



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
10.04.2013 Bulletin 2013/15

(51) Int Cl.:
D06F 35/00 (2006.01)

(21) Application number: **11183719.1**

(22) Date of filing: **03.10.2011**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

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(54) **Method for washing laundry in a laundry washing machine and 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 wetting and heating phase for wetting the laundry by means of a laundry washing liquid heated at a predetermined washing temperature. The wetting and heating phase comprises the steps of:

a) providing a first quantity of cold liquid at the bottom of

the washing tub up to a first level which is below, or equal to, the level of the lower part of the washing drum;
b) heating the liquid at the bottom of the washing tub by means of the heating device up to a first temperature which is higher than the predetermined washing temperature;
c) providing a second quantity of cold liquid into the washing tub and mixing it with the heated liquid at the first temperature in order to obtain the laundry washing liquid at the predetermined washing temperature.

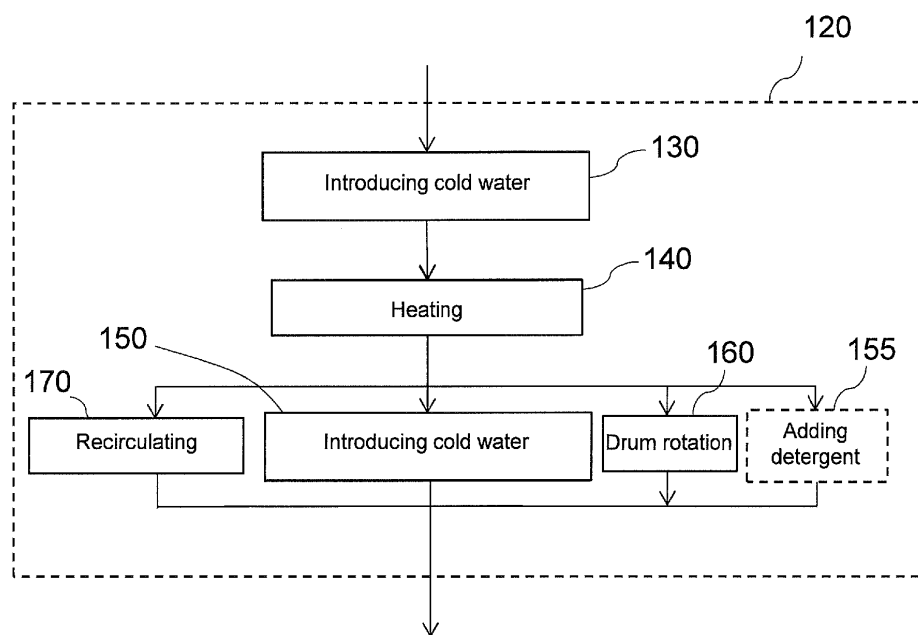


FIG. 4

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 wetting and 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 comprise 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 phase during which the laundry is wetted by means of the introduction of water into the tub. During this wetting phase preferably a preset quantity of washing detergent is also added to form a washing liquid which is then absorbed by the laundry.

[0012] During this initial phase the water (or the washing liquid) is typically heated to a preferred temperature, according to the washing program selected by the user and/or according to the type of the fabric of the laundry.

[0013] A washing cycle belonging to the known technique is disclosed in document DE102007037159A1.

[0014] In this document, a washing phase comprises a first section wherein a first amount of water at a predetermined washing temperature (for example 50°C) is introduced into the tub, which is followed by a second section in which an additional amount of water is added to the first amount of water. The increased amount of water is heated to another predetermined temperature (for example 35°C).

[0015] With the heating of the water in the second section combined with the increased amount of water, an improved flooding of the fabric of the laundry is achieved. During the washing phase the drum is rotated to produce a mechanical action on the laundry.

[0016] The water introduced in the first and the second sections is sufficient to carry out the washing phase.

[0017] It follows an intermediate spin phase, a rinsing phase and a final spin phase whereby the liquid is removed from the tub.

[0018] However, the washing phase above described belonging to the known art poses some drawbacks.

[0019] A first drawback posed by this known technique is constituted by the high power consumption due to the heating of the water during both the first section and the second section.

[0020] In fact, all the water introduced during the two sections into the tub is subjected to a heating phase to a predetermined temperature. Therefore, a large amount of liquid has to be heated to guarantee that all the laundry is wetted by the heated liquid.

[0021] 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.

[0022] Another drawback is the fact that during the first section the laundry is wetted by high-temperature water which may damage the fabric of the laundry.

[0023] The object of the present invention is therefore to overcome the drawbacks posed by the known technique.

[0024] It is a first object of the invention to implement a washing method that makes it possible to reduce the power consumption compared to the known technique.

[0025] It is another object of the invention to implement a washing method that makes it possible to obtain a more efficient wetting of the laundry compared to the known technique.

[0026] It is a further object of the invention to implement a washing method that makes it possible to achieve a more gently treatment of the laundry compared to the known technique.

DISCLOSURE OF INVENTION

[0027] 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 wetting and heating phase for wetting said laundry by means of a laundry washing liquid heated at a predetermined washing temperature, wherein the laundry washing liquid at the predetermined washing temperature is obtained by mixing a first quantity liquid at a high temperature and a second quantity of cold liquid, it is possible to obtain a reduction of the power required to heat the laundry.

[0028] The wetting and heating phase of the present washing method is advantageously performed in any washing method which requires the heating of a wetted laundry, independently of the washing program selected.

[0029] The present invention 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 wetting and heating phase for wetting said laundry by means of a laundry washing liquid heated at a predetermined washing temperature, said wetting and heating phase comprising the steps of:

- a) providing a first quantity of cold liquid at the bottom of said washing tub up to a first level which is below, or equal to, the level of the lower part of said washing drum;
- b) heating said liquid at the bottom of said washing tub by means of said heating device up to a first temperature which is higher than said predetermined washing temperature;
- c) providing a second quantity of cold liquid into said washing tub and mixing it with said heated liquid at said first temperature in order to obtain said laundry washing liquid at said predetermined washing temperature.

[0030] The term "cold liquid" comprises substantially any liquid which has not been subjected to heating.

[0031] Opportunely during the step a) of providing a first quantity of cold liquid, the liquid does not substantially enter inside the washing drum.

[0032] In a preferred embodiment of the invention, the method comprises rotations of the washing drum during, or after, the step c) of providing a second quantity of cold liquid.

[0033] In a further preferred embodiment of the invention, the method comprises the step of recirculating the laundry washing liquid inside the washing tub during, or after, the step c) of providing a second quantity of cold liquid.

[0034] Preferably the method comprises the phase of repeating at least a second time the heating step b) and the step c) of providing a second quantity of cold liquid. Advantageously the phase of repeating the steps b) and c) is carried out when the laundry washing liquid inside the washing tub descends to a level which is below, or equal to, the level of the lower part of the washing drum.

[0035] Preferably the method comprises the phase of

repeating at least a second time the step a) of providing a first quantity of cold liquid, the heating step b) and the step c) of providing a second quantity of cold liquid.

[0036] Advantageously the phase of repeating the steps a), b) and c) is carried out when laundry washing liquid inside the washing tub descends to a level which is below, or equal to, a minimum level inside the washing tub.

[0037] Opportunely the minimum level corresponds to the bottom level of the washing tub.

[0038] Preferably the method comprises a step of introducing a quantity of detergent inside the washing tub.

[0039] In a preferred embodiment of the invention, the step of introducing a quantity of detergent inside the washing tub takes place during the step a) of providing a first quantity of cold liquid.

[0040] Opportunely the method comprises a mixing phase in which the quantity of detergent and the first quantity of liquid are mixed.

[0041] Advantageously the mixing phase takes place in a drawer of the laundry washing machine.

[0042] In a further preferred embodiment of the invention, the step of introducing a quantity of detergent inside the washing tub takes place during the step c) of providing a second quantity of cold liquid.

[0043] Opportunely the method comprises a mixing phase in which the quantity of detergent and the second quantity of liquid are mixed.

[0044] Advantageously the mixing phase takes place in a drawer of the laundry washing machine.

[0045] In a preferred embodiment of the invention, the predetermined washing temperature is based on the washing program selected by the user.

[0046] It is underlined that in each washing program the "predetermined washing temperature" is the actual highest temperature of the washing liquid at which the laundry is washed; the predetermined washing temperature doesn't necessarily correspond to the temperature indicated in the name or in the setting of the washing program (eg. "Cotton 60°C"), but it is the actual maximum temperature of the washing liquid which washes the laundry, set by the control unit of the washing machine for each washing program.

[0047] In other words, even if the temperature corresponding to a washing program has a specific value, for example 60°C in case of a washing program named "Cotton 60°C", it is possible that the predetermined washing temperature (e.g. the actual maximum temperature of the washing liquid at which the laundry is washed) is for example 40°C, and not 60°C as indicated by the name of the washing program.

[0048] In a further preferred embodiment of the invention, the predetermined washing temperature is a value inputted by the user.

[0049] Preferably the value of the first temperature is based on the value of the predetermined washing temperature.

[0050] Advantageously the value of the first tempera-

ture is based on the value of the first quantity of cold liquid introduced in the step a) and on the value of the second quantity of cold liquid introduced in the step c).

[0051] Preferably the value of the first temperature is set in such a way that even if the warm or hot washing liquid accidentally comes in contact with the laundry, the latter isn't damaged by the high temperature of the washing liquid; it preferably depends on the kind of laundry loaded in the machine, and therefore on the selected washing program. For example the value of the first temperature may be set to 90°C if the laundry is not-delicate white cotton.

[0052] Preferably the liquid is water.

[0053] Advantageously the heating step b) takes place activating the heating device on the base of the sensed temperature of the liquid inside the washing tub. Oppor-
tunately the heating step b) takes place activating the heating device which is located at the bottom of the tub.

[0054] In a preferred embodiment of the invention, after the steps a), b) and c) the method further comprises the steps of:

- maintaining the heated wetted loaded laundry inside the washing drum for a predetermined dry maintenance time;
- supplying a third quantity of liquid 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.

[0055] Preferably the method comprises a rotation phase of the washing drum during the step of maintaining the heated wetted loaded laundry inside the washing drum for a predetermined dry maintenance time.

[0056] Oppor-
tunately the method comprises a recirculating phase of liquid inside the washing tub after the phase of supplying a third quantity of liquid in the washing tub.

[0057] In a preferred embodiment, the first quantity of liquid and the second quantity of liquid determine a quantity of the washing liquid the value of which is stated based on the quantity and/or on the type of the loaded laundry.

[0058] Preferably the ratio between the quantity of the washing liquid and the dry weight of the loaded laundry is comprised between 1 and 3 litres/kg. Advantageously the third quantity of liquid is stated based on the quantity and/or on the type of the loaded laundry.

[0059] Preferably the ratio between the third quantity of liquid and the dry weight of the loaded laundry is comprised between 0,7 and 0,9 litres/kg.

[0060] 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

[0061] 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 implementing the method according to the invention;
- Figure 2 shows a side view of the laundry washing machine shown in Figure 1;
- Figure 3 is a simplified flow chart of the basic operations of a method for washing laundry in the laundry washing machine of Figure 1 according to a first embodiment of the invention;
- Figure 4 shows in detail an operation of the flow chart of Figure 3;
- Figures 5 and 6 show further embodiments of Figure 4.

DETAILED DESCRIPTION OF THE INVENTION

[0062] 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 wetting and heating phase of the laundry is required.

[0063] With reference to Figure 1 and Figure 2, a laundry washing machine 1 is described, in which a method according to a first embodiment of the invention is implemented.

[0064] 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.

[0065] 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.

[0066] 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.

[0067] 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.

[0068] 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.

[0069] The tub 3 is preferably connected to the casing 2 by means of an elastic bellows 7, or gasket.

[0070] 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.

[0071] 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.

[0072] The water inlet circuit 5 advantageously comprises a drawer 6, preferably removable, provided with various compartments suited to be filled with washing and/or rinsing products.

[0073] In the embodiment herein described, the water is advantageously supplied into the tub 3 by making it flow from a main pipe 15 through the drawer 6 and then through a supply pipe 9.

[0074] The main pipe 15 is opportunely connected to an external water supply line, not illustrated.

[0075] The supply pipe output 9a of the supply pipe 9 preferably ends in correspondence of the tub 3. Preferably the supply pipe output 9a ends in correspondence of a lateral side of the tub 3. As an alternative, the supply pipe output 9a of the supply pipe 9 may end in correspondence of the bellows 7, preferably in an upper region of the latter.

[0076] 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) from the main pipe 15 to the tub 3.

[0077] 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.

[0078] 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. In other phases, as for example during the rinsing phase, only water is conveyed into the tub 3.

[0079] 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.

[0080] 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.

[0081] The laundry washing machine 1 advantageously

ly comprises a water outlet circuit 25.

[0082] 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.

[0083] 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.

[0084] 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.

[0085] A two-way valve 35 is preferably interposed between the drain pump 26, the outlet pipe 28 and the recirculation pipe 31.

[0086] 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.

[0087] In a further embodiment, not illustrated, the recirculation circuit may comprise a dedicated recirculation pipe connecting a bottom region of the tub with a higher region of the latter, and provided with a dedicated recirculation pump; in this case the recirculation circuit may be or may be not completely separated from the water outlet circuit.

[0088] Advantageously the laundry washing machine 1 comprises a device 19 suited to sense (or detect) the liquid level inside the tub 3.

[0089] 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.

[0090] Advantageously, 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.

[0091] In further embodiments the heating device may be different and suitable to heat the liquid at the bottom of the tub, as for example microwaves source, infra-red rays, etc.

[0092] 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.

[0093] 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.

[0094] 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 may select and set the washing parameters, 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.

[0095] 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.

[0096] A first embodiment of the washing method according to the invention is described here below with reference to the washing machine 1 shown in Figures 1 and 2 and with reference to the operation flow chart of Figure 3.

[0097] 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.

[0098] According to the selected washing program (step 110) the control unit 22 sets the washing temperature T_w at which the laundry 10 has to be washed.

[0099] Furthermore, as said before, in a preferred embodiment it is possible for the user to insert some parameters directly by the interface unit 22a.

[0100] Therefore, the washing temperature T_w may be inserted directly by the user.

[0101] At this stage, therefore, the washing temperature T_w is known, independently of the way it is set.

[0102] Once the user has selected the desired washing program (step 110), the control unit 22 sets the laundry washing machine 1 so that it starts the washing cycle.

[0103] 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). Once the user has selected the desired washing program (step 110), a wetting and heating phase (step 120) according a preferred embodiment of the present invention is performed.

[0104] A first embodiment of the wetting and heating phase (step 120) according to the invention is shown in detail in Figure 4.

[0105] In a first phase (step 130) a first quantity Q_{1w}

of water W is introduced into the tub 3.

[0106] The first quantity Q_{1w} of water W introduced into the tub 3 reaches a first level L_1 which is preferably substantially equal to the drum level L_d , as shown in Figures 2 and 3.

[0107] The drum level L_d may be defined as the level of the lower part of the bottom 4a of the drum 4.

[0108] 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.

[0109] 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.

[0110] In different embodiments, the first quantity Q_{1w} of water W introduced into the tub 3 may advantageously reach a first level L_1 which is lower than the drum level L_d .

[0111] In any case the first quantity Q_{1w} of water W is controlled and maintained at said first level L_1 so that the water does not substantially enter inside the washing drum 4.

[0112] This means that a certain quantity of water may enter inside the drum. Nevertheless said certain quantity of water 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 water wets the laundry is a very short time.

[0113] The amount of the first quantity Q_{1w} of water W introduced into the tub 3 may depend on the size and shape of the tub 3 and on the position of the drum 4 with respect to the tub 3. Preferably the first quantity Q_{1w} of water W is comprised between 2,5 lt and 3 lt, more preferably equal to 2,51t.

[0114] Advantageously the amount of the first quantity Q_{1w} of water W is set in such a way that the water in the bottom of the tub 3 doesn't enter the drum 4; preferably, if the heating element 20 comprises an electric resistor placed in the bottom of the tub 3, the amount of the first quantity Q_{1w} of water W is set in such a way that the water in the bottom of the tub 3 completely covers the electric resistor, so as to avoid overheating of the latter.

[0115] The introduction of the first quantity Q_{1w} of water W takes place preferably through the water inlet circuit 5. The water W introduced into the tub 3 is preferably clean water coming from the main pipe 15 which bypasses the compartments of the drawer 6. Therefore the water W coming from the main pipe 15 is cold water W , i.e. water at ambient temperature. With "cold water" we will

refer herein after to water which has not been subjected to heating, as for example the ambient temperature water coming from the main pipe 15.

[0116] All the first quantity Q_{1w} of water W introduced inside the tub 3 by means of the supply pipe 9 advantageously falls down on the bottom of the tub 3, substantially without entering into contact with the laundry placed in the drum. This is particularly guaranteed if the supply pipe output 9a is positioned laterally with respect to the tub 3.

[0117] Nevertheless a very small quantity of the water W may also reach the laundry 10 inside the perforated drum 4.

[0118] The liquid level L_1 reached by the first quantity Q_{1w} of water W is advantageously sensed by means of the pressure sensor 19. In further embodiment, the liquid level L_1 may be sensed by means of different level sensors, for example a mechanical sensor, an electro-mechanical sensor, an optical sensor, etc..

[0119] As said before, the first quantity Q_{1w} of water W introduced into the tub 3 is cold water. This means that its temperature, typically the ambient temperature, is lower than the known predetermined washing temperature T_w .

[0120] Once the first quantity Q_{1w} of water W has reached the first level L_1 , a heating phase (step 140) is performed.

[0121] During the heating phase (step 140) the heating element 20 is activated and the the first quantity Q_{1w} of water W is heated up to a first temperature T_1 .

[0122] The first temperature T_1 is a temperature which is higher than the washing temperature T_w . The value of the first temperature T_1 depends, therefore, on the value of the washing temperature T_w . Furthermore, the value of the first temperature T_1 may depend on the amount of the first quantity Q_{1w} of water W introduced inside the tub 3, and therefore on the first level L_1 reached. The value of the first temperature T_1 may also depend on the type of the loaded laundry 10 and/or the quantity of loaded laundry 10.

[0123] The water temperature is advantageously sensed by means of the temperature sensor associated to the heating device 20.

[0124] During the heating phase (step 140) the first quantity Q_{1w} of water W is preferably controlled and maintained at a first level L_1 so that the liquid does not substantially enter inside the washing drum 4.

[0125] This guarantees that during the heating phase (step 140) the laundry 10 is not wetted by the water at the first temperature T_1 which is a temperature higher than the correct washing temperature T_w . Advantageously the fabric of the laundry 10 is not damaged by hot water.

[0126] It has to be noted that the low quantity of water W which may enter inside the drum 4 during the heating phase (step 140) has a negligible effect in the laundry heating and does not damage the laundry 10.

[0127] The first temperature T_1 is advantageously cho-

sen in such a way that even if the warm or hot liquid accidentally comes in contact with the laundry, the latter isn't damaged by the hot temperature; therefore it preferably depends on the kind of laundry loaded in the machine. For example it may be set to 90°C if the laundry is not-delicate white cotton. Once the heating phase (step 140) has been completed, a second quantity Q_{2w} of water W is introduced into the tub 3 (step 150).

[0128] The second quantity Q_{2w} of water W introduced into the tub 3 together with the first quantity Q_{1w} of water W produces a quantity Q_w of washing liquid L_w . The washing liquid L_w reaches a second level L_2 which is higher than the drum level L_d , as shown in Figures 2 and 3.

[0129] The introduction of the second quantity Q_{2w} of water W takes place preferably through the water inlet circuit 5.

[0130] The second quantity Q_{2w} of water W introduced into the tub 3 is preferably clean water coming from the main pipe 15 which bypasses the compartments of the drawer 6. Therefore the water W coming from the main pipe 15 is cold water W, as defined before.

[0131] In a further preferred embodiment, during the introduction of the second quantity Q_{2w} of water W a quantity Q_d of detergent D is also preferably introduced into the tub 3 (step 155).

[0132] The introduction of the quantity Q_d of detergent D takes place preferably through the water inlet circuit 5; the quantity Q_d of detergent D, be it powder or liquid, is preferably brought out of the apposite compartment of the drawer 6 by the second quantity Q_{2w} of water W that passes through the proper compartment of the drawer 6.

[0133] The quantity Q_d of detergent D and the second quantity Q_{2w} of water W then flow together through the supply pipe 9 up to the supply pipe output 9a.

[0134] In a preferred embodiment, the method comprises a mixing phase in which the quantity Q_d of detergent D and the second quantity Q_{2w} of water W are properly mixed to form a more uniform washing liquid L_w .

[0135] Preferably the mixing phase takes place before said the introduction of the quantity Q_d of detergent D and of the second quantity Q_{2w} of water W into the washing tub 3.

[0136] In further embodiments, the mixing phase may take place in the drawer 6 or in a suitable separate container.

[0137] In a different embodiment, the mixing phase may take place inside the washing tub 3 after the introduction of the quantity Q_d of detergent D and of the second quantity Q_{2w} of water W.

[0138] The second quantity Q_{2w} of cold water W at ambient temperature introduced into the tub 3 is mixed with the first quantity Q_{1w} of heated water W at the first temperature T_1 .

[0139] The quantity Q_w of washing liquid L_w inside the tub 3 at this stage is the sum of the first quantity Q_{1w} and of the second quantity Q_{2w} of water W, as said before. In case of use of detergent D, this amount Q_w of washing

liquid L_w inside the tub 3 includes also the quantity Q_d of detergent D introduced therein.

[0140] It has to be noted that the quantity Q_d of detergent D used in the washing program represents a minimal part of the washing liquid L_w used for washing the laundry 10. For example a typical volume ratio between the detergent D and the quantity Q_w of washing liquid L_w is less than 2%. The amount of washing liquid L_w in terms of volume, or weight, corresponds substantially to the volume, or weight, of the first and second quantities $Q1_w$ and $Q2_w$ of water W.

[0141] The mixing of the first quantity $Q1_w$ and the of second quantity $Q2_w$ of water W produces a washing liquid L_w at a temperature T_L which has an intermediate value between the first temperature T_1 and the ambient temperature.

[0142] Preferably the temperature T_L of the washing liquid L_w corresponds to the predetermined washing temperature T_w .

[0143] Reaching of the predetermined washing temperature T_w may be easily guaranteed by knowing the first quantity $Q1_w$ and the second quantity $Q2_w$ of water W introduced inside the tub 3 and the first temperature T_1 set for the first quantity $Q1_w$ of water.

[0144] Advantageously, once the washing temperature T_w at which the laundry 10 has to be washed has been determined (step 110) the control unit 22 may set the proper values for the first quantity $Q1_w$ of water W, for the first temperature T_1 and for the second quantity $Q2_w$ of water W that allow obtaining a washing liquid L_w at the desired washing temperature T_w .

[0145] Preferably, during the introduction of the second quantity $Q2_w$ of water W (step 150) the drum 4 is set rotated (step 160), so as to enhance the mixing between the first quantity $Q1_w$ and the second quantity $Q2_w$ of water W. Drum rotations (step 160) also enhance the absorption of the washing liquid L_w by the laundry 10 inside the drum 4.

[0146] 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.

[0147] In a further embodiment, the rotation of the drum 4 (step 160) may be performed after the introduction of the second quantity $Q2_w$ of water W (step 150). Preferably after the introduction of the second quantity $Q2_w$ of water W (step 150) the recirculation circuit 30 is advantageously activated (step 170).

[0148] In this case the washing liquid L_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. The drain pump 26 takes the washing liquid L 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.

[0149] The washing liquid L_w therefore flows through the recirculation pipe 31 up to the terminal nozzle 32 and

from there advantageously reaches the laundry 10 from above.

[0150] By means of this recirculation process, uniform and complete wetting of the laundry 10 with the washing liquid L_w can be accomplished.

[0151] Preferably the recirculation process takes place for a pre-established period of time deemed sufficient to withdraw substantially all the washing liquid L_w from the bottom of the tub 3 and sufficient for its complete absorption by the laundry 10.

[0152] The complete absorption of the laundry 10 is guaranteed by the fact that the quantity Q_w of the washing liquid L_w is preferably properly chosen so that it does not exceed the absorption capacity of the laundry 10.

[0153] 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.

[0154] More generally, at the end of the recirculation process the washing liquid L_w is substantially totally absorbed by the laundry 10. It is clear that a minimum quantity of residual washing liquid L_r may remain on the bottom of the tub 3. Advantageously with the heating method above described only the first quantity $Q1_w$ of water W is heated to a first temperature T_1 .

[0155] Furthermore, all the heated washing liquid L_w at the desired washing temperature T_w used for washing the laundry 10 is totally absorbed by the laundry 10 itself. Inside the tub 3, therefore, there is no heated residual liquid which fills the hollow space between the tub 3 and the drum 4 which would not contribute to heat the laundry, as it happens in the prior art technique.

[0156] This makes it possible to reduce the power consumption compared to the known technique.

[0157] Still advantageously the heating method above described avoids the contact of the laundry 10 with the liquid at high temperature, namely the first quantity $Q1_w$ of water W at first temperature T_1 , which could damage the laundry 10. The laundry 10 is substantially always wetted by a liquid at the correct washing temperature T_w . A more gently treatment of the laundry 10 is therefore achieved compared to the known technique.

[0158] The first quantity $Q1_w$ of water W and the second quantity $Q2_w$ of water W which are introduced in the tub 3 may be measured during their introduction. Such a measure is carried out, 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 of washing liquid L_w .

[0159] The quantity Q_w of the washing liquid L_w 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 quantity Q_w of the washing liquid L_w 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.

[0160] The ratio between the quantity Q_w of the washing liquid L_w and the dry weight D_w of the laundry 10 is preferably comprised between 1 and 3 litres/kg. Preferably this ratio Q_w/D_w is comprised between 1,3 and 2,7 litres/kg.

[0161] More preferably this ratio Q_w/D_w is comprised between 1,5 and 2,5 litres/kg. More preferably this ratio Q_w/D_w is comprised between 1,7 and 2,3 litres/kg. More preferably this ratio Q_w/D_w is comprised between 1,8 and 2,2 litres/kg. Even more preferably this ratio Q_w/D_w is comprised between 1,5 and 2,0 litres/kg.

[0162] The ratio between the quantity Q_w of the washing liquid L_w and the dry weight D_w of the laundry 10 is more preferably comprised between 1,5 and 1,8 litres/kg when the laundry 10 is substantially constituted by the "cotton base load" as defined in the international standard IEC 60456.

[0163] In case of use of detergent D, the control unit 22 may also advantageously set the proper quantity Q_d of detergent D which form the washing liquid L so as to obtain a suitable water-detergent ratio value.

[0164] The dry weight D_w of the laundry 10 can be obtained by the control unit 22 in different ways.

[0165] The dry weight D_w can be, for example, one of the parameters introduced by the user when setting the washing program.

[0166] 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.

[0167] 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.

[0168] Clearly any other method may be used to determine the quantity of the loaded laundry 10.

[0169] 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.

[0170] 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.

[0171] In a further preferred embodiment, the quantity Q_d of detergent D is introduced into the tub 3 during the introduction of the first quantity $Q1_w$ of water W (step 130) instead of during the introduction of the second quantity $Q2_w$ of water W (step 150) as described above.

[0172] The introduction of the quantity Q_d of detergent D takes place preferably through the water inlet circuit 5; the quantity Q_d 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.

[0173] The quantity Q_d of detergent D and the first quantity $Q1_w$ of water W then flow together through the supply pipe 9 up to the supply pipe output 9a.

[0174] Also in this case, the method preferably comprises a mixing phase in which the quantity Q_d of detergent D and the first quantity $Q1_w$ of water W are properly mixed to form a more uniform washing liquid L_w .

[0175] The detergent D is then heated together with the first quantity $Q1_w$ of water W at the first temperature T_1 .

[0176] Nevertheless, introduction of detergent D is more preferably performed during the introduction of the second quantity $Q2_w$ of water W, as previously described. In this case, in fact, the detergent D acts at the temperature of the second quantity $Q2_w$ of water W and at the washing temperature T_w of the washing liquid L_w . These temperatures are both lower than the first temperature T_1 of the first quantity $Q1_w$ of water W. At these lower temperatures the detergent D may work effectively.

[0177] At the end of the wetting and heating phase (step 120) the laundry 10 is wetted and heated.

[0178] It has to be noted that the wetting and heating phase (step 120) of the present invention above described may generally be performed in a laundry washing method which requires the wetting and the heating of the laundry.

[0179] The following phases of the method hereinafter described represent therefore only a preferred embodiment of a complete washing program.

[0180] Different phases with respect to the ones here described may be performed to complete the washing program.

[0181] Once the wetting and heating phase (step 120) has been completed, a dry maintenance phase is started (step 185), as shown in Figure 3. 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 wetting and heating phase (step 120) described.

[0182] In the dry maintenance phase (step 185) 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 liquid L_w absorbed by the laundry 10 has time to react with the stained fabrics of the dirty laundry 10.

[0183] The predetermined dry maintenance time t_d is

advantageously set according to the type of loaded laundry 10 and/or the quantity of loaded laundry 10 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.

[0184] During the dry maintenance phase (step 185), one or more rotation cycles of the drum 4 are also preferably performed (step 187).

[0185] 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 185) has been completed, a wet maintenance phase is started (step 190).

[0186] In this phase a third quantity Q_{3w} of water W is introduced into the tub 3. During the wet maintenance phase (step 190), one or more rotation cycles of the drum 4 are also preferably performed (step 200).

[0187] The amount of liquid L_q inside the tub 3 at this stage is the sum of the quantity Q_w of the washing liquid L_w and of the third quantity Q_{3w} 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.

[0188] For this reason in a further preferred embodiment, the recirculation circuit 30 is activated (step 210) 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.

[0189] The introduction of the third quantity Q_{3w} 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 190) the liquid L_q may also be heated through the activation of the heating device 20.

[0190] Rotations of the drum 4, preferably in clockwise and/or anticlockwise direction, advantageously take place at a pre-determined rotational speed, for example in a range comprised between 10 rpm and 80 rpm.

[0191] The amount of the third quantity Q_{3w} of water W introduced during the wet maintenance phase (step 190) is preferably set so that the ratio between the third quantity Q_{3w} of water W and the dry weight D_w of the laundry 10 is comprised between 0,5 to 1,1 litres/kg.

[0192] More preferably this ratio Q_{3w}/D_w is comprised between 0,7 and 0,9 litres/kg.

[0193] The third quantity Q_{3w} 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 190) has been completed, the laundry 10 is clean and a rinsing phase is performed (step 220).

[0194] In further embodiments, the method may pref-

erably provide for a single phase before the rinsing phase (step 220) instead of the dry maintenance phase (step 185) and the wet maintenance phase (step 190) here described. In this single phase, the wetted and heated laundry 10 is preferably subjected to a washing mechanical action by means of drum rotations.

[0195] The rinsing phase (step 220) comprises the removal from the laundry 10 and from the tub 3 of the dirty liquid produced during the wet maintenance phase (step 190).

[0196] 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.

[0197] 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.

[0198] The rinsing phase (step 220) may preferably comprise several consecutive cycles of the type just described.

[0199] Hence the washing program continues with a spinning phase (step 230). The spinning phase (step 230) 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.

[0200] 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.

[0201] Once the spinning phase (step 230) terminates, the washing program is completed.

[0202] At this point, the user may take the laundry 10 out.

[0203] In case the washing program is performed in a laundry washing-drying machine, after the spinning phase (step 230) the laundry 10 may be advantageously subjected to a drying phase inside the drum 4 (step 240).

[0204] With reference to the flow chart of Figure 5 another embodiment of the wetting and heating phase (step 120') of the method of the invention is illustrated.

[0205] This embodiment differs from that previously described with reference to Figure 4 for the fact that the introduction of the second quantity Q_{2w} of water W into

the tub 3 is carried out in successive introductions of water W, preferably by means of "n" introductions (wherein "n" is a prefixed integer greater than 1). First of all a temporary variable "i" is set to 0 (step 125). This variable "i" will be used as a counter.

[0206] In a successive phase (step 130) a first quantity $Q1_w$ of cold water W, i.e. water at ambient temperature, is introduced into the tub 3.

[0207] The first quantity $Q1_w$ of water W introduced into the tub 3 reaches a first level L_1 which is substantially equal to the drum level L_d , as shown in Figures 2 and 3 (as described before with reference to the first embodiment of Figure 4).

[0208] Once the first quantity $Q1_w$ of water W has reached the first level L_1 , a heating phase (step 140) is performed.

[0209] During the heating phase (step 140) the heating element 20 is activated and the first quantity $Q1_w$ of water W is heated up to a first temperature T_1 .

[0210] During the heating phase (step 140), as said before, the first quantity $Q1_w$ of water W is controlled and maintained at the first level L_1 so that the water W does not substantially enter inside the washing drum 4.

[0211] Once the heating phase (step 140) has been completed, a second quantity $Q2_{iw}$ of cold water W, i.e. water at ambient temperature, is introduced into the tub 3 (step 150).

[0212] The second quantity $Q2_{iw}$ of water W introduced into the tub 3 together with the first quantity $Q1_w$ of water W produces a quantity Q_{iw} of washing liquid L_{iw} . The washing liquid L_{iw} reaches a level L_{i2} which is higher than the drum level L_d , as shown in Figures 2 and 3.

[0213] The second quantity $Q2_{iw}$ of cold water W at ambient temperature introduced into the tub 3 is mixed with the first quantity $Q1_w$ of heated water W at the first temperature T_1 .

[0214] The quantity Q_{iw} of washing liquid L_{iw} inside the tub 3 at this stage is the sum of the first quantity $Q1_w$ and of the second quantity $Q2_{iw}$ of water W, as said before. The mixing of the first quantity $Q1_w$ and of the second quantity $Q2_{iw}$ of water W produces a washing liquid L_{iw} at a temperature T_{iL} which is at an intermediate value between the first temperature T_1 and the ambient temperature.

[0215] Preferably the temperature T_{iL} of the washing liquid L_{iw} corresponds to the predetermined washing temperature T_w .

[0216] After the introduction of the second quantity $Q2_{iw}$ of water W (step 150) the drum 4 is set rotated (step 160), so as to enhance the mixing between the first quantity $Q1_w$ and the second quantity $Q2_{iw}$ of water W. Drum rotations (step 160) also enhance the absorption of the washing liquid L_{iw} by the laundry 10 inside the drum 4.

[0217] Preferably after the introduction of the second quantity $Q2_{iw}$ of water W (step 150) the recirculation circuit 30 is advantageously activated (step 170).

[0218] In a successive phase a check of the washing liquid level L_{i2} is performed (step 172).

[0219] If the washing liquid level L_{i2} is higher than the drum level L_d , drum rotations (step 160) continue. If the washing liquid level L_{i2} is higher than the drum level L_d , recirculation (step 170), when provided, also continues.

[0220] If the washing liquid level L_{i2} is below, or equal to, the drum level L_d , then the counter variable "i" is increased by one (step 174).

[0221] The fact that the washing liquid level L_{i2} is below, or equal to, the drum level L_d means that a quantity of water equal to the quantity $Q2_{iw}$ of water W previously introduced into the tub 3 has been totally absorbed by the laundry 10. The remaining washing liquid at the bottom of the tub 3 which is below, or equal to, the drum level L_d is substantially at the washing temperature T_w , or at a lower value.

[0222] In a successive step, if the counter variable "i" has reached the prefixed value "n" (step 176), then the wetting and heating phase (step 120') ends.

[0223] If the counter variable "i" has not reached the prefixed value "n" (step 176), then the washing method back to the heating phase (step 140).

[0224] During the heating phase (step 140) the heating element 20 is activated and the washing liquid at the bottom of the tub 3 is heated up to the first temperature T_1 .

[0225] Once the heating phase (step 140) has been completed, a new quantity $Q2_{(i+1)w}$ of cold water W is introduced into the tub 3 (step 150).

[0225] The wetting and heating phase (step 120') will continue until the counter variable "i" reaches the prefixed value "n".

[0226] This means that during the wetting and heating phase (step 120') a quantity Q_w of the washing liquid L_w has been introduced into the tub 3. The quantity Q_w of the washing liquid L_w , is the sum of the first quantity $Q1_w$ and of the total quantity $Q2'_w = \sum_{i=1 \text{ to } n} (Q2_{iw})$ of water W.

[0227] In a preferred embodiment, a quantity Q_d of detergent D is also introduced into the tub 3 (step 155) during one, or more, of said introductions of the quantity $Q2_{iw}$ of water W.

[0228] Preferably the quantity Q_w of the washing liquid L_w totally introduced inside the tub 3 in the wetting and heating phase (step 120'), namely the sum of the first quantity $Q1_w$ and of the second quantity $Q2'_w$ of water W, is properly chosen so that it does not exceed the absorption capacity of the laundry 10, as previously described with reference to the first embodiment.

[0229] With reference to the flow chart of Figure 6 another embodiment of the wetting and heating phase (step 120") of the method of the invention is illustrated.

[0230] This embodiment differs from that previously described with reference to Figure 4 for the fact that the introduction of the first quantity $Q1'_w$ of water W and of the second quantity $Q2'_w$ of water W into the tub 3 is carried out in successive introductions of water W, preferably by means of "n" introductions (wherein "n" is a prefixed integer greater than 1).

[0231] First of all a temporary variable "i" is set to 0 (step 125). This variable "i" will be used as a counter.

[0232] In a successive phase (step 130) a first quantity $Q_{1_{iw}}$ of cold water W , i.e. water at ambient temperature, is introduced into the tub 3.

[0233] The first quantity $Q_{1_{iw}}$ of water W introduced into the tub 3 reaches a first level L_{i1} which is substantially equal to the drum level L_d (as described before with reference to the first embodiment of Figure 4).

[0234] In different embodiments, the first quantity $Q_{1_{iw}}$ of water W introduced into the tub 3 may reach a first level L_{i1} which is lower than the drum level L_d .

[0235] Once the quantity $Q_{1_{iw}}$ of water W has reached the first level L_{i1} , a heating phase (step 140) is performed.

[0236] During the heating phase (step 140) the heating element 20 is activated and the first quantity $Q_{1_{iw}}$ of water W is heated up to a first temperature T_1 .

[0237] During the heating phase (step 140), as said before, the first quantity $Q_{1_{iw}}$ of water W is controlled and maintained at the first level L_1 so that the water W does not substantially enter inside the washing drum 4.

[0238] Once the heating phase (step 140) has been completed, a second quantity $Q_{2_{iw}}$ of cold water W , i.e. water at ambient temperature, is introduced into the tub 3 (step 150).

[0239] The second quantity $Q_{2_{iw}}$ of water W introduced into the tub 3 together with the first quantity $Q_{1_{iw}}$ of water W produces a quantity Q_{iw} of washing liquid L_{iw} . The washing liquid L_{iw} reaches a level L_{i2} which is higher than the drum level L_d , as shown in Figures 2 and 3.

[0240] The second quantity $Q_{2_{iw}}$ of cold water W at ambient temperature introduced into the tub 3 is mixed with the first quantity $Q_{1_{iw}}$ of heated water W at the first temperature T_1 .

[0241] The mixing of the two quantities $Q_{1_{iw}}$, $Q_{2_{iw}}$ of water W produces a washing liquid L_{iw} at a temperature T_{iL} which is at an intermediate value between the first temperature T_1 and the ambient temperature.

[0242] Preferably the temperature T_{iL} of the washing liquid L_{iw} corresponds to the predetermined washing temperature T_W .

[0243] After the introduction of the second quantity $Q_{2_{iw}}$ of water W (step 150) the drum 4 is set rotated (step 160), so as to enhance the mixing between the two quantities $Q_{1_{iw}}$, $Q_{2_{iw}}$ of water W . Drum rotations (step 160) also enhance the absorption of the washing liquid L_{iw} by the laundry 10 inside the drum 4. Preferably after the introduction of the second quantity $Q_{2_{iw}}$ of water W (step 150) the recirculation circuit 30 is advantageously activated (step 170).

[0244] In a successive phase a check of the washing liquid level L_{i2} is performed (step 173).

[0245] If the washing liquid level L_{i2} is higher than a prefixed minimum level L_{min} , drum rotations (step 160) and recirculation (step 170) continue.

[0246] The prefixed minimum level L_{min} may be defined as a level lower than the drum level L_d .

[0247] Preferably the prefixed minimum level L_{min} is set to a value which corresponds to the bottom of the tub 3.

[0248] If the laundry washing liquid level L_{i2} is below, or equal to, the minimum level L_{min} , then the counter variable "i" is increased by one (step 174).

[0249] The fact that the washing liquid level L_{i2} is below, or equal to, the minimum level L_{min} means that all the second quantity $Q_{2_{iw}}$ of water W previously introduced has been totally absorbed by the laundry 10 and also part of the first quantity $Q_{1_{iw}}$ has been absorbed.

[0250] Preferably, if the prefixed minimum level L_{min} is set to a value which corresponds to the bottom of the tub 3 the fact that the washing liquid level L_{i2} is below, or equal to, the minimum level L_{min} means that all the quantities $Q_{2_{iw}}$, $Q_{1_{iw}}$ of water W previously introduced has been totally absorbed by the laundry 10. The tub 3 is therefore substantially empty. It is clear that a minimum quantity of residual washing liquid L_r may remain on the bottom of the tub 3.

[0251] In a successive step, if the counter variable "i" has reached the prefixed value "n" (step 176), then the wetting and heating phase (step 120") ends.

[0252] If the counter variable "i" has not reached the prefixed value "n" (step 176), then the washing method back to the phase of introducing into the tub 3 (step 130) a new quantity $Q_{1_{(i+1)w}}$ of cold water W .

[0253] Then a heating phase (step 140) is performed.

[0254] Once the heating phase (step 140) has been completed, a new quantity $Q_{2_{(i+1)w}}$ of cold water W is introduced into the tub 3 (step 150").

[0255] The wetting and heating phase (step 120") will continue until the counter variable "i" reaches the prefixed value "n".

[0256] This means that during the wetting and heating phase (step 120") a quantity Q_w of the washing liquid L_w has been introduced into the tub 3. The quantity Q_w of the washing liquid L_w , is the sum of the total quantity $Q'_{1_w} = \sum_{i=1 \text{ to } n} (Q_{1_{iw}})$ and of the total quantity $Q'_{2_w} = \sum_{i=1 \text{ to } n} (Q_{2_{iw}})$ of water W .

[0257] In a preferred embodiment, a quantity Q_d of detergent D is also introduced into the tub 3 (step 155) during one, or more, of said introductions of the quantity $Q_{2_{iw}}$ of water W .

[0258] Preferably the quantity Q_w of the washing liquid L_w totally introduced inside the tub 3 in the wetting and heating phase (step 120'), namely the sum of the first quantity Q'_{1_w} and of the second quantity Q'_{2_w} of water W , is properly chosen so that it does not exceed the absorption capacity of the laundry 10, as previously described with reference to the first embodiment.

[0259] 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 wetting and heating phase in a washing cycle of a laundry washing machine that allows reducing the power consumption.

[0260] While the wetting and 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 var-

variants of the embodiments described herein fall within the scope of the present invention, which is defined in the claims.

[0261] 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 (10) 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 wetting and heating phase for wetting said laundry (10) by means of a laundry washing liquid (L_w ; L_{iw}) heated at a predetermined washing temperature (T_w),
characterized in that
said wetting and heating phase comprises the steps of:

- a) providing a first quantity ($Q1_w$; $Q1'_w$) of cold liquid (W) at the bottom of said washing tub (3) up to a first level (L_1) which is below, or equal to, the level (L_d) of the lower part (4a) of said washing drum (4);
- b) heating said liquid (W) at the bottom of said washing tub (3) by means of said heating device (20) up to a first temperature (T_1) which is higher than said predetermined washing temperature (T_w);
- c) providing a second quantity ($Q2_w$; $Q2'_w$) of cold liquid (W) into said washing tub (3) and mixing it with said heated liquid at said first temperature (T_1) in order to obtain said laundry washing liquid (L_w ; L_{iw}) at said predetermined washing temperature (T_w).

2. Method according to claim 1, **characterized in that** during said step a) of providing a first quantity ($Q1_w$; $Q1'_w$) of cold liquid (W), the liquid does not substantially enter inside the washing drum (4).
3. Method according to any of the preceding claims, **characterized in that** it comprises rotations of said washing drum (4) during, or after, said step c) of providing a second quantity ($Q2_w$; $Q2'_w$) of cold liquid (W).
4. Method according to any of the preceding claims, **characterized in that** it comprises the step of cir-

culating said laundry washing liquid (L_w ; L_{iw}) inside said washing tub (3) during, or after, said step c) of providing a second quantity ($Q2_w$; $Q2'_w$) of cold liquid (W).

5. Method according to any of the preceding claims, **characterized by** repeating at least a second time said heating step b) and said step c) of providing a second quantity ($Q2_w$; $Q2'_w$) of cold liquid (W).
6. Method according to any of the preceding claims, **characterized by** repeating at least a second time said step a) of providing a first quantity ($Q1_w$; $Q1'_w$) of cold liquid (W), said heating step b) and said step c) of providing a second quantity ($Q2_w$; $Q2'_w$) of cold liquid (W).
7. Method according to any of the preceding claims, **characterized in that** it comprises a step of introducing a quantity (Q_d) of detergent (D) inside said washing tub (3).
8. Method according to claim 7, **characterized in that** said step of introducing a quantity (Q_d) of detergent (D) inside the washing tub (3) takes place during said step c) of providing a second quantity ($Q2_w$; $Q2'_w$) of cold liquid (W).
9. Method according to any of the preceding claims, **characterized in that** the value of said first temperature (T_1) is based on the value of said predetermined washing temperature (T_w).
10. Method according to any of the preceding claims, **characterized in that** the value of said first temperature (T_1) is based on the value of said first quantity ($Q1_w$; $Q1'_w$) of cold liquid (W) introduced in said step a) and on the value of said second quantity ($Q2_w$; $Q2'_w$) of cold liquid (W) introduced in said step c).
11. Method according to any of the preceding claims, **characterized in that** said heating step b) takes place activating said heating device (20) on the base of the sensed temperature (T_L) of the liquid (W) inside said washing tub (3).
12. Method according to any of the preceding claims, **characterized in that** after said steps a), b) and c) it further comprises the steps of:

- maintaining said heated wetted loaded laundry (10) inside said washing drum (4) for a predetermined dry maintenance time (t_d);
- supplying a third quantity ($Q3_w$) of liquid (W) in said washing tub (3);
- rotating said washing drum (4);
- rinsing said loaded laundry (10) by means of drum rotations and by means of liquid drainage

from said washing tub (3).

13. Method according to any of the preceding claims, **characterized in that** said first quantity (Q_{1w} ; $Q_{1'w}$) of liquid (W) and said second quantity (Q_{2w} ; $Q_{2'w}$) of liquid (W) determine a quantity (Q_w) of said washing liquid (L_w ; L_{lw}) the value of which is stated based on the quantity and/or on the type of said loaded laundry (10). 5 10
14. Method according to claim 13, **characterized in that** said third quantity (Q_{3w}) of liquid (W) is stated based on the quantity and/or on the type of said loaded laundry (10). 15
15. A laundry washing machine (1) suited to implement a method according to any of the preceding claims. 20 25 30 35 40 45 50 55

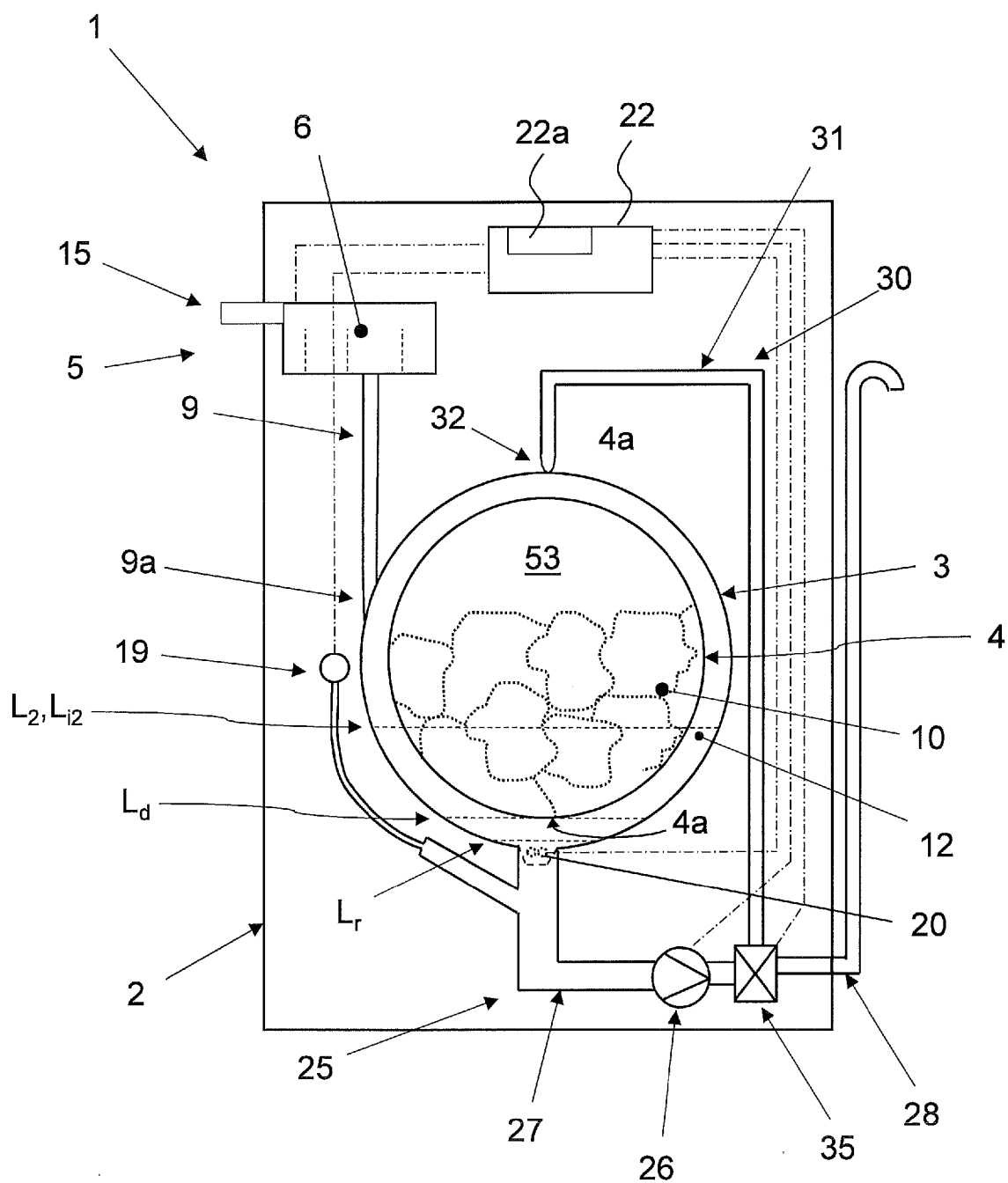


FIG. 1

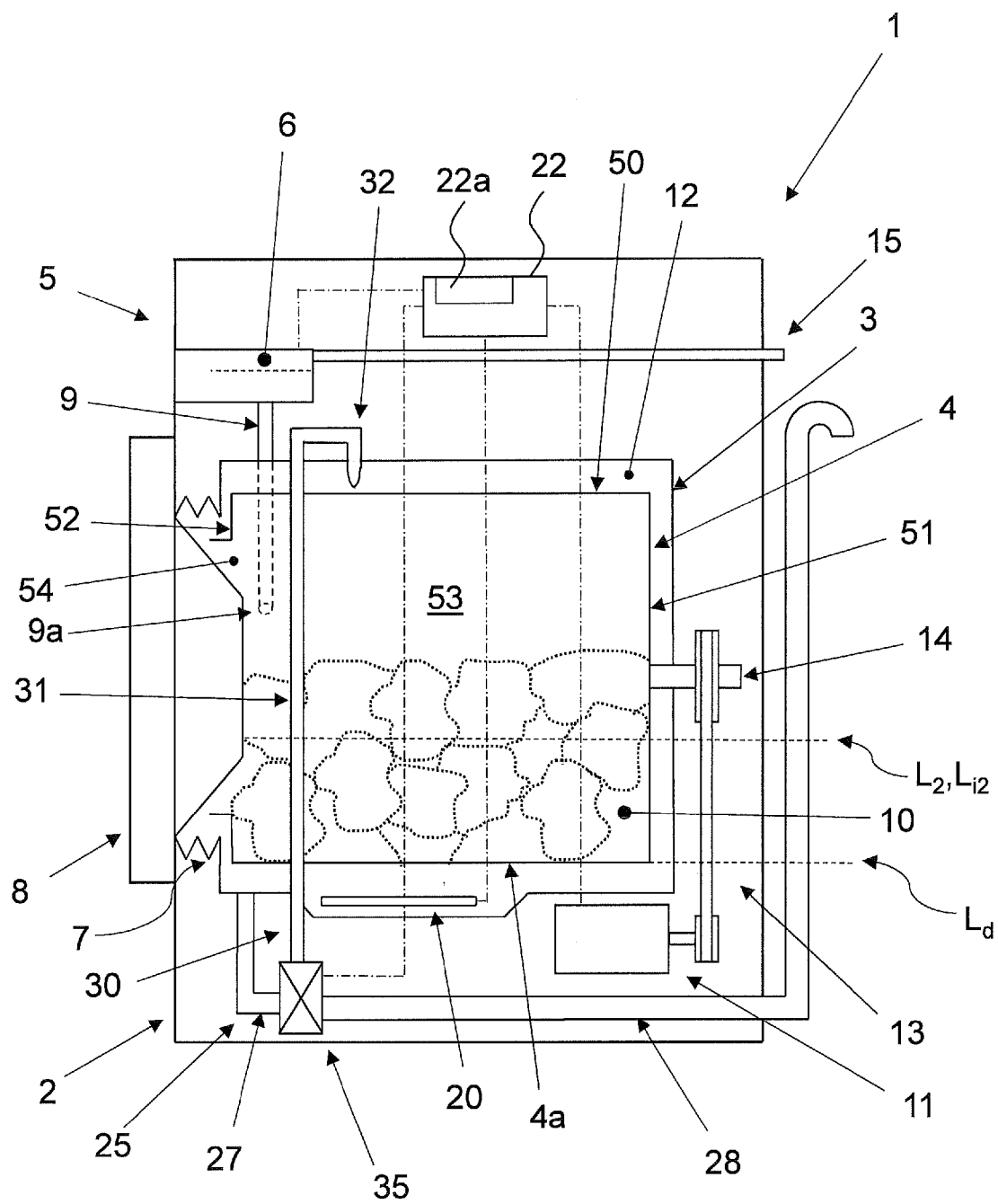


FIG. 2

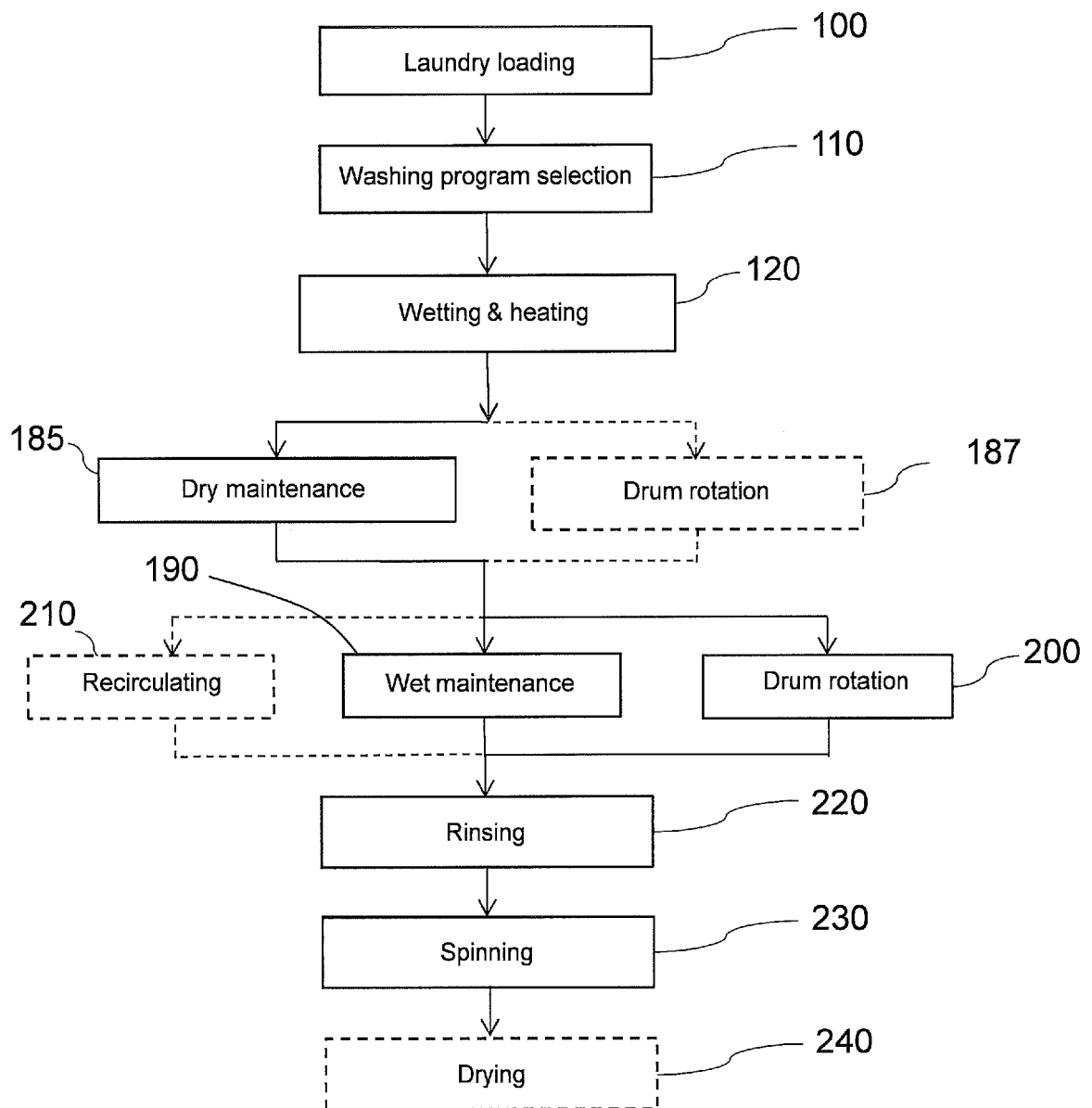


FIG. 3

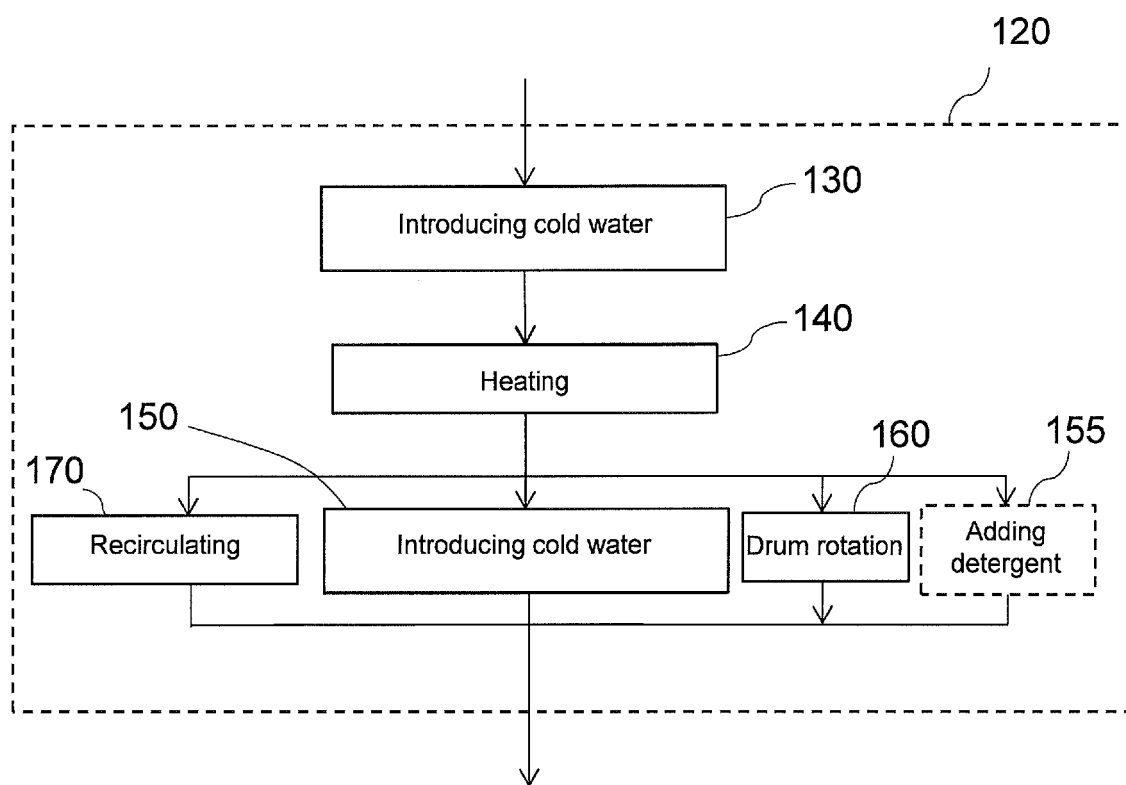


FIG. 4

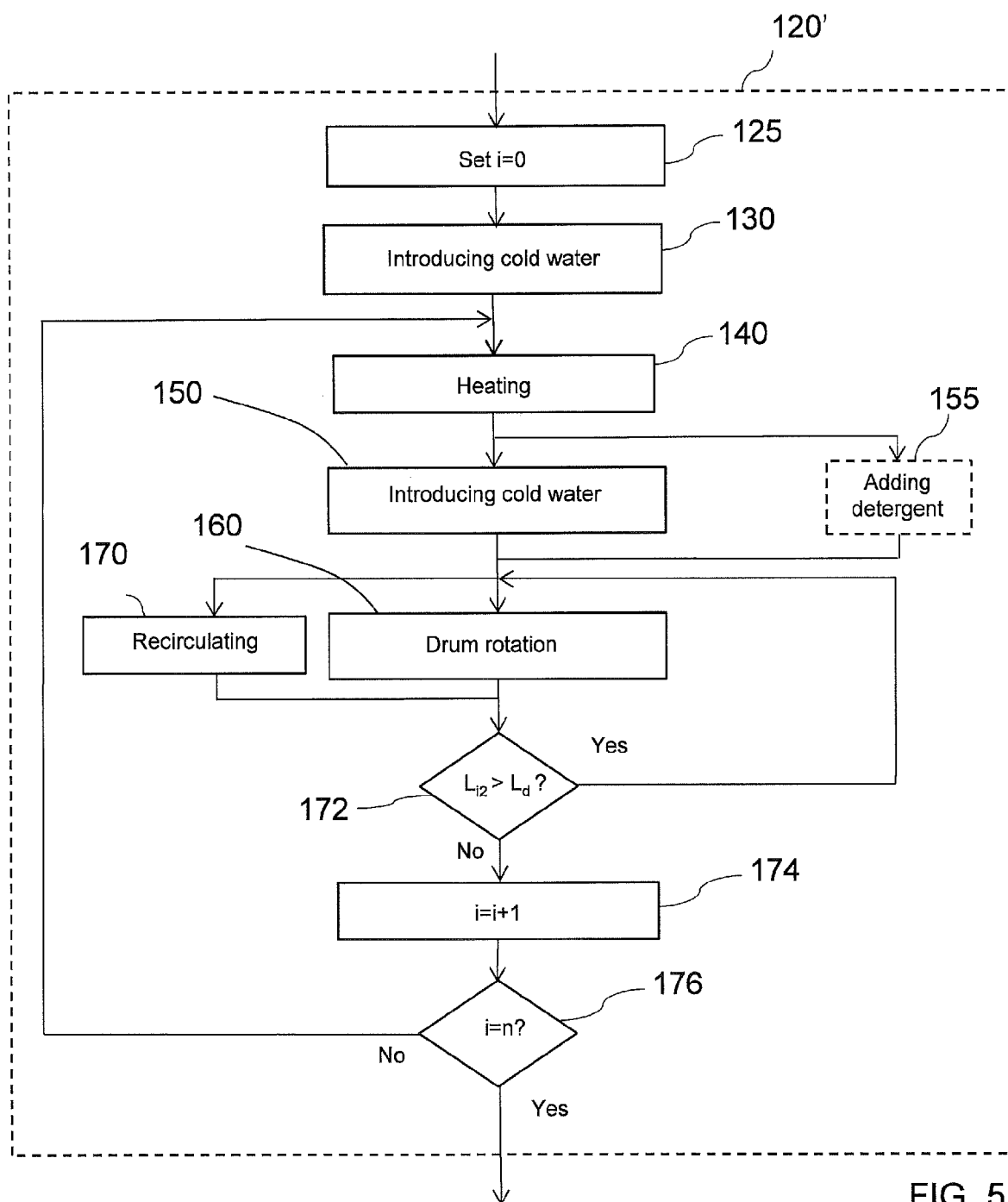


FIG. 5

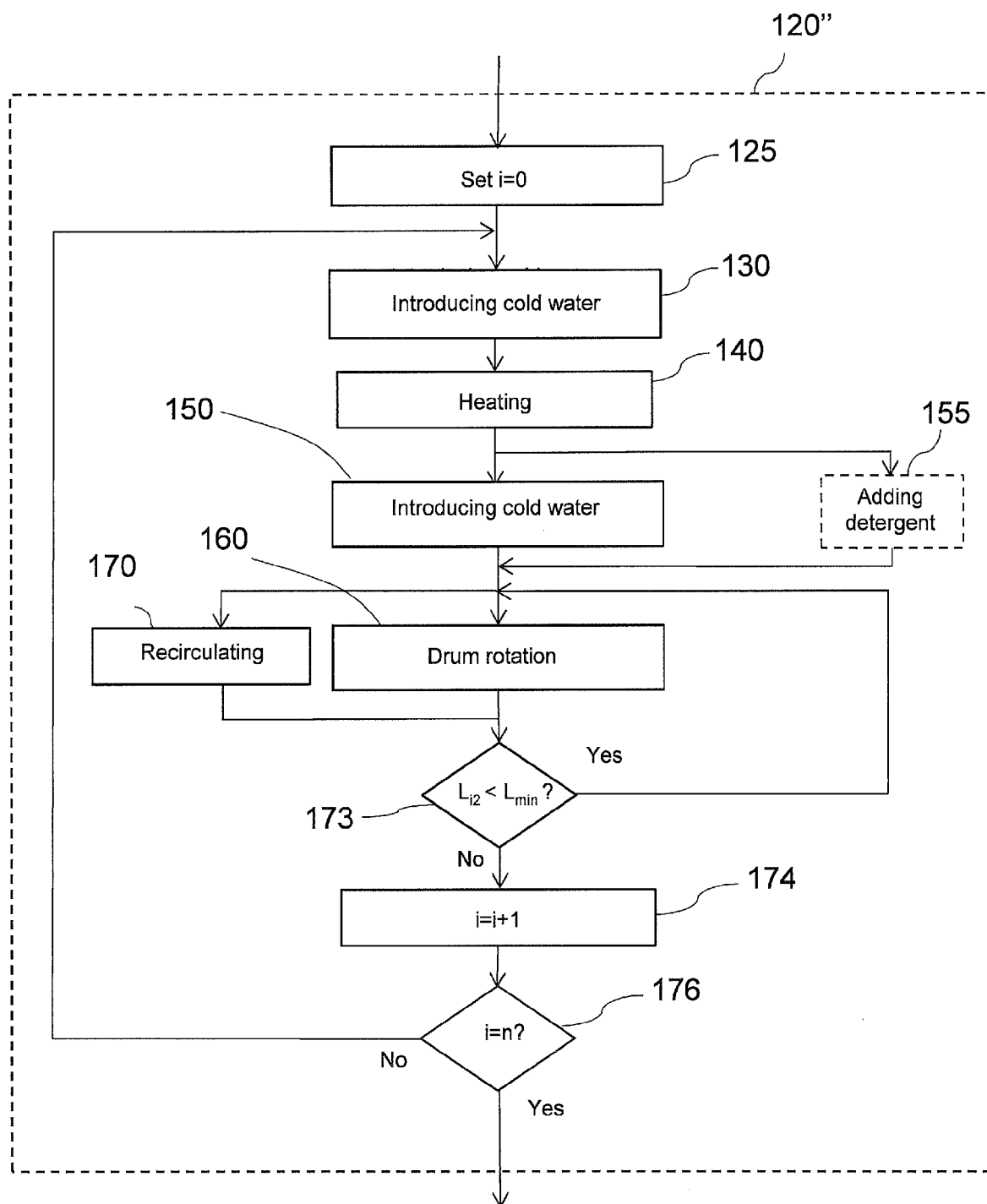


FIG. 6



EUROPEAN SEARCH REPORT

Application Number
EP 11 18 3719

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			D06F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 27 February 2012	Examiner 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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