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(54) **Laundry treating machine and method for control thereof**

(57) The present invention relates to a laundry treating machine (1) comprising an outer casing (2), a rotatable drum (3), which is arranged in axially rotating manner inside the outer casing (2) and is structured to receive the laundry to be treated, a laundry treating course select unit (7) provided for an operator to select a laundry treating course to be performed; laundry treating course having a nominal total course duration (t_n), and comprising a plurality of laundry treating phases/steps, each having a nominal duration ($t_{c(i)}$, $t_{p(i)}$); a time input unit (8) provided for an operator to input an end-time value (t_u), which is indicative of a time at which, or in which, the laundry treating course has to be ended; a start input unit (9) provided for an operator to input a course start command; a controller (5) configured to automatically start performing a selected laundry treating course based on a inputted course start command and an inputted end-time value (t_u); during the execution of said laundry treating course, determine a treating phase time information which is related to actual duration ($t_{a(i)}$) which a monitored laundry treating phase/step (i) spent to be completed, vary, with respect to its nominal value ($t_{c(i)}$, $t_{p(i)}$), the duration of laundry treating phases/steps (i+1) to be performed following the monitored laundry treating phase/step (i), based on the determined treating phases/steps time information, in such a way to cause the laundry treating course to end at/in said end-time value (t_u) set by operator.

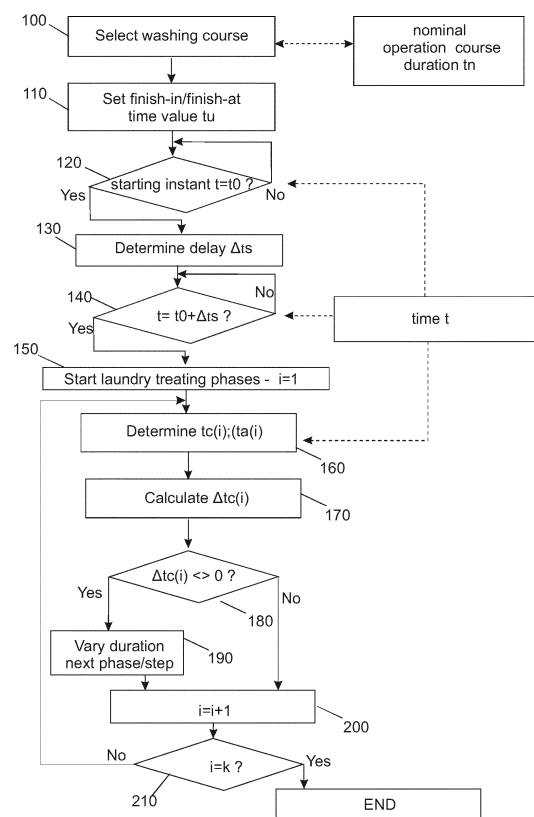


Fig. 4

Description

[0001] The present invention concerns the field of laundry treating machines, such as laundry washing machines and/or laundry washing drying machines and/or laundry drying machines.

[0002] The present invention further relates to a control method of a laundry machine, which is designed to control the duration of the phases/steps of a selected laundry treating course so that the selected laundry treating course is completed at/in an end time established by an operator.

BACKGROUND ART

[0003] Nowadays the use of laundry treating machines, such as laundry washing machines, i.e. laundry washing machines which wash and rinse laundry, or laundry washing and drying machines, i.e. laundry washing machines which can also dry laundry, or laundry drying machines, i.e. laundry machines which dries the laundry, is widespread. In this respect, in the present description, where not stated differently, the term "laundry treating machine" can be referred indiscriminately to a laundry washing machine, or to a laundry washing and drying machines, or to a laundry drying machine.

[0004] It is known that laundry treating machines are typically provided with a user control panel which comprises a laundry treating course select part to enable operator to select a laundry treating course (e.g. a washing course in a laundry washing machine, or a drying course in a laundry drying machine) among a plurality of laundry treating courses, each one comprising a plurality of treating phases; the user control panel of some known laundry treating machines also comprises a finish course input part which allows operator to select an end time at which the selected laundry treating course has to be finished. More specifically some known finish course input parts are designed to enable the user to set a "finish-at" time corresponding to the end time at which the selected washing course must be finish, e.g. a desired hour/minute of the day, for example finish-at time=10.15 AM.

[0005] It is further known that finish course input parts may be configured to enable operator to set a "finish-in" time corresponding to an interval/duration requested to complete the selected washing course; for example the finish-in time may be set so that the washing course has to be finished in a certain interval of hours/minutes, e.g. in 8 hours and 5 minutes.

[0006] In known washing machines provided with the "finish-in" and/or "finish-at" function, when user, after selecting a washing course (for example a washing course for washing cotton), sets the "finish-in time" or the "finish-at time", the controller of the machine, having in his memory the nominal duration of the selected washing course, automatically calculates (based on the nominal duration of the selected washing course) when the laundry treat-

ing course has to start in order to be finished according to finish-in time or finish-at time set by user, and automatically starts the laundry treating course accordingly.

[0007] However, in usage, duration of laundry treating courses, in particular of washing courses, is often different from the prefixed nominal duration due to several variable operating parameters which cause the duration of laundry treating phases to be varied. For this reason, since the controller of the machine starts the laundry treating course according to the finish-in time or finish-at time set by user and according to the nominal duration of the selected washing course, typically the laundry treating course does not actually end at the finish-in time or finish-at time set by user. For example, in a laundry washing machine water supply duration of the water loading phase/wetting phase is heavily subjected to vary because it depends on many loading variables, e.g. kind of laundry, amount of laundry, etc. Also the duration of the spin phases in a laundry washing machine are subjected to be varied. In fact, spin phases usually comprise a laundry unbalance detection step, in which, if a high level of unbalance is detected, a plurality of attempts to reach the spin speed is performed, alternated with redistribution phases in which drum is rotated in opposite rotation directions at low speed for changing laundry position inside the drum, so as to reduce the unbalance degree thereof. Therefore duration of the spin phase may heavily vary based on number/time required to perform balance attempts.

[0008] Due to variability of duration of laundry treating phases above disclosed, the known washing laundry machines have the drawback that the washing course may be completed before/after the finish-in or finish-at time set by the user.

[0009] Applicant conducted an in-depth study with the objective of providing a laundry treating machine which is able to complete a laundry treating course, and in particular, if the machine is a washing machine, a washing course exactly, at the finish-in or finish-at time set by the user, in particular regardless of a spin time and/or a water supply time.

DISCLOSURE OF INVENTION

[0010] According to the present invention, there is provided a laundry treating machine comprising: an outer casing, a rotatable drum which is arranged in axially rotating manner inside the outer casing and is structured to receive the laundry to be treated, a laundry treating course select unit provided for an operator to select a laundry treating course to be performed; said laundry treating course having a nominal total course duration, and comprising a plurality of laundry treating phases/steps, each having a nominal value; a time input unit provided for an operator to input an end-time value, which is indicative of a time at which, or in which, the laundry treating course has to be ended; a start input unit provided for an operator to input a course start command; the

laundry treating machine comprising a controller configured to: automatically start performing a selected laundry treating course based on a inputted course start command and an inputted end-time value; during the execution of said laundry treating course, determine a treating phase/step time information which is related to actual duration of at least one monitored laundry treating phase/step, and vary, with respect to its nominal value, the duration of one or more laundry treating phases/steps to be performed following said at least one monitored laundry treating phase/step, based on said determined treating phases/steps time information, in such a way to cause said laundry treating course to end at/in said end-time value set by operator.

[0011] Preferably the controller is further configured to: calculate the time difference between said actual duration of the monitored laundry treating phase/step, determined during a laundry treating course, and its nominal value; and adjust, with respect to its nominal value, the duration of at least a laundry treating phase/step to be performed following said monitored laundry treating phase/step, based on said calculated time difference. Preferably, the controller is further configured to reduce, with respect to its nominal value, the duration of a laundry treating phase/step to be performed following a monitored laundry treating phase/step, if the determined actual duration of said monitored laundry treating phase/step is greater than the nominal value of said monitored laundry treating phase/step.

[0012] Preferably the controller is further configured to skip at least a laundry treating phase/step to be performed following a monitored laundry treating phase, if the determined actual duration of said monitored laundry treating phase/step is greater than the nominal value of said monitored laundry treating phase/step.

[0013] Preferably, the controller is further configured to extend, with respect to its nominal value, the duration of a laundry treating phase/step to be performed following a monitored laundry treating phase/step, if the determined actual duration of said monitored laundry treating phase/step is lower than the nominal value of said monitored laundry treating phase/step.

[0014] Preferably, the extension of said duration of said laundry treating phase/step to be performed following said monitored laundry treating phase corresponds to the difference between said nominal value and said monitored actual duration of said monitored laundry treating phase.

[0015] Preferably the controller is further configured to add to a laundry treating course a prefixed laundry treating phase/step to be performed, if the actual duration of a laundry treating phase/step monitored during said laundry treating course is lower than the nominal value of said monitored laundry treating phase/step.

[0016] Preferably the controller is further configured to calculate the difference between a pre-set nominal total course duration and the actual duration of a monitored laundry treating phase/step so as to determine an actual

course remaining time indicating the remaining time required to perform the laundry treating phases/steps following said laundry treating phase/step in order to complete the course; determine a theoretical course remaining time; compare the actual course remaining time with said theoretical course remaining time; adjust, with respect to its nominal value, the duration of at least a laundry treating phase/step following said monitored laundry treating phase based on results of said comparison.

[0017] Preferably the controller is further configured to calculate the time difference between the determined actual course remaining time and said theoretical course remaining time, and adjust, with respect to its nominal value, the duration of a laundry treating phase/step following the monitored laundry treating phase so as to compensate said calculated time difference.

[0018] Preferably the controller is further configured to determine treating phases/steps time information, which is indicative of actual time which a unbalance detection/correction operation/s of a spin phase spent to be completed, vary, with respect to its nominal value, the duration of one or more rinse phases following said spin phase, based on determined time information to cause the course to end at/in said end-time value set by operator.

[0019] Preferably the controller is further configured to calculate the time difference between the determined actual duration of said unbalance detection/correction operation/s of a spin phase and a prefixed nominal duration of unbalance detection/correction operation/s of a spin phase; and adjust, with respect to its nominal value the duration of a rinse phase following said spin phase based on said calculated time difference.

[0020] The present invention is also related to a control method of a laundry treating machine comprising: an outer casing; a rotatable drum which is arranged in axially rotating manner inside the outer casing and is structured to receive the laundry to be treated; a laundry treating course select unit provided for an operator to select a laundry treating course to be performed, the laundry treating course having a nominal total course time and comprising a plurality of laundry treating phases/steps, each having a nominal duration; a time input unit provided for an operator to input an end-time value, which is indicative of a time at which, or in which, the laundry treating course has to be ended; a start input unit provided for an operator to input a course start command. The method comprises: automatically starting performing a selected laundry treating course (e.g. a washing course) based on an inputted course start command and an inputted end-time value; said method being characterized by comprising the following steps: during said laundry treating course, determining a treating phase/step time information which is related to actual duration of at least one monitored laundry treating phase/step; varying, with respect to its nominal duration, the duration of one or more laundry treating phases/steps to be performed following said at least one monitored laundry treating phase/steps,

based on said determined treating phase/step time information, in such a way to cause said laundry treating course to end at/in said end-time value set by operator.

[0021] Preferably the method comprises: calculating a time difference between the actual duration of the monitored laundry treating phase/step determined during said laundry treating course, and a prefixed nominal duration of said monitored laundry treating phase/step, and adjusting, with respect to its nominal value, the duration of at least a laundry treating phase/step to be performed following said monitored laundry treating phase/step, based on said calculated time difference.

[0022] Advantageously the method comprises reducing or extending, with respect to its nominal value, the duration of a laundry treating phase/step to be performed following a monitored laundry treating phase/step, if the determined actual duration of said monitored laundry treating phase/step is greater or respectively lower than the nominal duration of said monitored laundry treating phase/step.

[0023] Preferably the method comprises skipping or adding at least a laundry treating phase/step to be performed following a monitored laundry treating phase, if the determined actual duration of said monitored laundry treating phase/step is greater or respectively lower than the nominal duration of said monitored laundry treating phase/step.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] Further characteristics and advantages of the present invention will be highlighted in greater detail in the following detailed description of some of its preferred embodiments, provided with reference to the enclosed drawings. In the drawings, corresponding characteristics and/or components are identified by the same reference numbers. In particular:

- Figure 1 shows schematically a perspective view of a laundry treating machine according to the invention;
- Figure 2 shows schematically a front view of a the control panel of the laundry treating machine of Figure 1, according to an embodiment of the present invention;
- Figure 3 shows schematically a front view of the control panel of the laundry treating machine of Figure 1, according to a different embodiment of the present invention;
- Figure 4 shows a simplified flowchart illustrating the steps of a first embodiment of the control method of the laundry treating machine illustrated in Figure 1, according to the present invention;
- Figure 5 shows a simplified flowchart illustrating the steps of a second embodiment of the control method of the laundry treating machine illustrated in Figure 1, according to the present invention;
- Figure 6 shows a simplified flowchart illustrating the

steps of a third embodiment of the control method of the laundry treating machine illustrated in Figure 1, according to the present invention; while

- Figure 7 shows an example of adjustment of the nominal duration of a rinse phase performed according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0025] The control method of the present invention has proved to be particularly advantageous when applied to a laundry washing machine, as described below. It should be understood that although the control method is described with reference to a laundry washing machine, other applications are contemplated. As can be appreciated, the present invention can be conveniently applied to other laundry treating machines, like for example laundry washing and drying machines (called also washer/driers) or laundry drying machines (called also drier).

[0026] With reference to Figure 1, a laundry treating machine is described; in this advantageous embodiment this laundry treating machine is a laundry washing machine 1.

[0027] The laundry washing machine 1 is a front loading laundry washing machine. The present invention has proved to be particularly successful when applied to front loading laundry washing machines. It should in any case be understood that the present invention is not limited to this type of application. On the contrary, the present invention can be usefully applied to different types of laundry washing machines, for example top loading laundry washing machines or top loading laundry washing and drying machines, or top loading laundry drying machines.

[0028] The laundry washing machine 1 according to one embodiment of the invention comprises an external casing or casing 2, in which a washing tub (not illustrated) is provided, that contains a rotatable perforated drum 3 (only partially illustrated), where the laundry to be washed can be loaded. The washing tub and the drum 3 both have preferably a substantially cylindrical shape. The casing 2 is provided with a loading/unloading door 4 which allows access to the washing tub and the drum 3. The washing tub is preferably suspended in a floating manner inside the casing, advantageously by means of a number of coil springs and shock-absorbers (not illustrated). The drum 3 may be advantageously rotated by an electric motor (not illustrated), which may preferably transmit the rotating motion to the shaft of the drum 3, advantageously by means of a belt/pulley system (not illustrated). In a different embodiment of the invention, the motor can be directly associated with the shaft of the drum 3.

[0029] In this instance the washing tub, the drum 3, the electric motor, belt/pulley system of the laundry washing machine 1 are well-known elements provided in well-known laundry machine and detailed description thereof will be omitted accordingly.

[0030] The laundry washing machine 1 further comprises a control unit 5 (illustrated schematically in Figure 1 with broken line), which is configured to control driving of the laundry washing machine 1. In a preferred embodiment, the control unit 5 is configured to memorize a plurality of laundry washing courses (for example in a memory unit not illustrated) and controls driving of the laundry washing machine 1 in order to perform a laundry washing course selected by operator among the memorized laundry washing courses.

[0031] Terminology which will be used as follows is hereinafter defined.

[0032] With the term "laundry treating course" it will be understood a course comprising a number of prefixed sequential laundry treating phases; each of these phase can comprise one or more sub-phases hereinafter called simply "laundry treating steps", or steps.

[0033] In a laundry washing machine, laundry treating course corresponds to a laundry washing course typically comprising at least a main wash phase, one or more rinse phases, and one or more spin phases.

[0034] Laundry treating phases of a laundry washing course may be characterised by several laundry washing parameter, such as nominal phase time or duration $t_{c(i)}$ (wherein i indicates the sequential order of the washing phase), water/air temperature, spin speed of the drum, amount of supplied water, etc..., which may be established/calculated based on the corresponding laundry washing course.

[0035] The main wash phase may comprise at least a loading/wetting step (loading water and detergent into the washing tub), preferably, although not necessarily a heating step, wherein the water loaded in the washing tub is heated, a maintenance step (tumbling the laundry for detergent action) and a dry and spin steps (draining water and spinning the drum with continuous drain).

[0036] A rinse phase may comprise one or more laundry washing steps, for example a water loading/wetting step (loading water into the washing tub), a rinse maintenance step (tumbling the laundry) a dry step, and spin step (draining water and spinning the drum with continuous drain).

[0037] The spin phase may comprise one or more laundry unbalance detection laundry washing steps, wherein it is detected whether laundry inside the drum 3 is unbalanced, one or more laundry correction step/s wherein drum 3 is alternately rotated in opposite directions at low speed to redistribute the laundry inside of the same, and one or more acceleration step/s, wherein, if a balanced status of the laundry has been detected, the drum 3 is accelerated so that its rotational speed reaches a prefixed spin speed to cause the laundry to be squeezed.

[0038] It should be understood that each laundry treating step has a respective calculated nominal step duration $t_{p(i)}$, and each laundry washing course has its nominal operation duration t_n , which is the time required to perform the course as a whole when all the laundry treating phases are performed according to respective nom-

inal phase duration $t_{c(i)}$.

[0039] In accordance with one embodiment illustrated in Figure 1, laundry washing machine 1 is further provided with a control panel 6 which may comprise a washing course select part 7 configured to enable the operator to select a laundry washing course among a plurality of selectable prefixed laundry washing courses, and a start command select part 8 configured to enable the operator to input a start command to cause the selected laundry washing course to be started.

[0040] The control panel 6 further comprises a finish course select part 8 configured to enable the operator to input time information indicative of a request to end the selected washing course at a desired time (this function is called "finish-at"), or in a desired interval (this function is called "finish-in").

[0041] In accordance with one embodiment, the finish course select part 8 may be configured to enable the operator to select a finish-in time function, and/or a finish-at time function, and set an end time value t_u . It should be understood that if the finish-in time function is selected, the control unit 5 controls the devices/components of the laundry washing machine 1 so that the washing course is completed within an interval/duration corresponding to the end time value t_u set by operator. Thus, when the operator selects the finish-in time function, the set time value t_u corresponds to the amount of hours/minutes operator would like the selected laundry washing course to be finished in. For example, if operator selects the finish-in time function and sets $t_u = 5$ hours, 15 minutes, the control unit 5 automatically controls the washing machine 1 to cause the washing course to be performed/completed within 5 hours and 15 minutes.

[0042] When the finish-at time function is selected, the control unit 5 automatically controls the laundry washing machine 1 so that the selected laundry washing course is completed at the end time value t_u set by operator. Therefore, when operator selects the finish-at time function, the set time value t_u corresponds to the hours/minutes that operator would like the selected washing course to be finished at. For example, if operator selects the finish-at time function and set $t_u = 23$ hours and 30 minutes, the control unit 5 controls the laundry washing machine 1 such that the laundry washing course ends at 23:30.

[0043] In accordance with one exemplary embodiment illustrated in Figures 2 and 3, finish course select part 8 may be advantageously configured so that when it is firstly activated by operator, it displays a prefixed duration (3 hour in the example illustrated in Figure 2) or a prefixed time hour/minute (2 hour and 20 minutes in the example illustrated in Figure 3) depending on the finish-in/at time function selected by operator. In accordance with one exemplary embodiment illustrated in Figures 2 and 3, finish course select part 8 may comprise at least a button 9 and at least a display 10, e.g. LED-display.

[0044] The button 9 may be configured to enable the user to set/vary/adjust the time value t_u associated with

the finish-in/at time function, whereas display 10 may be configured so as to be illuminated when operator pushes the button 9 and provides the time end value t_u . For example finish course select part 8 may be configured so that when operator presses the button 9, the end time value t_u is increased by steps of a prefixed interval, e.g. 1 hour until 10 hours, then from 10 to 20 hours in steps of 2 hour increments. Pressing button 9, while maximum time/duration (for example 20h) is displayed, may deactivate the finish in/at time function, and the display 10 may provide the nominal washing course duration t_n to operator. For example finish course select part 8 may be further configured so that operator can also make a long key press on the button 9 to increase rapidly the end time value t_u by hours.

[0045] Referring to the example illustrated in Figure 1, the control panel 6 is operatively connected with the control unit 5, and is configured to provide the control unit 5 with one or more signals comprising: the selected laundry washing course, the start command, information about the selected finish-in/at time function, and the end time value t_u of the selected finish-in/at time function.

[0046] The control unit 5 may be a controller, e.g. a microprocessor or any similar electric/electronic control unit, configured to control the laundry treating machine 1 to perform the selected laundry washing course.

[0047] In accordance with a preferred embodiment, the control unit 5 is advantageously configured to receive input signal/s from the control panel 6 and determines based on said signals: the laundry washing course to be performed, a starting time $t=t_0$ indicative of the hour, minutes at which the button 9 has pressed; the selected finish-in/at time function; and the end time value t_u .

[0048] In accordance with a preferred embodiment, the control unit 5 is further configured to determine the nominal operation duration t_n of the selected laundry washing course, for example memorized in the control unit 5 or in a memory unit (not illustrated) and determine a washing delay time Δt_s (i.e. how much time has to pass from the starting time t_0 to when the washing course has to be actually started in order to finish in/at the end time t_u , if the duration of the course is the nominal operation duration t_n) based on the nominal operation duration t_n , the end time value t_u , and the starting time $t=t_0$.

[0049] The washing delay time Δt_s may be determined, for example, in case of finish-at function activated, by calculating: the difference between the end time value t_u and the starting instant $t=t_0$ so as to determine a first interval $\Delta t_1=(t_u-t_0)$ (i.e. how much time has to pass from the starting time t_0 to the end time t_u) and the difference between determined first interval Δt_1 and the nominal operation duration t_n , e.g. $\Delta t_s=\Delta t_1-t_n$. The control unit 5 may be further advantageously configured to: measure time t as from the starting time $t=t_0$ by a real time clock or a timer (not illustrated for example a module comprised in the control unit 5), and start performing the laundry treating course when the time reaches the value $t=t_0+\Delta t_s$, e.g. when the washing delay time Δt_s is lapsed.

[0050] In accordance with an exemplary embodiment, the control unit 5 may be configured to activate a timer which measures the time as from the starting time $t=t_0$, and when the measured time reaches the value $t=t_0+\Delta t_s$, the control unit 5 command the laundry treating course to be started.

[0051] In accordance with a different exemplary embodiment, the control unit 5 may be configured to receive the current time by a real-time clock, calculate the time, e.g. hour, minute, that laundry treating course has to be started based on the starting time t_0 and the current time, and starts performing the laundry treating when the current time corresponds to the calculated time.

[0052] The control unit 5 is further configured to determine time information related to (e.g. indicative of) the actual phase duration $t_a(i)$ which a "i-th" monitored laundry treating phase (hereinafter indicated with index (i)) spent to be completed; and adjust/vary, with respect of its nominal phase duration $t_c(i+1)$, the duration of a laundry treating phase (hereinafter indicated with index $(i+1/n)$) to be performed following the monitored laundry treating phase (i), based on the determined time information, so that the laundry washing course is completed at/in the end time value t_u set by operator.

[0053] It should be underlined that in the present application when reference is made to *adjust*, *vary*, *extend* or *reduce* the duration of a phase/step, what is meant is adjusting, varying, extending or reducing the duration of the phase/step *with respect to its nominal value* $t_c(i+1)/t_p(i+1)$; for example, extending the duration of a laundry treating phase/step means extending the duration of the laundry treating phase/step with respect to its nominal value $t_c(i+1)/t_p(i+1)$, while reducing the duration of the laundry treating phase/step means reducing the duration of the laundry treating phase/step with respect to its nominal value $t_c(i+1)/t_p(i+1)$.

[0054] In accordance with a preferred embodiment, the control unit 5 may be configured to determine the phase time difference $\Delta t_c(i)$ between the actual phase duration $t_a(i)$ and the nominal phase duration $t_c(i)$ of the i-th monitored laundry treating phase i, and to compensate/adapt the duration of next laundry treating phase/s $(i+1/n)$ to be performed, based on the determined phase time difference $\Delta t_c(i)$.

[0055] In accordance with an exemplary embodiment, if the phase time difference $\Delta t_c(i)$ is positive, the control unit 5 may reduce the duration of the next laundry treating phase $(i+1)$ by the phase time difference $\Delta t_c(i)$. On the contrary, if the phase time difference $\Delta t_c(i)$ is negative, the control unit 5 may extend the duration of the next laundry treating phase $(i+1)$ by adding the calculated phase time difference $\Delta t_c(i)$ to nominal phase duration $t_c(i+1)$. For example, if the calculated actual phase duration $t_a(i)$ of the main wash phase is greater than the nominal phase duration $t_c(i)$ of the main wash phase, the phase time difference $\Delta t_c(i)$ is positive (meaning that the main wash phase has been completed according to its nominal duration), and the control unit 5 reduces the du-

ration of the first rinse cycle by the calculated phase time difference $\Delta tc(i)$.

[0056] It should in any case be understood that the present control method is not limited to compensate the duration of the laundry treating phases, but could be performed in the same way so as to compensate the duration of laundry treating ss. In fact, the control unit 5 may be configured to determine the step time difference $\Delta tp(i)$ between the actual step duration $ta(i)$ of the laundry treating phase (i) and its calculated nominal step duration $tp(i)$, and vary the duration of a laundry treating step of the laundry treating phase (i+1) following the monitored phase (i) based on the calculated step time difference $\Delta tp(i)$. For example, if the calculated actual step duration $ta(i)$ of the wetting phase of the main wash phase (i) is greater than its nominal step duration $tp(i)$, the step time difference $\Delta tp(i)$ is positive (meaning that the wetting step has been completed after its nominal value), the control unit 5 may reduce the duration of the water loading phase to be performed during the first rinse phase with respect to its nominal value $tp(i+1)$.

[0057] It should in any case be understood that control unit 5 may be configured to vary the duration of a laundry treating step (i) of the monitored phase based on the calculated phase time difference $\Delta tp(i)$. For example if the calculated actual step duration $ta(i)$ of the water loading step of the first rinse phase (i) is greater than its nominal phase duration $tp(i)$, the phase time difference $\Delta tp(i)$ is positive (meaning that the water loading step has been completed after the prefixed time), the control unit 5 may reduce the duration of the spin step to be performed during the first rinse phase (i).

[0058] In accordance with an advantageous embodiment, the control unit 5 may be configured to skip (no performing) a next laundry treating step (i+1) (following the monitored step (i)) or a next laundry treating phase (i+1) (following the monitored /phase (i)), if the step time difference $\Delta tp(i)$ or respectively phase time difference $\Delta tc(i)$ is positive. For example if the calculated actual step duration $ta(i)$ of the water loading step in the first rinse phase (i) is greater than its relative nominal phase duration $tp(i)$, the step time difference $\Delta tp(i)$ is positive (meaning that the water loading step has been completed after the prefixed time), the control unit 5 do not perform one rinse phase following the main wash phase.

[0059] In accordance with an advantageous embodiment, the control unit 5 may be configured to add to the laundry washing course a prefixed laundry treating phase or prefixed laundry treating step having preferably a duration equal to the phase time difference $\Delta tc(i)$ or the step time difference $\Delta tp(i)$, whether the time difference $\Delta tc(i)$ or respectively the step time difference $\Delta tp(i)$ are negative. For example if the calculated actual step time $ta(i)$ of the water loading step of the first rinse phase (i) is lower than its nominal step duration $tp(i)$, the time step difference $\Delta tp(i)$ is negative (meaning that the water loading step has completed ahead its prefixed time), the control unit 5 may add a rinse phase to the laundry washing

course having a duration of the calculated phase time difference $\Delta tp(i)$.

[0060] Figure 4 illustrates a flow chart of operations performed by the washing machine 1 according to a first embodiment of the control method.

[0061] Referring to Figure 4, in step 100, control unit 5 receives from the washing course select part 7, the laundry washing course selected by operator, and determines the nominal operation time t_n based on the selected course.

[0062] In step 110, control unit 5 receives information from the finish course select part 8, which are indicative of the finish-in or finish-at function to be performed, and the time value t_u selected by operator. To the aim of simplifying the present description, without however limiting its scope, in the following example it will be considered that operator has selected finish-at function.

[0063] In step 120, control unit 5 receives the start command provided by operator via the button 9, determines/set the starting time $t=t_0$ by the real time clock or the timer, on the basis of the received start command, and determine the delay time Δts based on the pre-set nominal operation time t_n , the time value t_u of the finish-at time function, and the starting time t_0 .

[0064] For example, if the nominal operation time $t_n=5$ hours, the starting time provided by the real-time clock is $t_0=13.00$, and the time value $t_u=20.00$, then the delay time Δts is 2 h and may be calculated by the following equation:

$$\Delta ts = (t_u - t_0) - t_n = (20.00 - 13.00) - 5.00 = 2 \text{ h.}$$

[0065] In the step 140, the control unit 5 uses the real time clock or the timer to measures actual time t as from the starting time t_0 , and after washing delay time Δts is past, e.g. $t=t_0+\Delta ts$, it starts performing the laundry treating phases, i.e. the main wash phase (step 150) and set a counter $i=1$ wherein 1 indicates the index one associated with the first treating phase.

[0066] In step 160, the control unit 5 determines both the nominal phase duration $tc(i)$ of the laundry treating washing phase which is performing, the actual phase duration $ta(i)$ required to complete the laundry treating washing phase. In other words in step 160 the control unit 5 calculate/measure by the real time clock or the timer the actual phase duration time $ta(i)$ of the main washing phase.

[0067] In step 170, the control unit 5 calculates the phase time difference $\Delta tc(i)$ between the actual duration $ta(i)$ of the monitored phase and the nominal phase duration $tc(i)$ thereof.

[0068] In step 180, the control unit 5 checks whether the phase time difference $\Delta tc(i)$ is zero, and if the phase time difference $\Delta tc(i)$ is different of zero (output Yes from step 180), control unit 5 adjusts/varies with respect to its nominal phase duration $tc(i+1)$, the duration of the next

laundry treating washing phase (i+1) to be performed based on the phase time difference $\Delta tc(i)$. As above disclosed, the cycle duration $tc(i+1)$ of the laundry treating washing phase (i+1) following the monitored phase may be adjusted so as to compensate the calculated phase time difference $\Delta tc(i)$.

[0069] On the contrary, if the phase time difference $\Delta tc(i)$ is zero (output No from step 180) the control unit 5 may preferably increment the counter $i=i+1$ (step 190) and if the last phase (k) has not been performed (step 210), it starts performing the next laundry treating phase (i+1) and re-performs the steps from 160 to 210.

[0070] It should be understood that, as above disclosed, in step 180, the control unit 5 could selectively skip the next laundry treating phase (i+1) or add a laundry treating phase (i+1) to the course, based on the phase time difference $\Delta tc(i)$. It should be further understood that the control method is not limited to the laundry treating phases but it may compensate, with respect to its nominal value, the duration of laundry treating steps in the same manner as the laundry treating phases.

[0071] In the example illustrated in Figure 7 the control unit 5 monitors the first washing phase corresponding to the main wash phase. In detail, in the example of Figure 7 the actual duration $ta(1)$ of the main wash phase is greater than its nominal phase duration $tc(i)$. Therefore control unit 5 may reduce the duration of the second wash phase corresponding to the first rinse phase illustrated with $tec(2)$ by the phase time difference $\Delta tc(1) = ta(1) - tc(1)$.

[0072] Figure 5 relates to a flow chart of a second embodiment of the control method of laundry treating machine 1 which is similar to the first embodiment illustrated in Figure 4, wherein the steps will be numbered, as much as possible, with the same numbers indicating of corresponding steps of the first embodiment. More specifically the steps of the second embodiment of the method differ from the step of the first embodiment in that, during the performing of the laundry washing course, the control method measures the actual phase duration $ta(i)$; calculates/estimates an actual course remaining time $tte(i)$, i.e. the actual time required to end the course based on the difference between the nominal course duration tn and the measured actual phase duration $ta(i)$; determines a theoretical remaining duration/time $tth(i)$; compare the actual remaining time $tte(i)$ with the theoretical remaining time $tth(i)$, and varies the duration of a next washing phase (i+1) to be performed based on the results of comparison.

[0073] During the steps 100-140 control unit 5 performs the same operations disclosed in the first embodiment and therefore will not be further disclosed.

[0074] In the step 150, the control unit 5 starts performing the first treating phase, i.e. the main wash phase and, at the same time, measure the actual phase time $ta(i)$ (wherein $i=1$) (step 160) based on the current time provided by the real time clock or the measured time provided by the timer.

[0075] In step 300, the control unit 5 determines actual course remaining time $tte(i)$. The actual course remaining time $tte(i)$ is the real time required to complete all the washing phase (from $i+1$ to k being index of last cycle) of the laundry washing course in order to finish the latter according to the end time value tu set by operator. Actual course remaining time $tte(i)$ is calculated by calculating the difference between the nominal operation duration and the actual phase duration $ta(i)$.

[0076] In step 310, the control unit 5 determines a theoretical course remaining time $tth(i)$. The theoretical course remaining time $tth(i)$ is a calculated theoretical time remaining to end the course so as to satisfy the end time value tu set by the operator.

[0077] In step 330, the control unit 5 compares the actual course remaining time $tte(i)$ with the theoretical course remaining time $tth(i)$.

[0078] In accordance with an embodiment, if the actual course remaining time $tte(i)$ is greater than theoretical course remaining time $tth(i)$ ($tth < tte$; Yes output from step 330), the control unit 5 may extend the duration of the next washing phase (i+1) (step 340) by a value/time that compensates the ahead of the end of the washing phase that machine 1 has just performed.

[0079] In accordance with an exemplary embodiment, the duration of the following phase (i+1) to be performed may be extended by the difference between the actual course remaining time $tte(i)$ and the theoretical course remaining time tth .

[0080] It should be understood that the present invention is not limited to this type of control. In fact, in accordance with a different possible embodiments, control unit 5 may extend the duration of the next laundry treating phase (i+1) or of a laundry treating step comprised in the next washing phase (i+1) to be performed, or may perform the next washing phase/step (i+1) without varying its duration (which in this case corresponds to the nominal phase/step time), or could perform an additional washing treating phase/step having a prefixed duration calculated to compensate the actual course remaining time $tte(i)$ in order to finish the course at the end time value tu .

[0081] On the contrary, if the actual course remaining time $tte(i)$ is lower than theoretical course remaining time $tth(i)$ ($tth < tte$; Not output from step 330), the control unit 5 may reduce the duration of the next washing phase/step.

[0082] In accordance with an embodiment, if the actual course remaining time $tte(i)$ is lower than theoretical course remaining time $tth(i)$ (Yes output from step 350), the control unit 5 may reduce the duration of the next washing phase (step 360) by a value that compensates the delay of the end of the washing cycle (i) that machine 1 has just performed.

[0083] In accordance with an exemplary embodiment, the duration of the next phase to be performed may be reduced by the difference between the actual course remaining time $tte(i)$ and the theoretical course remaining time $tth(i)$. It should be understood that the present in-

vention is not limited to this type of control. In fact, in accordance with different possible embodiments, control unit 5 may reduce the duration of a prefixed washing step comprised in the next washing phase (i+1) to be performed, or could skip the next washing phase (i+1), or could skip one or more prefixed washing steps of the next washing phase (i+1/n).

[0084] After performing the steps from 300 to 360, the control unit 5 performs the step 200, 210 disclosed above so as to continue to perform the following laundry washing phase i+1 until i=k.

[0085] Figure 6 relates to a flow chart of a third embodiment of the control method of laundry treating machine 1 which is similar to the first embodiment illustrated in Figure 4, wherein the steps will be numbered, as much as possible, with the same numbers indicating of corresponding steps of the first embodiment. More specifically, the steps of the third embodiment of the method differ from the first embodiment in the fact that, during a spin phase of a washing cycle, the control unit 5 determines time information related to (e.g. indicative of) the actual duration $ta(i)$ spent during the performed unbalance detection/correction phase-part/s.

[0086] During the steps 100-140, control unit 5 performs the same operation disclosed to explain the first embodiment that therefore will not be further disclosed.

[0087] In the step 400, the control unit 5 starts performing the first treating phase, i.e. the main washing phase. When during the laundry treating course, the control unit 5 performs the spin phase (output Yes step 410), it determines time information indicative of the actual duration $ta(i)$ of the unbalance detection/correction phase-part/s.

[0088] In accordance with an embodiment, the control unit 5 may be configured to: determine the actual duration $ta(i)$, i.e. the time spent to perform the unbalance detection/correction phase, calculate a time difference $Dts(i)$ between the determined actual duration $ta(i)$ and a nominal duration $tc(i)$ indicative of the nominal time to perform the unbalance detection/correction phase, and modify, with respect to its nominal value, the duration of a rinse phase following said spin phase (step 430).

[0089] In accordance with an exemplary embodiment, the control unit 5 may determine the actual duration $ta(i)$ based on the number of correction attempts that machine 1 performed to start spinning operation, wherein the duration of each correction attempt is prefixed.

[0090] In accordance with an exemplary embodiment, if the time difference $Dts(i)$ is positive, control unit 5 determines that the time of unbalance detection/correction phase has to be compensated and may reduce the duration of the next rinse phase (i+1).

[0091] On the contrary if the time difference $Dts(i)$ is negative, control unit 5 determines that the time of unbalance detection/correction phase has to be compensated and may extend duration of the next rinse phase (i+1).

[0092] It has thus been shown that the present invention allows all the set objects to be achieved. In particular,

the present invention is able to complete a washing course exactly at the finish-in or finish-at time set by the user, regardless of a spin time and/or a water supply time.

[0093] While the present invention has been described with reference to the particular embodiments shown in the figures, it should be noted that the present invention is not limited to the specific embodiments illustrated and described herein; on the contrary, further variants of the embodiments described herein fall within the scope of the present invention, which is defined in the claims.

Claims

1. Laundry treating machine (1) comprising:

- an outer casing (2),
- a rotatable drum (3), which is arranged in axially rotating manner inside the outer casing (2) and is structured to receive the laundry to be treated,
- a laundry treating course select unit (7) provided for an operator to select a laundry treating course to be performed; said laundry treating course having a nominal total course duration (tn), and comprising a plurality of laundry treating phases/steps, each having a nominal duration ($tc(i)$, $tp(i)$),
- a time input unit (8) provided for an operator to input an end-time value (tu), which is indicative of a time at which, or in which, the laundry treating course has to be ended,
- a start input unit (9) provided for an operator to input a course start command, the laundry treating machine comprising a controller (5) configured to:
- automatically start performing a selected laundry treating course based on a inputted course start command and an inputted end-time value (tu),

said laundry treating machine (1) being **characterized in that** said controller (5) is configured to:

- during the execution of said laundry treating course, determine a treating phase/step time information which is related to actual duration ($ta(i)$) of at least one monitored laundry treating phase/step (i),
- vary, with respect to its nominal value ($tc(i+1)$, $tp(i+1)$), the duration of one or more laundry treating phases/steps (i+1) to be performed following said at least one monitored laundry treating phase/step (i), based on said determined treating phases/steps time information, in such a way to cause said laundry treating course to end at/in said end-time value (tu) set by operator.

2. Laundry treating machine according to claim 1, wherein said controller (5) is further configured to:

- calculate the time difference (Δt , Δt_p) between the actual duration ($t_a(i)$) of a monitored laundry treating phase/step, determined during a laundry treating course, and its nominal duration ($t_c(i)$, $t_p(i)$), and
 - adjust, with respect to its nominal value ($t_c(i+1)$, $t_p(i+1)$), the duration ($i+1$) of at least a laundry treating phase/step to be performed following said monitored laundry treating phase/step(i), based on said calculated time difference (Δt , Δt_p).

3. Laundry treating machine according to claims 1 or 2, wherein said controller (5) is further configured to reduce, with respect to its nominal value ($t_c(i+1)$, $t_p(i+1)$), the duration of a laundry treating phase/step ($i+1$) to be performed following a monitored laundry treating phase/step (i), if the determined actual duration ($t_a(i)$) of said monitored laundry treating phase/step (i) is greater than the nominal duration ($t_c(i)$, $t_p(i)$) of said monitored laundry treating phase/step (i).

4. Laundry treating machine according to one or more of the previous claims, wherein said controller (5) is further configured to skip at least a laundry treating phase/step ($i+1$) to be performed following a monitored laundry treating phase (i), if the determined actual duration ($t_a(i)$) of said monitored laundry treating phase/step (i) is greater than the nominal duration ($t_c(i)$, $t_p(i)$) of said monitored laundry treating phase/step (i).

5. Laundry treating machine according to any of the previous claims, wherein said controller (5) is further configured to extend, with respect to its nominal value ($t_c(i+1)$, $t_p(i+1)$), the duration of a laundry treating phase/step ($i+1$) to be performed following a monitored laundry treating phase/step (i), if the determined actual duration ($t_a(i)$) of said monitored laundry treating phase/step (i) is lower than the nominal duration ($t_c(i)$, $t_p(i)$) of said monitored laundry treating phase/step (i).

6. Laundry treating machine according to claim 5, wherein, the extension of said duration of said laundry treating phase/step ($i+1$) to be performed following said monitored laundry treating phase (i) corresponds to the difference between said nominal duration ($t_c(i)$, $t_p(i)$) and said monitored actual duration ($t_a(i)$) of said monitored laundry treating phase (i).

7. Laundry treating machine according to any of the previous claims, wherein said controller (5) is further configured to add to a laundry treating course a pre-

fixed laundry treating phase/step to be performed, if the determined actual duration ($t_a(i)$) of a laundry treating phase/step (i) monitored during said laundry treating course is lower than the nominal duration ($t_c(i)$, $t_p(i)$) of said monitored laundry treating phase/step (i).

8. Laundry treating machine according to claim 1, wherein said controller (5) is further configured to:

- calculate the difference between a pre-set nominal total course duration (t_n) and the actual duration ($t_a(i)$) of a monitored laundry treating phase/step (i) so as to determine an actual course remaining time ($t_{te}(i)$) indicating the remaining time required to perform the laundry treating phases/steps (i) following said laundry treating phase/step (i) in order to complete the course,
 - determine a theoretical course remaining time ($t_{th}(i)$),
 - compare the actual course remaining time ($t_{te}(i)$) with said theoretical course remaining time ($t_{th}(i)$),
 - adjust, with respect to its nominal value ($t_c(i+1)$, $t_p(i+1)$), the duration of at least a laundry treating phase/step ($i+1$) following said monitored laundry treating phase (i) based on results of said comparison.

9. Laundry treating machine according to claim 8, wherein said controller (5) is further configured to

- calculate the time difference (Δt , Δt_p) between the determined actual course remaining time ($t_{te}(i)$) and said theoretical course remaining time ($t_{th}(i)$); and
 - adjust, with respect to its nominal duration ($t_c(i+1)$, $t_p(i+1)$), the duration of a laundry treating phase/step ($i+1$) following the monitored laundry treating phase (i) so as to compensate said calculated time difference.

10. Laundry treating machine according to any of the previous claims, wherein said controller (5) is further configured to:

- determine treating phases time information which is indicative of actual time ($t_a(i)$) which a unbalance detection/correction operation/s of a spin phase spent to be completed,
 - vary, with respect to its nominal duration, the duration of one or more rinse phases following said spin phase, based on determined time information to cause the course to end at/in said end-time value (t_u) set by operator.

11. Laundry treating machine according to claim 10,

wherein said controller (5) is further configured to:

- calculate the time difference between the determined actual duration ($ta(i)$) of said unbalance detection/correction operation/s of a spin phase and a prefixed nominal duration ($tc(i+1)$, $tp(i+1)$) of unbalance detection/correction operation/s of a spin phase; and
- adjust, with respect to its nominal value ($tc(i+1)$, $tp(i+1)$), the duration of a rinse phase following said spin phase based on said calculated time difference.

12. Control method of a laundry treating machine (1) comprising:

- an outer casing (2),
- a rotatable drum (3) which is arranged in axially rotating manner inside the outer casing (2) and is structured to receive the laundry to be treated,
- a laundry treating course select unit (7) provided for an operator to select a laundry treating course to be performed, said laundry treating course having a nominal total course time (tn) and comprising a plurality of laundry treating phases/steps, each having a nominal duration ($tc(i)$, $tp(i)$),
- a time input unit (8) provided for an operator to input an end-time value (tu), which is indicative of a time at which, or in which, the laundry treating course has to be ended,
- a start input unit (9) provided for an operator to input a course start command, the method comprising:
- automatically starting performing a selected laundry treating course based on an inputted course start command and an inputted end-time value (tu),

said method being **characterized by** comprising the following steps:

- during said laundry treating course, determining a treating phase/step time information which is related to actual duration ($ta(i)$) of at least one monitored laundry treating phase/step (i),
- varying, with respect to its nominal duration ($tc(i+1)$, $tp(i+1)$), the duration of one or more laundry treating phases/steps (i+1) to be performed following said at least one monitored laundry treating phase/steps (i), based on said determined treating phase/step time information, in such a way to cause said laundry treating course to end at/in said end-time value (tu) set by operator.

13. Control method according to claim 12, comprising:

- calculating a time difference (Δct , Δpt) between the actual duration ($ta(i)$) of the monitored laundry treating phase/step determined during said laundry treating course, and a prefixed nominal duration ($tc(i)$, $tp(i)$) of said monitored laundry treating phase/step, and
- adjusting, with respect to its nominal value ($tc(i+1)$, $tp(i+1)$), the duration of at least a laundry treating phase/step (i+1) to be performed following said monitored laundry treating phase/step (i), based on said calculated time difference (Δct , Δpt).

14. Control method according to claims 12 or 13, comprising reducing or extending, with respect to its nominal value ($tc(i+1)$, $tp(i+1)$), the duration of a laundry treating phase/step to be performed following a monitored laundry treating phase/step (i), if the determined actual duration ($ta(i)$) of said monitored laundry treating phase/step (i) is greater or respectively lower than the nominal duration ($tc(i)$, $tp(i)$) of said monitored laundry treating phase/step (i).

15. Control method according to any of the previous claims from 12 to 14, comprising skipping or adding at least a laundry treating phase/step (i+1) to be performed following a monitored laundry treating phase (i), if the determined actual duration ($ta(i)$) of said monitored laundry treating phase/step (i) is greater or respectively lower than the nominal duration ($tc(i)$, $tp(i)$) of said monitored laundry treating phase/step (i).

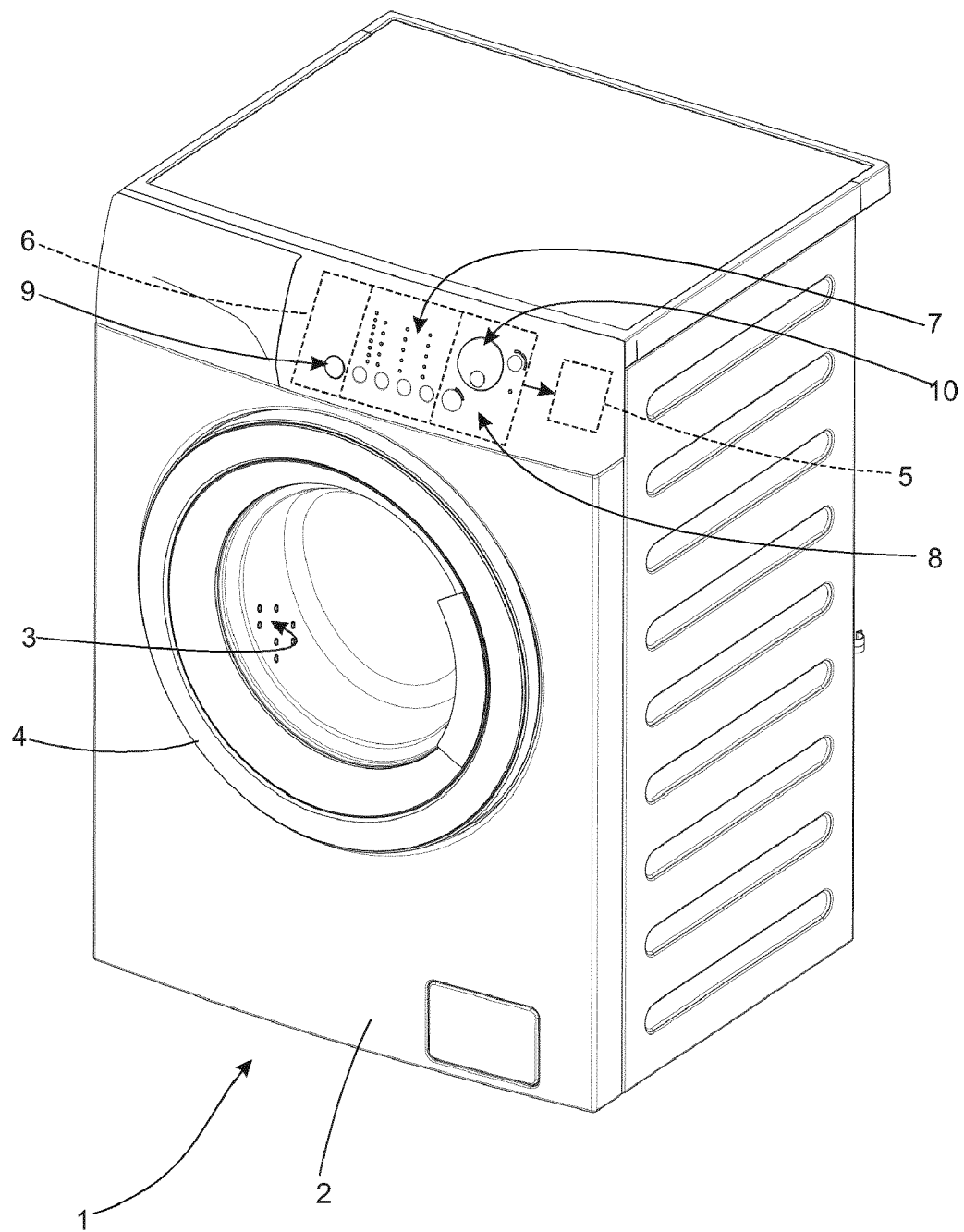


Fig. 1

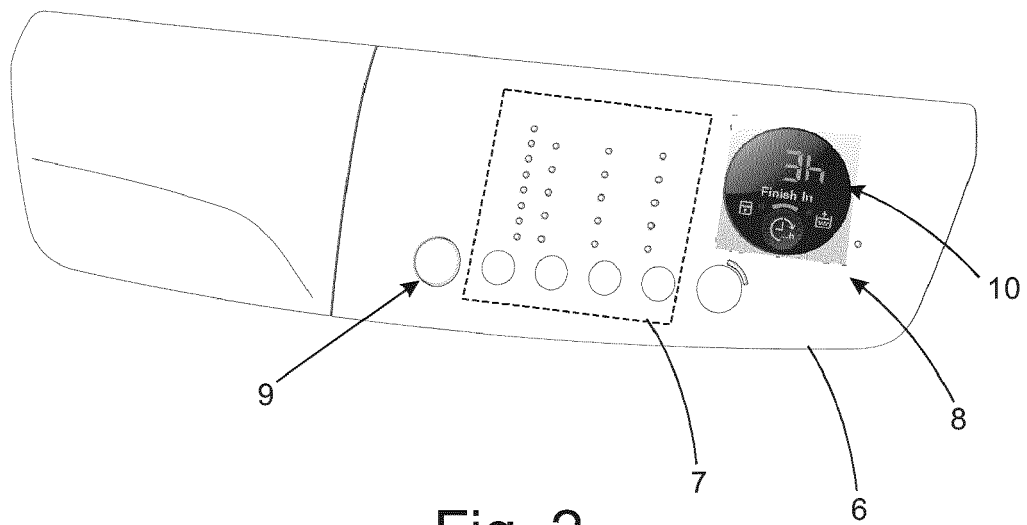


Fig. 2

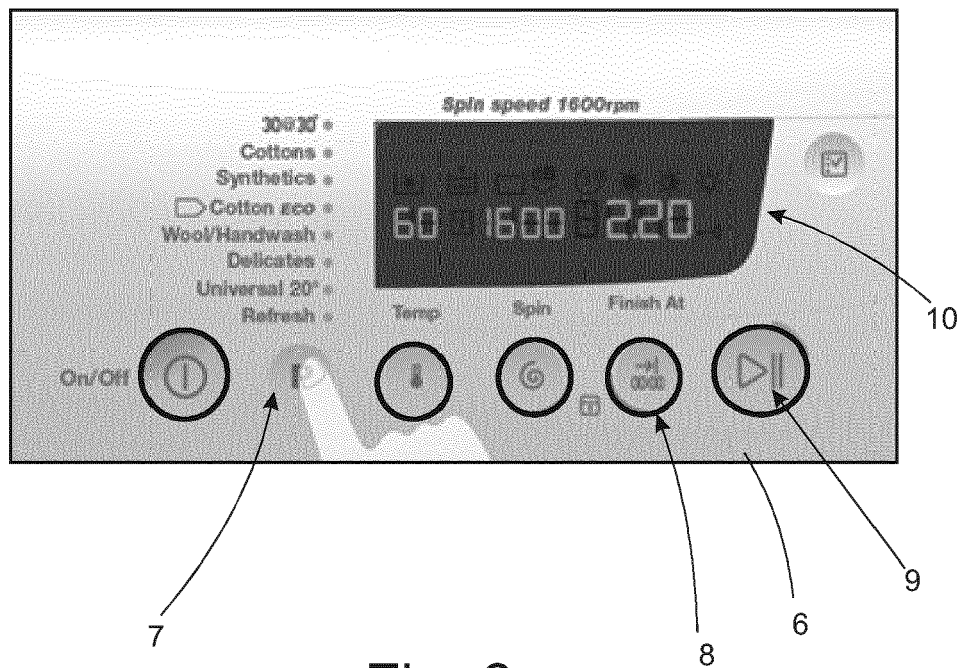


Fig. 3

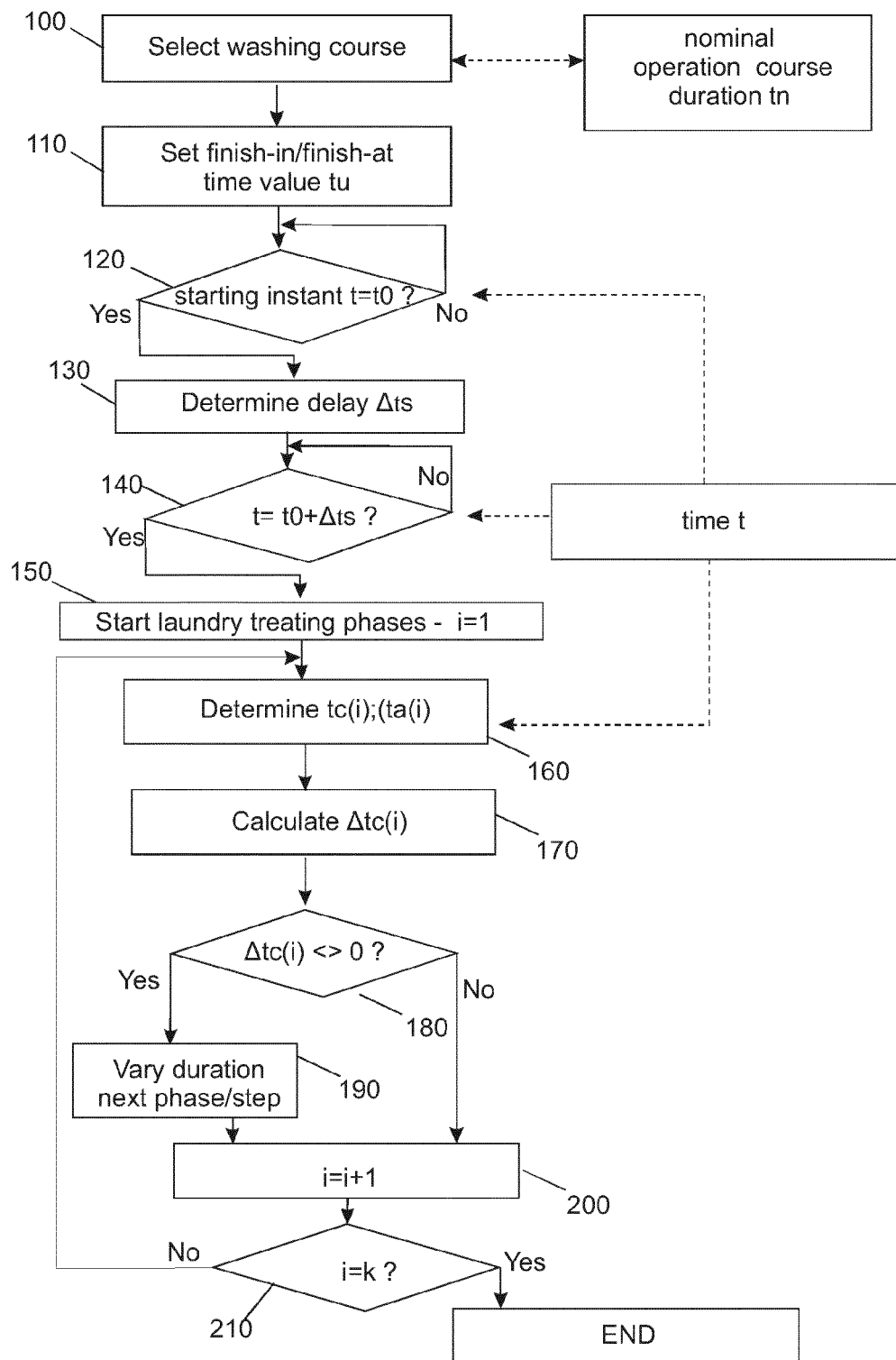
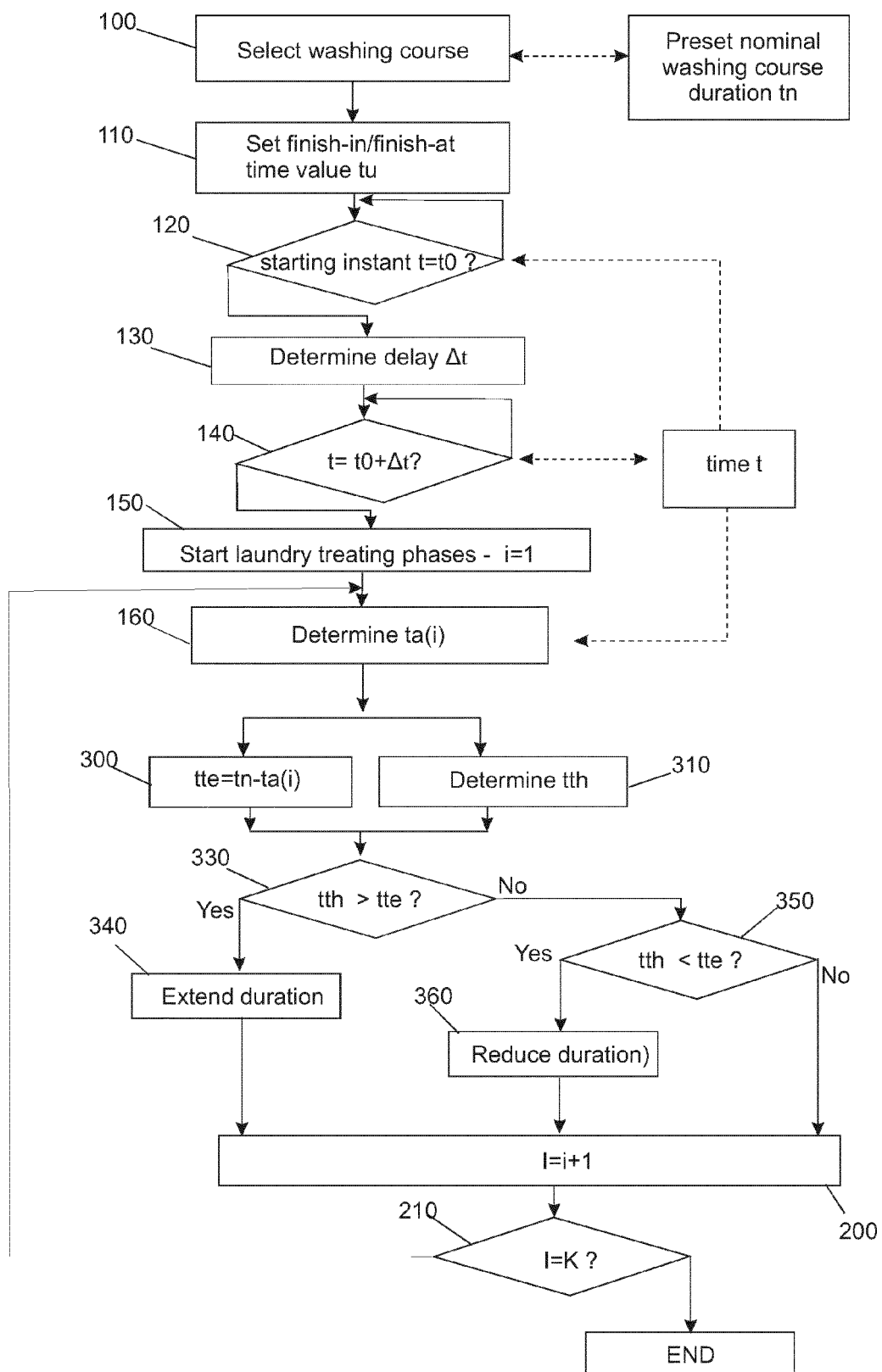


Fig. 4



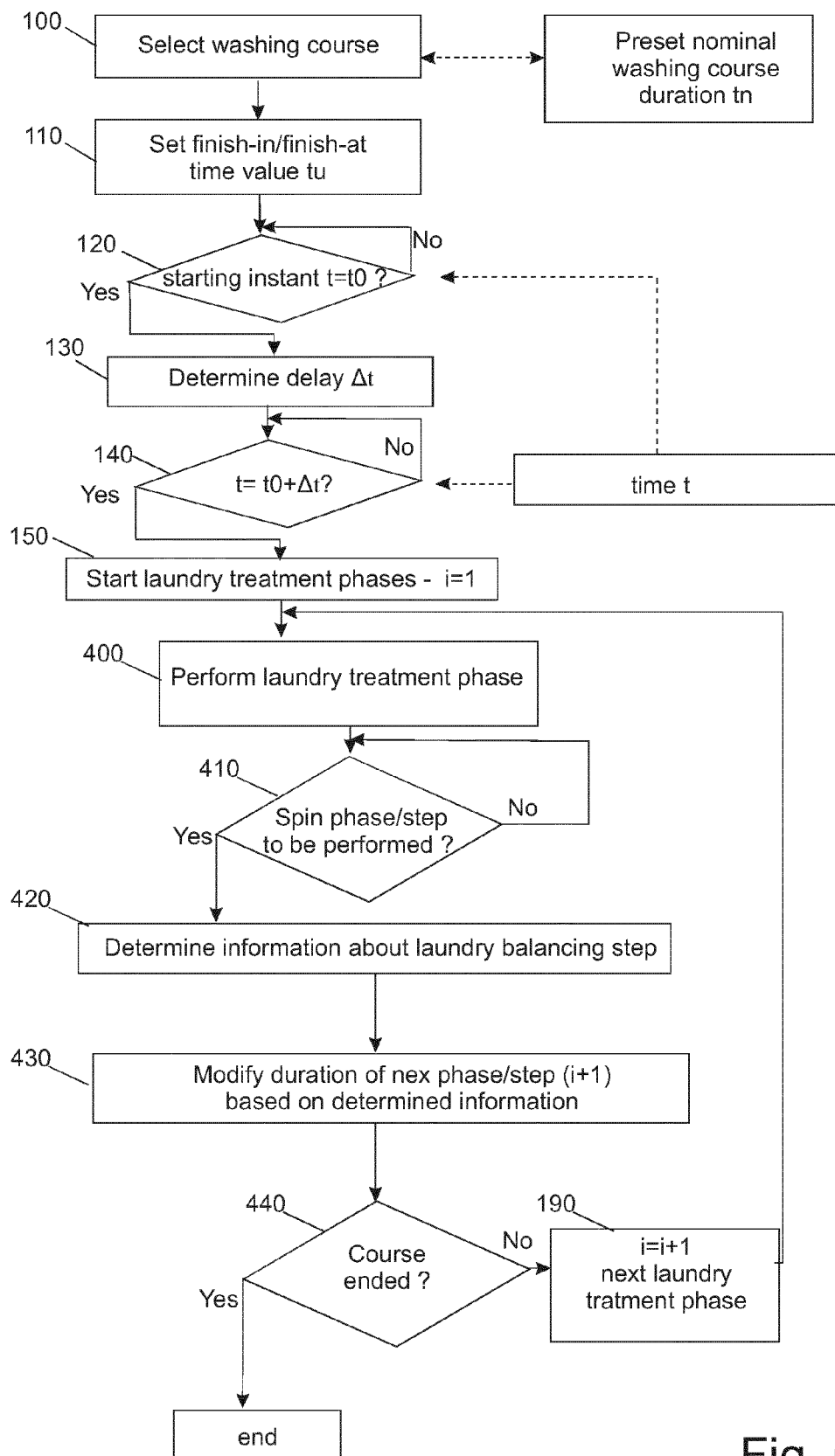


Fig. 6

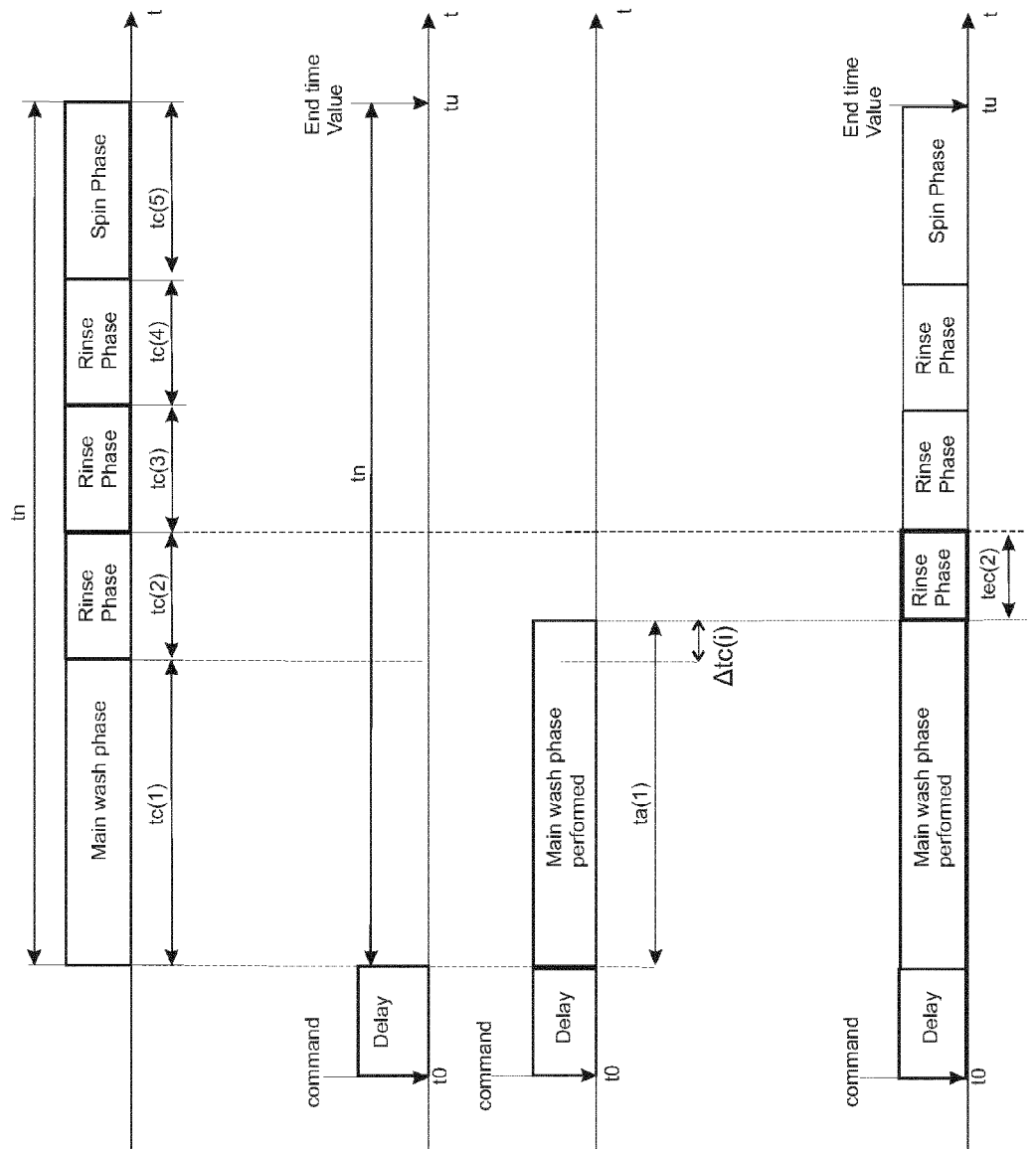


Fig. 7



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Application Number
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Place of search Munich		Date of completion of the search 7 April 2014	Examiner Engelhardt, Helmut
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