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(54) **Method for controlling a laundry washing machine and laundry washing machine**

(57) The present invention relates to a method for controlling a laundry washing machine (1) comprising: a casing (2), a washing tub (3) arranged within said casing (2), a rotatable laundry drum (4) which is mounted inside the washing tub (3) and is designed to contain laundry (10), a water-detergent supply system (5,6) supplying wash water and detergent into the washing tub/drum, and a water draining system (16) discharging wash water from the washing tub (3). The method performing the steps of: loading water and detergent in the washing tub (3), rotating the drum (4) at a preset high speed (ωss') in a first rotational direction in order to perform at least one first intermediate spin, reducing the speed of the drum (4) at a wash speed which than said high speed (ωss'), and rotating the drum at a preset high speed (ωss") in a second rotational direction, opposite to the first rotational direction in order to perform at least a second intermediate spin which generates a liquid flux removing detergent settled in the water draining system,

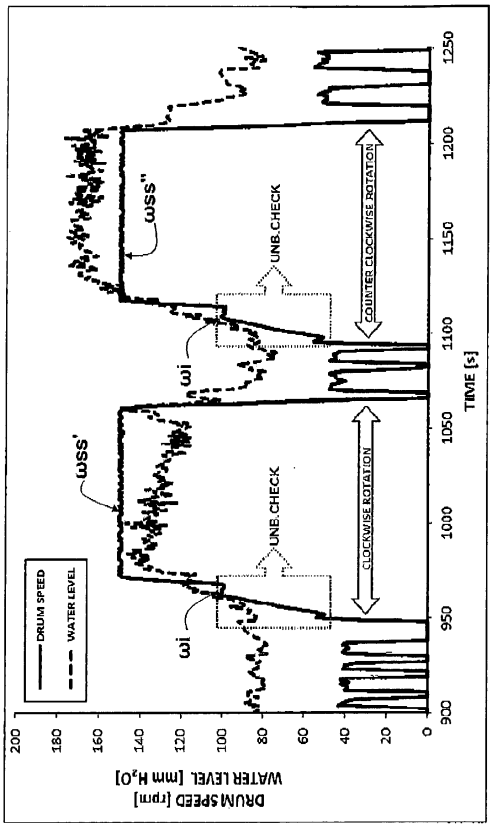

Fig. 4

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Description

[0001] The present invention concerns the field of laundry washing techniques.

[0002] In particular, the present invention refers to a method for controlling a laundry washing machine, which is configured to dissolve and recover a detergent gathered in a drainage duct of the laundry washing machine, and to a laundry washing machine implementing this method.

BACKGROUND ART

[0003] Nowadays the use of laundry washing machines, both "simple" laundry washing machines (i.e. laundry washing machines which can only wash and rinse laundry) and laundry washing and drying machines (i.e. laundry washing machines which can also dry laundry), is widespread.

[0004] In the present description the term "laundry washing machine" will refer to both simple laundry washing machines and laundry washing and drying machines.

[0005] In addition, in the present description when reference is made to "water", the term "water" may denote water as such, washing water, washing liquid, washing liquor or the like.

[0006] Laundry washing machines generally comprise an external casing provided with a washing tub which comprises a rotatable perforated drum where the laundry is placed, an electric motor which rotates the drum in the washing tub, a water-detergent supply system which supplies wash water and/or detergent into the washing tub/drum, and a water draining system which discharges/drains wash water from the washing tub.

[0007] The draining system typically comprise a drainage duct the mouth (or inlet) of which is defined in the bottom of the washing tub, and a drainage pump which is configured to drain the wash water from the washing tub into the drainage duct.

[0008] A typical laundry washing operation includes placing laundry to be washed within the drum. Thereafter, water and detergent are added by the supplying system into the washing tub to form a cleaning solution. The laundry is then subjected to various sequential phases such as: a main wash phase, a rinse phase, and a final spin phase. When the supply system fills the wash tub, a substantial portion of detergent (in particular when using powder detergent) tends to deposit inside the inlet of the drainage duct and therefore remains practically unused during the wash phases. In other words, the detergent introduced at the start of wash phase, drops directly through the drainage duct as detergent aggregates before it is completely dissolved in the water in washing tub. This causes the detergent to be gathered/settled into the drain space and then to be discharged without fulfilling its cleaning functions.

[0009] For overcoming this problem, some types of laundry washing machines are provided with hydraulic valve organs, like so called "OKO-balls" (i.e. valves having a floating ball acting as closure element) or membranes, which are arranged on the inlet of the drainage duct and are structured to close the inlet of the drainage duct when liquid is supplied to the tub.

[0010] However in these machines the hydraulic valve organs, in addition to increase the production costs, require a certain space to be placed, increasing the overall dimension of the machine and/or requiring a complex positioning of the other components of the machine (which makes the assembly of the machine more complex) in order to obtain enough free space for their positioning. Moreover the hydraulic valve organs may easily be clogged, requiring periodical maintenance.

[0011] On the other hand, other types of laundry washing machines are provided with a recirculation circuit so that water and detergent deposited in the drainage duct are removed and used in the wash phase.

[0012] However, in such a washing machine arrangements, either an additional recirculation pump (increasing the production costs of the machine) and/or complicated and expensive valves (to enable the recirculation pump to perform both recirculation and draining operations) must be employed. In this case, moreover, the presence of a greater number of additional components increases the maintenance costs of the machine, and the possibilities of breakdowns are increased.

[0013] US 6,557,199 discloses a mixing system for laundry washing machine which is configured to mix the detergent into a wash solution during an initial portion of the main wash phase. The system performs an intermediate spin in the wash phase wherein the drum is rotated at a high speed for the purpose of mixing and distributing the detergent in the wash solution. In detail, this additional step occurs shortly after the washing machine has been filled with water for the programmed wash phase. The time and drum speed associated with this additional step is established to provide sufficient mixing, while avoiding the development of excessive suds. More specifically, the drum is rotated at 70 RPM (rounds per minute) for approximately 9 seconds at about 3 minutes after the fill portion of the wash phase is completed.

[0014] Although efficient, the detergent mixing system disclosed in US 6,557,199 is not able to completely dissolve the detergent in water draining system provided with a draining sump arranged in the tub bottom, in particular when the sump has substantially a rectangular shape. Tests carried out by the applicant demonstrate that water turbulence generated inside a substantially parallelepiped shaped draining sump by rotating drum at 70 RPM in one rotational direction allows to only partially remove the detergent from only one inner side/angle of the sump, namely the side/angle of the sump that water strikes during the rotation of the drum, but the opposite side/angle of the sump remains partially filled with the gathered detergent, which, as a consequence, is not used during the wash phase.

[0015] The applicant conducted an in-depth study with

the objective of identifying a solution which specifically allows to:

- increase the dissolution of detergent depositing in the drainage duct of a laundry washing machine;
- ensure the complete removal of all the detergent gathered in the sump;
- obtain an efficient exploitation of the detergent during the wash phase, without however increasing the production cost of the machine.

[0016] It is thus the object of the present invention to provide a solution which allows achieving the objectives indicated above.

DISCLOSURE OF INVENTION

[0017] Applicant has found that by rotating the drum, after loading water and detergent in the washing tub, at a first and a second intermediate spins having both high rotational speeds, but different rotational directions, substantially all the detergent settled in the water draining system is effectively removed, even if the water draining system comprises, at its inlet, for example, a substantially parallelepiped shaped draining sump, since the water fluxes generated by the two spins, having opposite rotational directions, guarantee effectively removing the detergent settled in both the sides/angles of the sump.

[0018] In addition to removing the detergent settled in the sump, the first and second intermediate spins having opposite rotational directions generate a high turbulence in the washing liquid, which enhances (or favours) the melting of the detergent in the water.

[0019] According to the present invention, there is provided a method for controlling a laundry washing machine comprising: a casing, a washing tub arranged within the casing, a rotatable laundry drum which is mounted inside the washing tub and is designed to contain laundry, a water-detergent supply system designed to supply wash water and detergent into the washing tub and a water draining system designed to discharge wash water from the washing tub

[0020] During a main wash phase, the method performs the steps of:

- loading water and detergent in the washing tub;
- rotating the drum at a preset high speed in a first rotational direction in order to perform at least one first intermediate spin;
- reducing the speed of the drum at a wash speed lower than the high speed.

[0021] The method is characterised by performing, during the main wash phase, the steps of:

- rotating the drum at a preset high speed in a second rotational direction, opposite to the first rotational direction in order to perform at least a second intermediate spin which generates a liquid flux removing detergent settled in said water draining system.

[0022] Advantageously the second intermediate spin is performed after the first intermediate spin.

[0023] Clearly, above mentioned wash speed lower than the high speed could be also zero (i.e. the drum may be still between the first and second intermediate spins).

[0024] Clearly, the speed at which the first intermediate spin is performed may be equal to or different from the speed at which the second intermediate spin is performed. Advantageously, the speed at which the first intermediate spin is performed and the speed at which the second intermediate spin is performed, being these speeds equal or different one another, are advantageously both at least as high as (and preferably higher than) the speed at which, due to the rotation of the drum, a continuous liquid ring (i.e. a substantially ring-shaped flux of liquid rotating along the inner circumferential surface of the tub) is formed, circulating along the inner circumferential surface of the tub. Test performed by applicant have shown that a rotating speed of around 100-150 RPM is enough for ensuring the formation of such a continuous liquid ring, practically independently on the dimensions of the diameter of the drum.

[0025] Advantageously, the speed at which the first intermediate spin is performed and the speed at which the second intermediate spin is performed, being these speeds equal or different one another, are advantageously both at least as high as (and preferably higher than) the speed at which the laundry, due to the centrifugal force, is substantially completely stuck (or fixed) to the lateral walls of the drum. Test performed by applicant have shown that the minimum speed at which the laundry, due to the centrifugal force, is substantially completely stuck (or fixed) to the lateral walls of the drum, depends on the diameter of the drum, and that a speed of around 100 RPM is enough for almost all the diameters currently in the market (i.e. comprised between 400 and 550 mm).

Preferably the method comprises:

- checking whether the laundry in the drum is unbalanced, before performing the first intermediate spin;
- performing the first intermediate spin based on (i.e. depending on) the previous checked unbalanced laundry condition.

[0026] This is particularly advantageous, since, being in this phase the laundry wetted, i.e. full of washing liquid, and therefore quite heavy, performing the first intermediate spin with unbalanced laundry would generate high vibrations of the machine.

[0027] Preferably, the method comprises the steps of:

- skipping the first intermediate spin phase when an unbalanced laundry condition is consecutively determined a preset number of times.

[0028] Preferably the method comprises:

- checking whether the laundry in the drum is unbalanced before performing the second intermediate spin;
- performing the second intermediate spin based on the checked unbalanced laundry condition.

[0029] Preferably the method comprises the steps of:

- skipping the second intermediate spin when an unbalanced laundry condition is consecutively determined a preset number of times.

[0030] Preferably the high speed is comprised between about 100 and 400 RPM. This range is particularly advantageous, since tests carried out by the applicant have proved that with lower speeds there is the risk that the kinetic energy of the flux of liquid generated by the drum rotation and moving on the internal surface of the tub is not high enough for striking the detergent settled in the sump with a power high enough for ensuring the complete removal of this detergent, while higher speeds have the risk of generating high vibrations, and therefore high noise, and moreover increase too much the energy consumption of the washing cycle and reduce the life of the electric motor rotating the drum. Preferably, the high speed is about 150 RPM.

[0031] Preferably the first and second intermediate spins are performed before a heating phase of the main wash phase.

[0032] The present invention concerns also a laundry washing machine comprising: a casing, a washing tub arranged within the casing, a rotatable laundry drum which is mounted inside the washing tub and is designed to contain laundry, an electric motor structured to rotate the laundry drum, a water-detergent supply system designed to supply wash water and detergent into the washing tub, and a water draining system designed to discharge wash water from the washing tub;

[0033] The machine comprises a control unit configured to:

- control, during a main wash phase, the water-detergent supply system in order to load water and detergent in the washing tub;
- control the electric motor during the main wash phase, to cause the drum to rotate at a preset high speed in a first rotational direction in order to perform at least one first intermediate spin;
- control the electric motor during the main wash phase, to cause the drum to reduce the speed to a wash speed lower than the high speed;

[0034] The control unit is further configured to:

- control the electric motor during the main wash phase, to cause the drum to rotate the drum at a preset high speed in a second rotational direction, opposite to the first rotational direction in order to perform at least a second intermediate spin which generates a liquid flux removing detergent settled in the water draining system.

[0035] Preferably, in the machine according to the invention the control unit is further configured to:

- check whether the laundry in the drum is unbalanced, before performing the first intermediate spin;
- perform the first intermediate spin based on the previous checked unbalanced laundry condition.

[0036] Preferably, in the machine according to the invention the control unit is further configured to:

- skip the first intermediate spin phase when an unbalanced laundry condition is consecutively determined a preset number of times.

[0037] Preferably, in the machine according to the invention the control unit is further configured to:

- check whether the laundry in the drum is unbalanced before performing the second intermediate spin;
- perform the second intermediate spin based on the checked unbalanced laundry condition.

[0038] Preferably, in the machine according to the invention the control unit is further configured to:

- skip the second intermediate spin when an unbalanced laundry condition is consecutively determined a preset number of times.

[0039] Preferably, in the machine according to the invention the high speed is comprised between about 100 and 400 RPM.

[0040] Preferably, in the machine according to the invention the high spin speed is about 150 RPM.

DRIEF DESCRIPTION OF THE DRAWINGS

[0041] 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 front view of a laundry washing machine implementing the control method according to the invention;
- Figure 2 is a flow chart of the basic operations of a method for controlling the washing machine of Figure 1;

- Figure 3 is a graph which illustrates the variation of: the drum speed, water temperature, and water level, during operations performed by the control method according to the present invention;
- Figure 4 is an enlarged portion of phase P2 of the graph shown in Figure 3 illustrating the first and second spins performed by the control method during the wash phase, according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0042] The method of the present invention has proved to be particularly advantageous when applied to laundry washing machines, as described below. It should in any case be underlined that the present invention is not limited to this type of application. On the contrary, the present invention can be conveniently applied to other equipments, like for example laundry washing and drying machines (called also washer/driers), wherein one or more steps of introducing water inside a washing tub is required.

[0043] With reference to Figure 1, a laundry washing machine 1 according to the invention is described, in which a control method of the invention is implemented.

[0044] 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 underlined 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 loading washing devices, for example top loading laundry washing machines or top loading laundry washing and drying machines.

[0045] The laundry washing machine 1 comprises an external casing or casing 2, in which a washing tub 3 is provided that contains a rotatable perforated drum 4, where the laundry 10 to be washed can be loaded. The washing tub 3 and the drum 4 both have preferably a substantially cylindrical shape. The casing 2 is provided with a loading/unloading door (not illustrated) which allows access to the washing tub 3 and the drum 4. The washing tub 3 is preferably suspended in a floating manner inside the casing 2, advantageously by means of a number of coil springs and shock-absorbers (not illustrated). The drum 4 is advantageously rotated by an electric motor 7, which preferably transmits the rotating motion to the shaft of the drum 4, advantageously by means of a belt/pulley system 8. In a different embodiment of the invention, the motor can be directly associated with the shaft of the drum 4.

[0046] A water supply system 5 and a detergent supply system 6 are arranged preferably in the upper part of the laundry washing machine 1 and are structured to supply water and washing/rinsing products, i.e. detergent, softener, etc., into the washing tub 3.

[0047] The detergent supply system 6 advantageously comprises a, preferably removable, drawer 13 provided with various compartments suited to be filled with washing and/or rinsing products.

[0048] In the embodiment herein described, the water flowing through the water supply system 5 is advantageously supplied into the washing tub 3 by making it flow through the drawer 13 and through a supply pipe 9 which extends toward the tub 3. The supply pipe output of the supply pipe 9 advantageously ends in correspondence of the tub 3. Preferably the supply pipe output ends in correspondence of a lateral side of the tub 3, as shown in the example of Figure 1; alternatively the supply pipe output of the supply pipe 9 may advantageously end in correspondence of the bellows (not illustrated) connecting the loading/unloading openings of the tub and of the casing. The water supply system 5 further comprises a main pipe 15 which opportunely connects the drawer 13 to an external water supply line E, preferably by means of a controlled supply valve 11.

[0049] In a preferred embodiment, the water which reaches the washing tub 3 can selectively contain one of the products contained in the compartments of the drawer 13, or such water can be clean (i.e. without products), depending on the phase of the washing program which is actually performed; in the initial phases of the washing program, for example, the detergent is conveyed into the tub 3 by the incoming water, while in other phases, for example during the rinsing phase, only water is conveyed into the tub 3.

[0050] In an alternative embodiment of the invention, a further separate water supply pipe can be provided, which supplies exclusively clean water into the tub 3.

[0051] The laundry washing machine 1 further comprises a water draining system 16 which is configured to drain the wash water, i.e. dirty water or water mixed with washing and/or rinsing products, from the washing tub 3 to the outside.

[0052] The water draining system 16 advantageously comprises the bottom region of the tub 3, which is provided with a liquid outlet fluidly connected to a draining pump 19 arranged to remove liquid from the tub 3 and to take this liquid into a draining suction pipe 20 having an end fluidly connected to the draining pump 19, and the other end designed to be fluidly connected to a house draining pipe system (not illustrated).

[0053] According to a preferred embodiment of the invention, the water draining system 16 advantageously comprises a draining sump 22 which may preferably be a part of the bottom region of the tub 3 (preferably made in a single-piece construction with the latter) and which is fluidily connected to the draining pump 19, and is structured so that washing liquid in the washing tub 3 is collected and drained in the sump 22 under the influence of gravity and/or, in addition, by suction exerted by the draining pump 19. The laundry washing machine 1 may be advantageously provided with a one or more liquid level sensor device 25 (schematically illustrated in Figure 1), designed to sense or detect the water/liquid level inside the tub 3. The sensor device 25 may preferably comprise

a pressure sensor which senses the pressure in the tub 3. From the pressure values sensed by the sensor device 25 it is possible to determine the water level of the wash water contained in the tub 3.According to a preferred embodiment of the invention the pressure sensor is fluidly connected with the draining sump 22.

[0054] The sensor device 25 may preferably comprise in addition to or as a replacement of the pressure sensor, a level sensor, for example mechanical, electro-mechanical, optical, etc., configured to sense or detect the water level inside the tub 3.

[0055] The laundry washing machine 1 may be advantageously provided with a heating device 23 designed to heat the water solution loaded in the tub 3 to a prefixed temperature. Preferably, the heating device 23 may comprise one or more electric resistances or similar devices arranged in the tub bottom 12 and/or in the sump 22.

[0056] A control unit 24 is advantageously connected to the various parts of the laundry washing machine 1 in order to ensure its operation. The control unit 24 is preferably operatively connected to the electric motor 7, so that the drum speed may be controlled, the controlled supply valve 11, the draining pump 19, and receives information from the water level sensor device 25.

[0057] The control unit 24 is advantageously operatively connected also to an interface unit 24a (only schematically illustrated in Figure 1) which is accessible to the user and by means of which the user selects and sets the washing parameters, for example the desired washing program. Advantageously, other parameters can optionally be inserted by the user, for example the washing temperature, the spinning speed, the load in terms of weight of the laundry to be washed, the type of fabric of the load, etc.

[0058] The interface unit 24a also preferably comprises a display where some pieces of information are opportunely displayed.

[0059] Preferably based on the parameters acquired by said interface unit 24a, the control unit 24 sets and controls the various parts of the laundry washing machine 1 in order to carry out the desired washing program.

[0060] A preferred embodiment of the method for controlling the laundry washing machine 1 according to the invention is described here below with reference to the laundry washing machine 1 shown in Figure 1 and with reference to the flow charts illustrated in Figure 2.

[0061] During the washing program, the laundry washing machine 1 will sequentially proceed through a main wash phase (step 300), one or more rinse phases (step 400), and one or more final spin phases (500).

[0062] Referring to Figure 2, the method for controlling the laundry washing machine 1 according to a preferred embodiment of the present invention comprises a step 100 wherein the laundry 10 to be washed is first placed inside the drum 4; preferably a step 110 wherein a desired washing program is selected by the user; and the step 300 in which the method starts the main wash phase based on the selected washing program.

[0063] Clearly step 110 may be performed as well before step 100.

[0064] In a further advantageous embodiment, not illustrated, step 110 may be replaced by a step in which the machine automatically selects, for example among a set of memorized washing programs, the washing program best fittings with the specific characteristics (e.g. material, dirty degree, weight) of the loaded laundry; these characteristics which may be detected by the machine (for example by specific sensors), and/or set by the user for example by the interface unit 24a.

[0065] Referring to Figure 2, the wash phase (step 300) comprise a starting water-detergent loading phase (step 120), wherein preset amounts of water and detergent/s are loaded into the tub 3 so as to get a wash solution inside the latter. In an advantageous embodiment, during such starting water-detergent loading phase, the control unit 24 preferably controls the supply valve 11 based on the water level sensed by the sensor device 25 so that a preset amount/level of water is reached in the tub 3. Moreover, the control unit 24 preferably further controls detergent supply system 6 so that a prefixed amount of detergent is loaded in the tub 3.

[0066] After, or also during, the water-detergent loading phase, the drum 3 is rotated in order to cause the laundry 10 to tumble through the washing solution (step 130).

[0067] Figure 2 shows the case in which the tumbling movement is performed after the end of the detergent loading phase, but in a further embodiment the tumbling movement may be performed also during the water/detergent loading phase (in other words phases 120 and 130 may be performed contemporaneously). In a further advantageous embodiment, the tumbling movement phase may be performed both during and after the water/detergent loading phase 120. In a further advantageous embodiment, the tumbling movement phase may be performed before, during and after the water/detergent loading phase 120.

[0068] During the first tumble phase 130, the method may preferably, although not necessarily, periodically stop the drum 4 and/or alternate the rotational direction of the drum 4 to vary the tumbling laundry pattern, in order to cause the laundry 10 to be untangled. Preferably, during such first tumble phase, indicated with P1 in Figure 3, the drum 3 is made to rotate at a low wash speed, e.g. about 40-50 RPM. Advantageously this low wash speed is a speed lower than the speed (typically around 100 RPM) at which the liquid collected inside the tub forms a continuous liquid ring circulating along the inner surface of the tub; advantageously at this low speed the laundry loaded in the drum is not completely stuck (i.e. fixed) to the lateral surface of the drum, and therefore at least part of the laundry (depending on how much laundry is loaded) can tumble (i.e. rotate) inside the drum 3.

[0069] Detergent loaded in the tub 3 during the water/detergent loading phase and not completely dissolved in water tends to deposit into the tub bottom 12,

and to remain accumulated in the sump 22.

[0070] In accordance to the present invention, it is desired to assure that the detergent accumulated into the tub bottom 12 and/or in the sump bottom 22 is mixed with the water and distributed in the wash solution.

[0071] To this end, during the wash phase, preferably soon after water-detergent loading has been performed, the method sequentially performs the steps of: rotating the drum 4 at a preset high speed ωss' (higher than that for a normal wash phase, which is typically e.g. 40-50 RPM) in a first rotational direction in order to perform at least one first intermediate spin; and rotating the drum at a preset high speed ωss" in a second rotational direction, opposite to the first rotational direction, in order to perform at least a second intermediate spin so that the settled detergent is removed from the water draining system and mixed with the water.

[0072] Preferably, the high speeds ωss' and ωss" performed during the intermediate spins may be comprised between about 100 RPM and 400 RPM; preferably such high speeds are about 150 RPM.

[0073] According to a preferred embodiment of the present invention, the high speeds ωss' and ωss" of the two intermediate spins may be equal to each other.

[0074] According to a different embodiment of the present invention, the high speeds ωss' and ωss" of the two intermediate spins may be different to each other.

[0075] Moreover, the applicant has found that by rotating the drum 4, during the main wash phase at the high speeds ωss' and ωss", in opposite rotational directions, different liquid fluxes are created/generated inside the tub 3, which liquid fluxes strikes the detergent settled in the bottom of the tub and/or in the sump 22 from different directions, causing the detergent accumulated therein to be completely removed. Advantageously, these liquid fluxes reach any inner surfaces of the sump 22 causing a removal of the detergent from the latter. In addition, the removed detergent is moved/pushed towards the internal of the tub 3 wherein it is advantageously mixed with water. Moreover by rotating the drum 4, during the main wash phase at the high speeds ωss' and ωss", in opposite rotational directions, a high turbulence is generated in the washing liquid, which helps the melting of the detergent in the water.

[0076] Preferably, the time interval between the first and second intermediate spin is quite small, for example comprised between 10 s and 50 s (preferably 30 s), so that the effect of the turbulence due to the first intermediate spin is still present when the second intermediate spin begins; in this way the mixing effect of the washing liquid, and therefore also the melting of the detergent, is increased.

[0077] It should be pointed out that the method may perform one or more first intermediate spins and at least one (but also more than one) second intermediate spin.

[0078] Referring to the example shown in Figures 2, 3 and 4, after the end of the first intermediate spin (step 150) and before the beginning of the second intermediate spin (step 190), preferably the method rotates the drum 3 in order to cause the laundry 10 to tumble through the wash solution (step 170). During such second tumble phase, the method may preferably, although not necessarily, periodically stop the drum and/or alternate the rotational direction of the drum 4 to vary the tumble laundry pattern in order to cause the laundry 10 to be untangled as the first tumble phase. Preferably, during such phase, the drum 3 is rotated at a low wash speed (e.g. 40-50 RPM) at which at least part of the laundry can tumble (i.e. rotate) inside the drum. Anyway, in a different advantageous embodiment, after the end of the first intermediate spin (step 150) and before the beginning of the second intermediate spin (step 190), the drum rotation may be stopped, i.e. the wash speed could be zero. In a further advantageous embodiment, after the end of the first intermediate spin (step 150) and before the beginning of the second intermediate spin (step 190) the speed of the drum may have any pattern.

[0079] Applicant has found out that performing the above disclosed intermediate spins during the wash phase may be dangerous in case of unbalanced laundry drum condition. As it is known, when the drum 4 loaded with an unbalanced laundry is rotated at a high speed, various problems in the machine may occur, such as: collision of the wash assembly with the machine casing, and/or severe vibration resulting in a high noise level, and/or partial deformation of the laundry drum, and/or mechanical stress of the drum supporting members, i.e. bearings, dampers, springs, inside the wash assembly. In accordance with the present invention, it is desired that intermediate spins during the wash phase be performed in safety conditions.

[0080] To this end, according to a preferred embodiment of the present invention, after the end of step 130 (tumble phase) and before performing the step 150 (first intermediate spin), the method may advantageously perform a first unbalance check step (140) wherein it is determined whether the laundry loaded in the drum 4 is balanced or not.

[0081] Preferably, during such first unbalance check step (140), indicated in Figure 3 with the dot line rectangle titled "UNB. CHECK", the method rotates the drum 4 in the first rotational direction and gradually increases the rotational speed of the drum 4 from a low wash speed in which at least part of the laundry can tumble inside the drum, to a medium speed ωi wherein the laundry remains attacked to the drum inner surface. Medium speed ωi may be about 80 RPM, or more preferably 100 rpm, so as to ensure that all the laundry is stuck to the lateral walls of the drum, and therefore its position with respect to the drum is fixed.

[0082] Preferably, both during the speed increase for reaching the medium speed wi and when the drum 4 has reached the medium speed ωi, the method performs the unbalance laundry check to determine whether the laundry loaded in the drum 4 is balanced (YES output from block 140) or unbalanced (NO output from block 140).

The unbalance laundry check may be performed by means of known procedures such as, for example, procedure disclosed in EP2050856. Clearly, the unbalance laundry check of the unbalance check step may be performed in any other way.

[0083] If the laundry is balanced (Yes output from the step 140), the method determines that first intermediate spin may be performed in safety condition, and in consequence, further increases the drum rotating speed until the high speed ωss'. In such case, the method performs the first intermediate spin (step 150) (P2 in Figure 3), and the drum 4 is rotated at the high speed ωss', preferably for approximately 100-150 seconds, in the first rotational direction, preferably in a clockwise rotation.

[0084] On the other hand, if laundry is unbalanced (NO output from the step 140), preferably the method verifies whether the number of times that unbalanced condition has been detected (indicated with a counter NDL in Figure 2) is greater than a preset threshold (indicated with TH in Figure 2) (step 160).

[0085] If the number of consecutive detected unbalanced condition is lower than, or equal to the preset threshold (NDL<=TH) (Output NO form step 160), the method advantageously carries out a laundry untangle step 161, i.e. a phase in which the drum is rotated at a low speed, e.g. at 40-50 RPM in order to tumble the laundry contained therein and to redistribute it inside the drum, so as to try to reduce its unbalance. During the laundry untangle step 161, the rotational direction of the drum 4 may periodically alternate and/or the drum stopped, so as to vary the tumbling laundry pattern.

[0086] After the laundry untangle step 161, the first unbalance check step 140 is performed again, as above disclosed.

[0087] On the contrary, if the number of consecutive detected unbalanced conditions is greater than the preset threshold (NDL>TH) (Output YES form step 160), the method advantageously skips the first intermediate spin.

[0088] Advantageously, the method then performs a second tumble phase (step 170), wherein it start rotating the drum with a low wash speed at which at least part of the laundry can tumble inside the drum.

[0089] During the second tumble phase 170, the method may preferably, although not necessarily, periodically alternate the rotational direction of the drum 4 and/or stop the drum 4, to vary the tumbling laundry pattern in order to cause the laundry 10 to be untangled.

[0090] The second tumble phase 170 preferably last from 20s to 50s, more preferably 30s, but can have substantially any duration.

[0091] In a further advantageous embodiment, not illustrated, second tumble phase 170 may be replaced by a "zero speed phase", not illustrated in enclosed drawings, in which the drum 4 is stopped, i.e. a phase in which the drum speed is zero; preferably, but not necessarily, this "zero speed phase", preferably last from 20s to 50s, more preferably 30s, but can have substantially any duration.

[0092] In a further advantageous embodiment, not illustrated, neither the second tumble phase 170 nor a "zero speed phase" is performed between the first and second intermediate spins.

[0093] After the end of the second tumble phase 170 (or, if phase 170 is replaced by a phase in which the drum speed is zero, after this "zero speed" phase) the method preferably performs a step (180) wherein the method rotates the drum 4 in the second rotational direction and gradually increases the rotational speed of the drum 4 from a low wash speed at which at least part of the laundry can tumble in the drum, to the medium speed ωi.

[0094] Preferably before step 180 the counter NDL is reset (NDL=0). In a different advantageous embodiment a different counter can be used.

[0095] Both during the speed increase for reaching the medium speed ωi and when the drum 4 has reached the medium speed ωi, the method performs an unbalance laundry check to determine whether the laundry loaded in the drum 4 is balanced or unbalanced (step 180).

[0096] If the laundry is balanced (Yes output from the step 180), the method determines that the second intermediate spin may be performed in safety condition and, in consequence, further increases the drum rotating speed until the high speed ωss". In such case, the method performs the second intermediate spin (step 190), and the drum 4 is rotated at the high speed ωss", preferably for approximately 100-150 seconds, in the second rotational direction, preferably in the counter clockwise rotation.

[0097] Then, a heating phase 210 is then performed.

[0098] On the other hand, if unbalanced condition is detected (NO output from the step 180), the method verifies whether the number of times that unbalanced laundry condition has been detected (NDL) is greater than the preset threshold TH (step 200).

[0099] If the number of consecutive detected unbalanced condition is lower than, or equal to the preset threshold (MDL<=TH) (Output NO form step 200), the method carries out a laundry untangle step 201, i.e. a phase in which the drum is rotated at a low speed, e.g. at 40-50 RPM and/or the drum is stopped, in order to tumble the laundry contained therein and to redistribute it inside the drum, so as to try to reduce its unbalance. During the laundry untangle step 201, the rotational direction of the drum 4 may periodically alternated, so as to vary the tumbling laundry pattern.

[0100] After the laundry untangle step 201, the second unbalance check step 180 is performed again, as above disclosed.

[0101] On the contrary, if the number of consecutive detected unbalanced conditions is greater than the preset threshold (NDL>TH) (Output YES form step 200), the method skips the second intermediate phase, and performs an heating phase indicated with P3 in Figure 3 (step 210) wherein the water solution is heated.

[0102] Performing, as in the preferred embodiment described with reference to enclosed drawings, heating

phase 210 only after first and second intermediate spins have been performed, is preferred, since it allows improving the energetic efficiency of the washing cycle; in fact during the intermediate spins the washing liquid creates a washing flux which contacts the drum, the tub, and some parts of the water draining system, and therefore the liquid is cooled by these components which have typically a temperature lower than that of the heated liquid (e.g. 40-90 °C). Performing the heating phase only after these intermediate spins, therefore, allows the heated liquid to keep the temperature reached by the heating for more time, and/or to reduce its temperature more slowly.

[0103] After the heating phase, the method advantageously performs in known manner a maintenance phase (step 220) wherein the drum speed is reduced to a wash speed, for example 40-50 RPM, lower than the speed (typically around 100 RPM) at which the liquid collected inside the tub forms a continuous liquid ring circulating along the inner surface of the tub. The end of the maintenance phase corresponds to the end of the main wash phase (step 300).

[0104] After (or in correspondence to) the end of the main wash step 300, a spinning and draining step 330 is advantageously performed for extracting dirty washing liquid from the laundry and draining it via the water draining system 16. During this spinning and draining step 330 the draining pump is preferably activated, so as to drain dirty washing liquid from the laundry and draining it via the water draining system 16.

[0105] It is underlined that first and second intermediate spins have not to be confused with the spin performed after (or in correspondence to) the end of the main wash step, and immediately before the rinsing step, for extracting from the laundry as much washing liquid as possible, in order to drain it away from the machine; first and second intermediate spins are performed during the main wash, and preferably at the beginning of the latter, immediately after the loading of water and detergent, in order to help the removal of detergent that can settle in the water draining system, and after these first and second intermediate spins the main wash step continues with other steps (e.g. heating phase, maintenance phase), while the further spin performed after (or in correspondence to) the end of the main wash step, and immediately before the rinsing step, for extracting from the laundry as much washing liquid as possible, is not followed by further phases of the main wash (which is already ended or in correspondence of this spin), but by the rinsing phase.

[0106] Afterwards, the method performs one or more rinses phases (step 400) and one or more final spin phases (step 500). During the final spin phases, the method advantageously rotates the drum one or more times at the normal spin speeds, which may be at about 1000 RPM.

[0107] It has thus been shown that the present invention allows all the set objects to be achieved, In particular, the control method of the invention makes it possible to: increase the dissolution of detergent depositing in the draining system of a laundry washing machine; ensure that detergent gathered in opposite sides/angles of a parallelepiped shaped sump be completely removed during the washing phase; and obtain an efficient exploitation of the detergent during the washing phase, without however increasing the production cost of the machine.

[0108] 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. Method for controlling a laundry washing machine (1) comprising: a casing (2), a washing tub (3) arranged within said casing (2), a rotatable laundry drum (4) which is mounted inside the washing tub (3) and is designed to contain laundry (10), a water-detergent supply system (5,6) designed to supply wash water and detergent into the washing tub (3) and a water draining system (16) designed to discharge wash water from the washing tub (3);
during a main wash phase, the method performing the steps of:

   - loading water and detergent in the washing tub (3);
   - rotating the drum (4) at a preset high speed (ωss') in a first rotational direction in order to perform at least one first intermediate spin;
   - reducing the speed of the drum (4) at a wash speed lower than said high speed (ωss');

   the method being **characterised by** performing, during said main wash phase, the steps of:

   - rotating the drum at a preset high speed (ωss") in a second rotational direction, opposite to the first rotational direction in order to perform at least a second intermediate spin which generates a liquid flux removing detergent settled in said water draining system (16).

2. Method according to the claim 1, comprising:

   - checking whether the laundry in the drum (4) is unbalanced, before performing said first intermediate spin;
   - performing said first intermediate spin based on said previous checked unbalanced laundry condition.

3. Method according to claim 2, comprising the steps of:

- skipping said first intermediate spin phase when an unbalanced laundry condition is consecutively determined a preset number of times.

4. Method according to one or more of previous claims, comprising:

- checking whether the laundry in the drum (4) is unbalanced before performing said second intermediate spin;
- performing said second intermediate spin based on said checked unbalanced laundry condition.

5. Method according to claim 4, comprising the steps of:

- skipping said second intermediate spin when an unbalanced laundry condition is consecutively determined a preset number of times.

6. Method according to any of the previous claims, wherein said high speed is comprised between about 100 and 400 RPM.

7. Method according to any of the previous claims, wherein the high speed is about 150 RPM.

8. Method according to any of the previous claims, wherein said first and second intermediate spins are performed before a heating phase (210) of said main wash phase.

9. Laundry washing machine (1) comprising: a casing (2), a washing tub (3) arranged within said casing (2), a rotatable laundry drum (4) which is mounted inside the washing tub (3) and is designed to contain laundry, an electric motor (7) structured to rotate said laundry drum (4), water-detergent a supply system (5,6) designed to supply wash water and detergent into the washing tub (3), and a water draining system (16) designed to discharge wash water from the washing tub (3);
the machine (1) comprising a control unit (24) configured to:

- control, during a main wash phase, said water-detergent supply system (5,6) in order to load water and detergent in the washing tub (3);
- control said electric motor (7) during the main wash phase, to cause the drum (4) to rotate at a preset high speed (ωss') in a first rotational direction in order to perform at least one first intermediate spin;
- control said electric motor (7) during the main wash phase, to cause the drum (4) to reduce the speed to a wash speed lower than the high speed (ωss');

the machine being **characterised in that** said control unit (24) is further configured to:

- control said electric motor (7) during the main wash phase, to cause the drum (4) to rotate the drum at a preset high speed (ωss") in a second rotational direction, opposite to the first rotational direction in order to perform at least a second intermediate spin which generates a liquid flux removing detergent settled in said water draining system (16).

10. Machine according to claim 9, wherein said control unit (24) is further configured to:

- check whether the laundry in the drum (4) is unbalanced, before performing said first intermediate spin;
- perform said first intermediate spin based on said previous checked unbalanced laundry condition.

11. Machine according to claim 10, wherein said control unit (24) is further configured to:

- skip said first intermediate spin phase when an unbalanced laundry condition is consecutively determined a preset number of times.

12. Machine according to one or more of claims 9 to 11, wherein said control unit (24) is further configured to:

- check whether the laundry in the drum (4) is unbalanced before performing said second intermediate spin;
- perform said second intermediate spin based on said checked unbalanced laundry condition.

13. Machine according to claim 12, wherein said control unit (24) is further configured to:

- skip said second intermediate spin when an unbalanced laundry condition is consecutively determined a preset number of times.

14. Machine according to any of the previous claims from 9 to 13, wherein said high speed is comprised between about 100 and 400 RPM.

15. Machine according to according to any of the previous claims from 9 to 14, wherein the high spin speed is about 150 RPM.

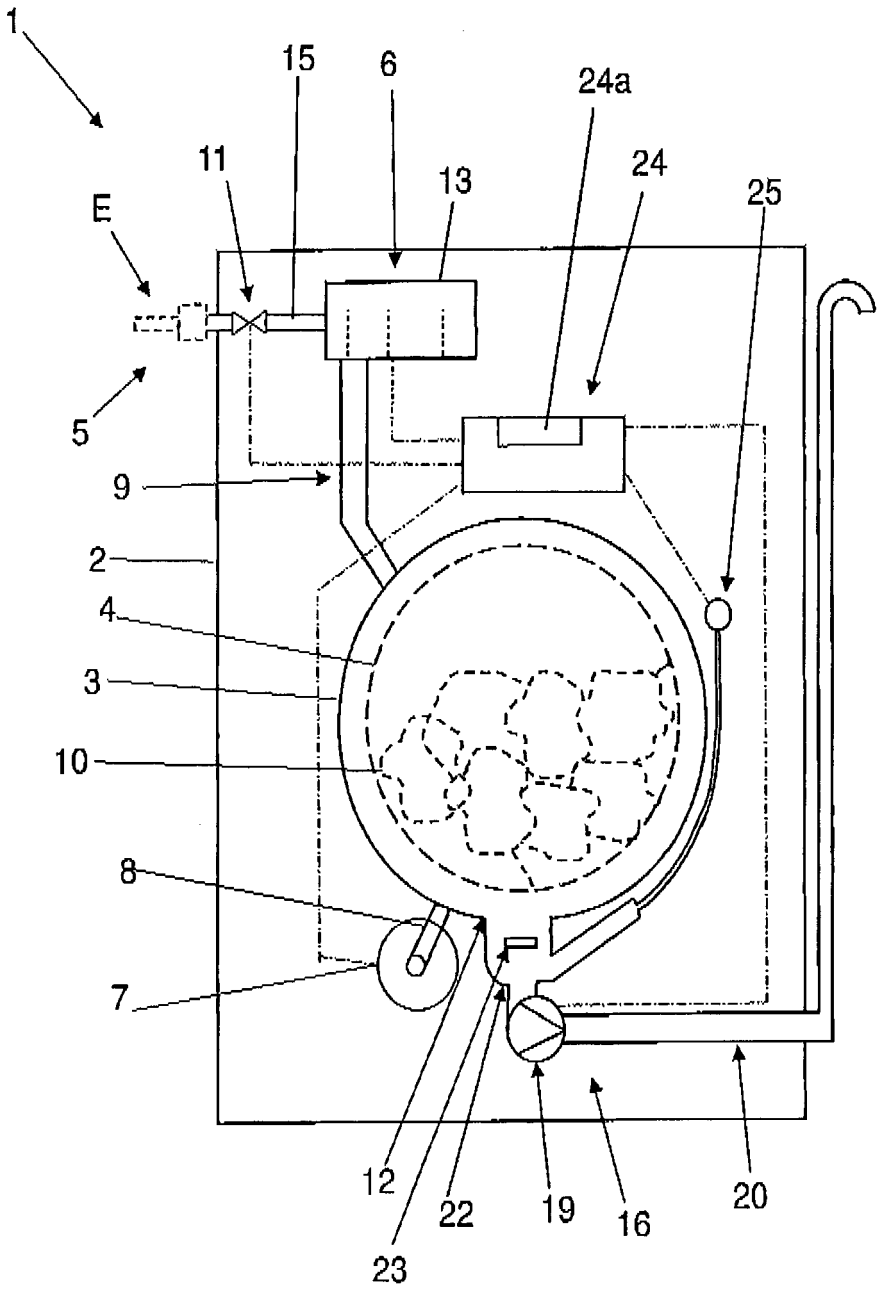

Fig. 1

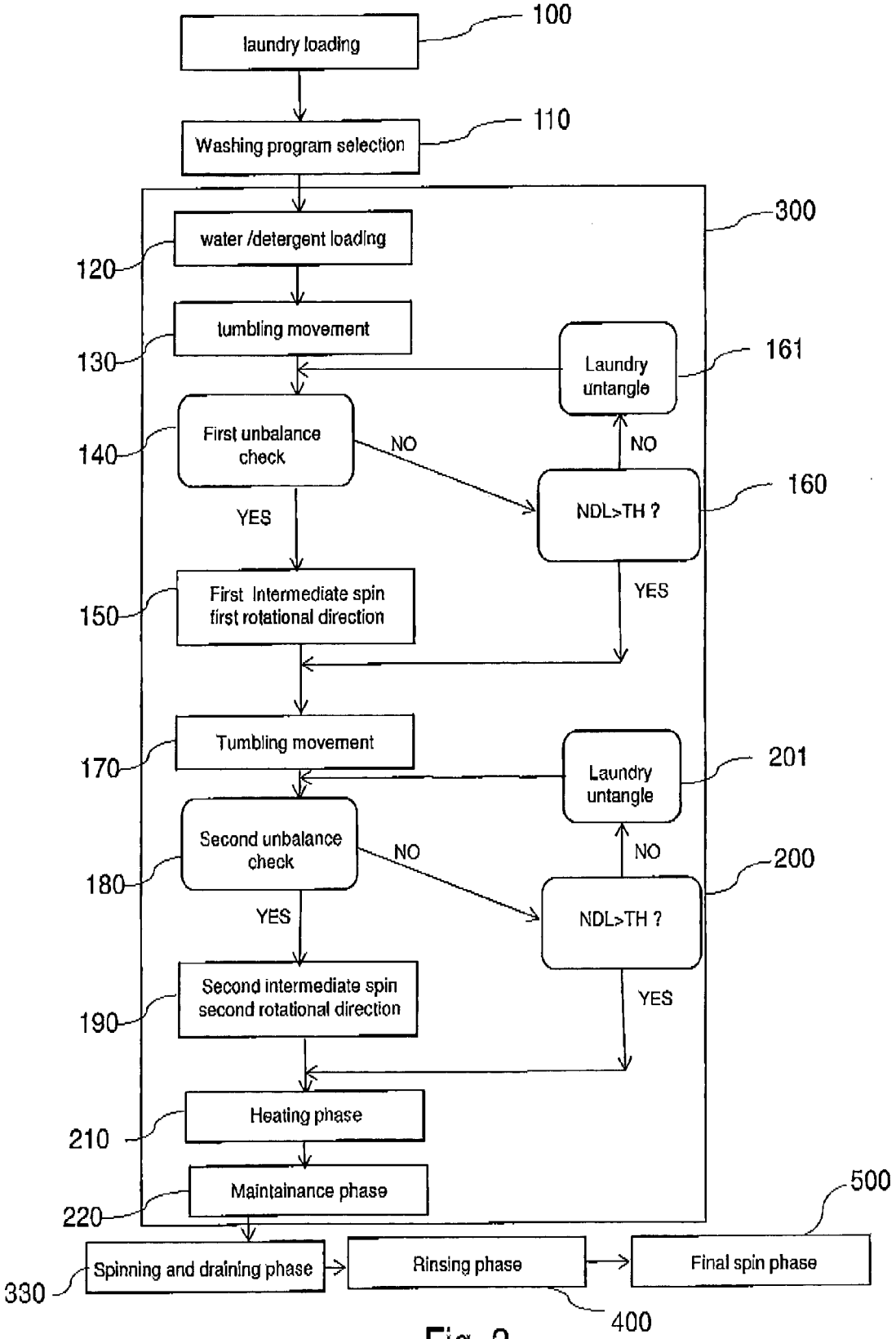
laundry loading
100
Washing program selection
110
300
water /detergent loading
120
tumbling movement
130
Laundry untangle
161
First unbalance check
140
NO
NO
NDL>TH ?
160
YES
YES
First Intermediate spin first rotational direction
150
Tumbling movement
170
Laundry untangle
201
Second unbalance check
180
NO
NO
200
NDL>TH ?
YES
YES
Second intermediate spin second rotational direction
190
Heating phase
210
Maintainance phase
220
500
Spinning and draining phase
330
Rinsing phase
Final spin phase
400

Fig. 2

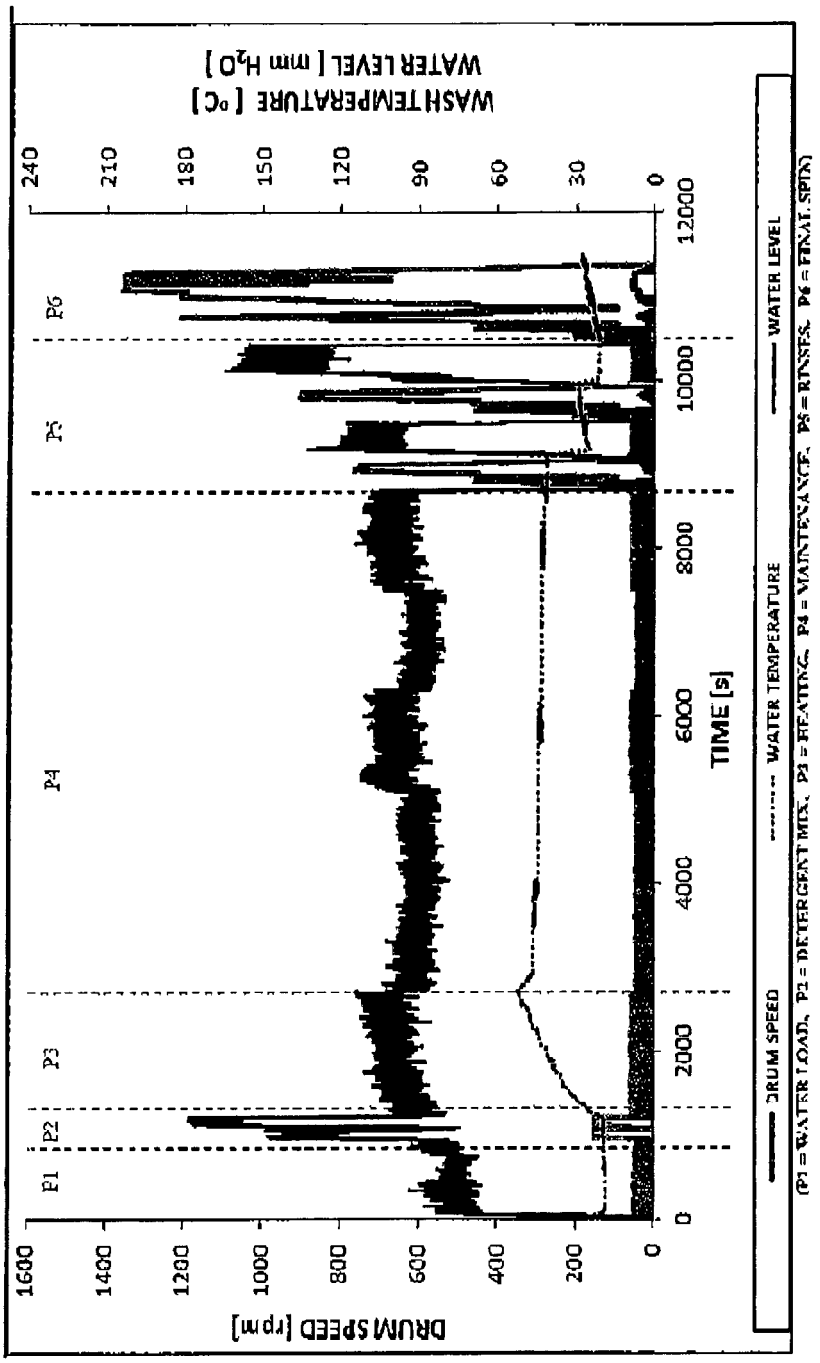
DRUM SPEED [rpm]
1600
1400
1200
1000
800
600
400
200
0
WASH TEMPERATURE [°C]
WATER LEVEL [mm H2O]
240
210
180
150
120
90
60
30
0
P1
P2
P3
P4
P5
P6
0
2000
4000
6000
8000
10000
12000
TIME [s]
DRUM SPEED
WATER TEMPERATURE
WATER LEVEL
(P1 = WATER LOAD, P2 = DETERGENT MIX, P3 = HEATING, P4 = MAINTENANCE, P5 = RINSES, P6 = FINAL SPIN)

Fig. 3

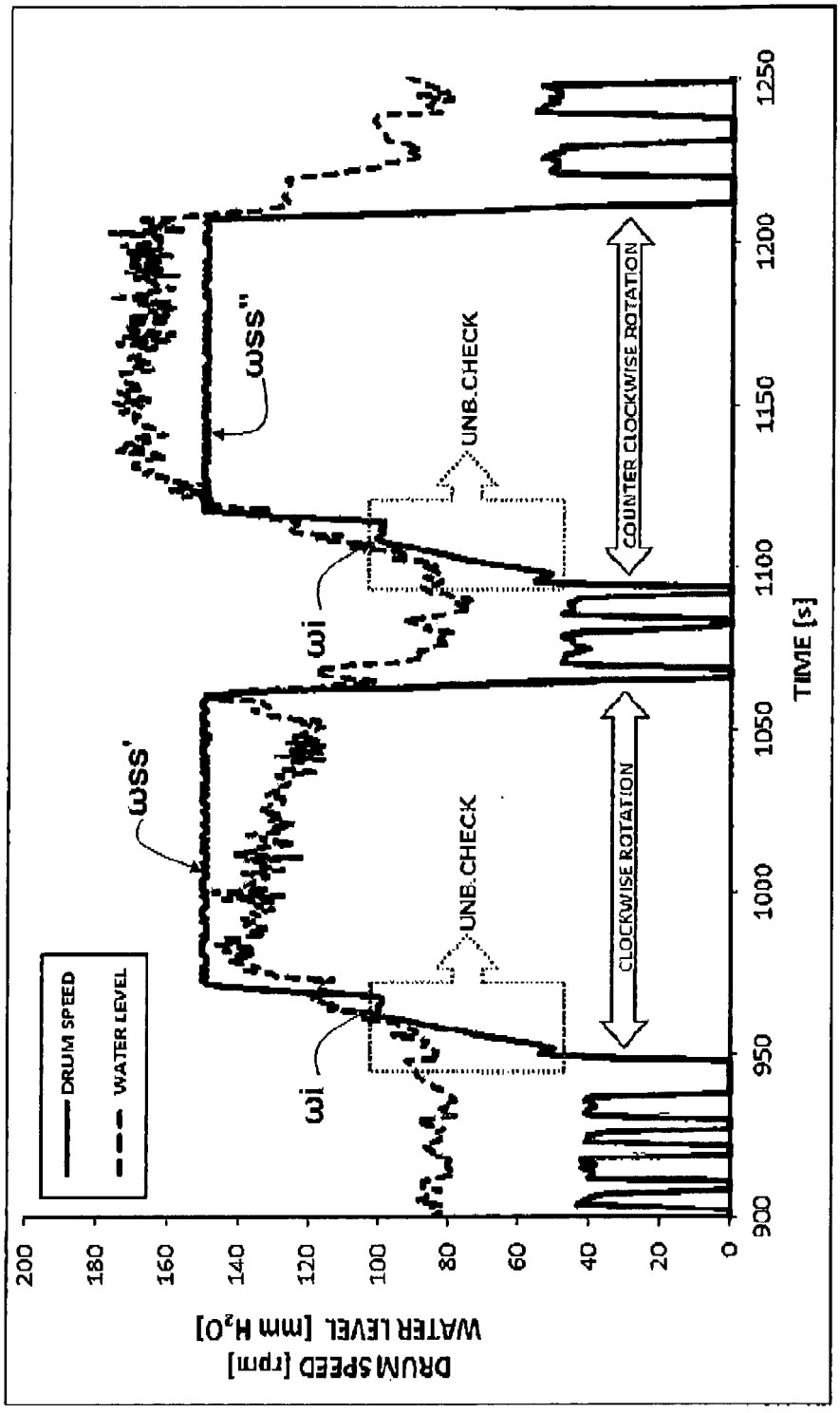
DRUM SPEED
WATER LEVEL
ωss'
ωss''
ωi
ωi
UNB.CHECK
UNB.CHECK
CLOCKWISE ROTATION
COUNTER CLOCKWISE ROTATION
DRUM SPEED [rpm]
WATER LEVEL [mm H2O]
TIME [s]
0
20
40
60
80
100
120
140
160
180
200
900
950
1000
1050
1100
1150
1200
1250

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 12 00 7386

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