 is advantageously rotated by the electric motor 11 which preferably transmits the rotating motion from a motor shaft 24 to the drum 6, advantageously by means of a belt/pulley system 29. In a different embodiment of the invention, the motor 11 can be directly associated with the shaft 24 of the drum 6. The speed of motor 11, and thus the speed of rotation of the drum 6, can be varied in a known manner.

[0061] The electric heater 18 is preferably positioned in a lower part of tub 5 and schematically depicted in figure 3 (heater 18 is not visible from the outside of tub 5). Preferably, the electric heater is positioned inside the bowl-shaped container 16 defined by drum 5, so that it is located below drum 6.

[0062] The washing machine 1 advantageously comprises a logic unit (for example an electronic board, a microcontroller, a microprocessor, or any other similar electronic control unit/device), schematically indicated in Figure 1 with the block numbered 12, configured to control the electric and/or electronic components of the washing machine 1, so as to make the washing machine 1 to perform a washing cycle, advantageously comprising one or more phases; for example the washing cycle may comprise a prewash phase, a soaking phase, a main washing phase (comprising, for example, the adduction into the washing tub 5 of water mixed with detergent and the rotation of the drum 6, so as to apply a mechanical action on the laundry), a steam supplying phase, a rinsing phase, a spinning phase, etc. The washing cycle may comprise one or more of the above mentioned phases (or also other phases well known in the art) adapted to apply to the laundry to be washed a specific chemical and/or physical action. A phase of the washing cycle may be performed, during a single washing cycle, only once or also two or more times. Clearly the duration of the overall washing cycle depends on the kind, on the number, and on the duration of its phases.

[0063] Each washing cycle is defined by a plurality of parameters, which are for example stored in a memory of the control unit 12. These parameters may include the duration of the cycle, the water temperature during the main washing phase, the number of rinsing phases, and so on. Thus, when a program among the plurality is set, a plurality of parameters is set as well.

[0064] Among the available cycles, the machine includes a cashmere cycle. The cashmere cycle includes a single phase in which steam is produced and the drum is rotated at a speed of about 100 rpm. No spinning is present.

[0065] The washing machine 1 comprises a user interface 14, which is operatively connected to the logic unit 12 and is configured to allow the user to manually set a washing cycle to be performed. Alternatively, the washing cycle can be set automatically.

[0066] User interface 14 may comprise, for example, a touch screen display, adapted to display information and to receive inputs from the user, and or it may comprise a one or more buttons, and/or switches, and/or knobs, and/or displays, etc. allowing the user to receive information and to input instructions/commands directed to the logic unit 12.

[0067] User interface 14 may be further configured to display user information; this information may comprise

the name of a particular washing cycle, the weight of the loaded laundry, the duration of the washing cycle, the temperature of the washing/rinsing liquid, the rotating speed of the spinning, etc. More in general, the user interface 14 is designed to present information related to the washing cycle and/or the status of the washing machine 1 and even more preferably it is designed to display the duration of the washing cycle.

[0068] In the embodiment illustrated in the enclosed Figures, the user interface 14 advantageously comprises a display device, preferably a LCD or a LED display, designed to present user information, and a separated input device, not illustrated, comprising for example a keyboard, and/or a set of keys or knobs, and/or one or more touch-sensitive input devices, etc., adapted for setting a washing cycle and washing-product information.

[0069] In another embodiment, not illustrated, the logic unit 12 may be advantageously integrated in the user interface 14.

[0070] A method of controlling the washing machine 1 will be described in more detail as follows, with reference to figure 4. First, laundry is loaded in the drum 6 and a washing program or cycle among the stored plurality is set in the washing machine in step 1F. Such program or cycle may be inputted by the user. The set program is for example a cashmere program. Set the program, water is loaded inside the tub in step 2F, for example coming from the mains. Water gathers in bowl-shaped container or sump 16. The amount of water introduced is fixed so that it reaches a level which does not touch the inside of the drum 6. Possibly, a check of the water level is performed. Alternatively or in addition, a fixed quantity of water in first introduced, followed by a second variable quantity of water. The second variable quantity of water depends on the water level in the sump 16. The water level may be measured by means of a pressure switch (not depicted in the drawings). The first fixed amount of water is preferably measured by a flow-meter (also not shown).

[0071] The washing cycle then starts and the water is heated, for example by means of heater 18, preferably provided on the sump 16, which is preferably activated once covered by the introduced water. The heater is commanded by logic unit 12 to switch on till a desired water temperature, for example between 70°C and 85°C, is obtained. The temperature is preferably checked by means of a sensor, not visible in the figure, which is preferably located in proximity of heater 18. The heater is switched on and off so that the temperature of the water is maintained in this temperature range. The switching on and off is obtained by means of signals sent from the logic unit 12 which also receives the temperature measurements from the non-depicted temperature sensor. In figure 5, lowermost curve indicated with 50, the switching on and off curve of the heater vs. time is depicted. The ordinate are in arbitrary unit, only the ON and OFF is shown. Still in figure 5, a curve of the water temperature vs. time is depicted, indicated with 60 in the drawing: as it is shown, the temperature may vary during the washing cycle, however it always remains within the desired temperature range. The cycle last in total 30 minutes and the temperature of the water, curve 60, remains within the desired range, that is circa between 66 °C and 83 °C during steam production. Due to the temperature reached by the water, vapor (or steam) is produced in step 3F. Steam can enter the drum 6 due to openings in the same. Steam therefore comes into touch with the laundry to clean the same.

[0072] While the steam is produced, the drum 6 is also rotated in step 4F by means of motor 11. The speed of the motor is controlled so that the speed of the drum is substantially constant for given time intervals and its value is of about 100 rpm. At this speed, for a drum having a diameter of 490 mm, most of the laundry for a maximum load of 1 kg (maximum load for the cashmere cycle) remains attached to the inner surface 6a of the drum. Between these time intervals which lasts each about 10 minutes during which the speed of the drum is substantially constant and as said it has a value of about 100 rpm, the drum is stopped and the direction of rotation of the drum is reversed in step 5F. Preferably, the speed of the drum in both directions of rotations is substantially the same, as shown in the curve 70 of figure 5. Therefore, during steam production, the drum is always rotated, either in one direction or in the opposite one, and between one rotation reversal and the following one the speed is substantially constant. Preferably a plurality of reversals take place (step 6F), till the end of the selected washing cycle. The whole cycle lasts about 30 minutes. The "stop and go" of the drum 6 and the plateaus of the speed between reversals are depicted in figure 5 (top most graph indicated with 70).

[0073] Preferably, the deceleration and acceleration of the drum to stop and restart the drum at a rotation reversal is of about 35 rpm/s.

[0074] Preferably, the method of the invention also includes a step of a fragrance introduction of a fragrance into the laundry, for example introducing the fragrance in the removable drawer 19.

Claims

1. Method to control operation of a washing machine (1), the washing machine including a rotatable drum (6) having an inner surface (6a) and a tub (5) housing the drum and connected to an external water source, the method comprising:

    o supplying water into the tub (5) from the external water source till a level at which water does not enter into the drum (6);
    o heating the water supplied in the tub (5) to a temperature between 60°C and 95°C to produce steam;
    o supplying steam to the drum (6) while keeping

the water temperature between 60°C and 95°C; and rotating the drum (6) at a speed at which laundry inserted in the drum at least partially remains attached to the inner wall (6a) of the drum for the majority of the time during which the steam is supplied to the drum,

- the method further includes the step of:

o accelerating or decelerating the drum (6) at an acceleration lower than 100 rpm/s.

2. Method according to claim 1, including the step of:
o reversing a direction of rotation of the drum (6) while supplying steam to the drum.

3. Method according to claim 2, including:
o reversing the direction of rotation of the drum (6) at least two times.

4. Method according to one or more of the preceding claims, including:

o selecting a washing cycle among a plurality of washing cycles, said washing cycle having a washing cycle duration;
o wherein steam is supplied to the drum (6) for the majority of the washing cycle duration.

5. Method according to claim 4, wherein
o selecting a washing cycle among a plurality of washing cycles includes selecting a cashmere washing cycle.

6. Method according to claim 4 or 5, wherein said cycle duration is less than 45 minutes.

7. Method according to any of the preceding claims, wherein rotating the drum at a speed at which laundry inserted in the drum at least partially remains attached to the inner wall of the drum includes:
o rotating the drum (6) at a speed higher than a tumbling speed.

8. Method according to any of the preceding claims, wherein rotating the drum at a speed at which laundry inserted in the drum at least partially remains attached to the inner wall (6a) of the drum includes:
o rotating the drum (6) at a speed lower than a spinning speed.

9. Method according to any of the preceding claims, wherein rotating the drum at a speed at which laundry inserted in the drum at least partially remains attached to the inner wall of the drum includes:
rotating the drum (6) at a speed lower than 300 rpm.

10. Method according to any of the preceding claims, wherein rotating the drum at a speed at which laundry inserted in the drum at least partially remains attached to the inner wall of the drum includes:
◦ rotating the drum (6) at a speed between 60 rpm and 200 rpm.

11. Method according to any of the preceding claims, including:

◦ heating the water supplied in the tub (5) to a temperature between 65°C and 85°C to produce steam; and
◦ keeping the water temperature between 65°C and 85°C during the whole steam production.

12. Method according to any of the preceding claims when dependent on claim 2, wherein a speed of rotation of the drum (6) in one direction of rotation and a speed of rotation of the drum in the opposite direction of rotation is the same.

13. Method according to any of the preceding claims when dependent on claim 2, wherein a rotating time interval during which the drum (6) rotates in one direction of rotation is equal to a rotating time interval during which the drum rotates in the opposite direction of rotation.

14. Method according to any of the preceding claims, wherein the washing machine (1) includes a heater (19) to produce the steam, the heater being positioned in the tub (5) and wherein the step of supplying water into the tub from the external water source till a level at which water does not enter into the drum includes:
◦ supplying water into the tub (5) from the external water source till a level at which water covers the heater (19).

Patentansprüche

1. Verfahren zum Steuern eines Betriebs einer Waschmaschine (1), wobei die Waschmaschine eine drehbare Trommel (6) mit einer Innenfläche (6a) und einen Laugenbehälter (5), der die Trommel aufnimmt und mit einer externen Wasserquelle verbunden ist, umfasst, wobei das Verfahren umfasst:

◦ Zuführen von Wasser in den Laugenbehälter (5) von der externen Wasserquelle bis zu einem Pegel, an dem kein Wasser in die Trommel (6) eintritt;
◦ Erwärmen des in den Laugenbehälter (5) zugeführten Wassers auf eine Temperatur zwischen 60 °C und 95 °C, um Dampf zu erzeugen;
◦ Zuführen von Dampf zu der Trommel (6), während die Wassertemperatur zwischen 60 °C und

95 °C gehalten wird; und

Drehen der Trommel (6) bei einer Geschwindigkeit, bei welcher in die Trommel eingebrachte Wäsche zumindest teilweise an der Innenwand (6a) der Trommel für den Großteil der Zeit, während welcher der Dampf zu der Trommel zugeführt wird, haften bleibt,

- wobei das Verfahren ferner den folgenden Schritt umfasst: ◦ Beschleunigen oder Verlangsamen der Trommel (6) bei einer Beschleunigung, die niedriger als 100 U/min/s ist.

2. Verfahren nach Anspruch 1, das den folgenden Schritt umfasst:
◦ Umkehren einer Drehrichtung der Trommel (6) während des Zuführens von Dampf zu der Trommel.

3. Verfahren nach Anspruch 2, das umfasst:
◦ Umkehren der Drehrichtung der Trommel (6) mindestens zwei Mal.

4. Verfahren nach einem der vorhergehenden Ansprüche, das umfasst:

◦ Auswählen eines Waschzyklus aus einer Mehrzahl von Waschzyklen, wobei der Waschzyklus eine Waschzyklusdauer aufweist;
◦ wobei Dampf zu der Trommel (6) für den Großteil der Waschzyklusdauer zugeführt wird.

5. Verfahren nach Anspruch 4, wobei
◦ das Auswählen eines Waschzyklus aus einer Mehrzahl von Waschzyklen Auswählen eines Kashmirwaschzyklus umfasst.

6. Verfahren nach Anspruch 4 oder 5, wobei die Zyklusdauer weniger als 45 Minuten ist.

7. Verfahren nach einem der vorhergehenden Ansprüche, wobei das Drehen der Trommel bei einer Geschwindigkeit, bei welcher in die Trommel eingebrachte Wäsche zumindest teilweise an der Innenwand der Trommel haften bleibt, umfasst:
◦ Drehen der Trommel (6) bei einer Geschwindigkeit, die höher als eine Taumelgeschwindigkeit ist.

8. Verfahren nach einem der vorhergehenden Ansprüche, wobei das Drehen der Trommel bei einer Geschwindigkeit, bei welcher in die Trommel eingebrachte Wäsche zumindest teilweise an der Innenwand (6a) der Trommel haften bleibt, umfasst:
◦ Drehen der Trommel (6) bei einer Geschwindigkeit, die niedriger als eine Schleudergeschwindigkeit ist.

9. Verfahren nach einem der vorhergehenden Ansprüche, wobei das Drehen der Trommel bei einer Geschwindigkeit, bei welcher in die Trommel eingebrachte Wäsche zumindest teilweise an der Innenwand der Trommel haften bleibt, umfasst:
Drehen der Trommel (6) bei einer Geschwindigkeit, die niedriger als 300 U/min ist.

10. Verfahren nach einem der vorhergehenden Ansprüche, wobei das Drehen der Trommel bei einer Geschwindigkeit, bei welcher in die Trommel eingebrachte Wäsche zumindest teilweise an der Innenwand der Trommel haften bleibt, umfasst:
◦ Drehen der Trommel (6) bei einer Geschwindigkeit zwischen 60 U/min und 200 U/min.

11. Verfahren nach einem der vorhergehenden Ansprüche, das umfasst:

◦ Erwärmen des in den Laugenbehälter (5) zugeführten Wassers auf eine Temperatur zwischen 65 °C und 85 °C, um Dampf zu erzeugen; und
◦ Halten der Wassertemperatur zwischen 65 °C und 85 °C während der gesamten Dampferzeugung.

12. Verfahren nach einem der vorhergehenden Ansprüche, wenn abhängig von Anspruch 2, wobei eine Drehgeschwindigkeit der Trommel (6) in einer Drehrichtung und eine Drehgeschwindigkeit der Trommel in der entgegengesetzten Drehrichtung gleich sind.

13. Verfahren nach einem der vorhergehenden Ansprüche, wenn abhängig von Anspruch 2, wobei ein Drehzeitintervall, während welchem sich die Trommel (6) in eine Drehrichtung dreht, gleich einem Drehzeitintervall ist, während welchem sich die Trommel in die entgegengesetzte Drehrichtung dreht.

14. Verfahren nach einem der vorhergehenden Ansprüche, wobei die Waschmaschine (1) eine Heizvorrichtung (19) zum Erzeugen von Dampf umfasst, wobei die Heizvorrichtung in dem Laugenbehälter (5) positioniert ist und wobei der Schritt Zuführen von Wasser in den Laugenbehälter von der externen Wasserquelle bis zu einem Pegel, an dem kein Wasser in die Trommel eintritt, umfasst:
◦Zuführen von Wasser in den Laugenbehälter (5) von der externen Wasserquelle bis zu einem Pegel, an dem Wasser die Heizvorrichtung (19) bedeckt.

Revendications

1. Procédé pour commander le fonctionnement d'une machine à laver (1), la machine à laver incluant un tambour rotatif (6), ayant une surface intérieure (6a), et une cuve (5) logeant le tambour et raccordée à

une source d'eau externe, le procédé comprenant :

◦ l'alimentation, dans la cuve (5), en eau provenant de la source d'eau externe, jusqu'à un niveau auquel de l'eau n'entre pas dans le tambour (6) ;
◦ le chauffage de l'eau, dont l'alimentation dans la cuve (5) est effectuée, jusqu'à une température entre 60°C et 95°C pour produire de la vapeur ;
◦ l'alimentation en vapeur au tambour (6) tout en maintenant la température d'eau entre 60°C et 95°C ; et

la mise en rotation du tambour (6) à une vitesse à laquelle du linge inséré dans le tambour reste au moins partiellement attaché à la paroi intérieure (6a) du tambour pendant la majorité du temps durant lequel l'alimentation en la vapeur au tambour est effectuée,

- le procédé inclut en outre l'étape de :

◦ l'accélération ou le ralentissement du tambour (6) à une accélération inférieure à 100 tr/min/s.

2. Procédé selon la revendication 1, incluant l'étape de :
◦ l'inversion d'une direction de rotation du tambour (6) tout en effectuant l'alimentation en vapeur au tambour.

3. Procédé selon la revendication 2, incluant :
◦ l'inversion de la direction de rotation du tambour (6) au moins deux fois.

4. Procédé selon une ou plusieurs des revendications précédentes, incluant :

◦ la sélection d'un cycle de lavage parmi une pluralité de cycles de lavage, ledit cycle de lavage ayant une durée de cycle de lavage ;
◦ dans lequel une alimentation en vapeur au tambour (6) est effectuée pendant la majorité de la durée de cycle de lavage.

5. Procédé selon la revendication 4, dans lequel
◦ la sélection d'un cycle de lavage parmi une pluralité de cycles de lavage inclut la sélection d'un cycle de lavage de cachemire.

6. Procédé selon la revendication 4 ou 5, dans lequel ladite durée de cycle est inférieure à 45 minutes.

7. Procédé selon l'une quelconque des revendications précédentes, dans lequel la mise en rotation du tambour à une vitesse à laquelle du linge inséré dans le tambour reste au moins partiellement attaché à la paroi intérieure du tambour inclut :
◦ la mise en rotation du tambour (6) à une vitesse supérieure à une vitesse de culbutage.

8. Procédé selon l'une quelconque des revendications précédentes, dans lequel la mise en rotation du tambour à une vitesse à laquelle du linge inséré dans le tambour reste au moins partiellement attaché à la paroi intérieure (6a) du tambour inclut :
◦ la mise en rotation du tambour (6) à une vitesse inférieure à une vitesse d'essorage.

9. Procédé selon l'une quelconque des revendications précédentes, dans lequel la mise en rotation du tambour à une vitesse à laquelle du linge inséré dans le tambour reste au moins partiellement attaché à la paroi intérieure du tambour inclut :
la mise en rotation du tambour (6) à une vitesse inférieure à 300 tr/min.

10. Procédé selon l'une quelconque des revendications précédentes, dans lequel la mise en rotation du tambour à une vitesse à laquelle du linge inséré dans le tambour reste au moins partiellement attaché à la paroi intérieure du tambour inclut :
◦ la mise en rotation du tambour (6) à une vitesse entre 60 tr/min et 200 tr/min.

11. Procédé selon l'une quelconque des revendications précédentes, incluant :

◦ le chauffage de l'eau, dont l'alimentation dans la cuve (5) est effectuée, jusqu'à une température entre 65°C et 85°C pour produire de la vapeur ; et
◦ le maintien de la température d'eau entre 65°C et 85°C durant la totalité de la production de vapeur.

12. Procédé selon l'une quelconque des revendications précédentes lorsqu'elle dépend de la revendication 2, dans lequel une vitesse de rotation du tambour (6) dans une direction de rotation et une vitesse de rotation du tambour dans la direction opposée de rotation sont les mêmes.

13. Procédé selon l'une quelconque des revendications précédentes lorsqu'elle dépend de la revendication 2, dans lequel un intervalle de temps de rotation durant lequel le tambour (6) entre en rotation dans une direction de rotation est égal à un intervalle de temps de rotation durant lequel le tambour entre en rotation dans la direction opposée de rotation.

14. Procédé selon l'une quelconque des revendications précédentes, dans lequel la machine à laver (1) inclut un élément chauffant (19) pour produire la vapeur, l'élément chauffant étant positionné dans la

cuve (5) et dans lequel l'étape de l'alimentation, dans la cuve, en eau provenant de la source d'eau externe, jusqu'à un niveau auquel de l'eau n'entre pas dans le tambour inclut :

◦ l'alimentation, dans la cuve (5), en eau provenant de la source d'eau externe, jusqu'à un niveau auquel de l'eau couvre l'élément chauffant (19).

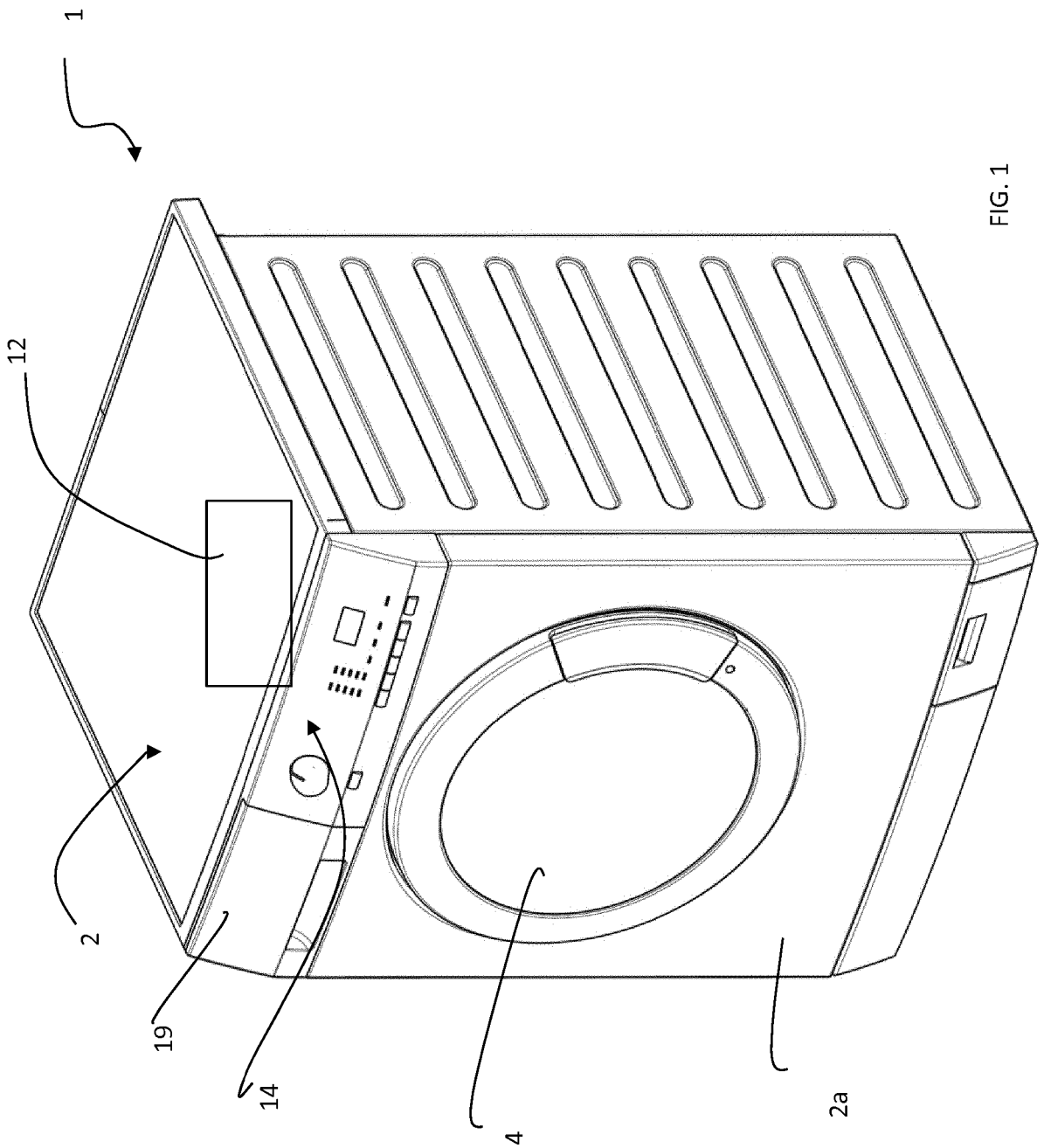

FIG. 1

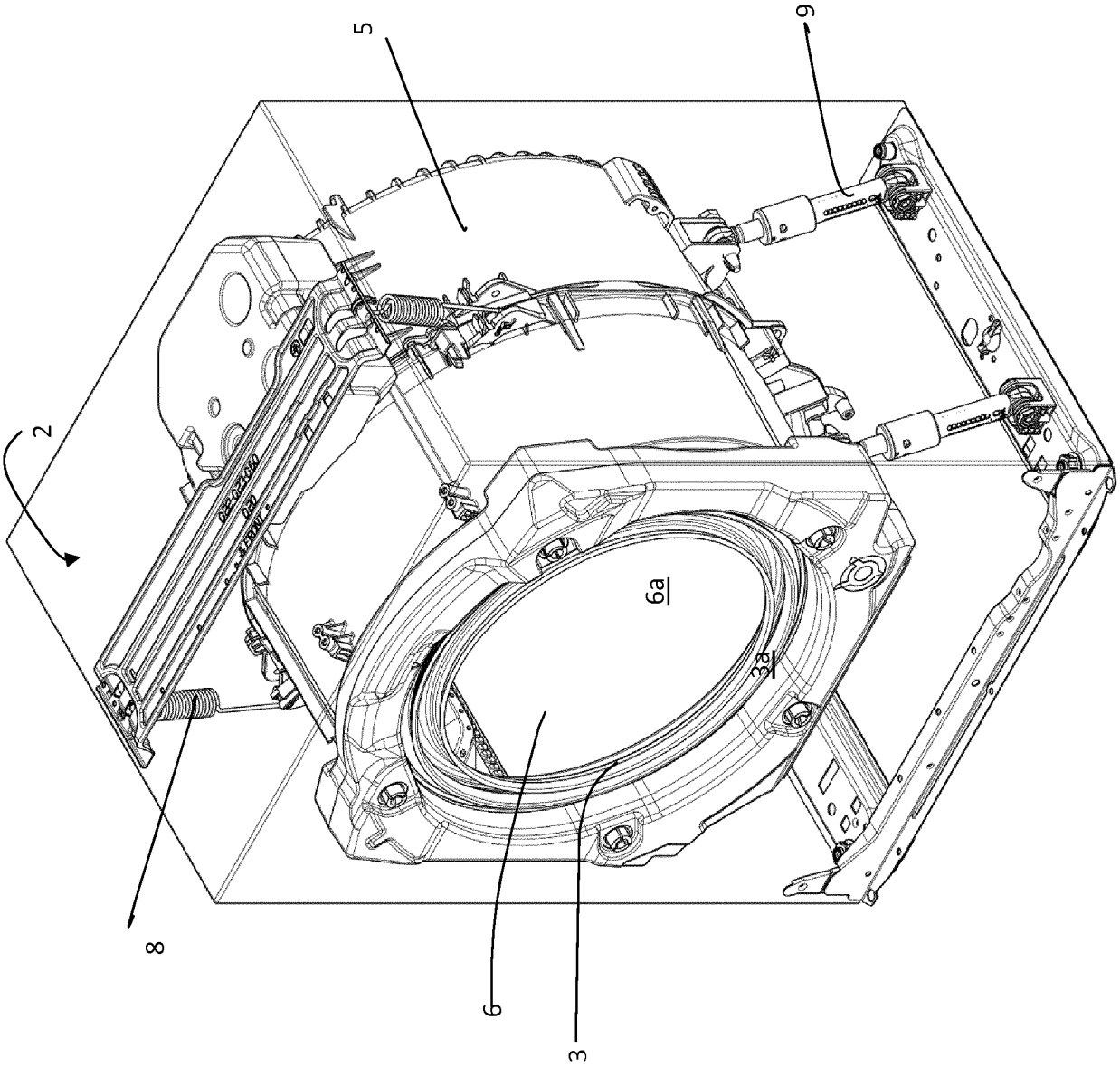

FIG. 2

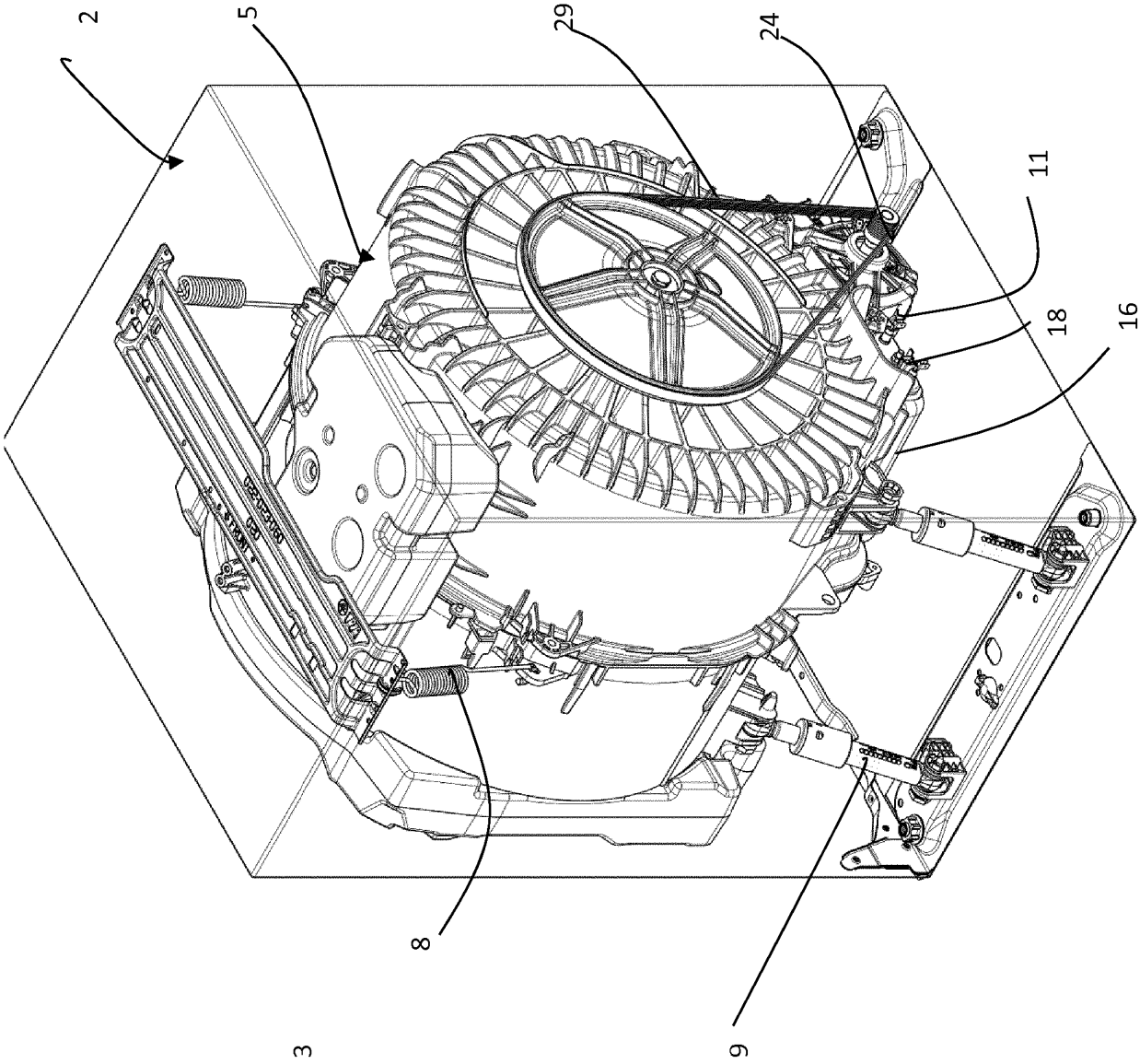

FIG. 3

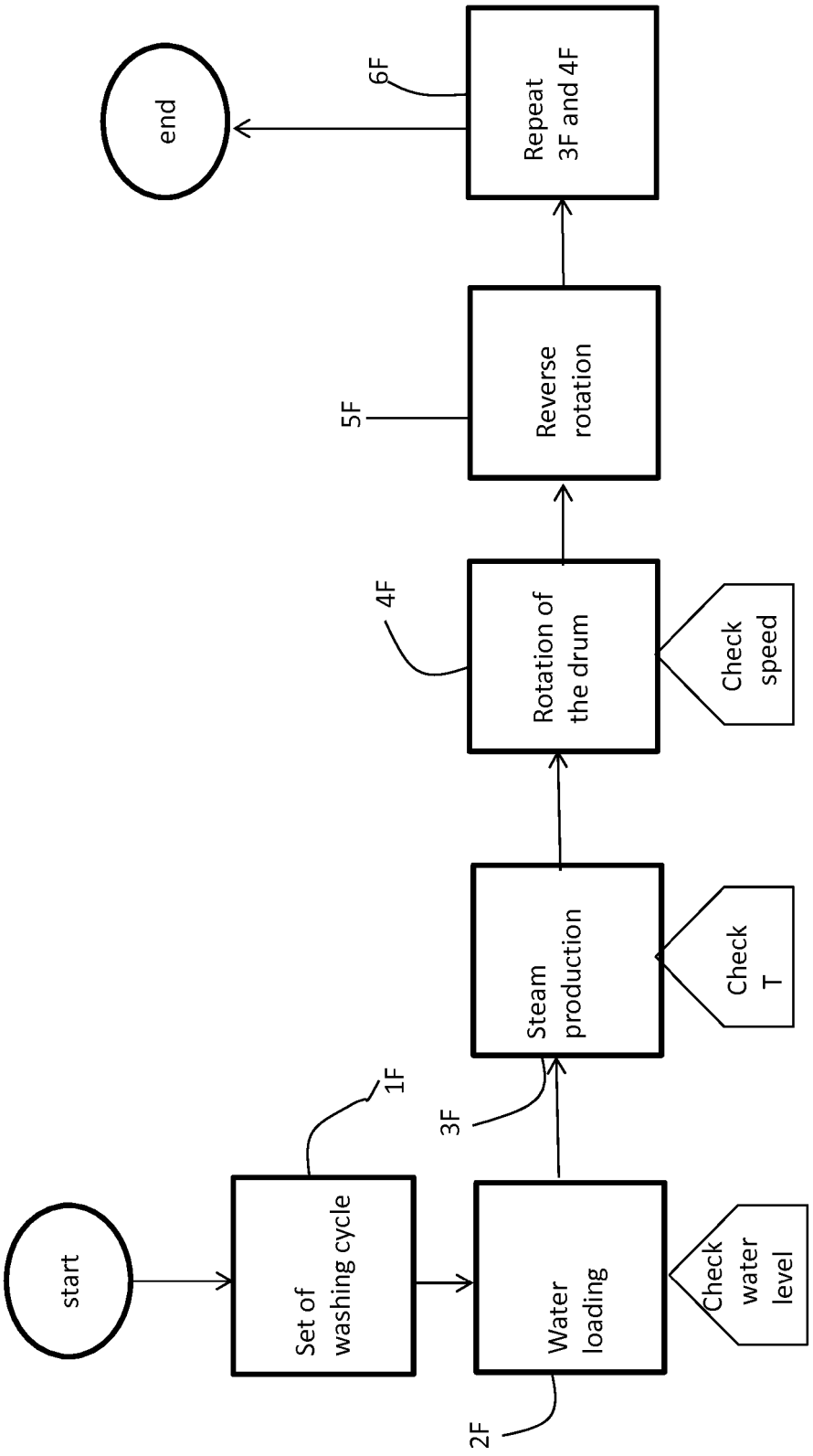
start
Set of washing cycle
1F
Water loading
2F
Check water level
3F
Steam production
Check T
4F
Rotation of the drum
Check speed
5F
Reverse rotation
6F
Repeat 3F and 4F
end

FIG. 4

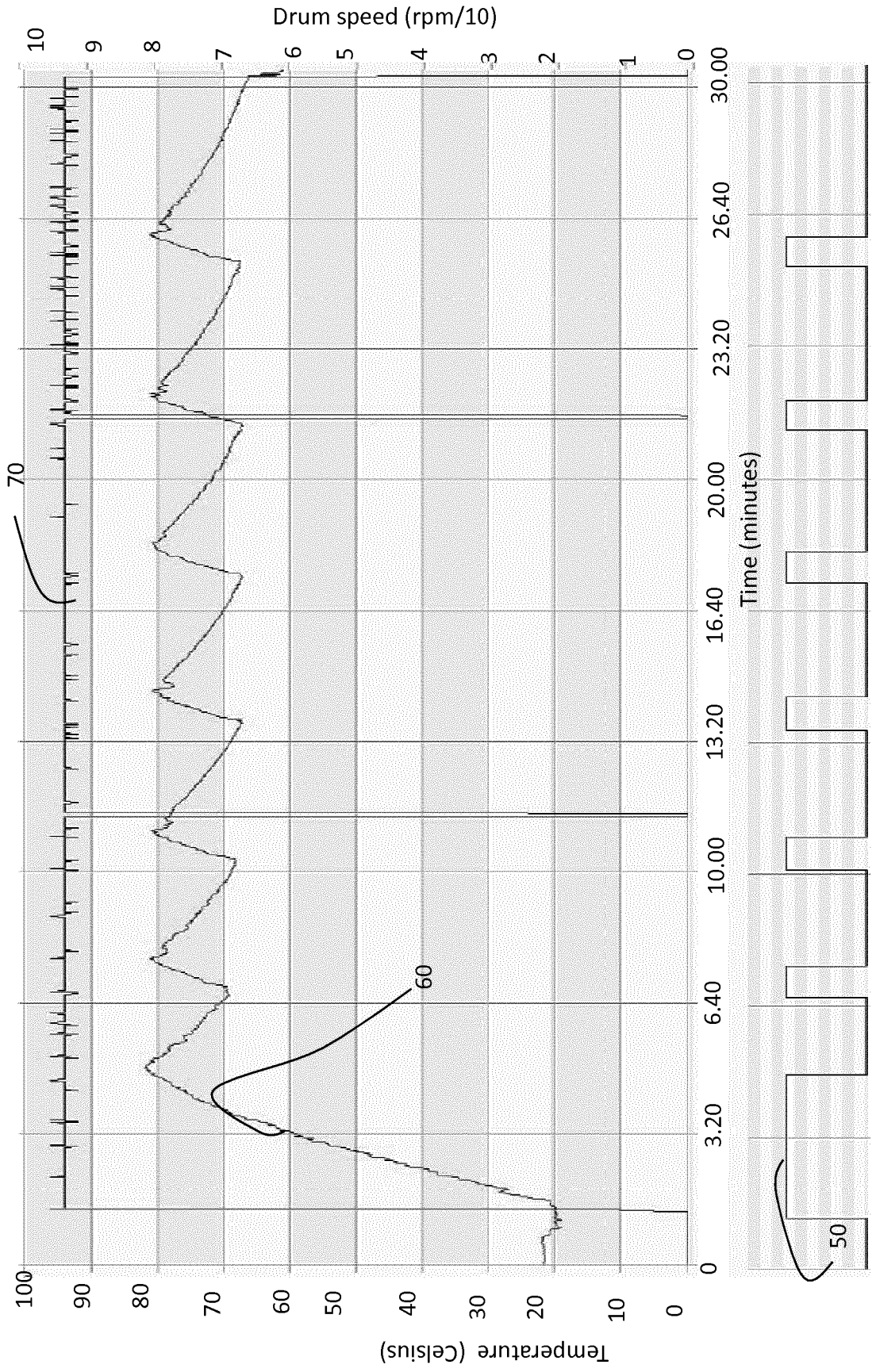
Drum speed (rpm/10)
Temperature (Celsius)
Time (minutes)
Time(minutes)
70
60
50

FIG. 5

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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