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(54) **Method of operating a machine for treating laundry and machine for treating laundry**

(57) The present application in particular is directed to a method of operating a laundry washing machine (1). The method comprises a main processing step (S4) in which a laundry drum (4) is rotated by a motor (9) for mechanical treatment of the laundry. The main processing step is divided into high-performance (H) and low-performance stages (L), wherein all high-performance stages (H) are of an equal first duration (d1) and/or all low-performance stages (L) are of an equal second duration (d2).

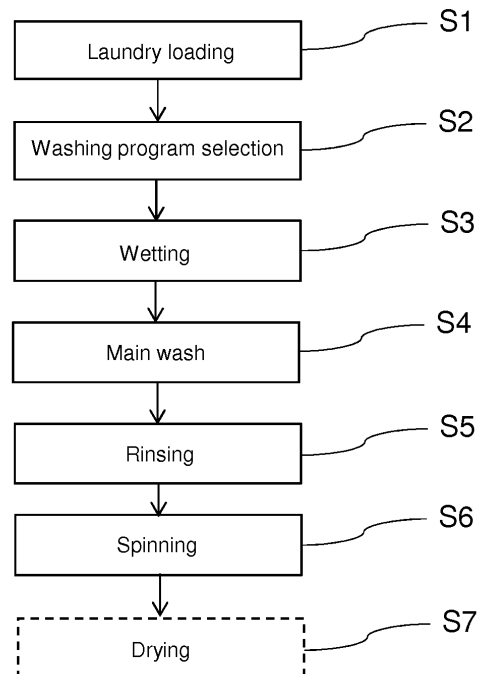


FIG. 3

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Description

[0001] The present invention is directed to a method of operating a machine for treating laundry and a respective machine adapted to execute the method. In particular the method and machine may be related to laundry washing; more in particular the machine may be a washing machine or a washer/drier (also called "laundry washing-drying machine", i.e. a machine allowing washing and drying laundry).

[0002] In general, laundry washing machines, i.e. washing machines and washer/driers, comprise an external casing provided with a washing tub and with a rotatable perforated drum where the laundry can be placed for washing the same. Other types of machines adapted to process or treat laundry may have a similar design, i.e. also comprise a rotatable drum for processing laundry placed therein.

[0003] The drum is rotated by an electric motor which may be connected to a rotating shaft of the drum by a belt pulley system, or may be a so called "direct drive motor", that is a motor fixed to the washing tub and directly connected to the rotating shaft of the drum.

[0004] Usually, a washing cycle comprises different phases during which the laundry to be washed is subjected to adequate treatments. A washing cycle may in particular comprise a main washing phase, or main washing step. Usually, in the main washing step, probably dependent on the washing program selected by the user, the drum is rotated, so as to apply a cleaning action, in particular mechanical cleaning action, to laundry within the drum.

[0005] During the main washing phase the electric motor used for rotating the drum, so as to exert a sufficient mechanical action to laundry, is subjected to high electrical and mechanical stress. This may lead to comparatively high temperature loads of the motor and respective components. High temperatures, in the worst case overheating, may lead to reduced life cycles of respective motors or components. Although there have been proposed different types of measures for reducing the overall temperature of and/or the temperature of and at motor components, there is still need for improvements.

[0006] Therefore, it is an object of the invention to provide an alternative method of operating a machine for treating laundry, which in particular is effective in reducing the temperature of a motor and/or motor components used for driving a laundry drum of the machine, and which at the same time is easy to implement, preferably also with known machines. Further, a respective machine, in particular a laundry washing machine and/or washer/drier, shall be provided.

[0007] This object is solved by claims 1 and 14. Embodiments result from respective dependent claims.

[0008] According to the invention, a method of operating a machine for processing or treating laundry is proposed. The machine in particular may be a laundry washing machine and/or a laundry washer/drier. Hence, the

method according to the invention is related to a method for washing laundry in a laundry washing machine or laundry washing-drying machine.

[0009] Nowadays laundry washing machines of different complexity are available. For example, laundry washing machines of comparative simple design, such as laundry washing machines only providing a wash and rinse functionality, as well as comparative complex designs, i.e. laundry washing machines additionally providing a drying functionality, are known. In the present description the term "laundry washing machine" shall cover both simple and more complex laundry washing machines, in particular laundry washing machines and laundry washing-drying machines (also called washer/driers).

[0010] The proposed method of operating the machine comprises a main processing step. In the main processing step, a laundry drum adapted to accommodate laundry is rotated by a motor, in particular by at least one electric motor, for mechanical treatment and cleaning of the laundry.

[0011] In case of washing machines and washing-drying machines, mechanical treatment is conducted by rotating the drum comprising fluid permeable perforations in a tub at least partially filled with washing fluid. In this way, mechanical treatment results in a cleaning action.

[0012] The main processing step of the proposed method is divided into high-performance and low-performance stages, which stages may be performed in a consecutive alternating manner.

[0013] In a high-performance stage, the drum is rotated comparatively intensively by the motor, in particular so as to apply an effective mechanical action to the laundry. In a low-performance stage the drum is rotated less intensively, in particular so as to obtain a cooling-off effect at least of the motor, or of components of the motor, such as motor brushes (if provided) and the like. The high-performance stages may also be called "energetic phases", whereas the low-performance phases may be called "cooling phases".

[0014] Reducing the overall temperature of the motor, of components of the motor, or even of other components of the machine, in particular related and involved in rotating the drum, will or at least may lead to reduced wear, reduced mechanical and/or temperature stress, and therefore may be effective in improving and prolonging life time of the motor and/or respective components and other components or elements of the machine.

[0015] With the proposed method, it is further provided that at least one of the following conditions applies:

- all high-performance stages are of an equal, i.e. essentially equal, first duration;
- all low-performance stages are of an equal, i.e. essentially equal, second duration.

[0016] Both these two conditions provide the advan-

tage that the method can comparatively easily be implemented, in particular in software, thus requiring less time for programming a respective electronic control unit of the machine.

[0017] In addition, due to the comparatively simple and compact structure of respective control algorithms, in particular with respect to variation in time, the proposed method, i.e. respective control algorithms, require less storage space on a memory of the electronic control unit of the machine.

[0018] These advantages in particular result from the fact that for any laundry treatment program, in particular washing program, a single alternation of high-performance and low-performance stages is very effective for reducing motor temperature, in particular independently from the overall duration of the treatment cycle, in particular of the main processing step. Note that the overall duration may be implemented as a parameter or variable to be essentially freely selected by the user, for example by a suitable knob or button provided in a user interface ("essentially freely" means that the overall duration can be selected among a continuous range of values, or that only some discrete values in a range can be selected). The two conditions given above (i.e. all high-performance stages of an equal first duration, and all low-performance stages of an equal second duration), only relate to respective "standard-length" stages. According to the present invention, all the high-performance stages having a same first duration are considered "standard-length" high-performance stages, and all the low-performance stages having a same second duration are considered "standard-length" low-performance stages.

[0019] In particular, all the high-performance stages, possibly except the last performed one, are "standard-length" high-performance stages, and all the low-performance stages, possibly except the last performed one, are "standard-length" low-performance stages.

[0020] However, if the overall duration of the main processing step, in particular main washing step, is such that it can be evenly divided into time intervals of first and second duration, then all the all the high-performance stages are "standard-length" high-performance stages, and all the low-performance stages are "standard-length" low-performance stages.

[0021] A "non-standard-length stage", for example a "truncated-length stage", may occur for example if the overall duration of the main processing step, in particular main washing step, is such that it cannot be evenly divided into time intervals of first and second duration.

[0022] In this case the last stage of the main processing step, which stage may be a high-performance or a low-performance stage, may be advantageously truncated (i.e. ended before reaching the duration of the corresponding standard-length stage) as soon as the end of the main processing step is reached, so that, if the last stage is an high-performance stage, the duration of the last stage is lower than the first duration, while if the last stage is a low -performance stage, the duration of the

last stage is lower than the second duration. The truncated-length stage corresponds therefore to a respective truncated (i.e. with a reduced duration) high-performance or low-performance stage.

[0023] The main processing step therefore may comprise in an alternating manner successive standard-length high-performance and standard-length low-performance stages, followed by a final, if required truncated-length, high-performance or low performance stage.

[0024] The overall number of respective standard-length stages and the type of the last, in particular truncated-length, stage are dependent on the overall length of the main processing step, which may be, in particular within certain boundaries, essentially freely selected by a user, for example by a user interface.

[0025] The advantage of truncation or interruption of respective final high- or low-performance stages is that corresponding standard-length stages are independent from, i.e. have not to be adapted to, the overall duration of the treatment program, in particular the main processing step.

[0026] In a different advantageous embodiment of the invention, the last stage of the main processing step, being it a high-performance or a low-performance stage, may be a "non-standard-length" stage, and in particular an "increased-length" stage, i.e. it may have an increased duration with respect to the corresponding standard-length stage; e.g. if the last stage is a high-performance stage, the duration of the last stage may be advantageously higher than the first duration, while if the last stage is a low-performance stage, the duration of the last stage may be advantageously higher than the second duration. In this advantageous embodiment, this may occur, for example, if the overall duration of the main processing step, in particular of the main washing step, is such that it cannot be evenly divided into time intervals of first and second duration.

[0027] In this case when, after performing a certain number of alternated successive standard-length high-performance and standard-length low-performance stages, the time remaining to the end of the main wash step is lower than the duration of the full-length stage that would have to follow the last performed full-length stage, instead of performing a following truncated stage (like in previously described embodiment), in this embodiment the duration of the last performed stage is increased of the remaining time, so that the overall duration of the last stage corresponds to the duration of the standard-length stage plus the remaining time. For example if, after performing a certain number of alternated successive standard-length high-performance and standard-length low-performance stages, after performing a last standard-length low-performance stage the time remaining to the end of the main wash step is lower than the above defined first duration (i.e. lower than the duration of the full-length high-performance stage that would have to follow), then the duration of this last standard-length low-performance stage is increased of the remaining time (i.e. up to reach

the end of the main wash step). Increasing the length of the final stage has the advantage that corresponding standard-length stages are independent from, i.e. have not to be adapted to, the overall duration of the treatment program, in particular the main processing step.

[0028] In a further advantageous embodiment of the invention, the last stage may advantageously be a truncated-length stage or an increased-length-stage. In this advantageous embodiment, this may occur, for example, if the overall duration of the main processing step, in particular of the main washing step, is such that it cannot be evenly divided into time intervals of first and second duration.

[0029] In this case when, after performing a certain number of alternated successive standard-length high-performance and standard-length low-performance stages, the time remaining to the end of the main wash step is lower than the duration of the full-length stage that would have to follow the last performed full-length stage, the choice if performing a further truncated-length stage or increasing the duration of the last performed stage depends on the remaining time; in other words the machine (i.e. its electronic controller unit), evaluates if the remaining time is higher or lower than a certain prefixed threshold value, and performs a further truncated-length stage, or increases the duration of the last performed stage, according to the fact that the remaining time is higher or lower than the threshold value. For example, if, after performing a certain number of alternated successive standard-length high-performance and standard-length low-performance stages, after performing a last standard-length low-performance stage the time remaining to the end of the main wash step is for example 5 minutes, and the threshold value is for example 10 minutes, the machine (i.e. its electronic controller unit) may increase the duration of this last standard-length low-performance stage of 5 minutes (i.e. up to reach the end of the main wash step); in this example, if the duration of the remaining time is, instead, for example 15 minutes (i.e. higher than the threshold value "10 minutes"), the machine (i.e. its electronic controller unit) may perform a truncated-length high-performance stage having a duration of 15 minutes (i.e. corresponding to the remaining time).

[0030] Also in this advantageous embodiment the standard-length high- or low-performance stages are independent from, i.e. have not to be adapted to, the overall duration of the treatment program, in particular the main processing step. In addition to this advantage, last illustrated embodiment has also the advantage that, thanks to the comparison of the remaining time to a prefixed threshold, the length of the last stage is not too different to the length of the corresponding standard-length stage.

[0031] Note that the proposed method has been proven to be effective in temperature reduction, i.e. in keeping the operating temperature of the motor and/or related elements or components and/or other elements of the machine below detrimental or harmful temperature rang-

es. Thus, the proposed method is also effective in extending the overall lifetime of respective components.

[0032] Operating the machine at moderate temperatures is particularly advantageous if the motor is a universal motor comprising motor brushes, since the motor brushes are subjected to high electrical and mechanical stress during the rotation of the motor and generally are highly affected by overheating. However, the method is also effective with brushless motors.

[0033] In one embodiment, the method is adapted for washing laundry, i.e. the method is adapted to operate a laundry washing machine. In this case, the method may further comprise at least one of a wetting step, a heating step, a rinsing step and spinning step. The wetting and heating step may be conducted prior to the main processing step, whereas the rinsing and spinning step may be conducted after the main processing step. As the proposed method has been proven to be effective in keeping operational temperatures at adequate and moderate temperatures, successive steps, such as rinsing and spinning, can be executed immediately thereafter without risking overheating of operational components, such as the motor. If the machine provides a respective functionality (i.e. if it is a washer/drier) a final drying step may be executed, in which laundry within the drum is subjected to a drying process.

[0034] As already indicated, it is of advantage if the high-performance and low-performance stages are executed alternately, i.e. cyclically, which shall mean that a full-length high-performance stage is followed by a full-length (or truncated or increased) low-performance stage and vice versa. Reference is also made to the description above. A cyclic execution of the high- and low-performance stages has advantages in particular with respect to reduced programming effort and reduced storage requirements, and in particular is effective in keeping operational temperatures at the motor drive unit, in particular comprising the motor and related components, for example motor brushes in the case of a brush motor, at moderate temperatures.

[0035] According to one advantageous embodiment, and as already has been discussed further above, the overall duration of at least the main processing step, in particular the overall duration of a processing cycle comprising the main processing step, can be essentially freely selected, for example by a user (in the present application, "essentially freely selected" means that the overall duration can be selected among a continuous range of values, or that only some discrete values in a range can be selected). In particular, in this case at least one of the first duration and second duration, preferably both durations are independent from the selected overall duration. This again has advantages with respect to programming effort and storage requirements. The processing cycle mentioned above may in case of a washing cycle advantageously comprise the steps of wetting, heating, washing in accordance with a main processing step as described herein, rinsing and spinning, optionally

followed by a drying step, if the machine is a washing-drying machine.

[0036] In a further embodiment the motor is operated in successive idle and rotating phases and a ratio between the time duration of successive rotating and idle phases in a high-performance stage is about 2 to 6, preferably about 3.

[0037] In a yet further embodiment, the motor is operated in successive idle and rotating phases and a ratio between the time duration of successive rotating and idle phases in a low-performance stage is about 0.5 to 1.5, preferably about 1.

[0038] Using such ratios has proven to be effective in keeping the overall temperature of at least the motor, preferably also related elements, at moderate levels essentially at nonhazardous levels with respect to temperature load, overheating and other temperature dependent aspects.

[0039] In an embodiment, it is provided that the first duration is larger than the second duration. In this case effective treatment of laundry can be obtained whilst avoiding hazardous temperatures. The first duration of the high-performance stage may for example be in the range between 900 s to 1800 s. The second duration of the low-performance stage may be in the range between 300 s to 1200 s. Further, a ratio of the first duration to the second duration may lie in the range between 1.5 and 3, preferably 2 (i.e. first duration is twice the second duration).

[0040] In a yet further advantageous embodiment of the method, the first and second duration are selected such that at least one of the following conditions advantageously apply:

- a motor brush temperature of the motor driving the drum is reduced in a low-performance stage by about 10% to 20%, preferably 15%; and
- an overall motor temperature of the motor driving the drum is reduced in a low-performance stage by about 3% to 6%, preferably 4.5%.

[0041] In obtaining at least one of the above conditions, the ranges and/or ratios of first and second duration may be selected accordingly, in particular as described and given further above. It shall be noted that the above mentioned temperature reductions can be obtained with the proposed method and, beyond that, are sufficient to avoid temperature overloads at respective components.

[0042] According to another aspect, the invention relates to a machine for processing or treating laundry. The machine comprises a controller unit and a laundry drum adapted to accommodate laundry for processing the same. The controller is adapted to execute a method in any embodiment or variant as described above and further above as well as further below. As to advantages and advantageous effects, reference is made to the description above. The machine may in particular be selected from the group comprising washing machines and

washer-dryers.

[0043] As can be seen, the proposed method is effective in avoiding high temperature loads on relevant operational elements and at the same time can be implemented in a comparatively easy way. Similar advantages apply to the machine.

[0044] Selected advantageous embodiments of the invention will now be described in more detail in connection with the annexed figures, in which

FIG. 1 shows a schematic front view of a laundry washing machine implementing a method according to the invention;

FIG. 2 shows a schematic side view of the laundry washing machine of FIG. 1;

FIG. 3 shows a flow chart of an operational cycle of the laundry washing machine of FIG. 1;

FIG. 4 shows a diagram of motor activity of the laundry washing machine of FIG. 1 during a washing program;

FIG. 5 shows a time course of motor activity in a high-performance stage of a main performance step of the washing program;

FIG. 6 shows a time course of motor activity in a low-performance stage of a main performance step of the washing program;

FIG. 7 shows a diagram of motor temperature during the washing program;

FIG. 8 shows a diagram of motor temperature in successive high- and low-performance stages

FIG. 9 shows a diagram of motor brushes temperature during the washing program; and

FIG. 10 shows a diagram of motor brushes temperature in successive high- and low-performance stages;

[0045] It shall be noted that even though the embodiments described in connection with the figures relate to a front-loading laundry washing machine, the invention may also be applied to a so called "top-loading" laundry washing machine and to a washer-drier (both of the front-loading and of the top-loading type).

[0046] With reference to FIG. 1 and FIG. 2, schematic front and side views of a laundry washing machine 1 are shown, in which laundry washing machine 1 a method according to the invention is advantageously implemented.

[0047] The laundry washing machine 1 comprises an external casing or housing 2 in which a washing tub 3 is

provided, containing a rotatable perforated drum 4 where laundry 5 to be washed can be loaded.

[0048] The tub 3 and the drum 4 both have preferably a substantially cylindrical shape. A hollow space 6 is defined between the tub 3 and the drum 4. The housing 2 is provided with a loading/unloading door 7 which allows access to the washing tub 3 and the drum 4.

[0049] The tub 3 is preferably connected to the casing 2 by means of an elastic bellow 8, or gasket (see FIG. 2).

[0050] The drum 4 is advantageously rotated by an electric motor 9 which preferably transmits the rotating motion to a shaft 10 of the drum 4, advantageously by means of a belt/pulley system 11. It is also possible, that the motor 9 is directly associated with and/or connected to the shaft 10 of the drum 4 (so called "direct drive").

[0051] The motor 9 in the present case is for example a universal motor comprising motor brushes. However, the proposed method and machine also allow the use of brushless motors.

[0052] A water inlet circuit 12 is provided, arranged preferably in the upper part of the laundry washing machine 1, and it is suited to supply water and washing/rinsing products, such as detergent, softener, etc., into the tub 3.

[0053] The water inlet circuit 12 preferably comprises a removable drawer 13 provided with various compartments suited to be filled with washing and/or rinsing products.

[0054] In the embodiment described herein, the water is supplied into the tub 3 by making it flow through the drawer 13. It is possible, that a further and separate water supply is provided, which is adapted to supply clean water, preferably directly, into the tub 3.

[0055] Laundry washing machine 1 further comprises a water outlet circuit 14. The water outlet circuit 14 may comprise a drain pump connected to the tub 3 and to an outlet pipe ending outside the housing 2. The water outlet circuit 15 is suited to drain the liquid, i.e. dirty water or water mixed with washing and/or rinsing products, from the tub 3 to the outside.

[0056] The laundry washing machine 1 comprises a heating device 15 adapted to heat the laundry 5 and/or the water or washing liquid inside the laundry 5 and/or free water or washing liquid inside the tub 3.

[0057] The laundry washing machine 1 further comprises a control unit 16 connected to the various parts of the laundry washing machine 1 in order to ensure its operations.

[0058] The control unit 16 may preferably be connected to the water inlet circuit 12, the water outlet circuit 14, the heating device 15 and the electric motor 9; and may receive information from various sensors provided on the laundry washing machine 1.

[0059] The control unit 16 is preferably adapted to execute a method of operating the laundry washing machine 1 in accordance with the invention. The control unit 16 may be advantageously adapted to control and operate the electric motor 9 adapted to rotate the drum 4

during different steps and stages of a washing program.

[0060] Laundry washing machine 1 advantageously comprises an interface unit, e.g. a user interface (not shown in the figures). The interface unit may be connected to the control unit 16. The interface unit is advantageously arranged to be easily accessible to a user, and is adapted and implemented in such a way that the user can select and set the washing parameters and operational details, such as for example a desired washing program. Preferably, also other parameters can be inserted by the user, for example a washing temperature, a spinning speed, a load in terms of weight of the laundry to be washed, an overall washing cycle duration and others.

[0061] Based on the parameters acquired by said interface unit and, if required additional parameters stored in a memory of the laundry washing machine 1, the control unit 16 sets and controls the various parts of the laundry washing machine 1 in order to carry out the desired washing program, i.e. washing cycle or cycles of a washing program.

[0062] FIG. 3 shows a flow chart of an exemplary operational cycle, in particular including a washing program, of the laundry washing machine 1.

[0063] In a first step S1, the laundry 5 to be washed is loaded inside the drum 4.

[0064] In a second step S2 the user selects a desired washing program.

[0065] The selection of the washing program may be carried out by the user in operating on or using the interface unit of the laundry washing machine 1. Note that steps 1 and 2 may be interchanged.

[0066] In a further embodiment, not illustrated, the machine may automatically select the washing program according to information related to the laundry (e.g. the type of fabric, the quantity of laundry, the soil degree, etc.) which the control 16 unit may acquire for example by specific sensors (e.g. weight sensor, barcode reader reading a barcode present on the laundry for indicating the kind of fabric, optical sensors for detecting the soil degree, etc.).

[0067] In case of selection by a user, the washing program may for example be selected in dependence of the type and dirty-level of the products, i.e. pieces of laundry, to be washed. In the second step S2, it is in particular possible that the user may insert some parameters, in particular operational parameters, directly via the interface unit. For example, the user may select or set a value for the washing temperature, the rotating or spinning speed of the drum 4 in the spinning phase, the duration of a main processing step or washing cycle, etc.

[0068] Once the user has finished all inputs, the user may start or activate the laundry washing machine 1 to carry out the selected washing program, if appropriate, in accordance with the parameters set by the user.

[0069] Starting the washing machine 1 in particular causes the control unit 16 to carry out the single steps of the washing program. In the present case, the washing

program comprises the steps S3 to S7.

[0070] The seventh step S7 is indicated as a dashed box, which shall mean that the seventh step S7 is not mandatory, i.e. that it is an optional step. In particular, the seventh step S7 will not be carried out on machines having no drying functionality.

[0071] In a third step S3, constituting a wetting and/or heating phase, a quantity of clean water is introduced into the tub 3 for wetting, preferably completely, the laundry 5 placed in the tub 3. In general, in the wetting phase a prefixed quantity of detergent is added.

[0072] The introduction of clean water preferably takes place through the water inlet circuit 12 provided for feeding clean water into the tub 3. The quantity of detergent may be taken from the drawer 13 and may be determined by the control unit 22, for example.

[0073] If required, i.e. in dependence of the selected washing temperature, in the third step S3 water, or more specifically washing liquid fed to the drum 4, is heated through activation of the heating device 15.

[0074] Once the wetting and/or heating phase has been completed, a main washing phase is started in the fourth step S4. The main washing phase in the fourth step S4 constitutes a main processing step in the sense of the invention. Before describing the main washing phase in the fourth step S4 in more detail, the further steps S5 to S7 are described.

[0075] Once the main washing cycle in the fourth step S4 has been completed, a fifth step S5 constituting a rinsing phase is carried out. The rinsing phase, as generally known in the art, comprises the removal of dirty water produced during the main wash cycle from laundry 5. The dirty water usually comprises detergents added in the wetting phase and used to wash the laundry 5.

[0076] The rinsing phase advantageously starts by draining the free dirty water from the tub 3, for example by activating a drain pump and, optionally, by contemporaneously rotating the drum 4 so as to extract dirty water from the laundry 5 by centrifugal forces generated by rotational movement. The rinsing phase continues by introducing clean water inside the tub 3, which penetrates into the laundry 5. Preferably during this phase the drum 4 is rotated at a low speed (e.g. at [40-60] rpm) so as to enhance the absorption of clean water by the laundry. The drum 4 is then rotated at a higher speed (e.g. [600-1000] rpm), so as to extract the water and the possible residual detergent contained in the laundry 5 by means of the centrifugal force which allows the ejection of the water outwardly through the holes of the drum 4.

[0077] The water expelled outside the drum 4 is removed from the tub 3; and drained towards the outside of the washing machine 1. The rinsing phase may preferably comprise several consecutive cycles of the type just described, i.e. consecutive steps of introduction of clean water followed by rotations of the drum 4 and drainage of the water from the tub 3 to the outside.

[0078] Once the rinsing phase in the fifth step S5 has been completed, the laundry 5 is substantially clean and

contains residual substantially clean water.

[0079] In a sixth step S6, the washing program may advantageously continue with a spinning phase. The spinning phase preferably comprises one or more high-speed rotation cycles of the drum 4 to remove from the laundry 5 as much residual water as possible. The expression "high-speed" has to be interpreted as a speed which allows removing a suitable quantity of water from the laundry by the centrifugal force. Suitable values of speed are for example from 800 rpm to 1600 rpm, or 1300 rpm to 1500 rpm. Water removed from the laundry 5 is drained to the outside.

[0080] Once the spinning phase in the sixth step S6 terminates, the washing program is completed, unless in a seventh step S7 a drying phase is carried out. A drying phase in particular may be conducted if the washing program is carried out on a laundry washing-drying machine.

[0081] FIG. 4 shows a diagram of motor activity of the motor 9 of the laundry washing machine 1 during executing the washing program described so far. In FIG. 4 the rotational speed in rpm is plotted versus time t. As can be seen, during the third step S3 and fourth step S4, the rotational speed of the drum is in the range between about 40 to 100 rpm, whereas in the fifth step S5 and sixth step S6 the rotational speed is higher, e.g. lies in the range from above 800 rpm to 1400 rpm or even more.

[0082] FIG. 5 and FIG. 6 show time courses of motor activity during the main washing phase in the fourth step S4. In more detail, the main washing phase S4, which constitutes a main processing step in the sense of the invention, is advantageously divided into high-performance stages H (see FIG. 7) and low-performance stages L (see FIG. 7). The high-performance stages H and low-performance stages L are executed alternately one after another.

[0083] The motor activity in high-performance stages H and in low-performance stages L is similar in so far that preferably the direction of rotation of the drum 4, i.e. the direction of rotation of the motor 9, is continuously switched between clockwise (CW) and counter-clockwise (CCW) rotation (however the direction of rotation of the motor 9 may be always the same in all the stages, or may have a different behaviour, for example CW-CWW-CWW-CW-CW, etc.). In between phases of CW rotation and CCW rotation idle (or still) phases are provided during which the drum 4, i.e. the motor 9, is not rotated. This can readily be seen from FIG. 5 and FIG. 6.

[0084] The difference in motor activity during high-performance stages H and low-performance stages L is that the idle phases of the high-performance stages H are reduced as compared to the low-performance stages L.

[0085] A ratio between the time duration of a CW or CCW rotating phase (t_{ON_CW} and t_{ON_CCW} in Fig. 5) and the time duration of the successive idle phase (t_{OFF} in Fig. 5) of the drum 4 or motor 9 in the high-performance stages H preferably lies in the range of about 2 to 6, preferably about 3 (for example 12 minutes ON CW and

3 min OFF, i.e. a ratio t_{ON_CW}/t_{OFF} of 4).

[0086] A ratio between the time duration of a CW or CCW rotating phase (t_{ON_CW} and t_{ON_CCW} in Fig. 6) and the time duration of the successive idle phase (t_{OFF} in Fig. 6) of the drum 4 or motor 9 in the low-performance stages L preferably lies in the range of about 0.5 to 1.5, preferably about 1 (for example 8 minutes ON CW and 8 min OFF, i.e. a ratio t_{ON_CW}/t_{OFF} of 1).

[0087] In the high-performance stages H the drum 4 is rotated intensively (i.e. with a low idle time) so as to apply a maximum mechanical cleaning effect to the laundry 5. In the low-performance stages L, the drum 4 is rotated less intensively (i.e. with an higher idle time) so as to reduce the motor operational load, in turn reducing the temperature or temperature load of the motor 9 and related components, such as motor brushes.

[0088] All the high-performance stages H, possibly with the exception of the last performed one, as will be better explained in the following, are executed in time spans of a first duration d1 (these stages are called "standard-length high-performance stages H").

[0089] All the low-performance stages L, possibly with the exception of the last performed one, as will be better explained in the following, are executed in time spans of a second duration d2 (these stages are called "standard-length low-performance stages L").

[0090] Preferably, and in particular for obtaining adequate cleaning results, the first duration d1 is larger than the second duration d2.

[0091] The first duration d1 of the high-performance stages H may be selected to lie in the range between 900 s to 1800 s, whereas the second duration d2 of the low-performance stages L may be in the range between 300 s to 1200 s.

[0092] In connection with the first and second duration d1 and d2, it is possible that a ratio of the first duration d1 to the second duration d2 lies in the range between 1.5 and 3, preferably 2.

[0093] Now reference is made to FIG. 7 to FIG. 10 showing diagrams of motor temperatures or motor brush temperatures during executing the washing program. In more detail, FIG. 7 shows the time course of the motor temperature in degree Celsius during executing the washing program. FIG. 8 shows a diagram of motor temperature of adjacent high- and low-performance stages H and L. FIG. 9 shows a diagram of motor brush temperature during the washing program. FIG. 10 shows a diagram of motor brushes temperature of adjacent high- and low-performance stages H and L.

[0094] From FIG. 7 it can be seen that during the wetting/heating phase in the third step S3, the motor temperature rises from about room temperature to about 100 degrees. Due to a comparatively moderate operational load of the motor 9 of CW and CCW rotations of the drum 4 in this stage, the temperature at the upper level of about 100 degrees remains comparatively constant. This means that heating of the motor 9 due to operational load and cooling of the motor 9 due to heat dissipation, in

particular in idle, non-rotating phases, is balanced. Temperatures in the mentioned range of about 100 °C generally are uncritical for motors and respective components of laundry washing machines 1.

[0095] In the main washing phase, the situation with regard to motor temperature is different. As can in particular be seen from FIG. 7 and FIG. 8, during high-performance stages H, the motor temperature rises, in particular to temperatures of about 120 °C. Continued operation at such comparatively high temperatures, in particular operating the motor and related components, in particular motor brushes (if provided), at such high temperature levels for longer time periods, in particular over the whole time duration of the washing phase, would or could be detrimental to the motor 9, and respective components, in particular motor brushes (if provided). In particular, the lifetime of the motor 9 and related components could be significantly reduced.

[0096] The temperature development of the motor brushes is depicted in diagrams in FIG. 9 and FIG. 10, which correspond to FIG. 7 and FIG. 8, respectively. Regarding the reasons for the temperature development, in particular temperature rise of the motor brushes, reference is made to the description above relating to the motor temperature, which parts of the description applies mutatis mutandis.

[0097] The motor brush temperature rises in the third step S3 to about 75 °C, and reaches in the fourth step S4 maximal temperatures in high-performance stages H of about 93 °C and 100°C, respectively.

[0098] During the low-performance stages L, the motor brush temperature drops to about 90°C or 95°C, respectively. The temperature drop is such that hazardous temperatures for the motor brushes can be prevented, at least over extended time periods. As a result, the lifetime of the motor (in particular of the motor brushes if the motor is a brushed motor) can be prolonged.

[0099] In order to avoid detrimental temperature loads or even overheating of the motor 9 and related components, the low-performance stages L are interposed between two successive high-performance stages H.

[0100] Due to the reduced operational load of the motor 9 in the low-performance stages L, the temperature of the motor 9, and related components, in particular motor brushes (if provided), can be and is reduced, as can be clearly seen from FIG. 7 to FIG. 10. Such a temperature reduction greatly contributes to reduced temperature loads and prolonged lifetimes of the motor 9 and related components, in particular motor brushes and the like.

[0101] In accordance with the invention, it is provided that the first duration d1 of all standard-length high-performance stages H are essentially equal. Also the second duration d2 of all standard-length low-performance stages L are advantageously essentially equal. In other words, all standard-length high-performance stages H have an equal first duration d1, and/or all standard-length low-performance stages L have an equal second duration d2. This can be recognized in particular from FIG. 7

to FIG. 10.

[0102] Using such equal first and/or second duration d1 and d2 has been proven effective in keeping the operational temperature of the motor 9 and related components, in particular the motor brushes (if provided), at acceptable temperature levels, i.e. below detrimental temperatures and over temperatures.

[0103] An additional and significant advantage of providing respective equal first durations d1 and second durations d2 is that the washing program, in particular the washing phase in the fourth step S4, can be programmed in a comparatively easy way. In particular, it is not required to adapt each program with respect to the first and second durations. This means in particular that program sections responsible for driving the motor in the washing phase can be made easier and less complex and in particular can be easily implemented.

[0104] In the present case, the washing phase in the fourth step S4 comprises two full-length high-performance stages H and two full-length low-performance stages L. At the end of the second low-performance stage L the end of the washing phase, i.e. the end of the time interval of the fourth step S4 is not reached.

[0105] Therefore, and in accordance with the proposed method, a further high-performance stage H' is started after the second, i.e. latest, low-performance stage L.

[0106] In order to observe and stick to the overall time duration of the washing phase in the fourth step S4, which time duration may be selected by the user in the second step S2, the further high-performance stage H' may be advantageously stopped or cancelled at the end of the time duration of the washing phase. Therefore, the further high-performance stage H' can be referred to as a truncated-length high-performance stage H'. Similarly, a low-performance stage may be advantageously truncated if it follows a standard-length high performance stage, lies at the end of the washing phase such that it cannot be executed in full length any more.

[0107] One particular advantage of the method in allowing or implementing truncated high-performance and low-performance stages is that the overall duration of the washing phase can be freely selected, in particular independent from the first duration d1 and second duration d2. In other words, the first duration d1 and second duration d2, which in general are set at earlier stages than the overall duration of the washing phase, can be selected and set independent of the overall durations of the washing phases initiated by a user in later operations.

[0108] In using respective equal lengths for the first duration d1 and the second duration d2, and in truncating a respective last high-performance stage or last low-performance stage, the implementation and programming of washing programs is considerably simplified.

[0109] The same advantages may be obtained, in a different embodiment, instead of by a truncated-length final step, by a final increased-length stage; in this case when, after performing a certain number of alternated successive standard-length high-performance and

standard-length low-performance stages, the time remaining to the end of the main wash step is lower than the duration of the full-length stage that would have to follow the last performed full-length stage, instead of performing a following truncated stage (like in previously described embodiment), the duration of the last performed stage is increased of the remaining time, so that the overall duration of the last stage corresponds to the duration of the standard-length stage plus the remaining time.

[0110] In a further advantageous embodiment, the last stage may advantageously be a truncated-length stage or an increased-length-stage. In this case, when after performing a certain number of alternated successive standard-length high-performance and standard-length low-performance stages, the time remaining to the end of the main wash step is lower than the duration of the full-length stage that would have to follow the last performed full-length stage, the choice if performing a further truncated-length stage or increasing the duration of the last performed stage depends on the remaining time; in other words the machine (i.e. its electronic controller unit), evaluates if the remaining time is higher or lower than a certain prefixed threshold value, and performs a further truncated-length stage or increases the duration of the last performed stage according to the fact that the remaining time is higher or lower than the threshold value.

[0111] By present invention, possibly hazardous temperatures at the motor 9 and components thereof, such as the motor brushes (if provided), can be greatly avoided, in principle as effective as with known methods implementing complicated determination and calculation processes for the first and second durations.

[0112] Regarding the temperatures of the motor 9 and related components, such as the motor brushes, the first and second durations d1 and d2 may be adapted in such a way that

- i) the motor brush temperature of the motor 9 is reduced in the low-performance stage L by about 10% to 20%; and/or
- ii) the overall motor temperature of the motor 9 is reduced in the low-performance stage L by about 3% to 6%.

[0113] In more general terms, in adequately selecting the length of the first duration d1 and second duration d2 the development of the temperature of the motor 9 and related components, such as the motor brushes (if provided) can be influenced.

[0114] In the fifth step S5 and sixth step S6, the drum 4 in general is rotated in one direction without reversing rotational direction. This and the fact that comparatively long idle phases are incorporated in rinsing and spinning, overheating of the motor and components thereof is non-critical. This in particular can be seen from FIG. 6.

Claims

1. Method of operating a machine (1) for processing or treating laundry (5), wherein the method comprises a main processing step (S4) in which a laundry drum (4) adapted to accommodate laundry (5) is rotated by a motor (9) for mechanical treatment of the laundry (5), wherein the main processing step (S4) is divided into high-performance (H) and low-performance stages (L), and wherein at least one of the following conditions applies:
 - i) all high-performance stages (H) are of an equal first duration (d1);
 - ii) all low-performance stages (L) are of an equal second duration (d2).
2. Method according to claim 1, wherein at least two high-performance stages (H) and/or at least two low-performance stages (L) are executed during the main processing step (S4).
3. Method according to at least one of claims 1 and 2, wherein the method is adapted for washing laundry (5) and further comprises at least one of a wetting step (S3), a rinsing step (S5) and spinning step (S6).
4. Method according to at least one of claims 1 to 3, wherein the high-performance (H) and low-performance stages (L) are executed alternately.
5. Method according to at least one of claims 1 to 4, wherein the overall duration of at least the main processing step (S4) can be essentially freely selected by a user, and wherein at least one of the first duration (d1) and second duration (d2) is independent from the selected overall duration.
6. Method according to at least one of claims 1 to 5, wherein the final stage of the main processing step (S4) is one of a truncated-length high-performance (H') or truncated-length low-performance stage.
7. Method according to at least one of claims 1 to 5, wherein the final stage of the main processing step (S4) is one of a increased-length high-performance or increased-length low-performance stage.
8. Method according to at least one of claims 1 to 7, wherein the motor (9) is operated in successive idle and rotating phases and a ratio between the time duration of successive rotating and idle phases (t_{ON_CW}/t_{OFF} , t_{ON_CCW}/t_{OFF}) in a high-performance stage (H, H') is about 2 to 6, preferably about 3.
9. Method according to at least one of claims 1 to 8, wherein the motor (9) is operated in successive idle and rotating phases and a ratio between the time duration of successive rotating and idle phases (t_{ON_CW}/t_{OFF} , t_{ON_CCW}/t_{OFF}) in a low-performance stage (L) is about 0.5 to 1.5, preferably about 1.
10. Method according to at least one of claims 1 to 9, wherein the first duration (d1) is larger than the second duration (d2).
11. Method according to at least one of claims 1 to 10, wherein the first duration (d1) of the high-performance stage (H) is in the range between 900 s to 1800 s and/or the second duration (d2) of the low-performance stage (L) is in the range between 300 s to 1200 s.
12. Method according to at least one of claims 1 to 11, wherein a ratio of the first duration (d1) to the second duration (d2) lies in the range between 1.5 and 3, preferably 2.
13. Method according to at least one of claims 1 to 12, wherein the first duration (d1) and second duration (d2) are selected such that at least one of:
 - i) a motor brush temperature of the motor (9) driving the drum (4) is reduced in a low-performance stage (L) by about 10% to 20%, preferably 15%, and
 - ii) an overall motor temperature of the motor (9) driving the drum (4) is reduced in a low-performance stage (L) by about 3% to 6%, preferably 4.5%.
14. Machine (1) for processing laundry (5), comprising a controller unit (16) and a laundry drum (4) adapted to accommodate laundry (5) for processing the same, wherein the controller unit (16) is adapted to execute a method according to at least one of claims 1 to 13.
15. Machine (1) according to 14, wherein the machine is selected from the group comprising laundry washing machines (1) and a washer/dryer.

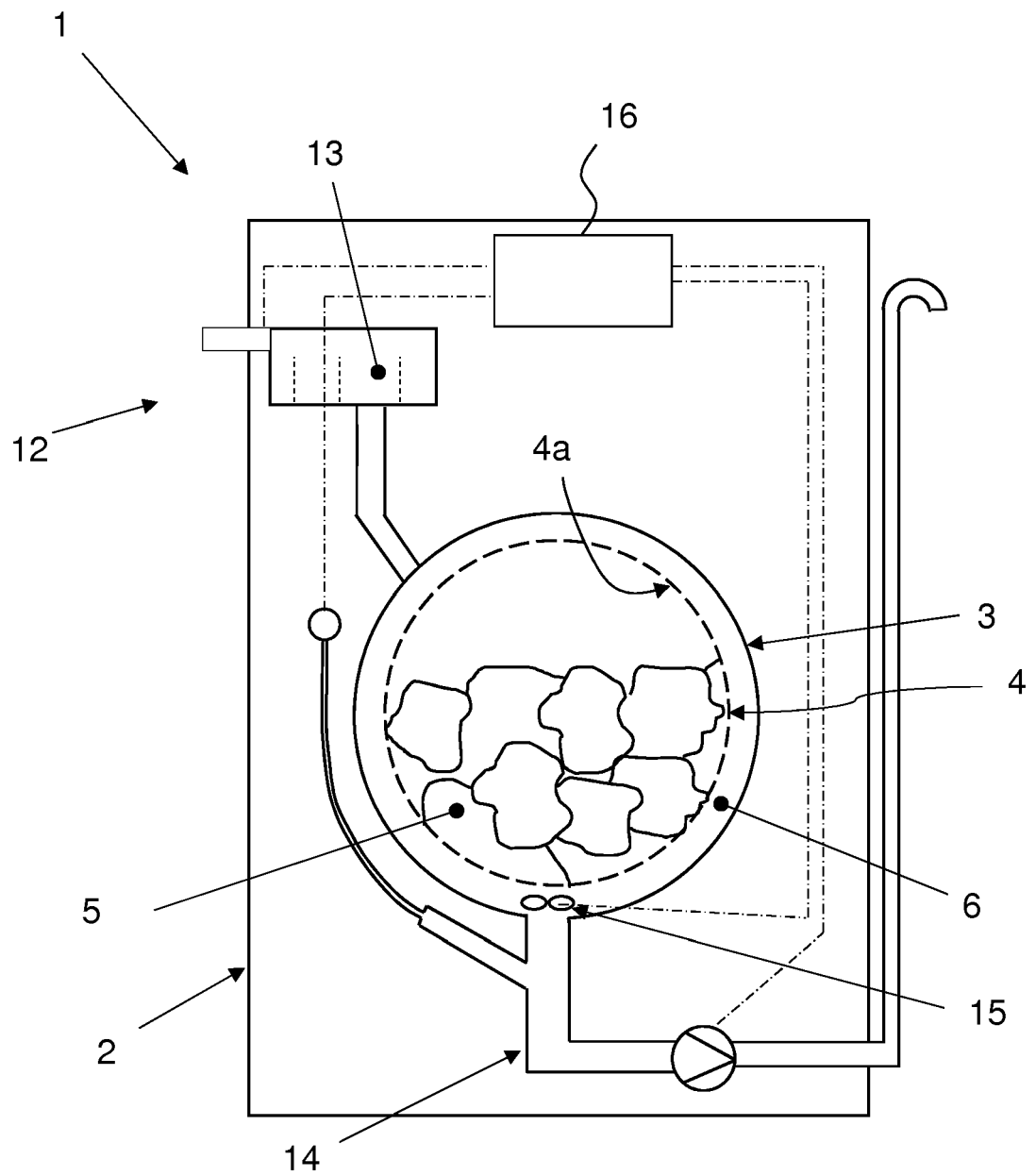


FIG. 1

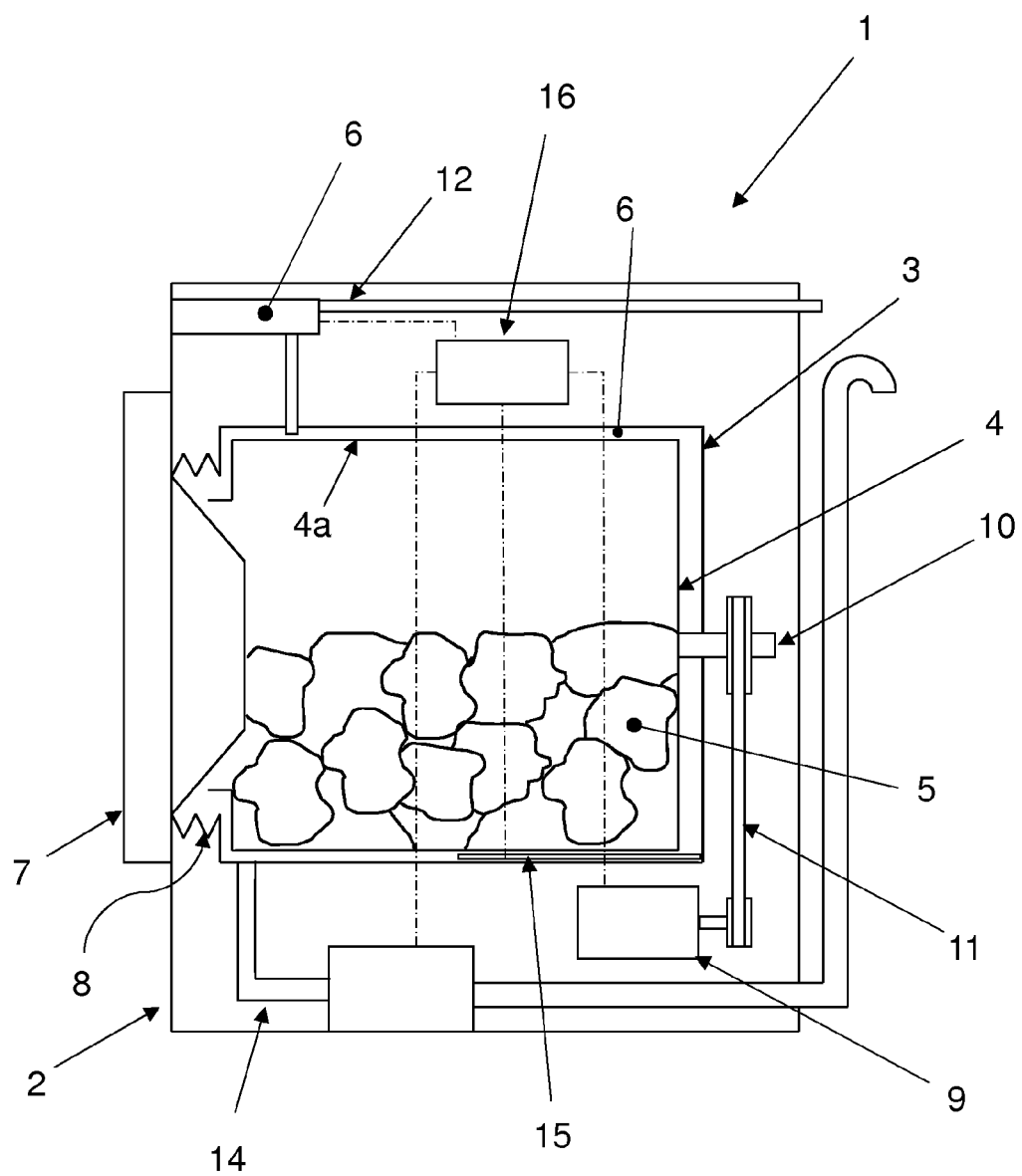


FIG. 2

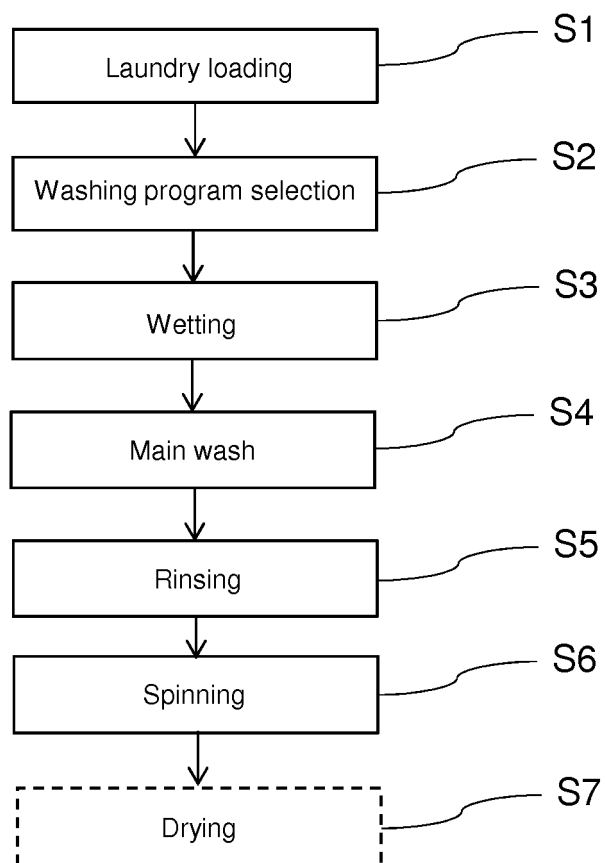


FIG. 3

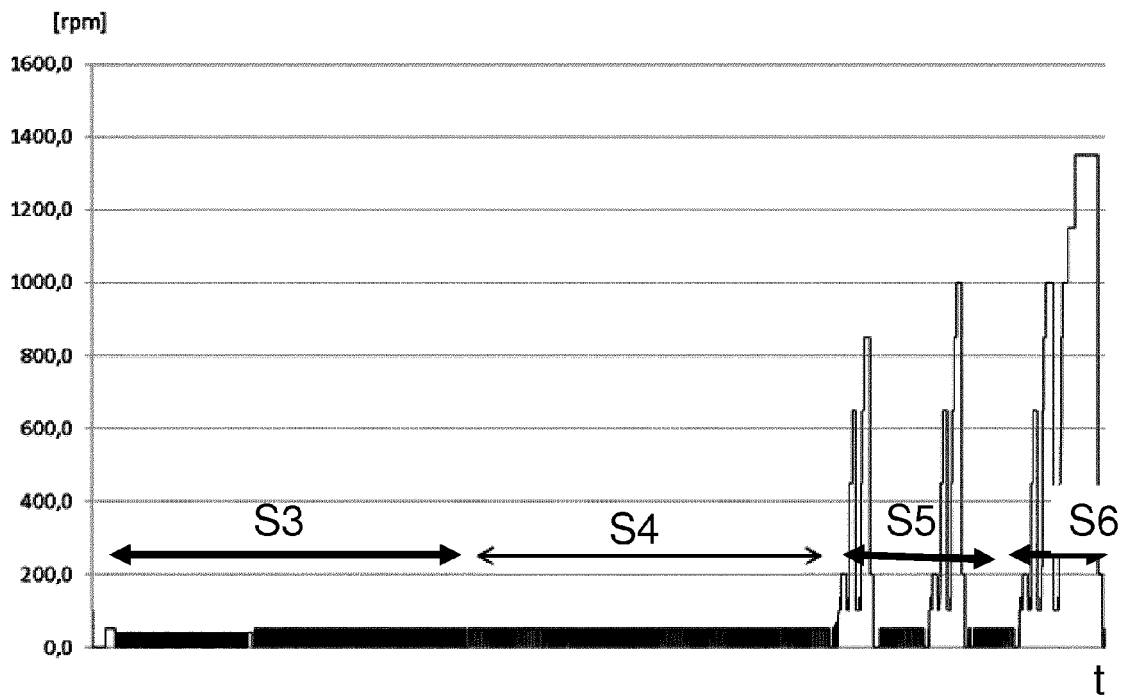


FIG. 4

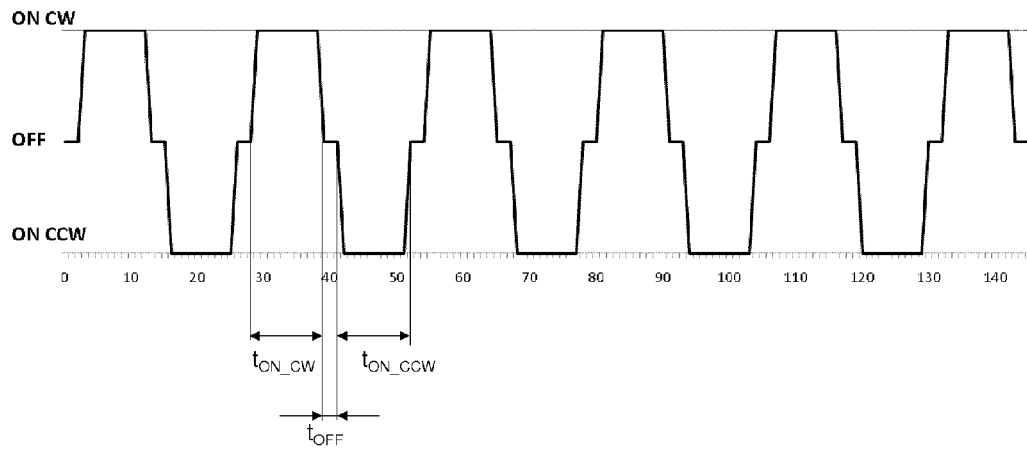


FIG. 5

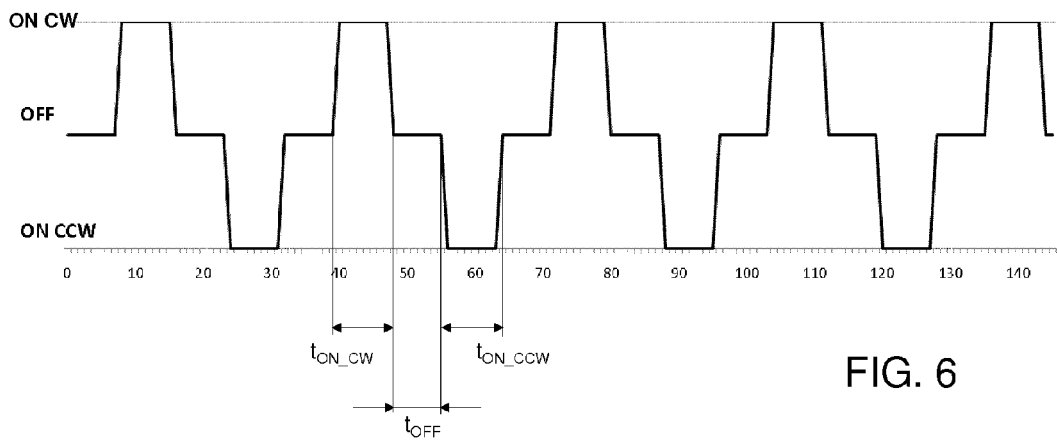


FIG. 6

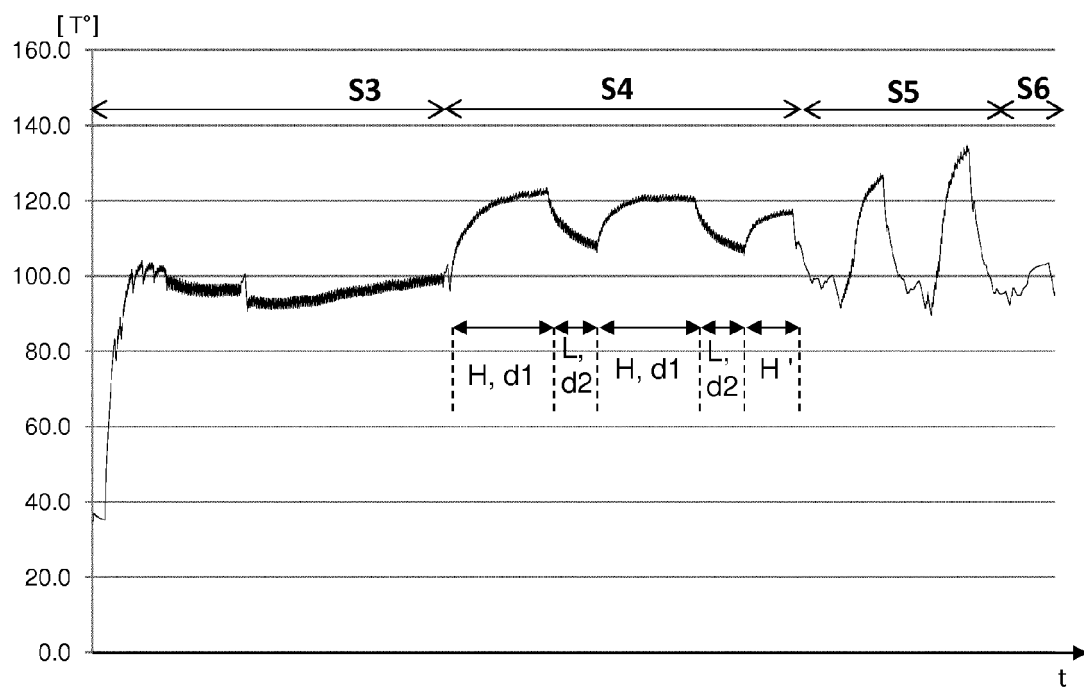


FIG. 7

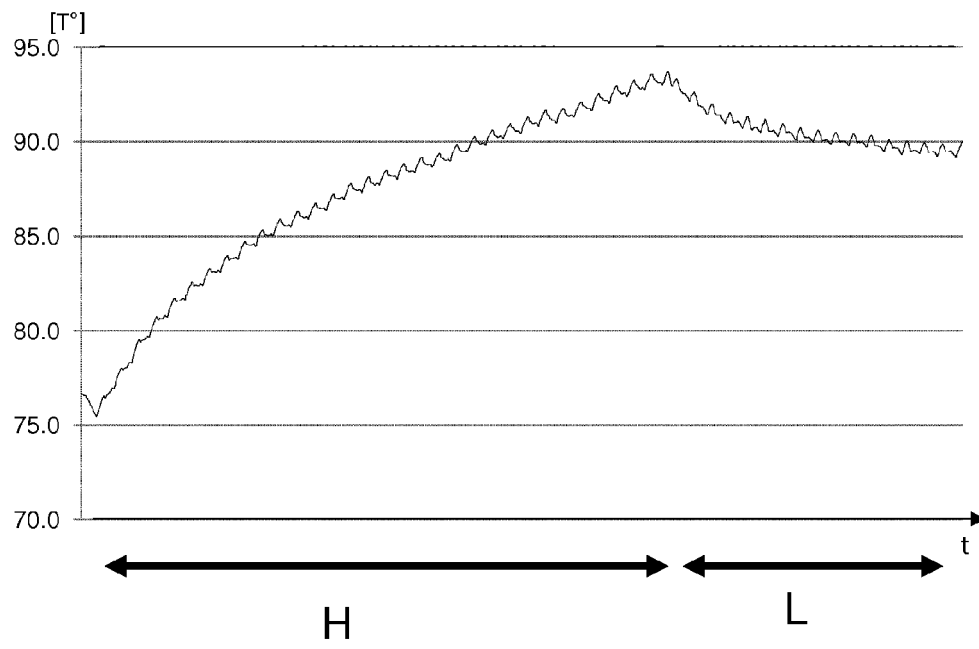


FIG. 8

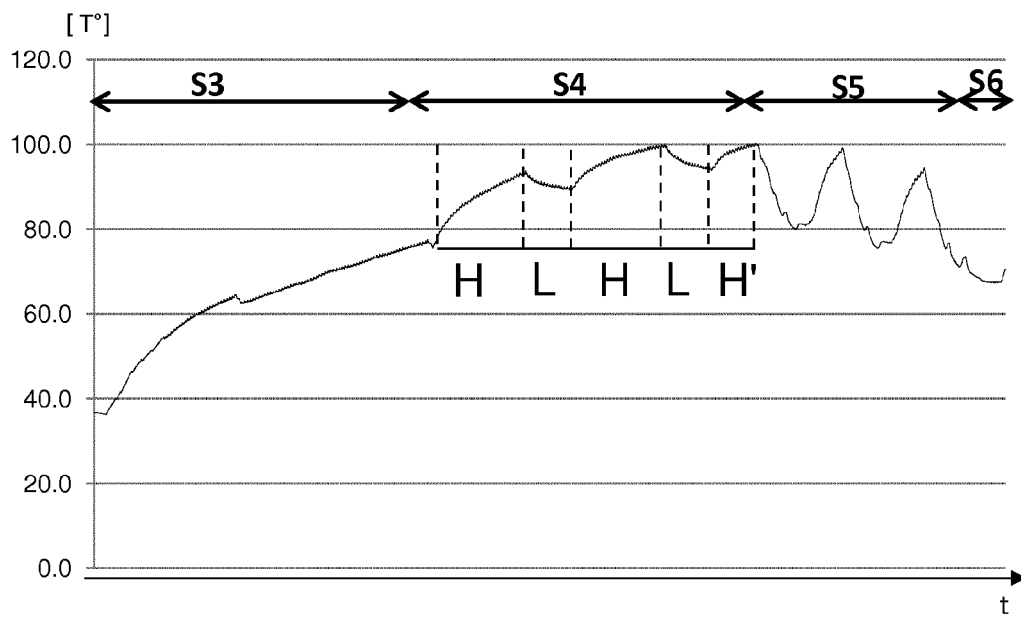


FIG. 9

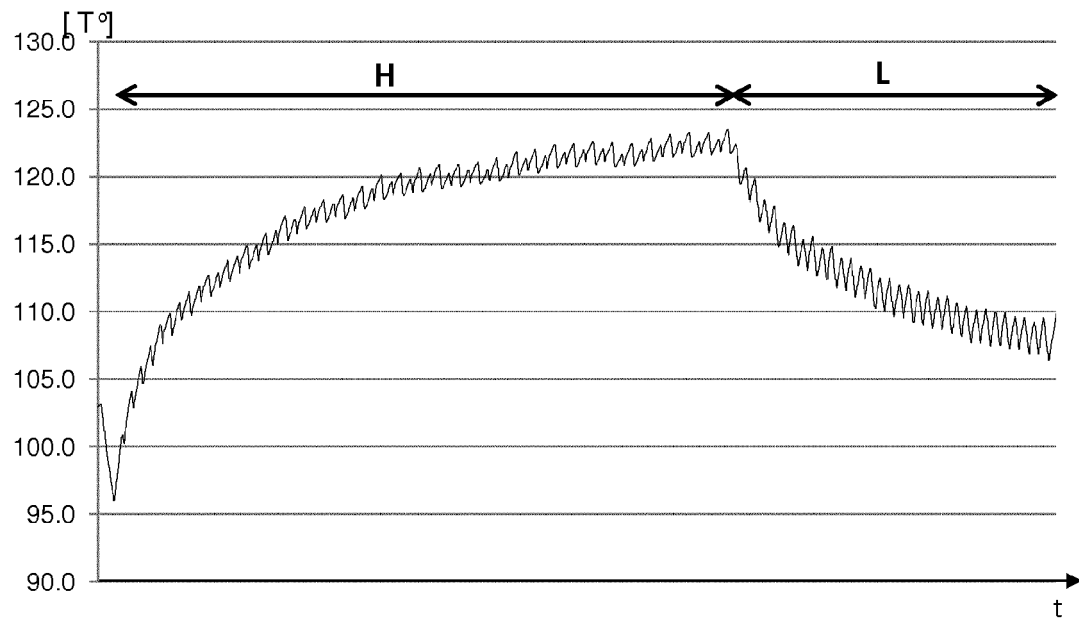


FIG. 10



EUROPEAN SEARCH REPORT

Application Number
EP 12 16 8935

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			D06F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 30 November 2012	Examiner Kising, Axel
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