(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 680 378 A1**

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
15.07.2020 Bulletin 2020/29

(21) Application number: **20154628.0**

(22) Date of filing: **23.12.2014**

(51) Int Cl.:
D06F 33/00 *(2020.01)* *D06F 39/02* *(2006.01)*
D06F 35/00 *(2006.01)* *D06F 39/08* *(2006.01)*

(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

(62) Document number(s) of the earlier application(s) in accordance with Art. 76 EPC:
14819024.2 / 3 237 664

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Remarks:
This application was filed on 30-01-2020 as a divisional application to the application mentioned under INID code 62.

(54) METHOD FOR WASHING LAUNDRY IN A LAUNDRY WASHING MACHINE WITH AN AUTOMATIC DOSING DEVICE AND LAUNDRY WASHING MACHINE

(57) The invention concerns a method for washing laundry in a laundry washing machine comprising an automatic dosing device (58) which supplies detergent in a plurality of washing cycles. The method comprises a water loading phase through a sequence of partial loads of water into the washing tub (3) and a step of introducing a quantity of detergent into the washing tub (3) from the automatic dosing (58) device only after it has been determined that the laundry is saturated, or substantially saturated.

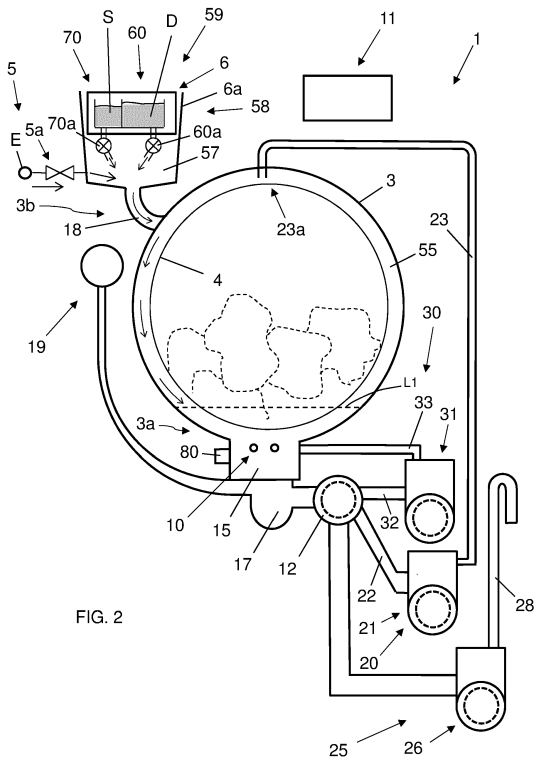

FIG. 2

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Description

[0001] The present invention concerns the field of laundry washing techniques. In particular, the present invention refers to a method for washing laundry in a laundry washing machine equipped with a detergent automatic dosing device which is capable of performing a more efficient dosage of the detergent.

BACKGROUND ART

[0002] 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.

[0003] In the present description the term "laundry washing machine" will refer to both simple laundry washing machines and laundry washing-drying machines.

[0004] Laundry washing machines generally comprise an external casing provided with a washing tub which contains a rotatable perforated drum where the laundry is placed. A loading/unloading door ensures access to the drum. An interface is accessible to the user and by means of which the user may select and set the washing parameters, like for example a desired washing program. Other parameters can optionally be inserted by the user, in particular the laundry load amount, for example selecting "half load" (laundry load<5kg) or "full load" (laundry load>5kg).

[0005] Laundry washing machines typically comprise a water supply unit and a products supply unit, preferably a drawer, for the introduction of water and washing/rinsing products (i.e. detergent, softener, rinse conditioner, etc.) into the tub.

[0006] Laundry washing machines of known type are also advantageously equipped with an automatic dosing device which is able to dose powder, liquid or other kinds of wash products from a container into the tub. In particular, the device comprises a container which is filled with a large amount of detergent that is then dispensed in a predetermined dose, when required, at any single washing cycle. The detergent in the container is therefore advantageously sufficient for several washing cycles.

[0007] According to the known technique, the predetermined dose of detergent is conveyed into the tub at the beginning of the washing cycle, preferably by means of a first quantity of water used to flush the detergent from a container which receives said dose of detergent. A further amount of water is then preferably conveyed into the tub. It follows a main washing phase during which the laundry load is treated by means of the water and detergent solution previously introduced into the tub. The solution is typically heated to a predetermined temperature based on the washing program selected by the user.

[0008] During the main washing phase the drum is rotated, so as to apply also a mechanical cleaning action on the laundry. At the end of the main washing phase the drum is typically rotated at high rotational speed, in such a way that dirty washing liquid (i.e. water mixed with detergent) is extracted from the laundry. The dirty washing liquid is drained to the outside by a water draining device.

[0009] A successive step of the cycle typically comprises a rinsing phase which usually comprises one or more rinsing cycles.

[0010] In a rinsing cycle, clean rinse water may be first added to the laundry. The rinse water is absorbed by the laundry and the rinse water removes from the laundry detergent and/or dirty particles not previously removed by washing liquid in the main washing cycle. The drum is then rotated to extract water and dirty particles/detergent from the laundry: the dirty water extracted is drained from the tub to the outside by the water draining device.

[0011] According to the known techniques, the predetermined dose of detergent is conveyed into the tub at the beginning of the washing cycle and is typically determined on the base of the load amount of the laundry which is placed inside the drum.

[0012] The laundry load amount may be inserted directly by the user, for example selecting between "half load" or "full load" as said above, or may be detected by means of a weight sensor placed, for example, on the dampers which support the tub.

[0013] A main drawback posed by said technique lies in that it does not allow to control the correct dosage of detergent with respect to the amount of water which is conveyed into the tub.

[0014] The object of the present invention is therefore to overcome the drawback posed by the known technique.

[0015] It is an object of the invention to provide an alternative method for washing laundry in a laundry washing machine equipped with an automatic dosing device that makes it possible to dose the correct amount of detergent in a washing cycle. In particular, it is an object of the invention to provide a method for washing laundry in a laundry washing machine equipped with an automatic dosing device that makes it possible to dose the correct percentage of detergent in the washing solution used to wash the laundry in a washing cycle.

[0016] It is a further object of the present invention to provide a method for washing laundry in a laundry washing machine equipped with an automatic dosing device that makes it possible to improve the cleaning effect of the washing solution in a washing cycle.

DISCLOSURE OF INVENTION

[0017] The applicant has found that by providing a method for washing laundry in a laundry washing machine comprising an automatic dosing device which supplies detergent in a plurality of washing cycles, wherein the method comprises a water loading phase through a sequence of partial loads of water into said washing tub

and by providing a step of introducing a quantity of detergent into the washing tub from the automatic dosing device only after it has been determined that the laundry is saturated, or substantially saturated, it is possible to dose the correct amount of detergent during the washing cycle.

[0018] The present invention relates, therefore, to a method for washing laundry during a washing cycle in a laundry washing machine comprising:

- a washing drum adapted to receive laundry;
- a washing tub external to said washing drum;
- a water supply unit to supply water into said washing tub from an external supply line;
- an automatic dosing device to supply detergent into said washing tub comprising a compartment suitable for receiving an amount of detergent sufficient for a plurality of washing cycles;
- a device suited to sense the liquid level inside said washing tub;
- a control unit for controlling functioning of said laundry washing machine;

the method comprising an initial phase of introducing water and detergent for washing said laundry and a successive main washing phase during which laundry is subjected to a washing mechanical action by means of drum rotations and to a cleaning action by means of said water and detergent;
wherein said initial phase comprises the steps of:

- a) loading water into said washing tub;
- b) rotating the washing drum;
- c) monitoring the variation of the water level sensed by said device for determining when the laundry is saturated or substantially saturated, said variation being due to the water supplied into said washing tub in step a) and due to the water absorbed by the laundry in step b);
- repeating at least one time steps a) to c);
- operating said automatic dosing device for introducing a quantity of detergent into said washing tub based on the amount of water introduced in said steps a), said amount of water being the water introduced in said steps a) for getting the laundry saturated or substantially saturated.

[0019] Preferably, the automatic dosing device is operated only after it has been determined that the laundry is saturated or substantially saturated.

[0020] In a preferred embodiment of the invention, the laundry is saturated or substantially saturated when the variation of the water level sensed by the device in step c) is below a determined range.

[0021] According to a preferred embodiment of the invention, the step a) of loading water into the washing tub is performed by opening and closing a controllable valve connected to the external supply line.

[0022] Preferably, the step of determining when the laundry is saturated or substantially saturated in the step c) is performed after the controllable valve has been closed. The step of determining when the laundry is saturated or substantially saturated in the step c) is preferably performed after the controllable valve has been closed and the washing drum is rotating.

[0023] Preferably, the step of determining when the laundry is saturated or substantially saturated in the step c) is performed after the controllable valve has been closed and wherein the laundry is saturated or substantially saturated when the decreasing speed of the water level sensed by the device is lower than a predetermined minimum level.

[0024] According to a preferred embodiment of the invention, before the laundry is saturated or substantially saturated, in the step a) the water level tends to increase and in the step b) the water level tends to decrease.

[0025] In a preferred embodiment of the invention, a predetermined time interval is provided between successive steps a), the time interval depending on the selection made by the user and/or the variation of the water level sensed by the device.

[0026] In a further preferred embodiment of the invention, the method comprises one or more further water loading phases after it has been determined that the laundry is saturated or substantially saturated.

[0027] According to a preferred embodiment of the invention, before the step of introducing the quantity of detergent, the method further comprises a step of determining the total amount of water introduced into the washing tub in the steps a).

[0028] In a preferred embodiment of the invention, the quantity of detergent introduced into the washing tub is a function of the total amount of water introduced into the washing tub in the steps a).

[0029] Preferably, the quantity of detergent introduced into the washing tub is a percentage of the total amount of water introduced into the washing tub in the steps a).

[0030] In a further preferred embodiment of the invention, the quantity of detergent introduced into the washing tub is further a function of the type of detergent used.

[0031] Preferably, the detergent type is determined on the base of its concentration level. According to a preferred embodiment of the invention, the concentration level of the detergent is a parameter set by a user or is a parameter determined through a concentration sensor arranged in the laundry washing machine.

[0032] In a further preferred embodiment of the invention, the quantity of detergent introduced into the washing tub is further a function of the water hardness level of the water supplied into the washing tub.

[0033] Preferably, the water hardness level is a parameter set by a user at the beginning of the washing cycle or at the time of installation of the laundry washing machine or is a parameter determined by means of a water hardness sensor arranged in the laundry washing machine.

[0034] According to a further preferred embodiment of the invention, the quantity of detergent introduced into the washing tub is further a function of the soil level of the laundry.

[0035] Preferably, the soil level is determined on the base of the washing cycle selected set by a user or is determined on the base of a soil sensor associated to the washing laundry machine.

[0036] In a further preferred embodiment of the invention, the quantity of detergent introduced into the washing tub is further a function of the fabric type of the laundry.

[0037] Preferably, the fabric type is determined on the base of the weight of the laundry. More preferably, the weight of the laundry is determined by a weight sensor of the laundry washing machine or by measuring the electrical parameters of the electric drum motor or by means of a torque sensor associated to the drum motor. In a preferred embodiment of the invention, after the steps a) and before the step of introducing a quantity of detergent into the washing tub the method further comprises the steps of checking the soil level of the water in the washing tub and if the soil level is above a prefixed level threshold then proceeding with a step of discharging a quantity of dirty water from the washing tub and a step of restoring the quantity of dirty water discharged with new clean water.

[0038] Preferably, the quantity of new clean water is equal to the discharged quantity of dirty water.

[0039] According to a preferred embodiment of the invention, the method further provides for the action of withdrawing liquid from a bottom region of the washing tub and re-admitting such a liquid into the washing drum in order to enhances absorption of the liquid by the laundry.

[0040] In a preferred embodiment of the invention, the action of withdrawing liquid from a bottom region of the washing tub and re-admitting such a liquid into the washing drum takes place during the steps a).

[0041] Preferably, the action of withdrawing liquid from a bottom region of the washing tub and re-admitting such a liquid into the washing drum takes place during the main washing phase.

[0042] In a further preferred embodiment of the invention, the action of withdrawing liquid from a bottom region of the washing tub and re-admitting such a liquid into the washing drum is carried out by means of a recirculation circuit suitable for withdrawing liquid from the bottom region of the washing tub and for re-admitting such a liquid into an upper region of the washing tub.

[0043] Preferably, the step of introducing the quantity of detergent comprises a step of introducing the quantity of detergent into recirculation circuit.

[0044] According to a preferred embodiment of the invention, the main washing phase comprises a step of heating the liquid which wets the laundry.

[0045] Preferably, the main washing phase comprises at least a step of draining dirty liquid from the washing tub to the outside.

[0046] In a preferred embodiment of the invention, after the main washing phase the method comprises one or more rinsing cycles for rinsing the laundry.

[0047] According to a further preferred embodiment of the invention, the method further comprises a step of reducing the hardness degree of the water to be supplied to the washing tub by means of a water softening device.

[0048] In a further aspect thereof, the present invention concerns a laundry washing machine suited to implement a method as described above.

BRIEF DESCRIPTION OF THE DRAWINGS

[0049] Further characteristics and advantages of the present invention will be highlighted in greater detail in the following detailed description of preferred embodiments of the invention, provided with reference to the enclosed drawings. In said drawings:

- Figure 1 shows a perspective view of a laundry washing machine implementing the method according to a first embodiment of the invention;
- Figure 2 shows a schematic view of the laundry washing machine of Figure 1;
- Figure 3 shows the laundry washing machine of Figure 1 with the external casing removed;
- Figure 4 shows the laundry washing machine of Figure 3 from another point of view;
- Figure 5 shows a partial view of the laundry washing machine of Figure 1 with the external casing partially removed;
- Figure 6 is a plan view of some components of the laundry washing machine of Figure 3 isolated from the rest;
- Figure 7 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 8 illustrates a schematic diagram of the theoretical water level in the washing tub as a function of the time according a preferred embodiment of the present invention;
- Figure 9 show a further embodiment of Figure 7;
- Figure 10 shows a further embodiment of Figure 2.

DETAILED DESCRIPTION OF THE INVENTION

[0050] 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 laundry washing machines. On the contrary, the present invention can be conveniently applied to laundry washing-drying machines (i.e. laundry washing machines which can also dry laundry).

[0051] In the present description, therefore, the term "laundry washing machine" will refer to both simple laundry washing machines and laundry washing-drying machines.

[0052] With reference to Figures from 1 to 6 a laundry washing machine 1 is illustrated, in which a method according to the invention is advantageously implemented. The laundry washing machine 1 comprises an external casing or housing 2, in which a washing tub 3 is provided that contains a perforated washing drum 4 where the laundry to be treated can be loaded.

[0053] The tub 3 and the drum 4 both preferably have a substantially cylindrical shape. Between the tub 3 and the drum 4 a gap 55 is defined.

[0054] The housing 2 is provided with a loading/unloading door 8 which allows access to the drum 4.

[0055] The tub 3 is preferably suspended in a floating manner inside the housing 2, advantageously by means of a number of coil springs and shock-absorbers 9. The drum 4 is advantageously rotated by an electric motor, not illustrated, which preferably transmits the rotating motion to the shaft of the drum 4, advantageously by means of a belt/pulley system. In a different embodiment of the invention, the motor can be directly associated with the shaft of the drum 4.

[0056] The drum 4 is advantageously provided with holes which allow the liquid flowing therethrough. Said holes are typically and preferably homogeneously distributed on the cylindrical side wall of the drum 4.

[0057] The tub 3 is preferably connected to the casing 2 by means of an elastic bellows 7, or gasket.

[0058] The tub 3 preferably comprises two complementary hemi-shells 13 and 14 structured for being reciprocally coupled to form the tub 3.

[0059] In a preferred embodiment of the invention, laundry washing machine 1 further comprises a load amount detection device. The load amount detection device gives indication of the amount of load (weight) of the laundry. The load amount detection device may comprise, for example, a weight sensor placed on the dampers. This type of device measures the damper displacement and it is based on differential measurements.

[0060] In different embodiments, measurements may be carried out using Hall sensors, magnet sensors or using strain gage devices.

[0061] In another embodiment of the invention, the amount of load may be determined by measuring the electrical parameters of the electric drum motor, like the electric current and/or the induced voltage. The electrical current through the electric drum motor is at least approximately proportional to the torque of the electric drum motor. For example, the electric current measured gives a measure of the torque of the electric drum motor and from the torque the amount of load is determined.

[0062] In further embodiments, the torque of the electric drum motor may be detected and/or calculated differently, for example by means of a torque sensor associated to the drum motor.

[0063] The bottom region 3a of the tub 3 preferably comprises a seat 15, or sump, suitable for receiving a heating device 10, as illustrated in Figure 5. The heating device 10, when activated, heats the liquid inside the sump 15.

[0064] The heating device 10 preferably comprises an electrical resistor of serpentine type. The heating device 10 is horizontally placed in the sump 15 and it extends substantially from a front part up to a rear part of the sump 15.

[0065] In different embodiments, nevertheless, the bottom region of the tub may be configured differently. For example, the bottom region of the tub may not comprise a seat for the heating device. The heating device may be advantageously placed in the annular gap between the tub and the drum.

[0066] In further embodiments, then, the heating device may not be present. The required heated water may come from an external hot water source.

[0067] In further embodiments the heating device may be different and suitable to heat the liquid in the tub, for example a hot air stream, a steam flow, microwaves source, infra-red rays, etc..

[0068] A water supply unit 5 is arranged in the upper part of the laundry washing machine 1 and is suited to supply water into the tub 3 from an external supply line E. The water supply unit 5 advantageously comprises a controlled supply valve 5a which is properly controlled, opened and closed, during the washing cycle. The water supply unit 5 also preferably comprises a water flow sensor (not shown), for example a flow meter, which makes it possible to calculate the quantity of water supplied into the tub 3.

[0069] The water supply unit 5 may then preferably comprise a water softening device (not illustrated) for removal of calcium, magnesium and/or certain other metal cations in hard water before entering the tub. The water softening device advantageously comprises water softening agents for reducing the hardness degree of the water to be supplied to the washing tub. The water softening device basically comprises a water-softening agent container and a regeneration-agent reservoir. The water-softening agent container is crossed by the fresh water arriving from the external water supply line. The water-softening agent container is filled with a water softening agent able to reduce the hardness degree of the fresh water flowing through the same water-softening agent container. The regeneration-agent reservoir instead is fluidly connected to the water-softening agent container and is structured for receiving a given quantity of salt or other regeneration agent which is able to regenerate the water softening function of the water softening agent stored inside the water-softening agent container.

[0070] The water supply unit 5 may then preferably comprise a water hardness sensor which detects the water hardness entering the laundry washing machine 1. The water hardness sensor may be a sensor based on impedance and/or conductivity water analysis. For example, the hardness sensor may be a conductometric sensor.

[0071] The water supply unit of a laundry washing ma-

chine is well known in the art, and therefore it will not be further described in detail.

[0072] The laundry washing machine 1 advantageously comprises a wash products dispenser 59 to supply wash products during a washing cycle, such as detergent, rinse additives, fabric softener or fabric conditioners, waterproofing agents, fabric enhancers, rinse sanitization additives, chlorine-based additives, etc..

[0073] In the preferred embodiment here illustrated and described, the wash products dispenser 59 advantageously comprises a detergent dispenser 60 to supply detergent D into the tub 3 and a rinse additive dispenser 70 to supply at least one rinse additive S into the tub 3. In a preferred embodiment, for example, the rinse additive S may comprise a softener.

[0074] In the preferred embodiment here described and illustrated, the detergent dispenser 60 and the rinse additive dispenser 70 are part of a removable drawer 6 provided with various compartments suited to be filled with said detergent D and rinse additive S.

[0075] In different embodiments, nevertheless, the removable drawer may comprise further compartments suited to be filled with other type of wash products, such as fabric conditioners, waterproofing agents, fabric enhancers, rinse sanitization additives, chlorine-based additives, i.e. products which are suitable to be used in the washing cycle.

[0076] According to a preferred aspect of the washing laundry machine 1 of the present invention, each compartment of the drawer 6 is filled with a large amount of wash product, detergent D or softener S, which is then dispensed in a predetermined dose during the washing cycle. The detergent D and the softener S in the compartments are advantageously sufficient for multiple washing cycles.

[0077] The wash products dispenser 59 therefore defines an automatic dosing device 58 which is suited to dose the detergent D or the softener S from the respective compartment of the drawer 6 into the tub 3. At this purpose, the automatic dosing device 58 preferably comprises a flushing chamber 57.

[0078] In the preferred embodiment here illustrated and described, the flushing chamber 57 is advantageously defined by the bottom of the housing 6a which receives the removable drawer 6.

[0079] In different embodiments, nevertheless, the flushing chamber may be a separate flushing chamber.

[0080] A dose of detergent D is preferably conveyed from the compartment of the drawer 6 into the flushing chamber 57 by activating a first feeding pump 60a. Analogously, a dose of softener S is preferably conveyed from the compartment of the drawer 6 into the flushing chamber 57 by activating a second feeding pump 70a.

[0081] A dose of detergent D or of softener S is conveyed from the respective compartment of the drawer 6 into the flushing chamber 57. In the preferred embodiment here illustrated, the water is supplied into the tub 3 from the water supply unit 5 by making it flow through the flushing chamber 57 and then through a supply pipe 18 together with the dose of detergent D, or the dose of softener S.

[0082] The water which reaches the tub 3 can be clean water if the wash products are not conveyed into the flushing chamber 57 from the respective compartment.

[0083] 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, thus bypassing the flushing chamber 57.

[0084] The supply pipe 18, as schematically illustrated in figure 2 and visible in Figure 4, is preferably arranged laterally with respect to the tub 3 and preferably terminates at an upper region 3b of the tub 3. More preferably, the supply pipe 18 terminates at a rear side of the tub 3.

[0085] Laundry washing machine 1 advantageously comprises a water outlet circuit 25 suitable for withdrawing liquid from the bottom region 3a of the tub 3.

[0086] The water outlet circuit 25 preferably comprises a main pipe 17, a draining pump 26 and an outlet pipe 28 ending outside the housing 2.

[0087] The water outlet circuit 25 preferably further comprise a filtering device 12 arranged between the main pipe 17 and the draining pump 26. The filtering device 12 is adapted to retain all the undesirable bodies (for example buttons that have come off the laundry, coins erroneously introduced into the laundry washing machine, etc.).

[0088] This filtering device 12 can preferably be removed, and then cleaned, through a gate 14 placed advantageously on the front wall of the housing 2 of the laundry washing machine 1, as illustrated in Figure 1.

[0089] The main pipe 17 connects the bottom region 3a of the tub 3 to the filtering device 12. An inlet end 17a of the main pipe 17 is advantageously positioned at the lower point of the tub 3, more preferably at the lower point of the sump 15. An outlet end 17b of the main pipe 17 is connected to a front part 12a of the filtering device 12, as illustrated in Figure 6.

[0090] In a further embodiment, not illustrated, the filtering device 12 may be provided directly in the tub 3, preferably obtained in a single piece construction with the latter. In this case the filtering device 12 is fluidly connected to the outlet of the tub 3, in such a way that water or washing liquid drained from the tub 3 enters the filtering device 12.

[0091] The draining pump 26 is preferably connected to a rear part 12b of the filtering device 12 and conveys the liquid to the outlet pipe 28 through an outlet 29, the latest better visible in Figure 5 where the outlet pipe 28 has been removed. Activation of the drain pump 26 drains the liquid, for example dirty water or water mixed with washing and/or rinsing products, from the tub 3 to the outside. Laundry washing machine 1 advantageously comprises a first recirculation circuit 30, or mixing circuit 30. The mixing circuit 30 is adapted to drain liquid from the bottom region 3a of the tub 3 and to re-admit such a liquid (recirculated mixing liquid) into a first region of the

tub 3, which corresponds substantially to the same bottom region 3a of the tub 3.

[0092] Preferably, the mixing circuit 30 is adapted to drain liquid from the bottom of the sump 15 and to re-admit such a liquid again into the sump 15. More preferably, the liquid is re-admitted again into the sump 15 below the heating device 10.

[0093] The mixing circuit 30 preferably comprises a first recirculation pump 31, a first pipe 32 connecting the filtering device 12 to the first recirculation pump 31 and a second recirculation pipe 33 advantageously provided with a terminal portion 34, or nozzle, better visible in Figure 5. The terminal portion 34 advantageously ends inside the sump 15, as mentioned above.

[0094] The liquid from the bottom region 3a of the tub 3 is conveyed again towards the bottom region 3a of the tub 3 by activation of the first recirculation pump 31. Advantageously, the liquid from the bottom region 3a of the tub 3 is conveyed towards the bottom region 3a of the tub 3 in the gap 55 between the tub 3 and the drum 4.

[0095] In a further embodiment, not illustrated, the mixing circuit may comprise a dedicated pipe connecting the bottom region of the tub to the recirculation pump; in this case the mixing circuit is advantageously completely separated from the water outlet circuit, i.e. completely separated from the filtering device 12 and the main pipe 17.

[0096] The mixing circuit is preferably realized for transferring a portion of a liquid from a bottom region of the tub to the same bottom region for mixing and/or dissolution of the wash products, for example the softener.

[0097] In general, the mixing circuit is preferably realized for transferring liquid from a bottom region of the tub and for re-admitting such a liquid into the washing tub such that at least a portion of the re-admitted liquid reaches the bottom region of the washing tub without entering the washing drum.

[0098] More preferably, the mixing circuit is realized for transferring liquid from a bottom region of the tub and for re-admitting such a liquid into the washing tub such that all, or substantially all, the re-admitted liquid reaches the bottom region of the washing tub without entering the washing drum.

[0099] The laundry washing machine 1 preferably comprises a turbidity sensor 80 for determining the clarity, or haziness of the liquid. The turbidity sensor 80, as better described below, advantageously determines the loss of transparency of the liquid (water) due to release of colour or removable dirty from the laundry.

[0100] The turbidity sensor 80 is preferably arranged at the bottom region 3a of the tub 3, preferably inside the sump 15.

[0101] In other preferred embodiments, the turbidity sensor may be arranged in other suitable zones, for example in the first recirculation circuit 30, for example along the second recirculation pipe 33.

[0102] Any turbidity sensor may be used. For example, the turbidity sensor may be a refractive index sensor including a light beam transmitter and a receiver. The refractive index sensor advantageously generates a signal indicative of the of transparency of the liquid.

[0103] Further to the turbidity sensor 80, a water hardness sensor may be also arranged in suitable zones at the bottom region 3a of the tub 3, rather than in the water supply unit 5 as mentioned above. In this case, the sensor may detect the water hardness from a quantity of clean water opportunely introduced into the tub 3. The water hardness detection may be advantageously carried out at the beginning of the washing cycle or more preferably by means of a dedicated hardness detecting cycle carried out just after the installation of the laundry washing machine and its connection to the external supply line E.

[0104] Laundry washing machine 1 preferably comprises a second recirculation circuit 20 adapted to drain liquid from the bottom region 3a of the tub 3 and to re-admit such a liquid into a second region 3b, or upper region, of the tub 3.

[0105] The second recirculation circuit 20 preferably comprises a second recirculation pump 21, a second pipe 22 connecting the filtering device 12 to the second recirculation pump 21 and a second recirculation pipe 23, preferably provided with a terminal nozzle 23a arranged preferably at the upper region 3b of the tub 3. The terminal nozzle 23a is opportunely arranged so that the liquid is sprayed directly into the drum 4 through its holes. More preferably the terminal nozzle 23a is integrally formed in the bellows 7, as visible in Figure 3, and the liquid is therefore advantageously sprayed in a direction against the perforated drum 4.

[0106] The terminal nozzle 23a, therefore, enhances distribution of liquid over the laundry through the perforated drum 4.

[0107] The liquid from the bottom region 3a of the tub 3 is conveyed towards the upper region 3b of the tub 3 by activation of the second recirculation pump 21.

[0108] The second recirculation circuit 20 is advantageously activated in order to improve wetting of the laundry inside the drum 4 and for reducing the water required in the whole washing cycle.

[0109] In general, the second recirculation circuit is properly realized for transferring a portion of a liquid from a bottom region of the tub, preferably from the sump, to an upper region of the tub in order to enhance absorption of the liquid by the laundry.

[0110] Advantageously, laundry washing machine 1 comprises a device 19 suited to sense (or detect) the liquid level inside the tub 3. The sensor device 19 preferably comprises a pressure sensor.

[0111] From the values sensed by the sensor device 19 it is possible to determine the liquid level of the liquid inside the tub 3. In another embodiment, not illustrated, laundry washing machine may preferably comprise (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.

[0112] Laundry washing machine 1 advantageously

comprises a control unit 11 connected to the various parts of the laundry washing machine 1 in order to ensure its operation. The control unit 11 is preferably connected to the water supply unit 5, the water outlet circuit 25, the recirculation circuits 30, 20, the heating device 10 and the electric motor and receives information from the various sensors provided on the laundry washing machine 1, like the pressure sensor 19, the water hardness sensor, the turbidity sensor 80, a temperature sensor, etc.

[0113] Laundry washing machine 1 advantageously comprises an interface unit 16, connected to the control unit 11, accessible to the user and by means of which the user may select and set the washing parameters, like for example a desired washing program. Usually, other parameters can optionally be inserted by the user, for example the washing temperature, the spinning speed, etc..

[0114] Based on the parameters acquired by said interface 16, the control unit 11 sets and controls the various parts of the laundry washing machine 1 in order to carry out the desired washing program.

[0115] A first embodiment of the washing method according to the invention is described here below with reference to Figure 7.

[0116] The laundry to be washed is first placed inside the drum 4 (step 100 of Figure 7). The user fills, or has already previously filled, the compartments of the drawer 6 with the wash products, i.e. detergent D and softener S, needed for a plurality of washing cycles of the laundry.

[0117] By operating on the interface unit 16 the user selects the desired washing program (step 110) depending, for example, on the type and on the soil level of the laundry 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 16, for example the value of the washing temperature, the rotating speed of the drum 4 in the spinning phase, the duration of the washing program, the type of detergent D (regular, concentrated, super concentrated, etc.).

[0118] Once the user has selected the desired washing program, the control unit 11 sets the laundry washing machine 1 so that it may start the washing program.

[0119] In a further embodiment, the selection of the desired washing program (step 110) may be performed before placing the laundry into the drum 4 (step 100).

[0120] From the desired washing program or the parameters inserted directly by the user, the control unit 11 may evaluate other working parameters which may be advantageously used during the washing cycle. Working parameters which may advantageously used are, for example, the soil level of the laundry, the water hardness etc..

[0121] Successively, the method provides for a water loading phase (block 120) comprising a sequence of partial loads of water (steps 130, 131, 132) into the tub 3. During the water loading phase (block 120), the water level WL in the tub 3 is advantageously monitored, preferably by means of the sensor device 19.

[0122] Figure 8 shows a possible evolution of the water level WL (which may be expressed in millimetres) in the tub 3 as a function of the time in the laundry machine 1 during the execution of the partial loads in the water loading phase (block 120).

[0123] Each partial load is for loading a corresponding water amount in the tub 3. The loads of water are preferably carried out such that, at the end of the water loading phase (block 120), the laundry is saturated, or substantially saturated.

[0124] At the beginning, a first amount of water Qp1 is loaded into the tub 3, e.g. 6 litres (step 130).

[0125] Loading of the first amount of water Qp1 (step 130) is carried out by activating (opening) the supply valve 5a of the water supply unit 5.

[0126] In particular, the first load of water is carried out by activating the supply valve 5a from time t0 to time t1. The supply valve 5a is preferably activated by an activation signal of the control unit 11. During the first load of water (step 130) the water level WL in the tub 3 increases and reaches a first level L1, also indicated in Figure 2. After the first supply valve 5a is deactivated, i.e. at time t>t1, the water level WL in the tub 3 decreases due to absorption by the laundry. Actually, water absorption can start already before t1, i.e. before the end of the first load of water in the tub 3, since water starts being absorbed by laundry as soon as it contacts the latter.

[0127] From time t1 on, the water level WL in the tub 3 is monitored. The water level WL in the tub 3 is monitored for a period of time t1÷t2.

[0128] Preferably, this period of time t1÷t2 has a value comprised between lmin and 2min.

[0129] At the end of this monitoring period of time, i.e. at time t2, if the water level WL in the tub 3 is still significantly decreasing, the control unit 11 assesses that the first load of water is not sufficient to wet (saturate) the laundry as required. One or more loads of water are therefore necessary.

[0130] With the terms "significantly decreasing" it is meant that the decreasing speed of the water level WL in the tub 3 is still high, for example higher than a predetermined minimum level for the decreasing speed, which in turns means that the laundry is still absorbing a high quantity of water and it is therefore not saturated, or substantially saturated.

[0131] The amount of water absorbed by the laundry and the speed of the absorption strongly depend on the amount of the laundry (clearly a greater amount of laundry absorbs more water that a smaller amount of the same type of laundry) and on the type of the laundry (for example if the laundry is made of cotton it absorbs more water that if it would be made of synthetic fibres) located in the drum 4.

[0132] According to the situation actually illustrated in Figure 8, from time t2 on a second amount of water Qp2 is loaded into the tub 3 (e.g. 1 litre).

[0133] Loading of the second amount of water Qp2 is again carried out by activating the supply valve 5a of the

water supply unit 5.

[0134] In particular, the second load is carried out by activating the supply valve 5a from time t2 to time t3. During the second load of water the water level WL in the tub 3 increases and reaches a second level L2. Diagram of Figure 8 shows that the second level L2 reached by the water is higher than the first level L1. This is just an exemplary illustration of the water level. In the real situation, the second level L2 could be even equal to, or lower than, the first level L1.

[0135] After the first supply valve 5a is deactivated, i.e. at time t>t3, the water level WL in the tub 3 decreases due to absorption by the laundry. Actually, as explained above, water absorption starts already before t3, i.e. before the end of the second load in the tub 3.

[0136] From time t3 on, the water level WL in the tub 3 is monitored. The water level WL in the tub 3 is monitored for a period of time t3÷t4, preferably equal to the previous monitoring period of time t1÷t2.

[0137] In different embodiments, the monitoring period of time t3÷t4 may be different from the previous monitoring period of time t1÷t2. In a preferred embodiment, the monitoring period of time t3÷t4 is shorter than the previous monitoring period of time t1÷t2.

[0138] At the end of this monitoring period of time, i.e. at time t4, if the water level WL in the tub 3 is still significantly decreasing, the control unit 11 assesses that the first and second loads of water are not sufficient to wet (saturate) the laundry as required. One or more loads of water are therefore necessary.

[0139] According to the situation actually illustrated in Figure 8, from time t4 on a third amount of water Qp3 is loaded into the tub 3 (e.g. 1 litre).

[0140] The third amount of water Qp3 may be equal to the second amount of water Qp2 or, preferably, the third amount of water Qp3 may be less than the second amount of water Qp2.

[0141] During the third load of water the water level WL in the tub 3 increases and reaches a third level L3. Diagram of Figure 8 shows that the third level L3 is higher than the first and the second level L1 and L2. This is just an exemplary illustration of the water level. In the real situation, the third level L3 could be different, as said above.

[0142] The water level WL in the tub 3 is then monitored for a period of time t5÷t6, preferably equal to the previous monitoring periods of time t1÷t2 and t3÷t4.

[0143] In different embodiments, the monitoring period of time t5÷t6 may be different from the previous monitoring periods of time t1÷t2 or t3÷t4. In a preferred embodiment, the monitoring period of time t5÷t6 is shorter than the previous monitoring periods of time t1÷t2 and t3÷t4.

[0144] In a preferred embodiments, then, the monitoring periods of time may depend on the selection made by the user through the interface unit 16. In a further preferred embodiment, the monitoring periods of time may set by the control unit 11 on the base of the variation of the water level WL inside the tub 3.

[0145] At the end of this period of time, i.e. at time t6, if the water level WL in the tub 3 is still significantly decreasing, the control unit 11 assesses that the previous loads of water are not sufficient to wet (saturate) the laundry as required. Conversely, if the water level WL in the tub 3 is not significantly decreasing, as actually illustrated in Figure 8, the control unit 11 assesses that the laundry is saturated, or substantially saturated, and no more loads of water are necessary.

[0146] In fact, if the water level WL in the tub 3 is not significantly decreasing means that the laundry is saturated, or substantially saturated, and is not absorbing water anymore. The water loading phase (block 120) with said partial water loads (steps 130, 131, 132) is therefore considered terminated.

[0147] With the terms "not significantly decreasing" it is meant that the decreasing speed of the water level WL in the tub 3 is low, for example lower than a predetermined minimum level for the decreasing speed, which in turns means that the laundry is substantially not absorbing water and it is therefore saturated, or substantially saturated.

[0148] By saying that the decreasing speed of the water level WL in the tub 3 is lower than a predetermined minimum level it has to be intended that the decreasing speed may be also negative, which is actually an increasing speed. This means that the laundry is saturated and is not absorbing water anymore and the water level WL in the tub 3 may increase, as illustrated with the dashed line A in Figure 8.

[0149] In the example here illustrated three water partial water loads (steps 130, 131, 132) have been performed. It is clear that in different embodiments the number of water partial loads may be different and will depend on the degree of absorption of the laundry.

[0150] During the water loading phase (block 120), preferably, the second recirculation pump 21 is activated enhancing the distribution of water over the laundry and improving wetting of the laundry inside the drum 4 and thus reducing the wetting time.

[0151] Also during the water loading phase (block 120), preferably, the drum 4 is set rotated thus further improving wetting of the laundry inside the drum 4 and thus reducing the wetting time.

[0152] In a different embodiment, nevertheless, the distribution of water in the laundry could be obtained exclusively with rotation of the drum 4. In such a case, the laundry washing machine could be not equipped with the second recirculation circuit.

[0153] As exemplary illustrated in Figure 8, and according to the method of the present invention above described, water load phases (t0÷t1, t2÷t3, t4÷t5) are followed by respective transitional phases (t1÷t2, t3÷t4, t5÷t6).

[0154] At the end of the last period of time, i.e. at time t6, the laundry is saturated, or substantially saturated, and the water loading phase (block 120) with said partial

water loads (steps 130, 131, 132) is considered terminated, as said above.

[0155] The amount of water which is conveyed into the washing tub during each of said partial water loads (steps 130, 131, 132) and hence the total amount of water Wt which is conveyed into the tub 3 during the entire water loading phase is advantageously established (step 140), preferably by means of the values coming from a water flow sensor (flow meter).

[0156] Once the water loading phase (block 120) is terminated and the total amount of water Wt is established (step 140), in a successive step (step 150) and according to an aspect of the present invention, the method provides for the supply of the detergent D.

[0157] In particular, the method provides for the supply of a quantity Q1d of detergent D into the tub 3.

[0158] The quantity Q1d of detergent D at this stage is evaluated as a function of the total amount of water Wt:

$$Q1d=f(Wt)$$

[0159] Preferably, the quantity Q1d of detergent D is a percentage of the total amount of water Wt previously established/determined, i.e.:

$$Q1d=(P/100)*Wt$$

wherein P is a constant representing the preferred desired percentage of detergent in the total amount of water. The quantity Q1d of detergent D is therefore preferably directly proportional to the total amount of water Wt (P is advantageously stored in the memory of the control unit 11). In this case, for example, 5-10 ml of liquid detergent may be supplied into the washing tub for 1 liter of water.

[0160] In preferred embodiments, the parameter P may depend on the washing cycle selected by user. For example, the parameter P may have a first value if the user selects a cotton cycle 30° and a second different value if the user selects a cotton cycle 60°.

[0161] In different embodiments, nevertheless, the function f(Wt) may be different.

[0162] The introduction of the quantity Q1d of detergent D takes place preferably through the detergent dispenser 60: the quantity Q1d of detergent D, preferably liquid detergent, is conveyed from the respective compartment of the drawer 6 into the flushing chamber 57 by activating the first feeding pump 60a and from there through the supply pipe 18 into the tub 3.

[0163] Once the introduction of the detergent D has been performed (step 150), the washing cycle continues with the main washing phase (block 200) according to the washing cycle selected. The laundry is subjected to a washing mechanical action by means of drum rotations and to a cleaning action by means of the detergent D.

[0164] During the main washing phase the second recirculation circuit 20 is advantageously activated. The wash liquid comprising water W and detergent D from the bottom region 3a of the tub 3 is conveyed towards the upper region 3b of the tub 3 by activation of the second recirculation pump 21. The second recirculation circuit 20 is advantageously activated in order to improve wetting of the laundry inside the drum 4. The wash liquid is then preferably heated to a predetermined temperature based on the washing program selected by the user.

[0165] The main washing phase (block 200) preferably terminates with a draining phase (step 202) wherein the dirty water is drained from the tub 3 to the outside by means of the water outlet circuit 25.

[0166] The washing cycle then advantageously comprises one or more rinsing cycles (step 205) during which clean rinse water is added to the laundry and drum is rotated to extract water and dirty particles/detergent from the laundry: the dirty water extracted is drained from the tub 3 to the outside by the water outlet circuit 25.

[0167] Once the washing cycle has been completed, in case of a laundry washing-drying machine, a drying phase (step 210) may be also preferably performed.

[0168] The method according to the steps above described correctly doses the amount Q1d of detergent D on the base of total amount of water Wt which has been conveyed into the washing tub 3.

[0169] Advantageously, the method according to the invention allows dosing the correct amount of detergent according to the total amount of water Wt conveyed into the tub for saturating or substantially saturating the laundry. This makes it possible to dose the correct amount, or percentage, of detergent and water in the solution used to wash the laundry in a washing cycle. Therefore, the cleaning effect of the solution is improved with respect to the washing cycle of the known technique.

[0170] According to the method above described, furthermore, the detergent D is supplied into the tub 3 only after the water loading phase (step 120) is terminated, i.e. only when the laundry has already absorbed water and is saturated or substantially saturated. Advantageously, it is avoided that detergent D causes stains or halos on the laundry, as it may happen if detergent D is put on dry laundry or on laundry not sufficiently wetted, in particular when concentrated or super concentrated detergents are used.

[0171] In a further embodiment of the washing method of the invention, the step of supplying detergent D into the tub 3 (step 150) takes into account of the evaluation of a further parameter, namely the particular type of detergent Dt, i.e.:

$$Q1d=f(Wt, Dt)$$

[0172] The detergent type Dt is preferably defined by its concentration, for example the detergent D may be regular, concentrated, super concentrated etc.. The type

of detergent Dt is a parameter which may evaluated in different ways. For example, the type of detergent D may be selected directly by the user through said interface 16, or automatically detected through a proper concentration sensor arranged in the laundry washing machine. For example, the concentration sensor may be arranged in a recirculation circuit and/or in a suitable position in the tub and/or in the detergent dispenser.

[0173] Any concentration sensor may be used. For example, the concentration sensor may be a conductometric sensor.

[0174] The following table exemplary shows a correlation between the amount of detergent which is supplied into the tub 3 and the liquid detergent type Dt:

Table 1

Liquid detergent type Dt	Amount of detergent
Regular	Q1'd=f'(Wt)
Concentrated	Q1"d-f"(Wt)
Super concentrated	Q1'"d=f"'(Wt)

which indicates that different functions are used for different detergent types Dt. For example:

$$Q1'd=(P'/100)*Wt$$

when the detergent is regular;

$$Q1''d=(P''/100)*Wt$$

when the detergent is concentrated;

$$Q1'''d=(P'''/100)*Wt$$

when the detergent is super concentrated;
wherein P', P" and P'" are constants representing the preferred desired percentage of detergent in the total amount of water and wherein, preferably, P'>P">P'" (P', P" and P'" are constants advantageously stored in the memory of the control unit 11).

[0175] The quantity Q1d of detergent D is again preferably directly proportional to the total amount of water Wt.

[0176] In this case, for example, 10ml of regular liquid detergent may be supplied into the washing tub for 1 liter of water or 7,5ml of concentrated liquid detergent may be supplied into the washing tub for 1 liter of water or 5ml of super concentrated liquid detergent may be supplied into the washing tub for 1 liter of water.

[0177] In different embodiments, nevertheless, the functions f'(Wt), f"(Wt) and f'"(Wt) may be different, even more complex.

[0178] Advantageously, the method according to this embodiment allows dosing the correct amount of detergent according to the total amount of water Wt and the detergent type Dt.

[0179] In a further embodiment of the washing method of the invention, the step of supplying detergent D into the tub 3 (step 150) takes into account of the evaluation of a further parameter, namely the water hardness parameter Wh, i.e.:

$$Q1d=f(Wt, Wh)$$

[0180] The following table exemplary shows a correlation between the amount of detergent which is supplied into the tub 3 and the water hardness Wh:

Table 2

Water hardness Wh	Amount of detergent
Hard	Q1'd=f'(Wt)
Medium	Q1"d=f"(Wt)
Soft	Q1'"d=f'"(Wt)

which indicates that different functions are used for different water hardness Wh. For example:

$$Q1'd=(P'/100)*Wt$$

when the water hardness Wh is hard;

$$Q1''d=(P''/100)*Wt$$

when the water hardness Wh is medium;

$$Q1'''d=(P'''/100)*Wt$$

when the water hardness Wh is soft.
wherein P', P" and P'" are constants representing the preferred desired percentage of detergent in the total amount of water and wherein, preferably, P'>P">P'" (P', P" and P'" are constants advantageously stored in the memory of the control unit 11).

[0181] The quantity Q1d of detergent D is again preferably directly proportional to the total amount of water Wt.

[0182] In different embodiments, nevertheless, the functions f'(Wt), f"(Wt) and f'"(Wt) may be different.

[0183] Advantageously, the method according to this embodiment allows dosing the correct amount of detergent according to the total amount of water Wt and the water hardness Wh.

[0184] The water hardness parameter Wh may be a

parameter already stored in the memory of the control unit 11. For example, and preferably, the water hardness Wh may be set by the user at the time of the installation of the machine and its connection to the external water supply line E. In a further preferred embodiment, the water hardness Wh may be measured by means of a suitable water hardness sensor.

[0185] In a further embodiment of the washing method of the invention, the step of supplying detergent D into the tub 3 (step 150) takes into account of the evaluation of a further parameter, namely the soil level Sl, i.e.:

$$Q1d=f(Wt, Sl).$$

[0186] The following table exemplary shows a correlation between the amount of detergent which is supplied into the tub 3 and the soil level Sl:

Table 3

Soil level Sl	Amount of detergent
Normal	Q1'd=f'(Wt)
High	Q1"d=f"(Wt)

which indicates that different functions are used for different soil levels Sl.

[0187] For example:

$$Q1'd=(P'/100)*Wt$$

when the soil level Sl is high;

$$Q1''d=(P''/100)*Wt$$

when the soil level Sl is normal;

wherein P', P" are constants representing the preferred desired percentage of detergent in the total amount of water and wherein, preferably, P'>P" (P', P" and P'" are constants advantageously stored in the memory of the control unit 11).

[0188] The quantity Q1d of detergent D is again preferably directly proportional to the total amount of water Wt.

[0189] In different embodiments, nevertheless, the functions f'(Wt), f"(Wt) may be different.

[0190] Advantageously, the method according to this embodiment allows dosing the correct amount of detergent according to the total amount of water Wt and the soil level Sl.

[0191] Preferably, the soil level parameter Sl is evaluated on the base of the desired washing cycle selected by the user. In different more sophisticated embodiments the soil level Sl parameter may be detected by means of a suitable soil sensor which detects the amount of dirt released by the laundry in the clean water.

[0192] For example, the soil level may be evaluated after the water loading phase (block 120) and before the step of supplying the detergent D (step 150) by evaluating the turbidity of the water in the tub 3.

[0193] The soil level Sl may be advantageously detected by means of the turbidity sensor 80.

[0194] Advantageously, the detection of the amount of dirt present in the water is carried out before other agents, in particular detergent or foam, may distort the measure by the turbidity sensor 80.

[0195] In further embodiments of the washing method of the invention, the step of supplying detergent D into the tub 3 (step 150) may take into account of one or more of said further parameters, namely the particular type of detergent Dt, the water hardness Wh and the soil level Sl. For example, one of the following functions may be used:

$$Q1d=f(Wt, Dt, Wh);$$

$$Q1d=f(Wt, Dt, Sl);$$

$$Q1d=f(Wt, Wh, Sl);$$

$$Q1d=f(Wt, Dt, Wh, Sl).$$

[0196] Independently of the function which is actually used, the method doses the amount Q1d of detergent D on the base of total amount of water Wt which has been conveyed into the washing tub 3, in particular after the water partial loads.

[0197] Advantageously, the method according to the invention allows dosing the correct amount of detergent according to the total amount of water Wt and the detergent type Dt and/or the water hardness W and/or the soil level Sl.

[0198] This makes it possible to dose the correct amount, or percentage, of detergent and water in the solution used to wash the laundry in a washing cycle detergent for washing the laundry in a washing cycle. Therefore, the cleaning effect of the solution is improved with respect to the washing cycle of the known technique.

[0199] With reference to the flow chart of Figure 9 another embodiment of the washing method of the invention is illustrated.

[0200] Phases and/or steps with the same reference numbers of the first embodiment correspond to phases and/or steps described above for the first embodiment. This embodiment differs from that previously described with reference to Figure 7 in that after the water loading phase (block 120) and before the step of supplying de-

tergent D (step 150) the method comprises the control of the soil level Sl of the water in the tub 3 (step 180) and, in case, discharging the dirty water (step 181) and restoring it (step 182) with new clean water.

[0201] In particular, the method provides for the control of the water dirty level (step 180) preferably by means of the turbidity sensor 80.

[0202] If the dirty level is below, or equal to, a prefixed threshold (output "Yes" of step 180), the method normally proceeds with the introduction of detergent D (step 150), as described above.

[0203] If the dirty level is above the prefixed level threshold (output "No" of step 180), the method proceeds with the discharge of the dirty water Qwd from the tub 3 (step 181), preferably activating the draining pump 26 of the water outlet circuit 25.

[0204] The quantity Qwd of dirty water discharged to the outside, for example measured by means of a proper flowmeter or differently estimated, is then restored with introduction of clean water into the tub 3 (step 182), preferably activating the supply valve 5a of the water supply unit 5. Preferably, the quantity of new clean water is equal to the discharged quantity Qwd of dirty water.

[0205] Advantageously, the substitution of dirty water with clean water increase the efficiency of the cleaning action of the detergent D in the main washing phase (step 200).

[0206] Furthermore, on the base of the dirty level detected (step 180), the control unit 11 may preferably set and/or adjust the heating temperature (step 183) of the wash liquid for the following main washing phase (step 200).

[0207] In a preferred embodiment of the washing method of the invention, the function f(Wt) which determines the quantity Q1d of detergent D as a function of the total amount of water Wt, or other parameters Dt, Wh, Sl, further takes into account of the fabric type Ft of the laundry; i.e.:

$$Q1d=f(Wt, Ft).$$

[0208] The fabric type of the laundry is preferably determined by analyzing the weight of the laundry, detected for example by a weight sensor placed on the dampers, and the course of the level of water level WL in the tub 3 during the water loading phase. Duration of the water absorption phases and quantities of water introduced in each partial load give, in fact, an indication of the water absorption capacity of the laundry. These parameters are therefore used to determine the type of fabric of the laundry (i.e. sponge-cloth, cotton. synthetics, silk, wool, etc.). The form of function f(Wt) will depend on the type of fabric determined.

[0209] In the preferred embodiments above described, the step of supplying detergent D (step 150) is carried out after the water loading phase (block 120) and the total amount of water Wt has been determined (step 140). After the detergent supplying step (step 150), the washing cycle continues with the main washing phase (block 200), as explained above. In other embodiments, nevertheless, the method may perform one or more further water loads or one or more further detergent supplying steps before the main washing phase (step 200). The further quantities of water and/or detergent are preferably predetermined known quantities, so that the total amount of water Wt previously used in function Q1d=f(Wt) advantageously takes into account of this quantities.

[0210] Figure 10 shows a laundry washing machine 300 according to a further embodiment of the invention, in which a method according to the invention is implemented.

[0211] The laundry washing machine 300 differs from the laundry washing machine 1 previously described in that the first feeding pump 60a comprises an outlet duct 60b which terminates at the second recirculation pipe 23 of the second recirculation circuit 20.

[0212] The method according to the invention may be performed in the laundry washing machine 300 of Figure 10 analogously to what described for the laundry washing machine 1 of Figure 2. The only difference lies in that the second recirculation circuit 20 is activated (by means of the second recirculation pump 21 activation) when the first feeding pump 60a is activated for the introduction of the quantity Qd of detergent D,

[0213] Advantageously, when the detergent D reaches the second recirculation pipe 23, the detergent D is homogenously sprayed over the laundry together with the water flowing in the second recirculation pipe 23.

[0214] In the preferred embodiment here illustrated, the outlet duct 60b of the first feeding 60a terminates substantially at the terminal nozzle 23a of the second recirculation pipe 23. In different embodiments, nevertheless, the outlet duct 60b of the first feeding 60a may terminate at any point of the second recirculation pipe 23.

[0215] In a further preferred embodiment, then, the outlet duct 60b of the first feeding 60a may terminate at the second recirculation pipe 33 of the mixing circuit 30.

[0216] It has thus been shown that the present invention allows all the set objects to be achieved. In particular, it makes it possible to provide an alternative method for washing laundry in a laundry washing machine equipped with an automatic dosing device which doses the correct amount of detergent in any single washing cycle according to the laundry load amount.

[0217] 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.

[0218] Furthermore, the laundry washing machines illustrated in the enclosed figures preferably comprise two recirculation circuits; however the method according to

the invention can be applied as well to laundry washing machine without one, or both, of said recirculation circuits.

[0219] While the present invention has been described with reference to the particular embodiments shown in the figures, it should be noted that the present invention is not limited to the specific embodiments illustrated and described herein; on the contrary, further variants of the embodiments described herein fall within the scope of the present invention, which is defined in the claims.

Claims

1. A method for washing laundry during a washing cycle in a laundry washing machine (1; 300) comprising:

   - a washing drum (4) adapted to receive laundry;
   - a washing tub (3) external to said washing drum (4);
   - a water supply unit (5) to supply water (W) into said washing tub (3) from an external supply line (E);
   - an automatic dosing device (58) to supply detergent (W) into said washing tub (3) comprising a compartment suitable for receiving an amount of detergent (D) sufficient for a plurality of washing cycles;
   - a device (19) suited to sense the liquid level (WL) inside said washing tub (3);
   - a control unit (11) for controlling functioning of said laundry washing machine (1; 300);

   the method comprising an initial phase of introducing water and detergent for washing said laundry and a successive main washing phase during which laundry is subjected to a washing mechanical action by means of drum rotations and to a cleaning action by means of said water and detergent;
   wherein said initial phase comprises the steps of:

   - a) loading water into said washing tub (3);
   - b) rotating the washing drum (4);
   - c) monitoring the variation of the water level (WL) sensed by said device (19) for determining when the laundry is saturated or substantially saturated, said variation being due to the water supplied into said washing tub (3) in step a) and due to the water absorbed by the laundry in step b);
   - repeating at least one time steps a) to c);
   - operating said automatic dosing device (58) for introducing a quantity of detergent (D) into said washing tub (3) based on the amount of water (Wt) introduced in said steps a), said amount of water (Wt) being the water introduced in said steps a) for getting the laundry saturated or substantially saturated.

2. The method according to claim 1, **wherein** said laundry is saturated or substantially saturated when the variation of said water level (WL) sensed by said device (19) in step c) is below a determined range.

3. The method according any of the preceding claims, **wherein** before said step of introducing said quantity of detergent, the method further comprises a step of determining the total amount of water (Wt) introduced into said washing tub (3) in said steps a).

4. The method according to claim 3, **wherein** said quantity of detergent introduced into said washing tub (3) is a function of said total amount of water (Wt) introduced into said washing tub (3) in said steps a).

5. The method according to claim 4, **wherein** said quantity of detergent introduced into said washing tub (3) is a percentage (P) of said total amount of water (Wt) introduced into said washing tub (3) in said steps a).

6. Method according to any claims 3 to 5, **wherein** said quantity of detergent introduced into said washing tub (3) is further a function of the type of detergent (Dt) used.

7. Method according to claim 6, **wherein** said detergent type (Dt) is determined on the base of its concentration level.

8. Method according to claim 4, **wherein** said concentration level of said detergent is a parameter set by a user or is a parameter determined through a concentration sensor arranged in said laundry washing machine (1; 300).

9. Method according to any claims 3 to 8, **wherein** said quantity of detergent introduced into said washing tub (3) is further a function of the water hardness level (Wh) of the water supplied into said washing tub (3).

10. The method according to claim 9, **wherein** said water hardness level (Wh) is a parameter set by a user at the beginning of said washing cycle or at the time of installation of said laundry washing machine (1; 300) or is a parameter determined by means of a water hardness sensor arranged in said laundry washing machine (1; 300).

11. Method according to any claims 3 to 10, **wherein** said quantity of detergent introduced into said washing tub (3) is further a function of the soil level (Sl) of said laundry.

12. The method according to claim 11, **wherein** said soil level (Sl) is determined on the base of the washing

cycle selected set by a user or is determined on the base of a soil sensor associated to said washing laundry machine (1; 300).

13. Method according to any claims 3 to 12, **wherein** said quantity of detergent introduced into said washing tub (3) is further a function of the fabric type (Ft) of said laundry.

14. The method according to claim 13, **wherein** said fabric type (Ft) is determined on the base of the weight of said laundry.

15. The method according to claim 14, **wherein** said weight of said laundry is determined by a weight sensor of said laundry washing machine (1; 300) or by measuring the electrical parameters of the electric drum motor or by means of a torque sensor associated to the drum motor.

16. A laundry washing machine (1; 300) suited to implement a method according to any of the preceding claims.

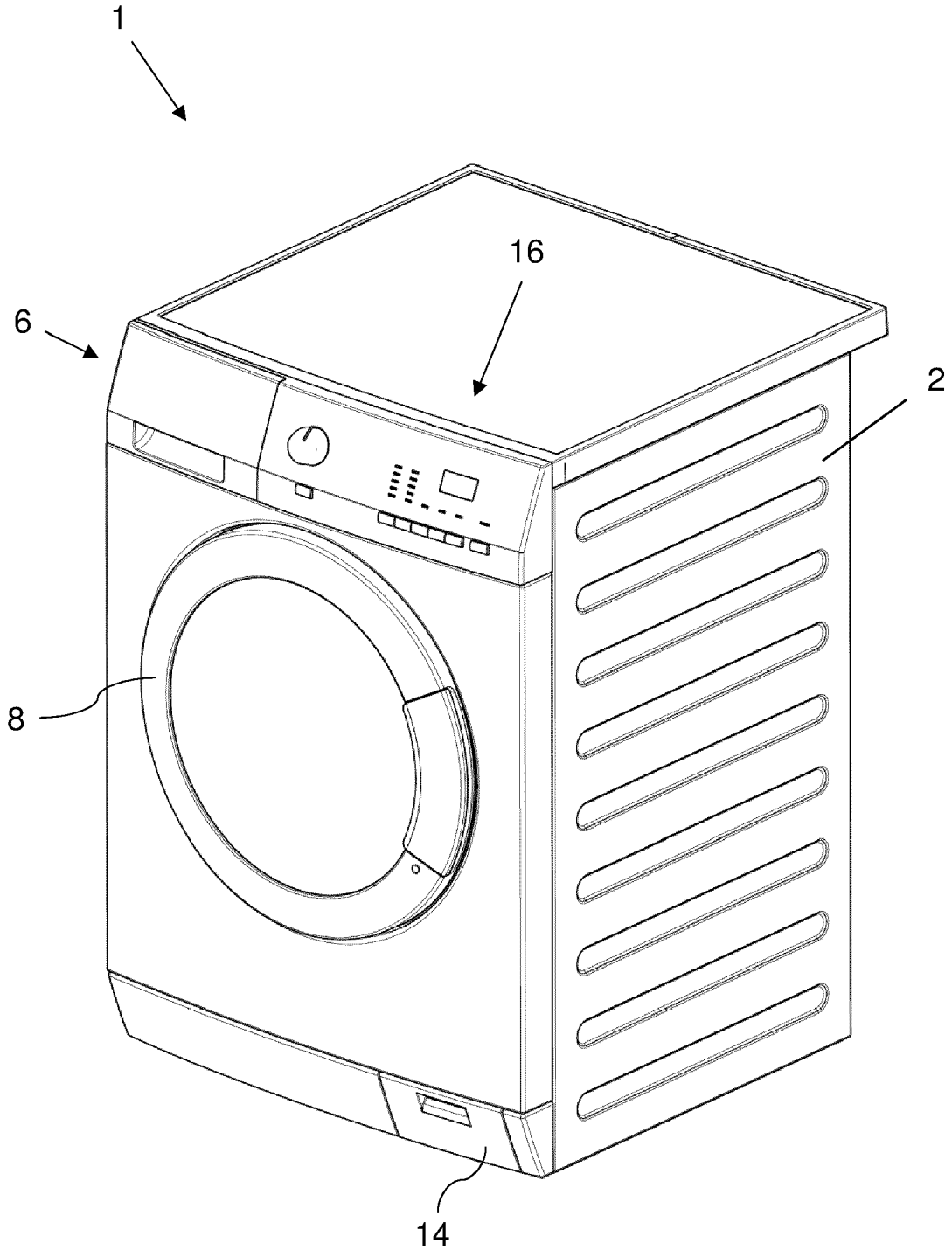

FIG. 1

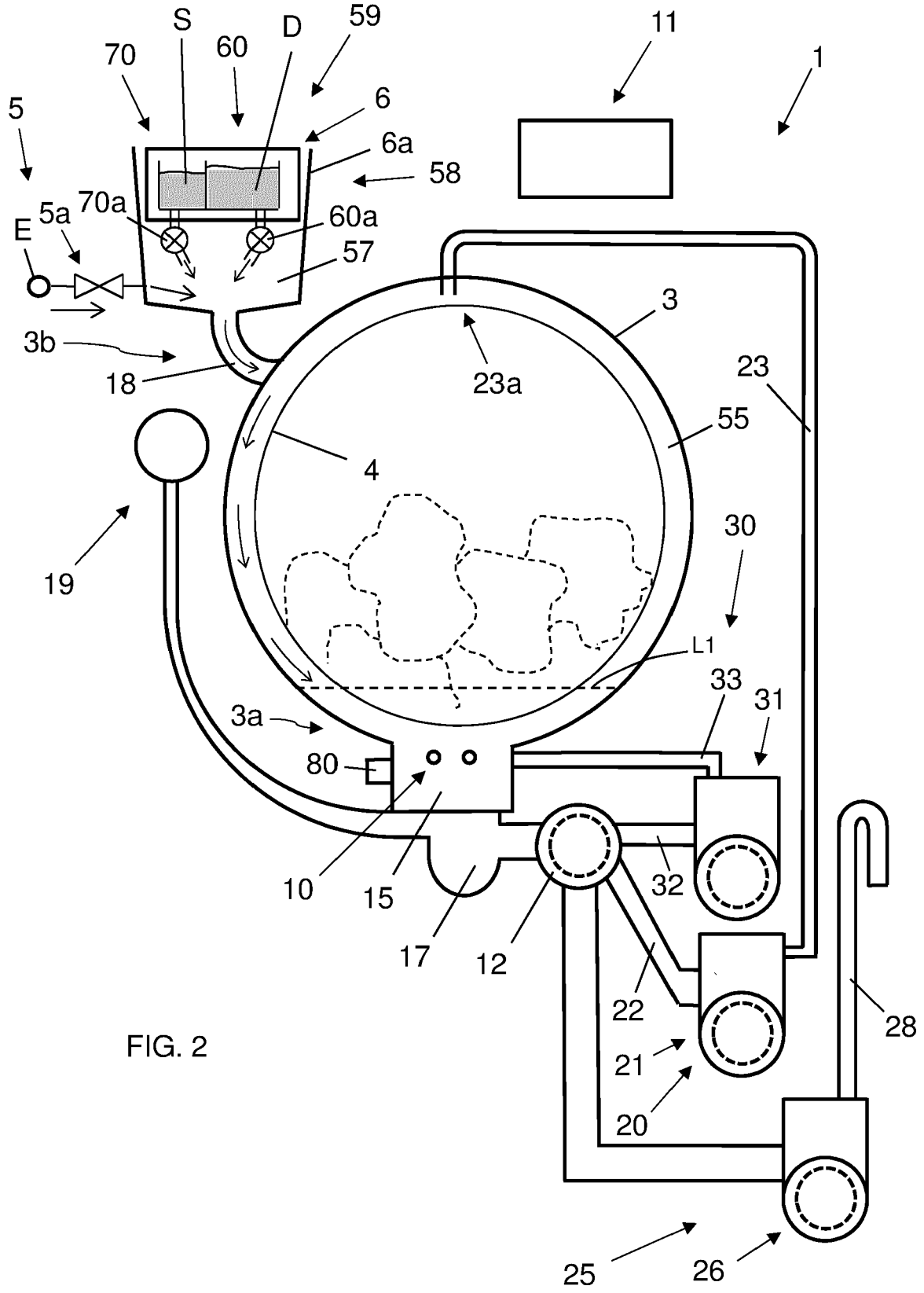
S
D
59
11
1
70
60
6
5
6a
58
70a
5a
60a
E
57
3
3b
23a
23
18
55
4
30
19
L1
33
31
3a
80
10
15
32
17
12
22
28
21
20
25
26

FIG. 2

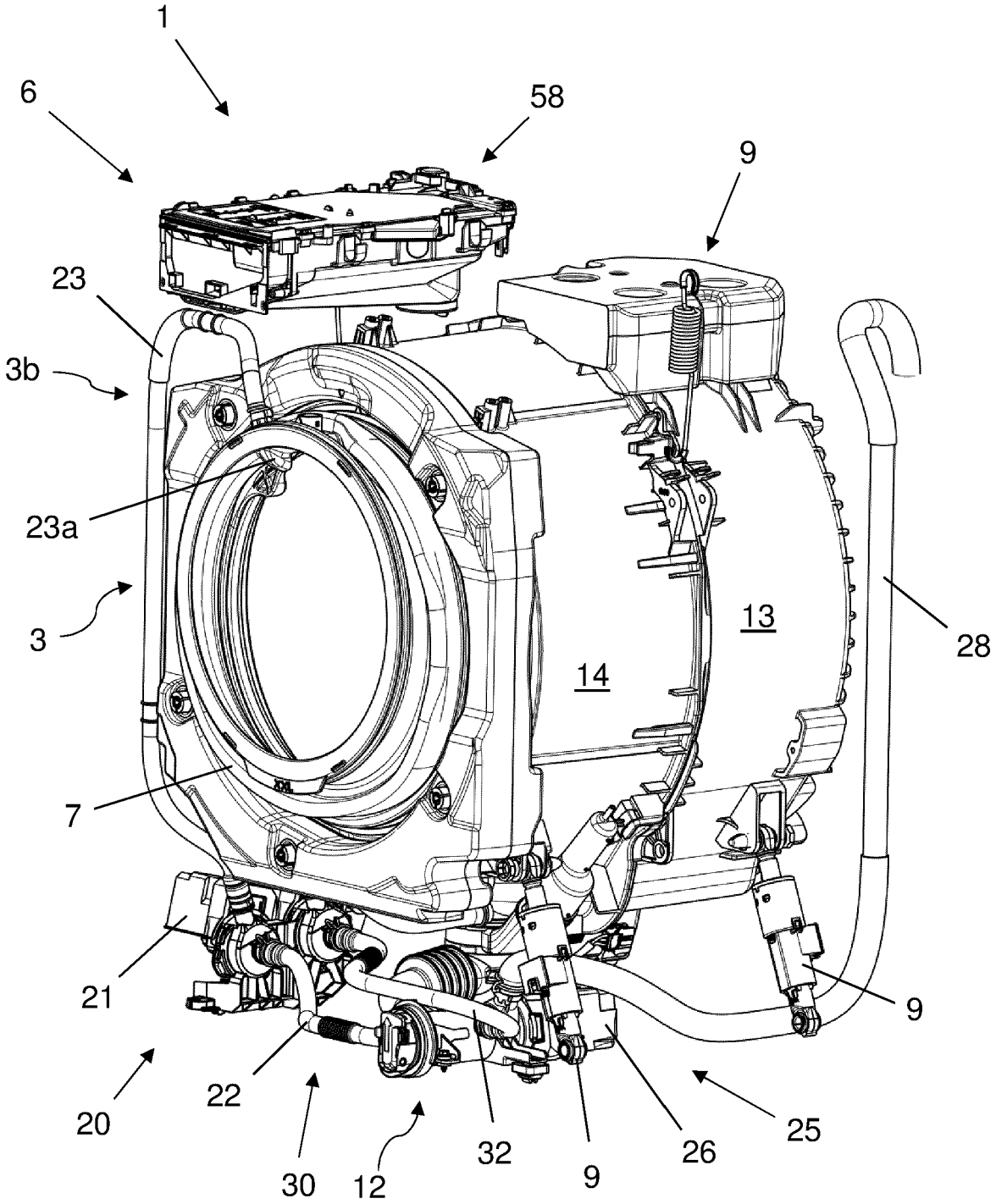

FIG. 3

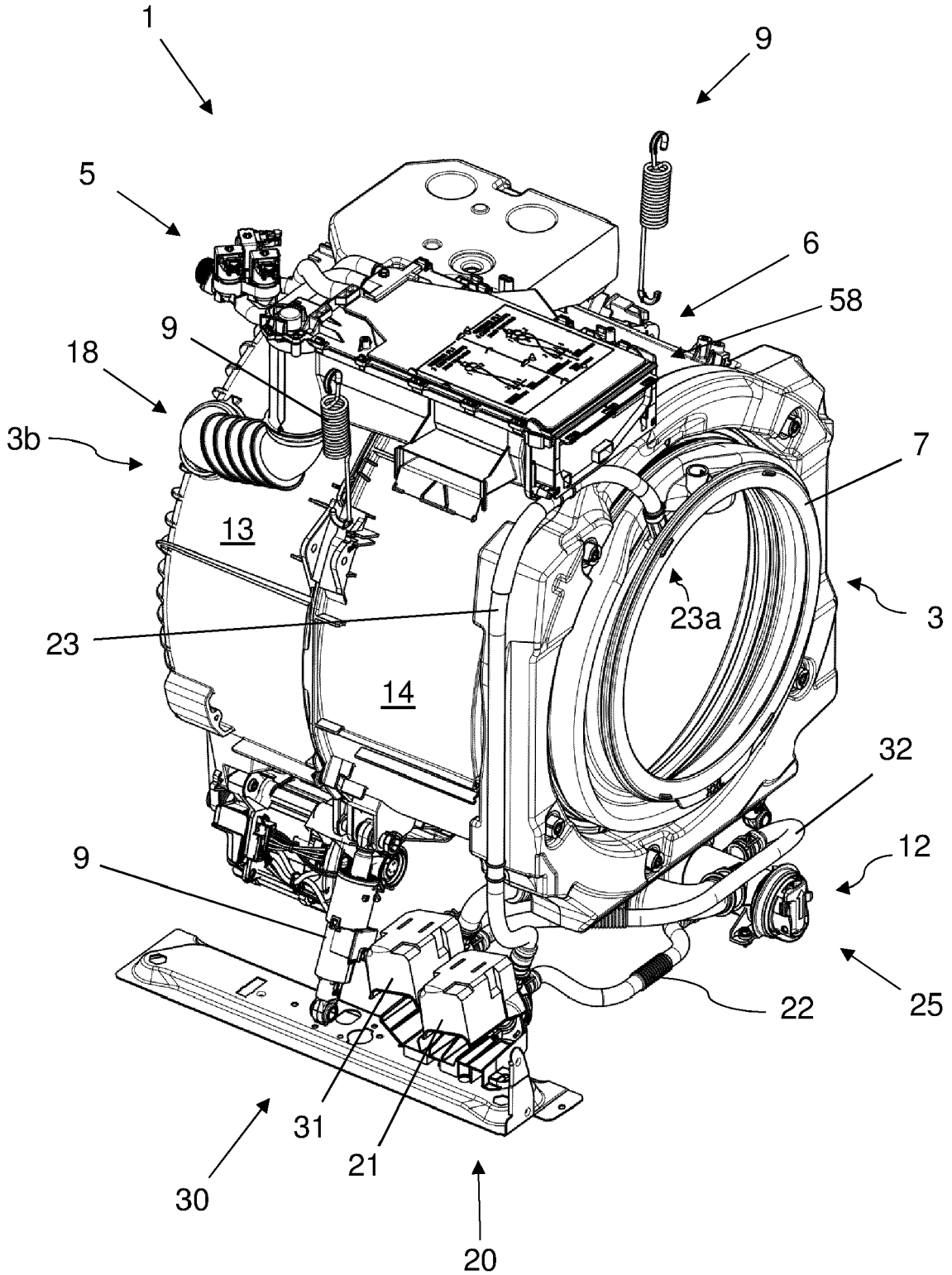

FIG. 4

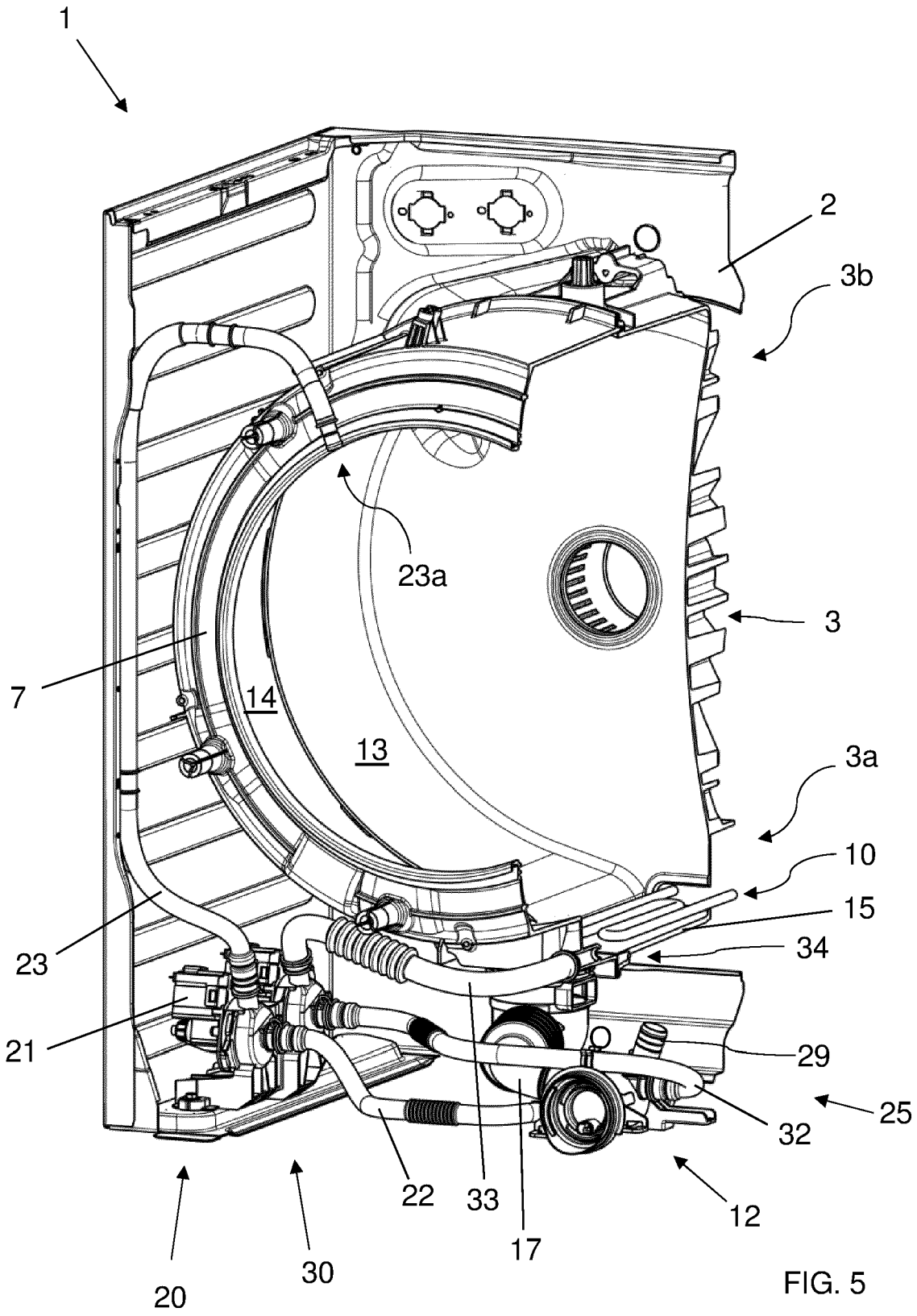

FIG. 5

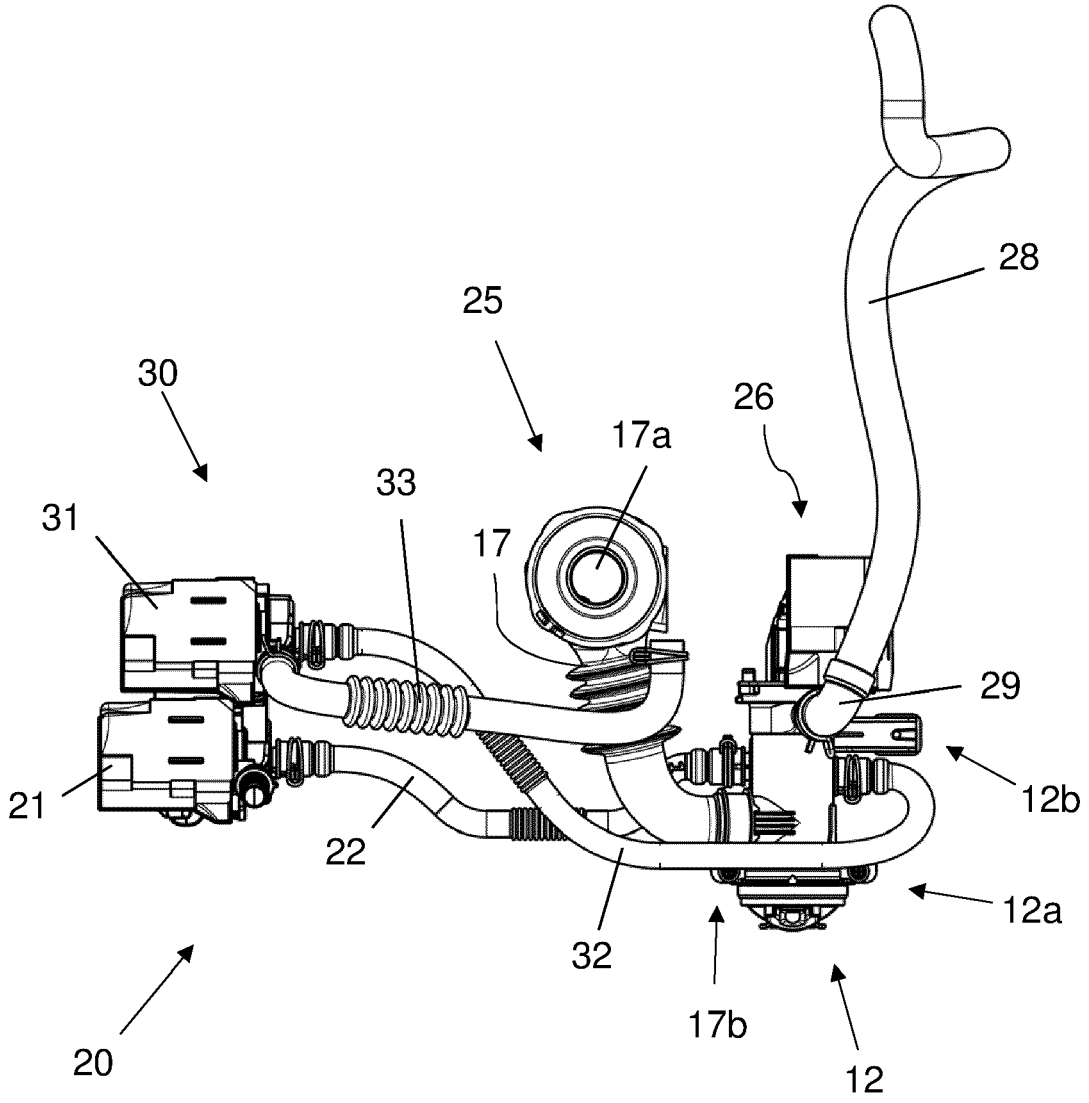

FIG. 6

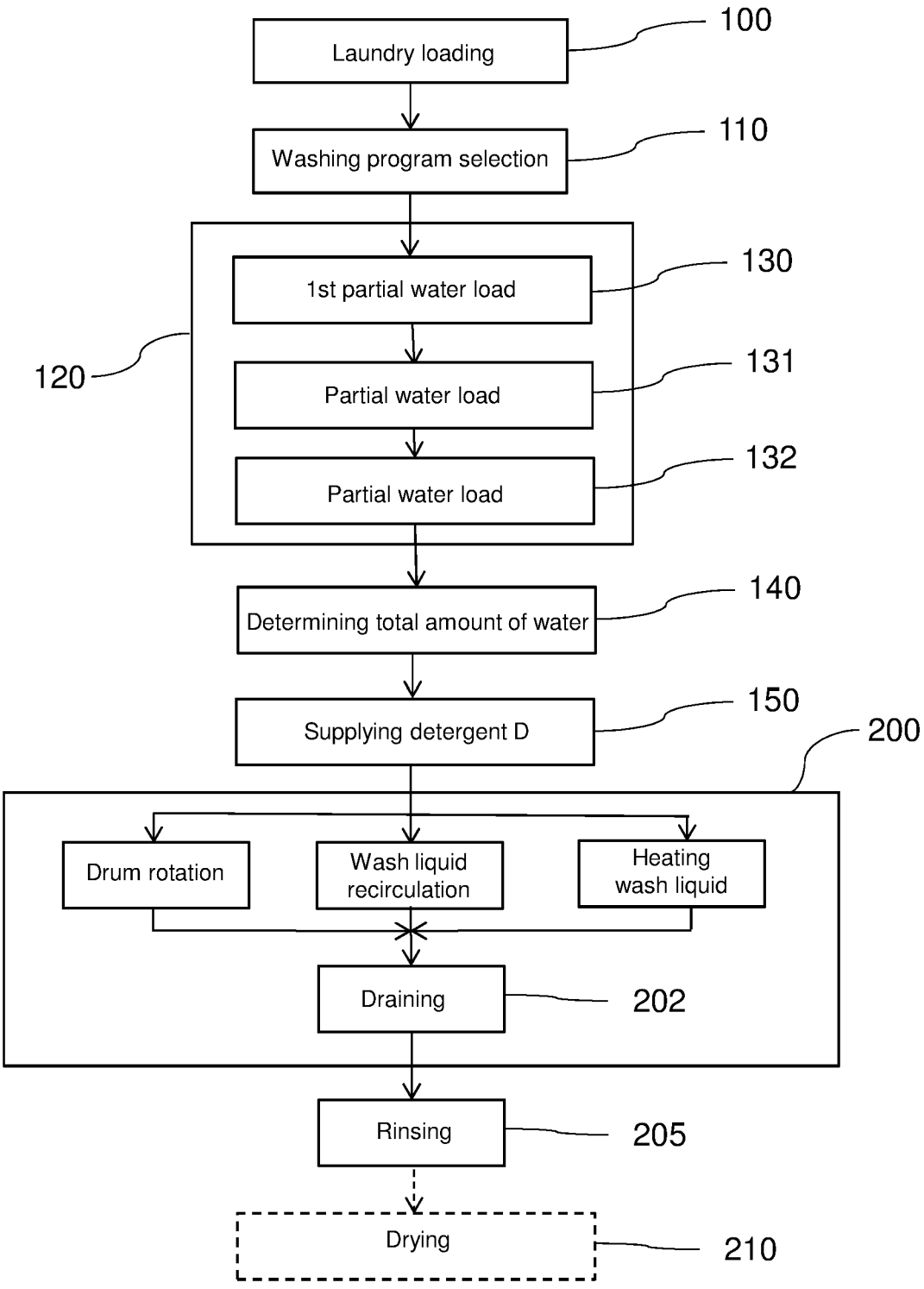
Laundry loading
100
Washing program selection
110
120
1st partial water load
130
Partial water load
131
Partial water load
132
Determining total amount of water
140
Supplying detergent D
150
200
Drum rotation
Wash liquid recirculation
Heating wash liquid
Draining
202
Rinsing
205
Drying
210

FIG. 7

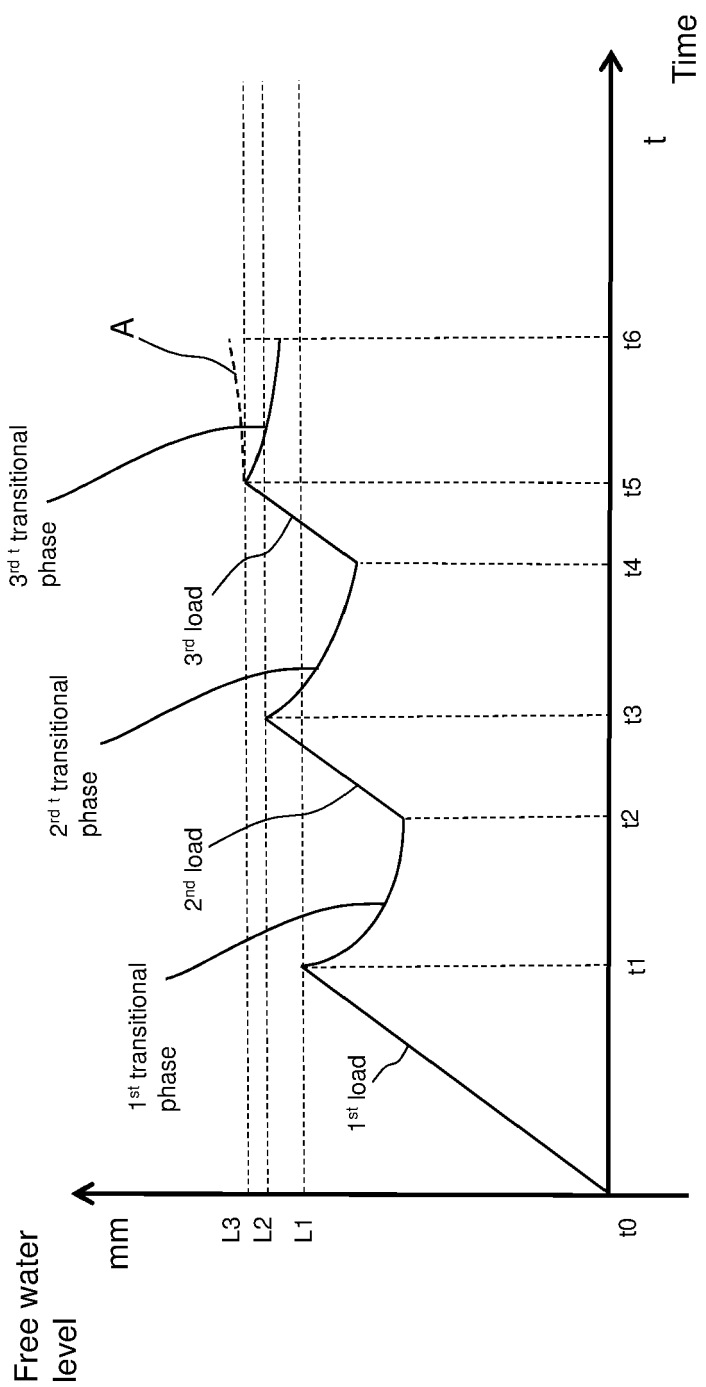
Free water level
mm
L3
L2
L1
t0
t1
t2
t3
t4
t5
t6
t
Time
1st transitional phase
1st load
2nd transitional phase
2nd load
3rd transitional phase
3rd load
A

FIG. 8

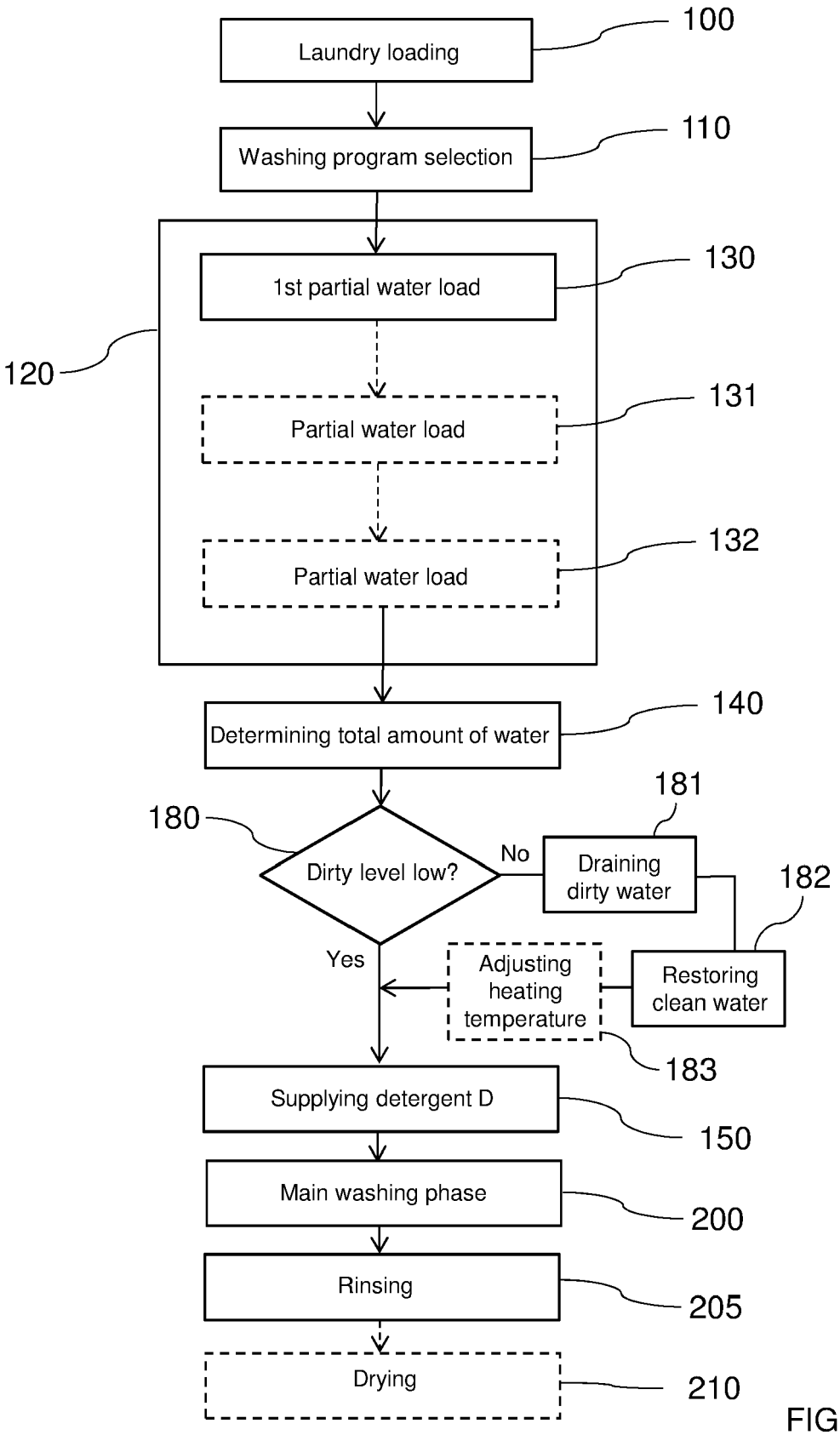
Laundry loading
100
Washing program selection
110
120
1st partial water load
130
Partial water load
131
Partial water load
132
Determining total amount of water
140
180
Dirty level low?
No
181
Draining dirty water
182
Restoring clean water
Yes
Adjusting heating temperature
183
Supplying detergent D
150
Main washing phase
200
Rinsing
205
Drying
210

FIG. 9

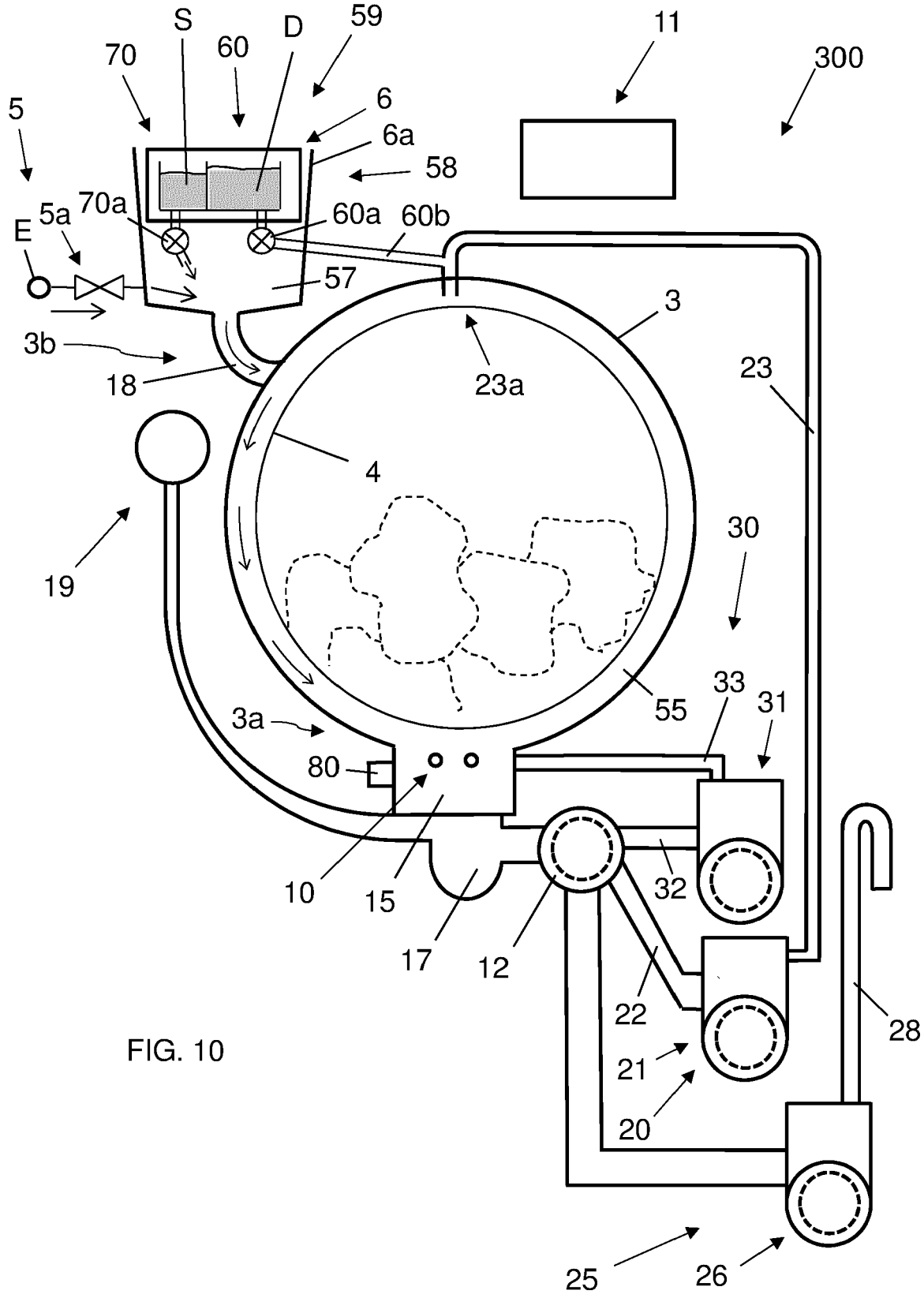
S
D
59
11
300
70
60
6
5
6a
58
70a
5a
60a
60b
E
57
3
3b
23a
23
18
4
19
30
55
33
31
3a
80
10
15
32
17
12
22
28
21
20
25
26

FIG. 10

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EUROPEAN SEARCH REPORT

Application Number
EP 20 15 4628

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A	EP 2 447 411 A2 (PANASONIC CORP [JP]) 2 May 2012 (2012-05-02) * paragraphs [0023] - [0033] * * paragraphs [0041] - [0063] * * figures 1-3 * -----	1-3,16	
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D06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	11 May 2020	Weidner, Maximilian

CATEGORY OF CITED DOCUMENTS

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		US 4503575 A	12-03-1985
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