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(54) **Method for washing laundry in a laundry washing machine**

(57) The present invention relates to a method for washing laundry in a laundry washing machine, the laundry washing machine comprising a washing tub external to a washing drum suited to receive the laundry and comprising a heating device, wherein the method comprises a heating phase for heating the laundry. The heating phase comprises a steps of providing a quantity of liquid

into the washing tub up to a level at which the liquid touches the lower part of the washing drum, a step of heating the liquid by means of the heating device and a step of controlling the liquid level to maintain the liquid at a contacting level so that the liquid touches the washing drum in order to transfer the thermal energy from the liquid to the washing drum and from the washing drum to the laundry.

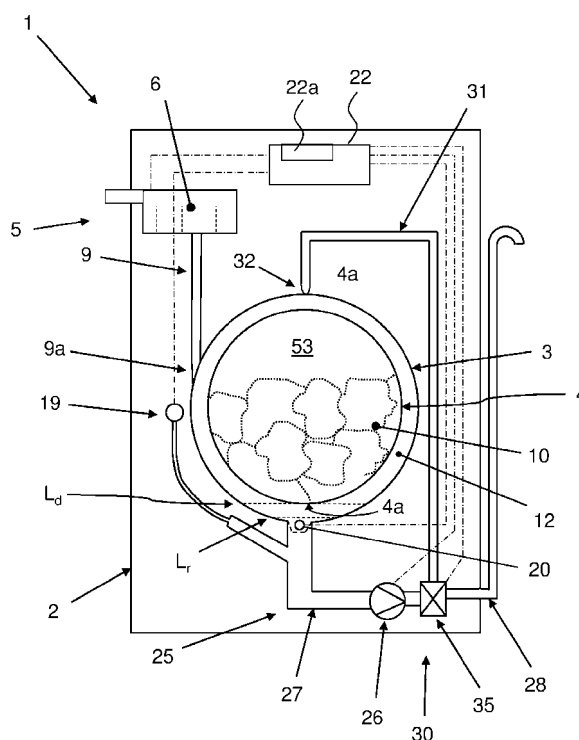


FIG. 2

Description

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

[0002] In particular, the present invention refers to a method for washing laundry in a laundry washing machine.

[0003] More particularly, the present invention refers to a method for heating laundry in a laundry washing machine.

BACKGROUND ART

[0004] 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-drying machines (i.e. laundry washing machines which can also dry laundry), is widespread.

[0005] In the present description the term "laundry washing machine" will refer to both simple laundry washing machines and laundry washing-drying machines. Laundry washing machines generally comprise an external casing provided with a washing tub which contains a rotatable perforated drum where the laundry is placed.

[0006] A loading/unloading door ensures access to the tub and the drum.

[0007] Laundry washing machines typically comprise a detergent supply unit and a water inlet circuit for the introduction of water and washing/rinsing products (i.e. detergent, softener, etc.) into the tub.

[0008] Known laundry washing machines are also provided with water draining devices that may operate both during the initial phases of the washing cycle and at the end of the same to drain the dirty water.

[0009] Heating means are provided in order to heat the liquid, namely water or water with detergent, inside the tub. Heating means typically comprises electrical heaters, as for example a resistor, placed at the bottom of the tub and suited to come into contact with the liquid present on the bottom of the tub. Activation of the heating means heats the liquid in which they are immersed.

[0010] According to the known technique, a washing cycle typically includes different phases during which the laundry to be washed is subjected to adequate treatments.

[0011] A washing cycle usually comprises an initial laundry wetting phase during which the laundry is wetted by means of the introduction of water into the tub. During the wetting phase preferably a preset quantity of washing detergent is also added to form a mixed washing liquid which is then absorbed by the laundry.

[0012] A further phase in the washing cycle typically comprises a heating phase during which the wetted laundry is heated to a preferred temperature, according the washing program selected by the user and/or according to the type of the fabric of laundry.

[0013] In a heating method belonging to the know tech-

nique, as shown in Figure 1, the heating of the laundry La inside the drum Dr is carried out by heating a quantity of liquid inside the tub T up to a level H which assures that the liquid partially surrounds the washing drum Dr.

The heated liquid enters inside the drum and is then absorbed by the laundry La. The liquid which reaches this level H guarantees that substantially all the laundry La is heated by the absorbed heated liquid.

[0014] However, this heating phase of the known art pose some drawbacks.

[0015] A first drawback posed by this known technique is constituted by the fact that a large amount of liquid has to be heated to guarantee that all the laundry is wetted by the heated liquid.

[0016] A further drawback is represented by the fact that a portion of the heated liquid, namely the heated liquid which fills the hollow space between the tub and the drum, does not heat the laundry inside the drum.

[0017] In a further heating method belonging to the know technique, the heating of the laundry inside the drum is carried out by heating a quantity of liquid at the bottom of tub and then wetting the laundry with this heated liquid by means of a re-circulation circuit. During the recirculation phase by means of the re-circulation circuit the heated liquid which lies on the bottom of the tub is drained towards the upper part of the tub through one or more re-circulation pipes and from there conveyed over the laundry by means of one or more respective nozzles present at the end of the re-circulation pipes.

[0018] However, also this heating phase of the known art pose some drawbacks.

[0019] A first drawback posed by this known technique is constituted by the fact that part of the thermal energy used for heating the liquid is dispersed along the re-circulation circuit, for example along the re-circulation pipe.

[0020] Another drawback is represented by the fact that the heated liquid is not uniformly distributed inside the drum but it is concentrated in correspondence of the conveying nozzles. This is particularly emphasized in the known washing machine where a conveying nozzle is placed in proximity of the front door. Most of the heated liquid in fact tends to heat the laundry close to the front door while the laundry at the rear of the drum is not reached by the heated liquid. The laundry inside the drum, therefore, is not uniformly heated.

[0021] A further drawback is represented by the fact that the heating phase requires the activation of the re-circulation circuit with activation of suitable re-circulation pump. This determines an undesired power consumption.

[0022] The object of the present invention is therefore to overcome the drawbacks posed by the known techniques.

[0023] It is a first object of the invention to implement a washing method for washing laundry in a washing laundry machine that makes it possible to reduce the power consumption with respect to the know techniques.

[0024] It is a further object of the invention to implement

a washing method that makes it possible to obtain a more uniform laundry heating with respect to the known techniques.

DISCLOSURE OF INVENTION

[0025] The applicant has found that by providing a method for washing laundry in a laundry washing machine, the laundry washing machine comprising a washing tub external to a washing drum suited to receive the laundry and comprising a heating device, the method comprising a heating phase for heating the laundry during which the drum is heated by means of heated liquid and the heated drum heats the laundry by heat conduction while the heated liquid does not substantially enter inside the drum, it is possible to obtain a reduction of the power required to heat the laundry and to obtain an uniform laundry heating. The heating phase of the present washing method which requires the heating of a wetted laundry, independently of the way the laundry has been wetted.

[0026] Advantageously the applicant has found that by providing a method for washing laundry in a laundry washing machine, the laundry washing machine comprising a washing tub external to a washing drum suited to receive the laundry and comprising a heating device, the method comprising a heating phase for heating the laundry, in which the heating phase comprises a step of providing a quantity of liquid into the washing tub up to a level at which the liquid touches the lower part of the washing drum, a step of heating the liquid by means of the heating device and a step of controlling the liquid level to maintain the liquid at a contacting level so that the liquid touches the washing drum in order to transfer the thermal energy from the liquid to the washing drum and from the washing drum to the laundry, it is possible to obtain a reduction of the power required to heat the laundry and an uniform laundry heating.

[0027] The present invention therefore relates, in a first aspect thereof, to a method for washing laundry in a laundry washing machine, said laundry washing machine comprising a washing tub external to a washing drum suited to receive said laundry and comprising a heating device, said method comprising a heating phase for heating said laundry, said heating phase comprising the steps of:

- providing a quantity of liquid into said washing tub up to a level at which said liquid touches the lower part of said washing drum;
- heating said liquid by means of said heating device;
- controlling said liquid level to maintain said liquid at a contacting level so that said liquid touches said washing drum in order to transfer the thermal energy from said liquid to said washing drum and from said washing drum to said laundry.

[0028] Maintain the liquid at a contacting level substan-

tially means that the liquid level is kept at a level in which the liquid touches substantially continuously the washing drum in its lower part.

[0029] Opportunely during the phase of controlling the liquid, the liquid does not substantially enter inside the washing drum.

[0030] This means that during the liquid level control a certain quantity of liquid, or heated liquid, may also enter inside the drum. Nevertheless said certain quantity of liquid which may enter inside the drum and which wets the laundry is a very low quantity, for example may enter for some millimetres. Furthermore also the time during which said low quantity of liquid wets the laundry is a short time. Therefore the heating effect on the laundry due to this certain quantity of liquid which may enter inside the drum is negligible with respect to the heating effect obtained with the thermal energy transfer through the drum.

[0031] Preferably the contacting level is less than 2 cm away from the level of the lower part of said washing drum.

[0032] In a preferred embodiment, the step of controlling the liquid level comprises adding water into the washing tub if the liquid level is below the contacting level. In another embodiment of the invention, the step of controlling the liquid level comprises draining liquid from the washing tub if the liquid level is above the contacting level.

[0033] Advantageously the method comprises rotations of the washing drum during the heating phase.

[0034] In a preferred embodiment, the step of controlling the liquid level comprises sensing the liquid level by means of a pressure sensor placed at the bottom of the tub.

[0035] In another embodiment of the invention, the step of controlling the liquid level comprises sensing the liquid level by means of an optical sensor associated to the tub.

[0036] Preferably the heating phase takes place for a predetermined heating time. Opportunely the predetermined heating time is based on the selected program by the user.

[0037] In a preferred embodiment, the heating phase takes place activating continuously the heating device.

[0038] In another embodiment of the invention, the heating phase takes place activating intermittently the heating device.

[0039] In a further embodiment of the invention, the heating phase takes place activating the heating device on the base of the sensed temperature of the liquid inside the washing tub.

[0040] Advantageously the heating phase takes place activating the heating device which is located at the bottom of the tub.

[0041] Preferably the method comprises at least a phase of wetting the laundry before the heating phase.

[0042] In a preferred embodiment, before the heating phase the method further comprises the steps of:

- providing a quantity of detergent;
- providing a first quantity of water to form with the quantity of detergent a quantity of washing solution;
- introducing the washing solution into the washing tub;
- recirculating the washing solution inside the washing tub by means of recirculation means until the washing solution is absorbed by the laundry inside the washing drum and the level of the washing solution is below the washing drum.

[0043] Preferably after the heating phase the method further comprises the steps of:

- maintaining the heated wetted laundry inside the washing drum for a predetermined dry maintenance time;
- supplying a second quantity of water in the washing tub;
- rotating the washing drum;
- rinsing the loaded laundry by means of drum rotations and by means of liquid drainage from the washing tub.

[0044] Advantageously the method comprises a rotation phase of the washing drum during the step of recirculating the washing solution inside the washing tub. Opportunely the method comprises a rotation phase of the washing drum during the step of maintaining the heated wetted laundry inside the washing drum for a predetermined dry maintenance time.

[0045] In a preferred embodiment, the method comprises a recirculating phase of liquid inside the washing tub after the phase of supplying a second quantity of water in the washing tub.

[0046] Preferably the method comprises a further phase of providing a pre-wetting quantity of water inside the washing tub in order to wet the laundry before the phase of introducing the washing solution into the washing tub.

[0047] Advantageously the method comprises a recirculating phase of water inside the washing tub after the phase of providing a pre-wetting quantity of water.

[0048] In a preferred embodiment, the first quantity of water is stated based on the quantity and/or on the type of the laundry.

[0049] Preferably the ratio between the first quantity of water and the dry weight of the laundry is comprised between 1 and 3 litres/kg.

[0050] Advantageously the second quantity of water is stated based on the quantity and/or on the type of said laundry.

[0051] Preferably the ratio between the second quantity of water and the dry weight of the laundry is comprised between 0,7 and 0,9 litres/kg.

[0052] Opportunely the pre-wetting quantity of water and the first quantity of water are stated based on the quantity and/or on the type of the laundry.

[0053] Advantageously the ratio between the sum of the pre-wetting quantity of water and the first quantity of water and the dry weight of the laundry is comprised between 1 and 3 litres/kg.

[0054] In a second aspect thereof, the present invention concerns a laundry washing machine suited to implement the method of the invention described above.

BRIEF DESCRIPTION OF THE DRAWINGS

[0055] 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 a front view of a laundry washing machine of the prior art;
- Figure 2 shows a front view of a laundry washing machine implementing the method according to the invention;
- Figure 3 shows a side view of the laundry washing machine shown in Figure 2;
- Figure 4 is a simplified flow chart of the basic operations of a method for washing laundry in the laundry washing machine of Figure 2 according to a first embodiment of the invention;
- Figure 5 shows in detail an operation of the flow chart of Figure 4;
- Figures from 6 to 8 show further embodiments of Figure 5;
- Figure 9 shows an enlarged view of a detail of Figure 2;
- Figure 10 shows a further embodiment of Figure 4.

DETAILED DESCRIPTION OF THE INVENTION

[0056] 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 equipment, like for example laundry washing-drying machines, wherein a heating phase of the laundry is required.

[0057] With reference to Figure 2 and Figure 3, a laundry washing machine 1 is described, in which a method according to a first embodiment of the invention is implemented.

[0058] The laundry washing machine 1 is a front loading 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, as for example top loading laundry washing machines or top loading laundry washing-drying machines.

[0059] 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. The drum 4 comprises a peripheral side wall 50, a rear side wall 51 and a front side wall 52. The side walls 50, 51 and 52 define a laundry receiving space 53 where the laundry 10 to be washed can be loaded.

[0060] The front side wall 52 comprises an aperture 54, substantially aligned with a loading/unloading door 8, from which the laundry 10 is loaded/unloaded.

[0061] The tub 3 and the drum 4 both have preferably a substantially cylindrical shape. A hollow space 12 is defined between the tub 3 and the drum 4.

[0062] The 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, that are not illustrated herein.

[0063] The tub 3 is preferably connected to the casing 2 by means of an elastic bellows 7, or gasket.

[0064] The drum 4 is advantageously rotated by an electric motor 11 which preferably transmits the rotating motion to the shaft 14 of the drum 4, advantageously by means of a belt/pulley system 13. In a different embodiment of the invention, the motor can be directly associated with the shaft 14 of the drum 4.

[0065] A water inlet circuit 5 is preferably arranged in the upper part of the laundry washing machine 1 and is suited to supply water and washing/rinsing products (i.e. detergent, softener, etc.) into the tub 3.

[0066] The water inlet circuit 5 advantageously comprises a removable drawer 6 provided with various compartments suited to be filled with washing and/or rinsing products.

[0067] In the embodiment herein described, the water is advantageously supplied into the tub 3 by making it flow through the drawer 6 and then through a supply pipe 9. The supply pipe output 9a of the supply pipe 9 ends in correspondence of the tub 3. Preferably the supply pipe output 9a ends in correspondence of a lateral side of the tub 3.

[0068] In the embodiment herein described, the water is supplied into the tub 3 by making it flow through the drawer 6.

[0069] In a preferred embodiment of the invention the inlet circuit 5 comprises a bypass duct, not illustrated, that bypasses the compartments of the drawer 6, so as to allow supplying exclusively water (i.e. without detergent) into the tub 3.

[0070] In a preferred embodiment, the water which reaches the tub 3 can selectively contain one of the products contained in the compartments of the drawer 6, or such water can be clean and in this case it may reach the tub 3 directly, bypassing the compartments of the drawer 6.

[0071] This may depend on the phase of the washing cycle selected. In the initial phases of the washing cycle, for example, the products are conveyed into the tub 3 over the laundry 10. In other phases, as for example during the rinsing phase, only water is conveyed into the tub 3.

[0072] 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.

[0073] The water inlet circuit 5 also preferably comprises a water flow sensor, for example a flow meter, which makes it possible to calculate the quantity of water supplied into the tub 3.

[0074] The laundry washing machine 1 advantageously comprises a water outlet circuit 25.

[0075] The water outlet circuit 25 advantageously comprises a drain pump 26, a first pipe 27 connecting the tub 3 to the drain pump 26 and an outlet pipe 28 ending outside the casing 2. The water outlet circuit 25 is suited to drain the liquid, i.e. water or dirty water or water mixed with washing and/or rinsing products, from the tub 3 to the outside.

[0076] The water outlet circuit 25 is advantageously provided with a recirculation circuit 30 adapted to drain liquid from a bottom region of the tub 3 and to re-admit such a liquid into another region of the tub 3.

[0077] The recirculation circuit 30 preferably comprises the drain pump 26 and a recirculation pipe 31. The recirculation pipe 31 advantageously ends with an injection nozzle 32 in an upper region of the tub 3. In further preferred embodiments other injection nozzles in different locations along the tub 3 may be preferably provided.

[0078] A two-way valve 35 is preferably interposed between the drain pump 26, the outlet pipe 28 and the recirculation pipe 31.

[0079] The two-way valve 35 is preferably properly controlled in order to allow selective drainage towards the outside through the outlet pipe 28 or towards the upper region of the tub 3 through the recirculation pipe 31.

[0080] In a further embodiment, not illustrated, the recirculation circuit may comprise a dedicated recirculation pipe connecting a bottom region of the tub with an higher region of the latter, and provided with a dedicated recirculation pump; in this case the recirculation circuit is advantageously completely separated from the water outlet circuit.

[0081] Advantageously the laundry washing machine 1 comprises a device 19 suited to sense (or detect) the liquid level inside the tub 3.

[0082] The device 19 preferably comprises a pressure sensor which senses the pressure in the tub 3. From the values sensed by the device 19 it is possible to determine the liquid level L of the liquid inside the tub 3. In another embodiment, not illustrated, laundry washing machine 1 comprises (in addition to or as a replacement of the pressure sensor) a level sensor (for example mechanical, electro-mechanical, optical, etc.) adapted to sense (or detect) the liquid level inside the tub 3.

[0083] At the level of the bottom of the laundry washing machine 1, and preferably on the bottom of the tub 3, there is a heating element 20. The heating element 20 preferably comprises an electric resistor suited to come into contact with the liquid present on the bottom of the tub 3 to heat said liquid.

[0084] Advantageously laundry washing machine 1 comprises a temperature sensor, not illustrated in the figures, for sensing the temperature of the liquid inside the tub 3. Preferably the temperature sensor is placed in correspondence or in proximity of said heating element 20, more preferably integrally made with it.

[0085] A control unit 22 is connected to the various parts of the laundry washing machine 1 in order to ensure its operation. The control unit 22 is preferably connected to the water inlet circuit 5, the water outlet circuit 25, the electric motor 11 and the two-way valve 35 and receives information from the various sensors provided on the laundry washing machine 1, like the flow meter of the water inlet circuit 5, the pressure sensor 19 on the bottom of the tub 3 (level sensor), the temperature sensor, etc.

[0086] The control unit 22 advantageously is connected also to an interface unit 22a which is accessible to the user and by means of which the user selects and sets the washing parameters from time to time, in particular 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.

[0087] Based on the parameters acquired by said interface unit 22a, the control unit 22 sets and controls the various parts of the laundry washing machine 1 in order to carry out the desired washing program.

[0088] A first embodiment of the washing method according to the invention is described here below with reference to the washing machine 1 shows on Figures 2 and 3 and with reference to the operation flow charts of Figures 4 and 5.

[0089] The laundry 10 to be washed is first placed inside the drum 4 (step 100). By operating on the interface unit 22a the user selects the desired washing program (step 110) depending for example on the type and on the dirty-level of the products to wash. Furthermore, as said before, in a preferred embodiment it is possible for the user to insert some parameters directly by the interface unit 22a, for example the value of the washing temperature, the rotating speed of the drum 4 in the spinning phase, the duration of washing cycle, etc.

[0090] Once the user has selected the desired washing program, the control unit 22 sets the laundry washing machine 1 so that it starts the washing cycle.

[0091] In a further embodiment, the selection of the desired washing program (step 110) may be performed before placing the laundry 10 into the drum 4 (step 100).

[0092] In a successive phase (step 120) a quantity Qd of detergent D together with a first quantity Q1_w of water W is introduced into the tub 3. The quantity Qd of deter-

gent D and the first quantity Q1_w of water W form a washing solution S intended to wet the laundry 10.

[0093] Advantageously the quantity Qs of the washing solution S, namely the sum of the quantity Qd of detergent D and the first quantity Q1_w of water W, is a quantity Qs that does not exceed the absorption capacity of the laundry 10, as better explained below in the description.

[0094] It has to be noted that the quantity Qs of the washing solution S in terms of volume, or weight, corresponds substantially to the volume, or weigh, of the first quantity Q1_w of water W. In fact, the quantity Qd of detergent D used for the washing solution S represents a minimal part of the washing solution S itself. For example a typical volume ratio between the detergent D and the washing solution S is less than 2%.

[0095] It follows that throughout the description when we state that the quantity Qs of the washing solution S does not exceed the absorption capacity of the laundry 10 is substantially equivalent to state that the first quantity Q1_w of water W does not exceed the absorption capacity of the laundry 10.

[0096] The introduction of the quantity Qd of detergent D takes place preferably through the water inlet circuit 5; the quantity Qd of detergent D, be it powder or liquid, is preferably brought out of the apposite compartment of the drawer 6 by the first quantity Q1_w of water W that passes through the proper compartment of the drawer 6.

[0097] The quantity Qd of detergent D and the first quantity Q1_w of water W, i.e. the washing solution S, then flow through the supply pipe 9 up to the supply pipe output 9a.

[0098] All the washing solution S introduced inside the tub 3 by means of the supply pipe 9 advantageously falls down on the bottom of the tub 3. This is guaranteed by the lateral position of supply pipe output 9a with respect to the tub 3. Nevertheless a minimum quantity of the washing solution S may also reach the laundry 10 inside the perforated drum 4.

[0099] During the introduction of the washing solution S (step 120) the recirculation circuit 30 is advantageously activated (step 130).

[0100] The washing solution S which lies on the bottom of the tub 3 is drained towards the upper part of the tub 3 by means of the drain pump 26. The drain pump 26 takes the washing solution S from the bottom of the tub 3 and conveys it towards the upper part of the tub 3 through the recirculation pipe 31 via the valve 35 opportunely driven by the control unit 22.

[0101] The washing solution S therefore flows through the recirculation pipe 31 up to the terminal nozzle 32 and from there advantageously reaches the laundry 10 from above.

[0102] By means of this recirculation process, uniform and complete wetting of the laundry 10 with the washing solution S can be accomplished.

[0103] Preferably the recirculation process takes place for a pre-established period of time deemed sufficient to withdraw substantially all the washing solution S from the

bottom of the tub 3 and sufficient for its complete absorption by the laundry 10.

[0104] The complete absorption of the laundry 10 is guaranteed by the fact that, as said before, the quantity Q_s of the washing solution S is preferably properly chosen so that it does not exceed the absorption capacity of the laundry 10.

[0105] At the end of the recirculation process the hollow space 12 between the tub 3 and the drum 4, therefore, is advantageously substantially empty and free from any liquid.

[0106] More generally, at the end of the recirculation process the washing solution S is substantially totally absorbed by the laundry 10. It is clear that a minimum quantity of residual washing solution S may remain on the bottom of the tub 3. In any case, the level L_r of the residual washing solution S on the bottom of the tub 3 is substantially below the bottom part 4a of the drum 4, as shown in Figure 2. Preferably, during the introduction of the washing solution S (step 120) or/and during the recirculation phase (step 130) the drum 4 is set rotated (step 135), so as to enhance the absorption of the washing solution S by the laundry 10. Rotations of the drum 4 takes place with a preferred rhythm, for example in clockwise and/or anticlockwise direction, at a low speed (e.g. at [10-80] rpm), and advantageously with stop interval time between successive rotations.

[0107] In a further embodiment, the recirculation phase (step 130) may be performed after the introduction of the washing solution S into the tub 3 (step 120).

[0108] The first quantity $Q1_w$ of water W is preferably defined before its introduction in the tub 3 in such a way that the washing solution S completely wet the loaded laundry 10, as said before.

[0109] The first quantity $Q1_w$ of water W which is introduced in the tub 3 may be measured, during its introduction, for example by a flow meter, not illustrated, provided in the water inlet circuit 5, or by processing other parameters, for example the pressure of the delivered water and the duration of the water delivery; in this way it is possible to introduce into the tub 3 exactly the prefixed quantity $Q1_w$.

[0110] The first quantity $Q1_w$ of water W of the washing solution S necessary to completely wet the laundry 10 depends mainly on the quantity (i.e. dry weight D_w) of loaded laundry 10 and on the type of laundry 10. In fact, for example, cotton absorbs much more water than synthetic fibres, and therefore a certain quantity of laundry made of cotton requires, in order to be completely wetted, much more water than a same quantity of laundry made of synthetic fibres. The control unit 22 may be advantageously configured in such a way to state (i.e. to calculate by applying a prefixed algorithm or to select among a series of memorized values) which is the first quantity $Q1_w$ of water W of the washing solution S necessary to completely wet the laundry 10 on the basis of the dry weight D_w and preferably also of the type of the loaded laundry.

[0111] The ratio between the first quantity $Q1_w$ of water W and the dry weight D_w of the laundry 10 is preferably comprised between 1 and 3 litres/kg.

[0112] Preferably this ratio $Q1_w/D_w$ is comprised between 1,3 and 2,7 litres/kg.

[0113] Preferably this ratio $Q1_w/D_w$ is comprised between 1,5 and 2,5 litres/kg.

[0114] Preferably this ratio $Q1_w/D_w$ is comprised between 1,7 and 2,3 litres/kg.

[0115] Preferably this ratio $Q1_w/D_w$ is comprised between 1,8 and 2,2 litres/kg.

[0116] Preferably this ratio $Q1_w/D_w$ is comprised between 1,5 and 2,0 litres/kg.

[0117] The ratio between the first quantity $Q1_w$ of water W and the dry weight D_w of the laundry 30 is more preferably comprised between 1,5 and 1,8 litres/kg when the laundry 30 is substantially constituted by the "cotton base load" as defined in the international standard IEC 60456.

[0118] The control unit 22 may also advantageously set the proper quantity of first quantity $Q1_w$ of water W which form the quantity Q_s of washing solution S so as to obtain a suitable water-detergent ratio value. This optimal value allows obtaining the better washing performances.

[0119] The provision of this optimal water-detergent ratio value allows the use of a reduced quantity of detergent D with respect to the known technique.

[0120] The dry weight D_w of the laundry 10 can be obtained by the control unit 22 in different ways.

[0121] The dry weight D_w can be, for example, one of the parameters introduced by the user when setting the washing program.

[0122] In further embodiment, the dry weight D_w of the laundry 10 can be advantageously obtained by means of suitable weight sensors provided in the laundry washing machine 1, for example sensors that can be associated with the shock-absorbers of the tub 3.

[0123] Again, the control unit 22 may advantageously obtain the dry weight D_w of the laundry 10 by measuring the power absorbed by the motor 11 for the rotation of the drum 4 with the laundry 10 inserted therein. In this case, it is possible to set a brief rotation cycle of the drum 4 before the introduction of water, therefore with dry laundry 10, in order to measure the moment of inertia of the laundry 10 based on the power absorbed by the electric motor 11 and thus obtain the dry weight D_w of the laundry 10 itself by means of simple calculations.

[0124] Clearly any other method may be used to determine the quantity of the loaded laundry 10.

[0125] The type of fabric to be washed may be advantageously communicated to the control unit 22 directly by the user, for example by the interface unit 22a when setting the washing program.

[0126] In another embodiment the control unit 22 may be configured in such a way to sense or detect the type of loaded laundry by suitable sensing/detecting means, for example optical detecting means.

[0127] Once the laundry 10 is completely wetted, a

heating phase (step 140) according a preferred embodiment of the present invention is performed.

[0128] The heating phase (step 140) of the present invention hereinafter described takes advantageously place after the preferred phases above described with reference to the flow chart of Figure 4, which represents a particular embodiment.

[0129] It has to be noted that the heating phase of the present invention may generally be performed in a laundry washing method which provides for a previous phase, or phases, wherein the laundry has been wetted.

[0130] The heating phase of the present invention, therefore, is advantageously performed in any washing method which requires the heating of a wetted laundry, independently of the way the laundry has been wetted.

[0131] A first embodiment of the heating phase (step 140) of the invention is shown in detail in Figure 5.

[0132] In a first step (step 141), the heating element 20 is activated and a heating time t_h is started.

[0133] In successive steps, a control of the liquid level L inside the tub 3 with respect to a drum level L_d is performed.

[0134] The drum level L_d may be defined as the level of the lower part of the bottom 4a of the drum 4, as shown in Figures 2 and 3.

[0135] In the embodiment here described and illustrated in the figures, the drum 4 has a cylindrical shape and it is substantially horizontally placed. Therefore the drum level L_d corresponds to a line extending longitudinally along the bottom 4a of the drum 4 from its rear side 51 to its front side 52.

[0136] More generally a washing drum in a laundry washing machine comprises a central part having a substantially cylindrical shape while its front side and/or its rear side may preferably have a reduced size with respect to the central part. The washing drum is then preferably substantially horizontally placed inside the tub. In general, therefore, the drum level L_d as previously defined, corresponds to a line extending longitudinally along the central part of the drum, such a line being preferably substantially horizontal.

[0137] Hence, if the liquid level L is less than the drum level L_d (step 142), water is introduced inside the tub 3 (step 143).

[0138] The water is advantageously supplied into the tub 3 by making it flow through the drawer 6 and through the supply pipe 9.

[0139] If the liquid level L is more than the drum level L_d (step 144), the liquid is drained outside (step 145).

[0140] The liquid is advantageously drained outside through the water outlet circuit 25, preferably by activating the drain pump 26 and driving the two-way valve 35 (if provided) to allow the drainage through the outlet pipe 28.

[0141] The liquid level L is advantageously sensed by means of the pressure sensor 19. In further embodiment, the liquid level L may be sensed by means of different level sensors, for example a mechanical sensor, an elec-

tro-mechanical sensor, an optical sensor, etc..

[0142] In the previous described steps (steps 142-145) the method therefore provides for a liquid level control and maintains the liquid level L inside the tub 3 at a drum level L_d in which the liquid substantially touches the drum 4 from outside but does not substantially enters inside the drum 4.

[0143] It has to be noted that during said liquid level control a certain quantity of liquid, or heated liquid, may enter inside the drum 4. This may be due, for example, to the unavoidable reaction time of the control and/or to the slight movements of the drum 4 and/or of the tub 3. Nevertheless said certain quantity of liquid which may enter inside the drum 4 and which wets the laundry is a very low quantity, for example may enter for some millimetres. Furthermore also the time during which said low quantity of liquid wets the laundry is a short time. It can be assumed, therefore, that the liquid substantially touches the drum 4 from outside but does not substantially enters inside the drum 4.

[0144] In a successive step (step 146), if the heating time t_h is less than a predetermined heating time t_p the washing program goes back to the liquid level control performed by the previous described steps (steps 142-145).

[0145] When the heating time t_h reaches the predetermined heating time t_p (output "No" of step 146), the heating element 20 is turned off (step 147) and the heating phase ends.

[0146] The heating phase (step 140) above described, therefore, takes place for a predetermined heating time t_p .

[0147] In further embodiment, nevertheless, the duration of the heating phase may differently determined. For example the heating phase may end when the sensed temperature of the liquid T_L inside the tub 3 reaches a pre-determined heating temperature T_{Lh} or when the average of sensed temperature of the liquid inside the tub 3 reaches a pre-determined average heating temperature T_{Lah} . More, the heating phase may end when the laundry temperature T_l reaches a pre-determined laundry heating temperature T_{lh} or a pre-determined average laundry temperature T_{lah} . The laundry temperature T_l may be sensed through suitable sensors, for example an infrared sensor, or may be a value estimated by the control unit 22 on the base of other parameters, as for example the sensed liquid temperature T_L and the weight D_w of the laundry 10.

[0148] During the heating phase (step 140) above described the heated liquid which is kept at the drum level L_d touches the lower part of the bottom 4a of the drum 4 and transfers the thermal energy to the drum 4 by heat conduction. The heated drum 4 in turn transfers the thermal energy to the laundry 10 inside the drum 4. Advantageously, the drum 4 is heated along its central part having a substantially cylindrical shape. More advantageously, the drum 4 is heated along its entire length from the rear side 51 to the front side 52.

[0149] In this way, the laundry 10 is gradually and uniformly heated from its periphery, where it touches the drum 4, towards its centre.

[0150] It has to be noted that the low quantity of liquid which may enter inside the drum 4 during the liquid level control and which wets the laundry, as explained before, has a negligible effect in the laundry heating with respect to the described laundry heating effect obtained with the thermal energy transfer through the drum 4.

[0151] During the heating phase (step 140), one or more rotation cycles of the drum 4 are also preferably performed (step 150), as shown in Figure 4, so as to enhance uniform heating of the drum 4 and, in turn, of the laundry 10.

[0152] In a preferred embodiment, a continuous rotation is performed, preferably at a low rotation speed, for example comprised between around 10 and 80 rpm.

[0153] In further embodiments, successive rotation cycles are performed at prefixed time interval, preferably at low speed (for example around 10 and 80 rpm), with the same advantages mentioned above.

[0154] Heat transfer of thermal energy from the heating device 20 to the laundry 10 allows the reduction of thermal dispersion with respect to the known art. In fact the thermal energy of the heated liquid is directly transferred to the drum 4 and from there to the laundry 10, thus avoiding dispersion in other duct of the washing machine 1, as for example occurs with the dispersion along the recirculation circuit of known methods where the heating phase provides for the use of the recirculation circuit to recirculate the heated liquid. Furthermore, the control of the liquid level L which is maintained at the drum level L_d avoid the liquid entering inside the drum 4. In this way advantageously the ratio between the first quantity $Q1_w$ of water W and the dry weight D_w reached in the previous phases is maintained.

[0155] It has to be noted that a minimum quantity of liquid may enter into the tub 3, in particular due to the slight movements of the drum 4 and/or of the tub 3 during rotations of the drum 4. Nevertheless this minimum quantity of liquid entering inside the drum 4, which is typically absorbed by the laundry 10, does not substantially modify the desired optimal ratio $Q1_w/D_w$, as said above. Furthermore, the heating phase (step 140) of the present method is advantageously obtained with a reduced power consumption with respect the heating phase of the known technique. In fact the energy used during the heating phase of the present method is almost totally dissipated for heating the quantity of liquid which lays at the bottom of the tub 3 up to the drum level L_d .

[0156] In the mentioned method belonging to the prior-art, on the contrary, the energy is used to heat a larger amount of water which surrounds the washing drum, and in particular is used to heat the liquid which fills the hollow space between the tub and the drum over the drum level L_d , as shown in Figure 1 with reference to the gray areas indicated with G.

[0157] It has to be noted that the heating phase (step

140) according to the present invention may be advantageously performed in the known laundry washing machine without any modification.

[0158] During the heating phase (step 140) the temperature T_L of the heated liquid is preferably kept at a substantially constant value, for example a constant value between 30°C and 65°C, or in a temperature range between a minimum temperature T_{min} and a maximum temperature T_{max} .

[0159] The minimum temperature T_{min} is preferably comprised between 25°C and 35°C, and the maximum temperature T_{max} is preferably comprised between 55°C and to 65°C.

[0160] The liquid temperature T_L is advantageously set according to the type of the loaded laundry 10 and/or the quantity of loaded laundry 10.

[0161] During the heating phase (step 140) the predetermined heating time t_p is advantageously set according to the type of loaded laundry 10 and/or the quantity of loaded laundry 10. For example for cotton laundry, the predetermined heating time t_p may be comprised between 15 and 25 minutes with the liquid temperature T_L at 60°C.

[0162] In different embodiments, the heating device 20 may not be activate continuously but at pre-determined time interval. In further embodiments, the heating device 20 may be activate by means of a control based on the liquid temperature T_L , preferably by means of a closed loop control.

[0163] The liquid temperature T_L is advantageously sensed by means of the temperature sensor associated to the heating device 20.

[0164] At the end of the heating phase (step 140) the laundry 10 is wetted and heated.

[0165] Once the heating phase (step 140) has been completed, a dry maintenance phase is started (step 155), as shown in Figure 4. With the term "dry" we mean that no more liquid is introduced during the maintenance phase, while the laundry 10 is certainly wetted according to the previous phases described.

[0166] In the dry maintenance phase the heating device 20 is deactivated and the laundry 10 is kept in this condition for a predetermined dry maintenance time t_d . This phase ensures that the washing solution S absorbed by the laundry 10 has time to react with the stained fabrics of the dirty laundry 10.

[0167] The predetermined dry maintenance time t_d is advantageously set according to the type of loaded laundry 30 and/or the quantity of loaded laundry 30 and is preferably comprised between 10min and 90min. For example for cotton laundry, the dry maintenance time t_d may be preferably comprised between 30 min and 75min.

[0168] During the dry maintenance phase (step 155), one or more rotation cycles of the drum 4 are also preferably performed (step 157).

[0169] In a preferred embodiment, a continuous rotation is performed, preferably at a low rotation speed, for example comprised between around 10 and 80 rpm.

Once the dry maintenance phase (step 155) has been completed, a wet maintenance phase is started (step 160).

[0170] In this phase a second quantity Q_{2w} of water W is introduced into the tub 3. During the wet maintenance phase (step 160), one or more rotation cycles of the drum 4 are also preferably performed (step 170).

[0171] The amount of liquid L_q inside the tub 3 at this stage is the sum of the quantity Q_s of the washing solution S, of the water added during the heating phase (step 140) and of the second quantity Q_{2w} of water W. The laundry 10 is already completely wetted from the previous phases and therefore the liquid L_q exceeds the absorption capacity of the laundry 10. Part of liquid L_q , therefore, falls down on the bottom of the tub 3.

[0172] For this reason in a further preferred embodiment, the recirculation circuit 30 is activated (step 180) so that the exceeding liquid on the bottom of the tub 3 can be pumped and recirculated in the drum 4 over the laundry 10.

[0173] The introduction of the second quantity Q_{2w} of water W preferably takes place through the water inlet circuit 5 that will provide for feeding water into the tub 3. If necessary, during the wet maintenance phase (step 160) the liquid L may also be heated through the activation of the heating device 20.

[0174] Rotations of the drum 4, preferably in clockwise and/or anticlockwise direction, advantageously takes place at a pre-determined rotational speed, for example in a range comprised between 10 rpm and 80 rpm.

[0175] The amount of the second quantity Q_{2w} of water W introduced during the wet maintenance phase (step 160) is preferably set so that the ratio between the second quantity Q_{2w} of water W and the dry weight D_w of the laundry 10 is comprised between 0,5 to 1,1 litres/kg.

[0176] More preferably this ratio Q_{2w}/D_w is comprised between 0,7 and 0,9 litres/kg.

[0177] The second quantity Q_{2w} of water W introduced during the wet maintenance phase helps the removal of stains from the stained fabrics and/or the removal of the detergent D which has reacted with the stained fabrics of the dirty laundry 10. The stains are therefore removed from the fabrics and transferred in the water inside the tub 3 together with the detergent D to form a dirty liquid solution. Once the wet maintenance phase (step 160) has been completed, the laundry 10 is clean and a rinsing phase is performed (step 190).

[0178] In further embodiments, the method may preferably provide for a single main washing phase before the rinsing phase (step 190) instead of the dry maintenance phase (step 155) and the wet maintenance phase (step 160) here described. In this main washing phase, the wetted and heated laundry 10 is preferably subjected to a washing mechanical action by means of drum rotations.

[0179] The rinsing phase (step 190) comprises the removal from the laundry 10 and from the tub 3 of the dirty liquid produced during the wet maintenance phase (step

160).

[0180] The liquid on the bottom of the tub 3 is removed from the tub 3; the removal operation preferably includes the drainage of the liquid from the tub 3 towards the outside of the washing machine 1 by means of the drain pump 26 that takes the liquid from the bottom of the tub 3 and conveys it towards the outside through the outlet duct 28. The drainage of the liquid from the tub 3 towards the outside of the washing machine 1 is advantageously performed contemporaneously with, or after the, rotations of the drum at higher speed, so as to extract the rinsing liquid from the laundry 10.

[0181] Preferably clean water is added during the rinsing phase. More preferably the clean water is added during between stop interval time between successive rotations. The clean water enhances the extraction of the dirty liquid from the laundry 10.

[0182] The rinsing phase (step 190) may preferably comprise several consecutive cycles of the type just described.

[0183] Hence the washing program continues with a spinning phase (step 200). The spinning phase preferably comprises one or more high-speed rotation cycles of the drum 4 to remove from the laundry 10 as much water as possible. Expression "high-speed" has to be interpreted as a speed which allows removing a suitable quantity of water from the laundry 10 by the centrifugal force; suitable values of speed are for example from 400 rpm to 1600 rpm.

[0184] The water expelled outside the drum 4 falls down on the bottom of the tub 3 and is removed from the tub 3 (after or contemporaneously with the spinning phase) by means of the drain pump 26 that takes the water from the bottom of the tub 3 and conveys it towards the outside through the outlet duct 28.

[0185] Once the spinning phase (step 200) terminates, the washing program is completed.

[0186] At this point, the user may take the laundry 10 out.

[0187] In case the washing program is performed in a laundry washing-drying machine, after the spinning phase (step 200) the laundry 10 may be advantageously subjected to a drying phase inside the drum 4 (step 210).

[0188] With reference to the flow chart of Figure 6 and the enlarged view of Figure 9 another embodiment of the heating phase of the method of the invention (step 140') is illustrated.

[0189] In a first step (step 141), the heating element 20 is activated and a heating time t_h is started.

[0190] In successive steps, a control of the liquid level L inside the tub 3 with respect to a drum level L_d is performed.

[0191] The drum level L_d may be defined as previously described with reference to the flow chart of Figure 5.

[0192] If the liquid level L is less than the drum level L_d (step 142), water is introduced inside the tub 3 (step 143).

[0193] The water is advantageously supplied into the

tub 3 by making it flow through the drawer 6 and through the supply pipe 9.

[0194] Then, if the liquid level L is more than a high drum level L_{dH} (step 144'), the liquid is drained outside (step 145).

[0195] The high drum level L_{dH} , as shown in Figure 9, may be defined as a level which is a small quantity S_H higher than the drum level L_d as previously defined, i.e. the level of the lower part of the bottom 4a of the drum 4. The small quantity S_H has a value preferably less than 2 cm. In the embodiment here described and illustrated in the figures, the drum 4 has a cylindrical shape and it is substantially horizontally placed. Therefore the high drum level L_{dH} corresponds to a line extending longitudinally along the drum 4 from its rear side 51 to its front side 52 and parallel to the drum level L_d .

[0196] More generally, as said before, a washing drum in a laundry washing machine comprises a central part having a substantially cylindrical shape while its front side and/or its rear side may preferably have a reduced size with respect to the central part. The washing drum is then preferably substantially horizontally placed inside the tub. In general, therefore, the high drum level L_{dH} , as previously defined, corresponds to a line extending longitudinally along the central part of the drum and parallel to the drum level L_d , such a line being preferably substantially horizontal.

[0197] In the previous described steps (steps 142-145) the method therefore provides for a liquid level control and maintains the liquid level L inside the tub 3 at a level comprised between the two extreme levels L_d and L_{dH} in which the liquid substantially touches the drum 4 from outside. In this embodiment a minimum quantity of liquid may enter into the tub 3. Nevertheless this minimum quantity of liquid entering inside the drum 4, which is typically absorbed by the laundry 10, does not substantially modify the desired optimal ratio $Q1_w/D_w$ reached in the previous phases for the laundry 10. The provision of the high drum level L_{dH} advantageously enhances the liquid level control since such a control takes into account the slight movements of the drum 4 and/or of the tub 3 during rotations of the drum 4.

[0198] In a successive step (step 146), if the heating time t_h is less than a predetermined heating time t_p , the washing program goes back to the liquid level control performed by the previous described steps (steps 142-145).

[0199] When the heating time t_h reaches the predetermined heating time t_p (output "No" of step 146), the heating element 20 is turned off (step 147) and the heating phase ends.

[0200] The heating phase (step 140') above described, therefore, takes place for a predetermined heating time t_p .

[0201] In further embodiment, nevertheless, the duration of the heating phase may differently determined. For example the heating phase may end when the sensed temperature of the liquid T_L inside the tub 3 reaches a

pre-determined heating temperature T_{Lh} or when the average of sensed temperature of the liquid inside the tub 3 reaches a pre-determined average heating temperature T_{Lah} . More, the heating phase may end when the laundry temperature T_1 , reaches a pre-determined laundry heating temperature T_{1h} or a pre-determined average laundry temperature T_{1ah} . The laundry temperature T_1 , may be sensed through suitable sensors, for example an infrared sensor, or may be a value estimated by the control unit 22 on the base of other parameters, as for example the sensed liquid temperature T_L and the weight D_w of the laundry 10.

[0202] With reference to the flow chart of Figure 7 and the enlarged view of Figure 9 another embodiment of the heating phase of the method of the invention (step 140") is illustrated.

[0203] In a first step (step 141), the heating element 20 is activated and a heating time t_h is started.

[0204] In successive steps, a control of the liquid level L inside the tub 3 with respect to a low drum level L_{dL} is performed.

[0205] The low drum level L_{dL} , as shown in Figure 9, may be defined as a level which is a small quantity S_L lower than the drum level L_d as previously defined, i.e. the level of the lower part of the bottom 4a of the drum 4. The small quantity S_L has a value preferably less than 2 cm.

[0206] In the embodiment here described and illustrated in the figures, the drum 4 has a cylindrical shape and it is substantially horizontally placed. Therefore the low drum level L_{dL} corresponds to a line extending longitudinally and parallel to the drum level L_d .

[0207] Hence if the liquid level L is less than the low drum level L_{dL} (step 142'), water is introduced inside the tub 3 (step 143).

[0208] The water is advantageously supplied into the tub 3 by making it flow through the drawer 6 and through the supply pipe 9.

[0209] Then, if the liquid level L is more than the drum level L_d (step 144), the liquid is drained outside (step 145).

[0210] The liquid is advantageously drained outside through the water outlet circuit 25 by activating the drain pump 26 and driving the two-way valve 35 to allow the drainage through the outlet pipe 28.

[0211] In the previous described steps (steps 142'-145) the method therefore provides for a liquid level control and maintains the liquid level L at a level comprised between the two extreme levels L_d and L_{dL} in which the liquid substantially touches the drum 4 from outside. The provision of the low drum level L_{dL} advantageously enhances the liquid level control since such a control takes into account the slight vertical movements of the drum 4 and/or of the tub 3 during rotations of the drum 4.

[0212] In a successive step (step 146), if the heating time t_h is less than a predetermined heating time t_p , the washing program goes back to the liquid level control performed by the previous described steps (steps 142'-145).

[0213] When the heating time t_h reaches the predetermined heating time t_p (output "No" of step 146), the heating element 20 is turned off (step 147) and the heating phase ends.

[0214] The heating phase (step 140'') above described, therefore, takes place for a predetermined heating time t_p .

[0215] In further embodiment, nevertheless, the duration of the heating phase may differently determined. For example the heating phase may end when the sensed temperature of the liquid T_L inside the tub 3 reaches a pre-determined heating temperature T_{Lh} or when the average of sensed temperature of the liquid inside the tub 3 reaches a pre-determined average heating temperature T_{Lah} . More, the heating phase may end when the laundry temperature T_l reaches a pre-determined laundry heating temperature T_{lh} or a pre-determined average laundry temperature T_{lah} . The laundry temperature T_l may be sensed through suitable sensors, for example an infrared sensor, or may be a value estimated by the control unit 22 on the base of other parameters, as for example the sensed liquid temperature T_L and the weight D_w of the laundry 10.

[0216] With reference to the flow chart of Figure 8 and the enlarged view of Figure 9 another embodiment of the heating phase of the method of the invention (step 140''') is illustrated.

[0217] This embodiment corresponds to the combination of the previous two embodiments described with reference to the flow charts of Figures 6 and 7.

[0218] In a first step (step 141), the heating element 20 is activated and a heating time t_h is started.

[0219] In successive steps, a control of the liquid level L inside the tub 3 with respect to a low drum level L_{dL} is performed.

[0220] The low drum level L_{dL} , as shown in Figure 9, may be defined as previously described with reference to the flow chart of Figure 7.

[0221] If the liquid level L is less than the low drum level L_{dL} (step 142'), water is introduced inside the tub 3 (step 143).

[0222] The water is advantageously supplied into the tub 3 by making it flow through the drawer 6 and through the supply pipe 9.

[0223] In the successive step, if the liquid level L is more than a high drum level L_{dH} (step 144'), the liquid is drained outside (step 145).

[0224] The high drum level L_{dH} , as shown in Figure 9, may be defined as previously described with reference to the flow chart of Figure 6.

[0225] In the previous described steps (steps 142'-145) the method therefore provides for a liquid level control and maintains the liquid level L at a level comprised between the two extreme levels L_{dH} and L_{dL} in which the liquid substantially touches the drum 4 from outside. In this embodiment a minimum quantity of liquid may enter into the tub 3. Nevertheless this minimum quantity of liquid entering inside the drum 4, which is typ-

ically absorbed by the laundry 10, does not substantially modify the desired optimal ratio $Q1_w/D_w$ reached in the previous phases for the laundry 10. The provision of the high and low drum levels L_{dH} and L_{dL} advantageously enhances the liquid level control since such a control takes into account the slight movements of the drum 4 and/or of the tub 3 during rotations of the drum 4.

[0226] In a successive step (step 146), if the heating time t_h is less than a predetermined heating time t_p , the washing program goes back to the liquid level control of the previous described steps (steps 142'-145).

[0227] When the heating time t_h reaches the predetermined heating time t_p (output "No" of step 146), the heating element 20 is turned off (step 147) and the heating phase ends.

[0228] The heating phase (step 140''') above described, therefore, takes place for a predetermined heating time t_p .

[0229] In further embodiment, nevertheless, the duration of the heating phase may differently determined. For example the heating phase may end when the sensed temperature of the liquid T_L inside the tub 3 reaches a pre-determined heating temperature T_{Lh} or when the average of sensed temperature of the liquid inside the tub 3 reaches a pre-determined average heating temperature T_{Lah} . More, the heating phase may end when the laundry temperature T_l reaches a pre-determined laundry heating temperature T_{lh} or a pre-determined average laundry temperature T_{lah} . The laundry temperature T_l may be sensed through suitable sensors, for example an infrared sensor, or may be a value estimated by the control unit 22 on the base of other parameters, as for example the sensed liquid temperature T_L and the weight D_w of the laundry 10.

[0230] Figure 10 shows the flow chart of a further embodiment of the washing program of the invention described with reference to Figure 4 performed in the laundry washing machine 1 of Figures 2 and 3.

[0231] This method differs from the method described with reference to Figure 4 for the fact that after the washing program selection (step 110) and before the phase of introducing into the tub 3 a quantity Qd of detergent D together with a first quantity $Q1_w$ of water W (step 120) a further phase of pre-wetting the laundry 10 with a pre-wetting quantity Qp_w of water W is provided (step 112).

[0232] This pre-wetting phase (step 112) is advantageously performed on the base of the quantity (i.e. dry weight D_w) of loaded laundry 10 and on the type of laundry 10. This phase (step 112) is preferably, but not necessarily, performed when the quantity (i.e. dry weight D_w) of loaded laundry 10 can be considered high.

[0233] In fact, if the dry weight D_w of the loaded laundry 10 is high, namely a load greater than half the rated-load capacity of the laundry washing machine 1, a pre-wetting quantity Qp_w of water W is preferably introduced in one step into the tub 3 (step 112). This quantity Qp_w of water W is absorbed by the laundry 10 inside the drum 4 and enhance the wetting of the high quantity of laundry 10

before the introduction of the first quantity $Q1_w$ of water W in the following step. The amount of this pre-wetting quantity Qp_w of water W is calculate, or estimate, in such a way that after the successive phase (step 120) of introducing the washing solution S, the loaded laundry 10 is completely wetted and the level L_r of the residual washing solution S on the bottom of the tub 3 is substantially below the bottom part of the drum 4 or, even more preferably, the hollow space 12 between the tub 3 and the drum 4 is substantially empty and free from any liquid.

[0234] The amount of the pre-wetting quantity Qp_w of water W is preferably set so that the ratio $(Qp_w + Q1_w)/D_w$ between the sum $Qp_w + Q1_w$ of the pre-wetting quantity Qp_w of water W and the first quantity $Q1_w$ and the dry weight D_w of the laundry 10 is comprised between 1 and 3 litres/kg.

[0235] Preferably this ratio $(Qp_w + Q1_w)/D_w$ is comprised between 1,3 and 2,7 litres/kg. Preferably this ratio $(Qp_w + Q1_w)/D_w$ is comprised between 1,5 and 2,5 litres/kg. Preferably this ratio $(Qp_w + Q1_w)/D_w$ is comprised between 1,7 and 2,3 litres/kg. Preferably this ratio $(Qp_w + Q1_w)/D_w$ is comprised between 1,8 and 2,2 litres/kg. Preferably this ratio $(Qp_w + Q1_w)/D_w$ is comprised between 1,5 and 2,0 litres/kg. The amount of the pre-wetting quantity Qp_w of water W is preferably set so that the ratio $(Qp_w + Q1_w)/D_w$ between the sum $Qp_w + Q1_w$ of the pre-wetting quantity Qp_w of water W and the first quantity $Q1_w$ and the dry weight D_w of the laundry 30 is comprised between 1,5 and 1,8 litres/kg when the laundry 30 is substantially constituted by the "cotton base load" as defined in the international standard IEC 60456.

[0236] The complete absorption of the laundry 10 is guaranteed by the fact that the sum of the pre-wetting quantity Qp_w of water W and the quantity Q_s of the washing solution S is properly chosen so that it does not exceed the absorption capacity of the laundry 10.

[0237] This phase (step 112) is also preferably performed on the base of the type of the laundry 10, for example if the laundry is made of cotton it will require a higher quantity of water than a load of synthetic laundry.

[0238] During the introduction of the pre-wetting quantity Qp_w of water W (step 112) the recirculation circuit 30 is advantageously activated (step 114).

[0239] The water W which lies on the bottom of the tub 3 is drained towards the upper part of the tub 3 by means of the drain pump 26 and reaches the laundry 10 from above.

[0240] By means of this recirculation process, uniform and complete wetting of the laundry 10 with the pre-wetting quantity Qp_w of water W can be accomplished. Preferably, the recirculation process takes place for a pre-established period of time deemed sufficient for the complete absorption of the pre-wetting quantity Qp_w of water W by the laundry 10.

[0241] It has to be noted that the quantity Qp_w of water W of the pre-wetting phase (step 112) here disclosed has to be considered the quantity of water that wet the laundry 10 before the phase of introducing into the tub 3 a quantity

Q_d of detergent D together with a first quantity $Q1_w$ of water W (step 120).

[0242] In the embodiment above described, the quantity Qp_w of water W has been provided by introducing it in one step into the tub 3. Nevertheless, the pre-wetting phase (step 112) may be differently performed by comprising further steps of introducing water into the tub 3 and draining water from the tub 3. This steps may advantageously enhance and render more uniform the absorption of water by the laundry 10. Spinning steps may also advantageously be provided between said steps of introducing and draining water. In any case, the quantity of the remaining water which wet the laundry at the end of pre-wetting phase (step 112) represents the pre-wetting quantity Qp_w of water before the successive introducing phase (step 120).

[0243] The quantity of this remaining water, i.e. the pre-wetting quantity Qp_w , may be easily calculated by the control unit 22 through the measurement of the water introduced in the tub 3 and the water drained from the tub during the pre-wetting phase (step 112).

[0244] The following phases of the method may then continue according to the described remaining phases of the method as described in Figure 4. In particular, a heating phase (step 140) is carry out according to the heating phase of the present invention above described.

[0245] It has thus been shown that the present invention allows all the set objects to be achieved. In particular, it makes it possible to obtain a heating phase in a washing cycle of a laundry washing machine that allows to obtain a more uniform heating of the laundry in the drum with respect to the methods of the prior art.

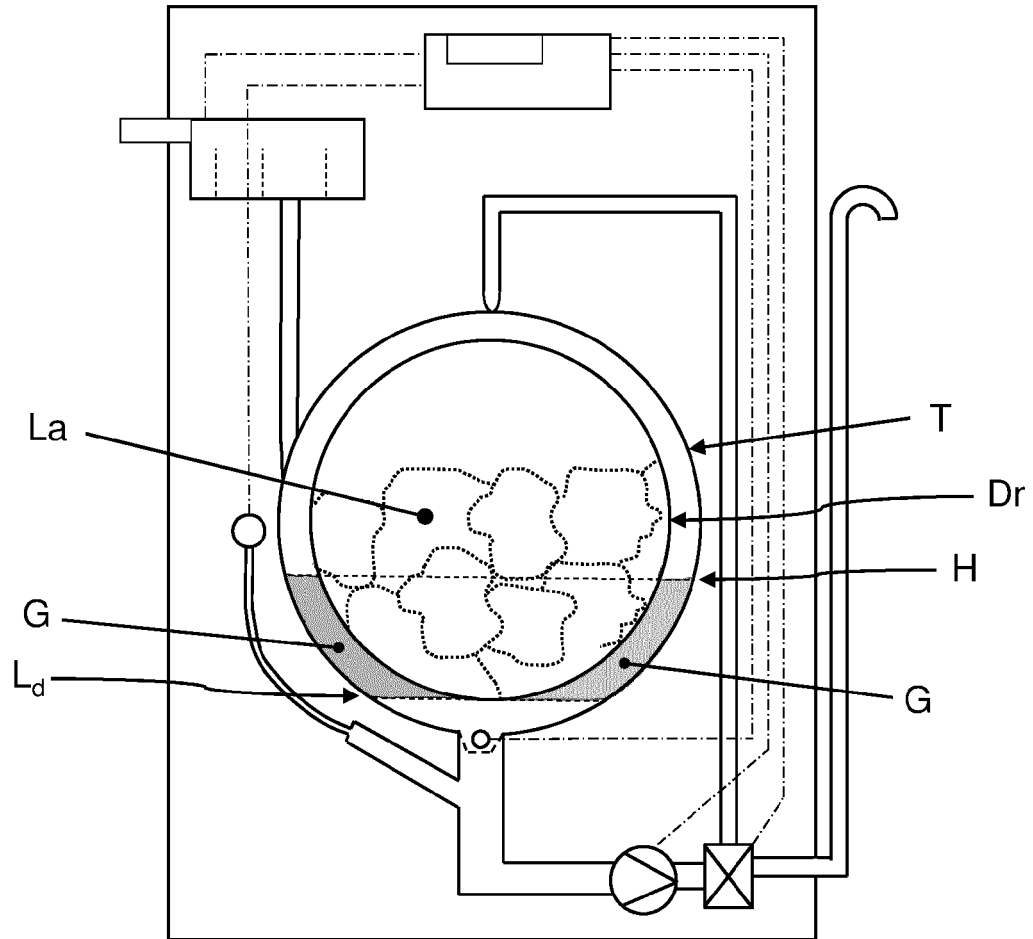
[0246] While the heating phase of present invention has been described with reference to a particular washing cycle, it should be noted that the present invention is not limited to the specific embodiment illustrated and described herein; on the contrary, further variants of the embodiments described herein fall within the scope of the present invention, which is defined in the claims.

[0247] It is underlined that the laundry washing machines illustrated in the enclosed figures, and with reference to which some embodiments of the method according to the invention have been described, are of the front-loading type; however it is clear that the method according to the invention can be applied as well to a top-loading washing machine, substantially without any modification.

Claims

1. Method for washing laundry in a laundry washing machine (1), said laundry washing machine (1) comprising a washing tub (3) external to a washing drum (4) suited to receive said laundry (10) and comprising a heating device (20), said method comprising a heating phase for heating said laundry (10),
characterized in that
said heating phase comprises the steps of:

- providing a quantity of liquid into said washing tub (3) up to a level (L_d ; L_{dL} ; L_{dH}) at which said liquid touches the lower part (4a) of said washing drum (4);
 - heating said liquid by means of said heating device (20);
 - controlling said liquid level to maintain said liquid at a contacting level (L_d ; L_{dL} ; L_{dH}) so that said liquid touches said washing drum (4) in order to transfer the thermal energy from said liquid to said washing drum (4) and from said washing drum (4) to said laundry (10).
2. Method according to claim 1, **characterized in that** during said phase of controlling said liquid, the liquid does not substantially enter inside the washing drum (4).
 3. Method according to claim 1 or 2, **characterized in that** said contacting level (L_{dL} ; L_{dH}) is less than 2 cm away from the level (L_d) of the lower part (4a) of said washing drum (4).
 4. Method according to any of the preceding claims, **characterized in that** said step of controlling said liquid level comprises adding water into said washing tub (3) if said liquid level is below said contacting level (L_d ; L_{dL} ; L_{dH}).
 5. Method according to any of the preceding claims, **characterized in that** said step of controlling said liquid level comprises draining liquid from said washing tub (3) if said liquid level is above said contacting level (L_d ; L_{dL} ; L_{dH}).
 6. Method according to any of the preceding claims, **characterized in that** it comprises rotations of said washing drum (4) during said heating phase.
 7. Method according to any of the preceding claims, **characterized in that** said step of controlling said liquid level comprises sensing said liquid level by means of a pressure sensor (19) placed at the bottom of the tub (3).
 8. Method according to any of the claims from 1 to 6, **characterized in that** said step of controlling said liquid level comprises sensing said liquid level by means of an optical sensor associated to the tub (3).
 9. Method according to any of the preceding claims, **characterized in that** said heating phase takes place for a predetermined heating time (t_p).
 10. Method according to claim 9, **characterized in that** said predetermined heating time (t_p) is based on the selected program by the user.
 11. Method according to any of the preceding claims, **characterized in that** said heating phase takes place activating continuously said heating device (20).
 12. Method according to any of the preceding claims, **characterized in that** said heating phase takes place activating intermittently said heating device (20).
 13. Method according to any of the preceding claims, **characterized in that** said heating phase takes place activating said heating device (20) on the base of the sensed temperature (T_L) of said liquid inside said washing tub (3).
 14. Method according to any of the preceding claims, **characterized in that** said heating phase takes place activating said heating device (20) which is located at the bottom of the tub (3).
 15. Method according to any of the preceding claims, **characterized in that** it comprises at least a phase of wetting said laundry (10) before said heating phase.



PRIOR ART

FIG. 1

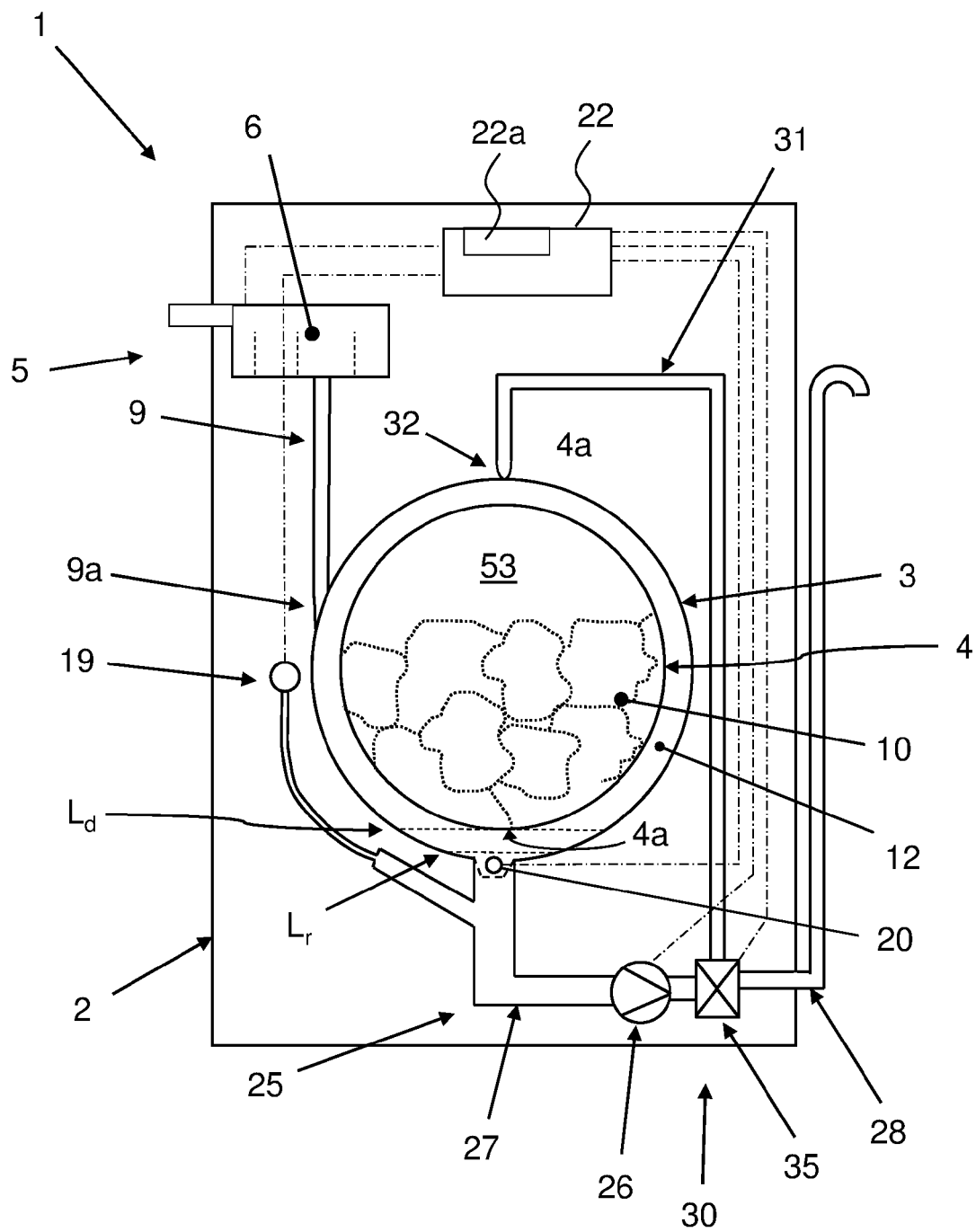


FIG. 2

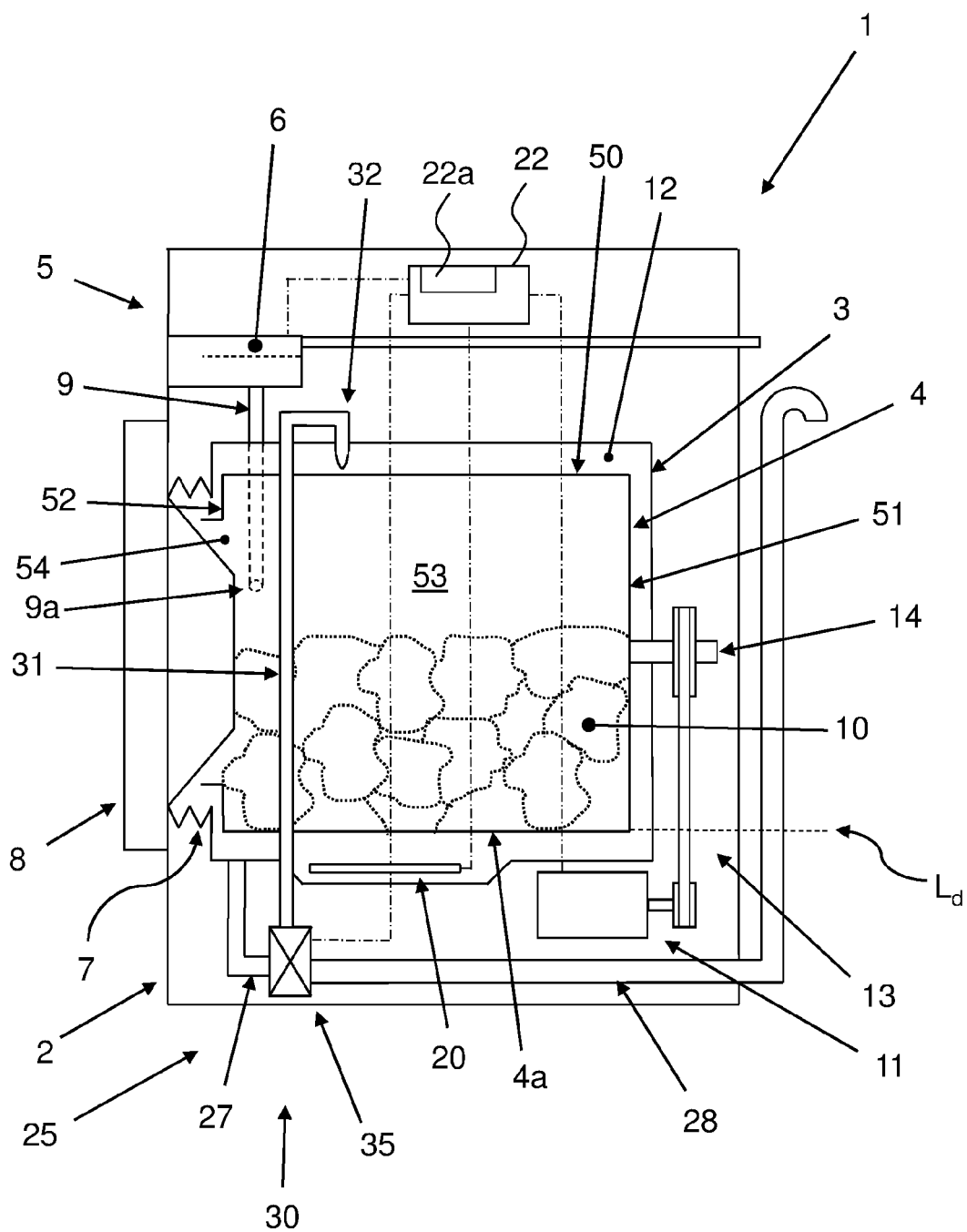


FIG. 3

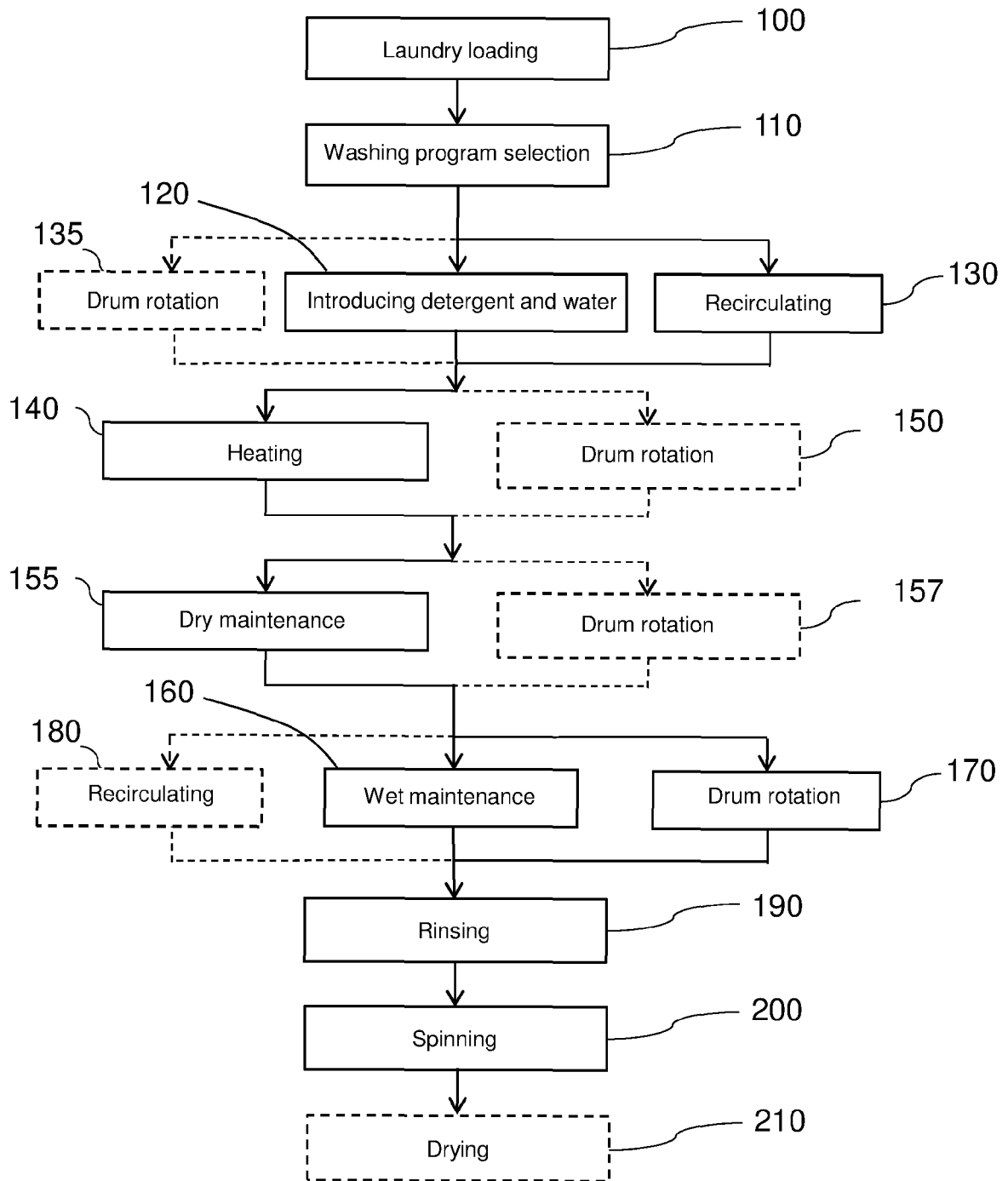


FIG. 4

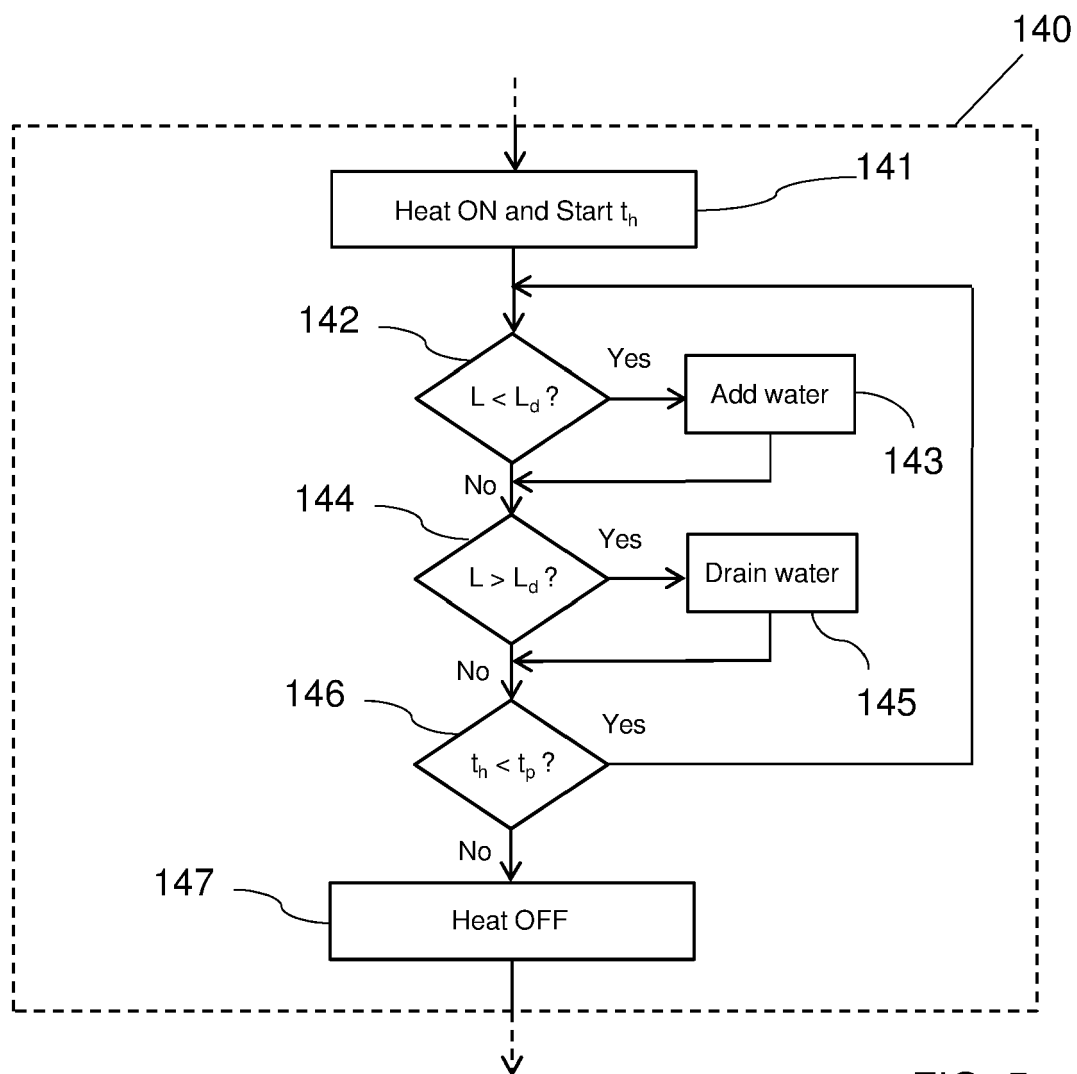


FIG. 5

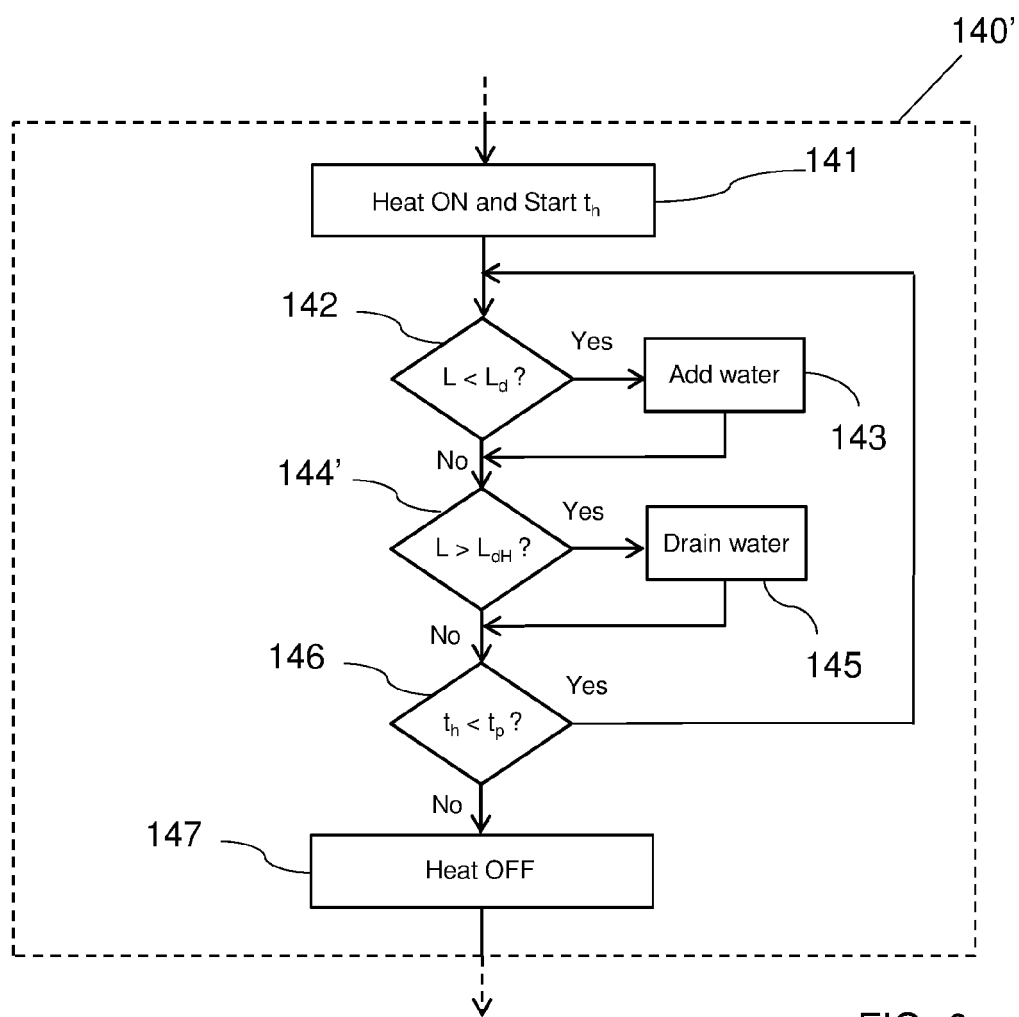


FIG. 6

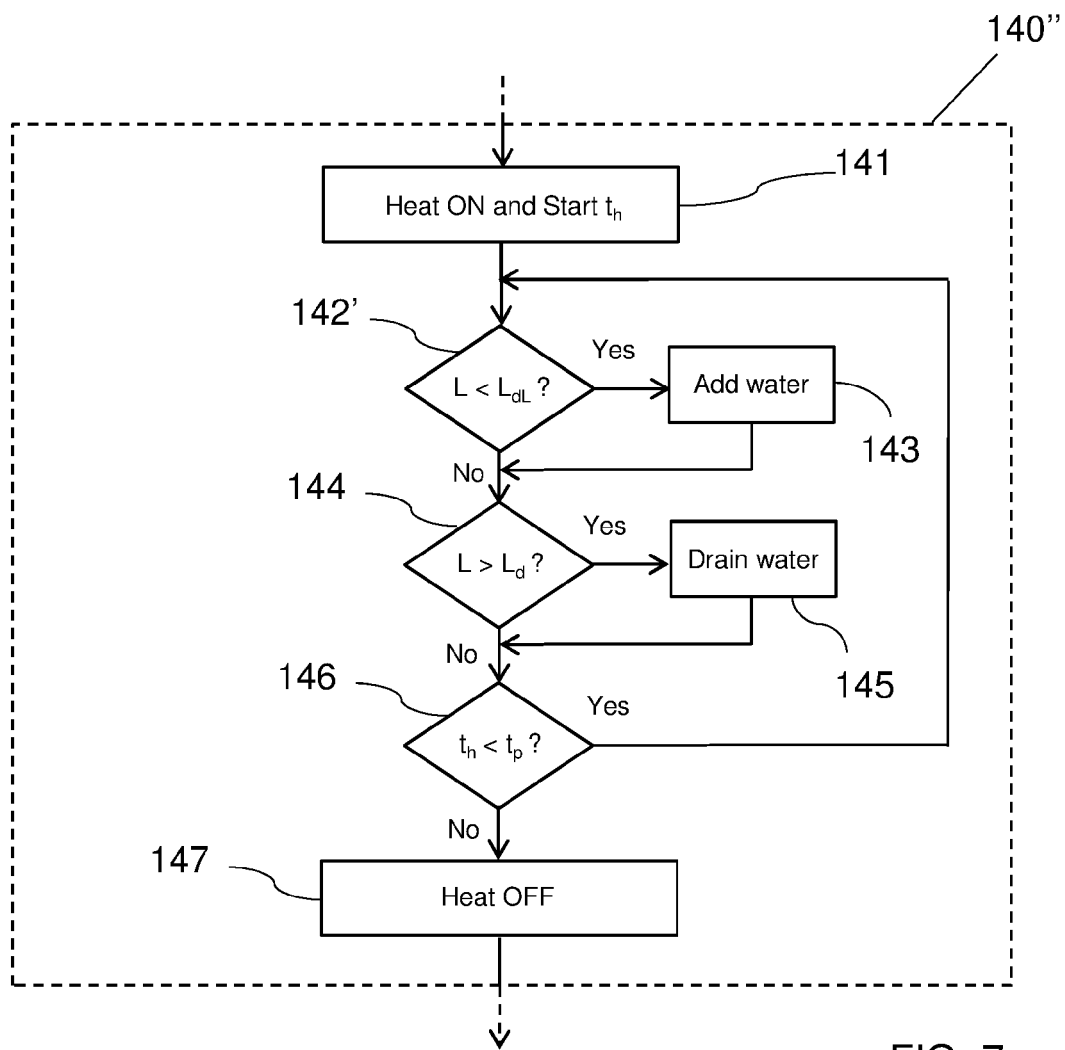


FIG. 7

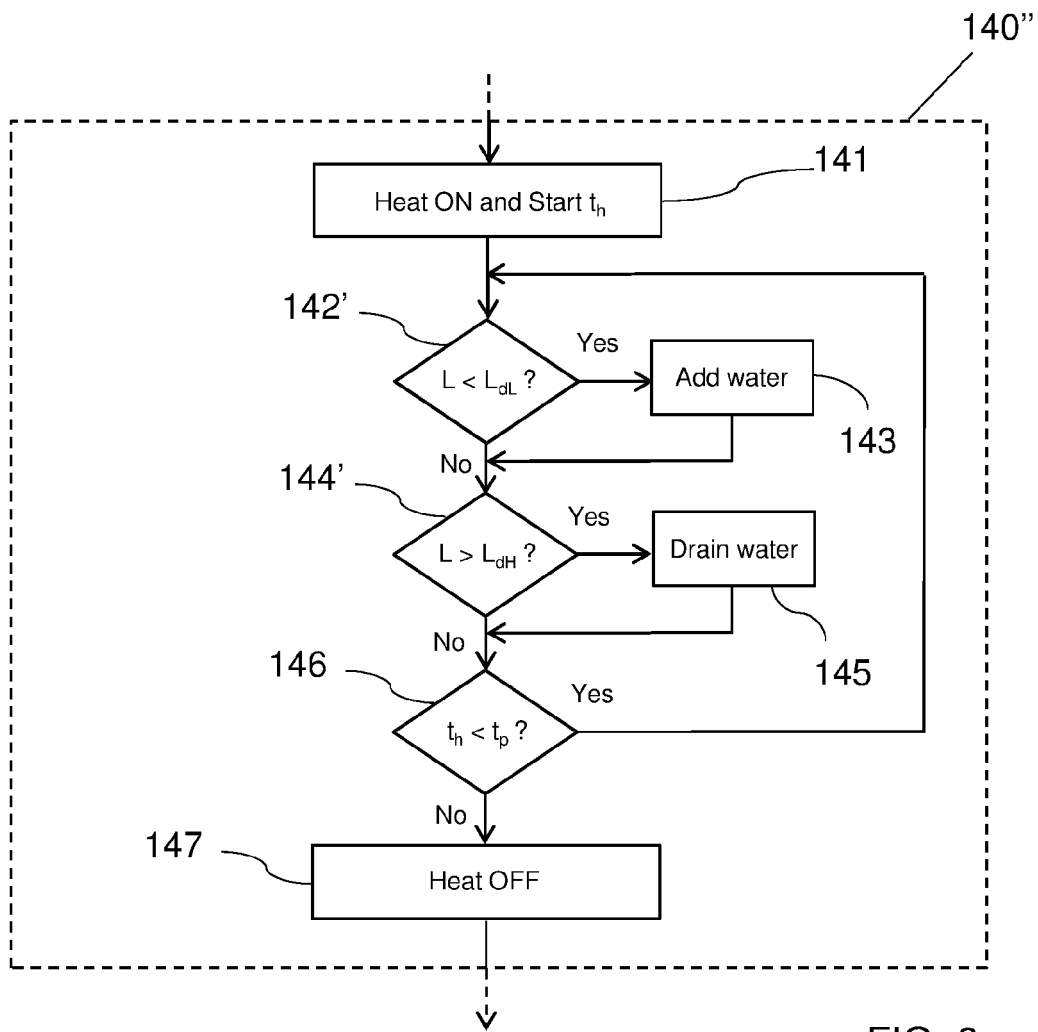


FIG. 8

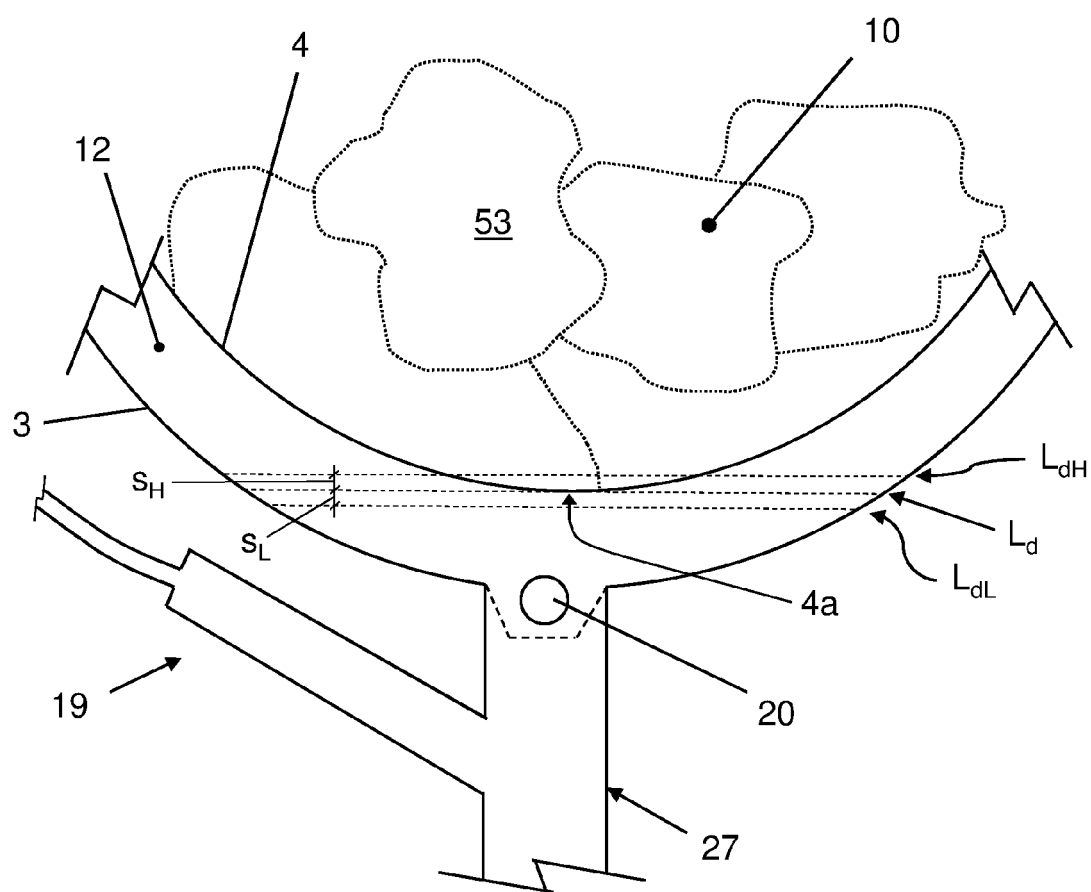


FIG. 9

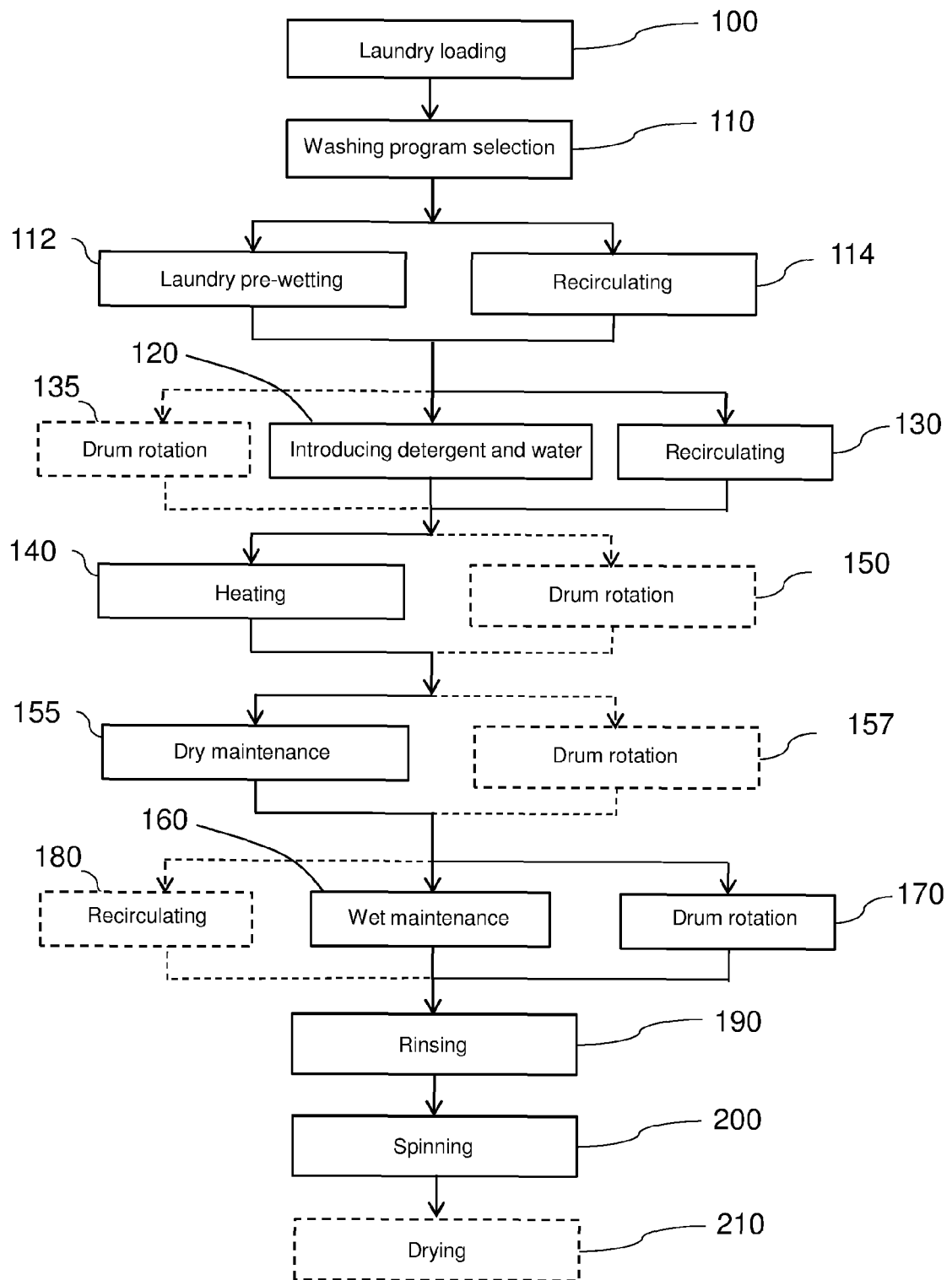


FIG. 10



EUROPEAN SEARCH REPORT

Application Number
EP 11 18 3717

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Munich		28 February 2012	Hannam, Martin
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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