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

Verfahren zum Waschen von Wäsche in einer Wäschewaschmaschine

Procédé de lavage du linge dans une machine à laver le linge

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Description

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

[0002] In particular, the present invention refers to a method for washing laundry in a laundry washing machine capable of performing a more efficient liquid/water draining phase.

BACKGROUND ART

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

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

[0005] 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.

[0006] Laundry washing machines typically comprise a water inlet circuit and a products supply unit for the introduction of water and washing/rinsing products (i.e. detergent, softener, etc.) into the washing tub.

[0007] Known laundry washing machines are also provided with a draining device for draining washing liquid from the washing tub. The draining device typically comprises a draining pump, arranged at the bottom of the washing tub, which is operated when necessary during the washing program. Draining pumps of known type comprise an inlet and a rotating element, or impeller, which increases the pressure and flow of the liquid towards an outlet of the pump itself.

[0008] Usually the draining device drains the washing liquid out of the laundry washing machine, when it is not needed any more. The pump may be operated both during the initial phases of the washing program and at the end of the same to drain the dirty water.

[0009] According to the known technique, a complete washing program typically includes different phases during which the laundry to be washed is subjected to adequate treatments.

[0010] A washing program usually comprises a laundry wetting phase wherein a proper amount of water and detergent is introduced in the washing tub so that at the end of the phase the laundry is preferably completely drenched.

[0011] The washing program then typically proceeds with a main washing phase during which the drum is rotated and the water contained therein is heated to a predetermined temperature based on the washing program selected by the user.

[0012] A successive step of the washing program typically comprises a rinsing phase which usually comprises one or more rinsing cycles. In a rinsing cycle clean, rinse water is first added to the laundry, the drum is then rotated to extract dirty water from the laundry and finally the dirty water extracted is drained from the washing tub to the outside.

[0013] After the rinsing phase, a final spinning phase allows the extraction of the residual water contained in the wet laundry.

[0014] The water extracted during the spinning phase is again drained from the washing tub to the outside.

[0015] All the draining phases are advantageously carried out by operating the draining device, or the draining pump, which drains the washing liquid (dirty water) from the washing tub to the outside at a desired flow rate.

[0016] Document WO 2014/097251 A1 discloses a method of a washing machine for controlling the draining in which the drainage flow rate is checked; if the measured flow rate exceed the pump nominal flow value, the drain operation can continue; if the measured flow rate is below the pump nominal flow value but above the alarm flow value, the pump performs a "duty cycle".

[0017] Document US 2012/0199162 A1 relates to a method for removing a forming or a fully developed clog from a drain hose in a dish washer; said removal is obtained through a predetermined activation /deactivation of the draining pump.

[0018] Document DE 100 02 687 A1 discloses an impeller flow rate measuring device provided in the drain circuit of an household appliance; in case of a detected low flow rate, an error message is displayed/stored in the machine memory.

[0019] Document US 2008/163930 A1 discloses a home appliance with a drain function and a method controlling the same; the method comprises a cavitation-solving step composed of switch-on and a switch-off of the pump respectively; the cavitation-solving step can be performed once or several times, followed by a continuous drain step.

[0020] Document US 2013/312201 A1 discloses a washing machine operable in a recirculation washing mode, in which the filter clogging state is monitored; in case of detected clogging state of the filter, the recirculation mode is deactivated.

[0021] Document EP 2 712 950 A1 discloses a method in which a intermittent working of the draining pump is provided to eliminate the syphon phenomenon in the water circuit.

[0022] Document DE10 2006 025139 A1 discloses an operating process for a washing machine involving the activation of the draining pump and its deactivation when a first level is reached or after a set time. During the repetition of this cycle, a critical operating condition is predicted, but failure is only detected when the critical operating condition is reached again after at least one such cycle.

[0023] Document DE 102 33 278 A1 discloses a water level device, provided with a position sensor system al-

lowing the continuous display of the actual liquid level; said value is compared with different level thresholds by the program control circuit for controlling the water feed, the water drainage and the water circulation.

[0024] However, laundry washing machines and washing programs of the known art pose some drawbacks.

[0025] A drawback of the laundry washing machines of the known art derives from the presence of air, or air bubbles, at the pump inlet. Air or air bubbles, in fact, may be easily found at the bottom of the washing tub where the pump is connected.

[0026] Air, or air bubbles, at the pump inlet may cause the pump to lose its efficiency, thus working at a lower flow rate than its nominal flow rate.

[0027] This firstly causes the draining phase and the washing program last longer than desired.

[0028] Furthermore, a low flow rate of the draining device may be interpreted by the machine, in particular by its control unit, as a malfunctioning of the same draining device (for example it may be interpreted as a clogged drain filter and/or a pump failure). The control unit may automatically interrupt the washing program and/or display an alarm notification in a graphical user interface.

[0029] In order to overcome said drawbacks, new design of the draining device has been proposed which uses additional pipes in order to eject the air before it reaches the pump inlet, or impeller. Said proposed solutions, nevertheless, increase the complexity of the draining device, its size and/or its manufacturing costs.

[0030] The object of the present invention is therefore to overcome the drawbacks posed by the known technique.

[0031] It is an object of the invention to provide a method for draining liquid from a laundry washing machine which makes it possible to avoid that the washing program lasts longer than desired.

[0032] It is another object of the invention to provide a method for draining liquid from a laundry washing machine that makes it possible to avoid that wrong alarm are notified to the user.

DISCLOSURE OF INVENTION

[0033] The applicant has found that by providing a method for washing laundry in a laundry washing machine wherein the method comprises a draining phase for draining liquid from the washing tub by means of a draining pump, wherein the draining phase comprises at least one activation and operation of the draining pump followed by its de-activation and stoppage if the drainage flow rate of the liquid flowing through the draining pump is below a minimum flow rate threshold, it is possible to avoid that the washing program lasts longer than desired.

[0034] The present invention relates, therefore, to a method for washing laundry in a laundry washing machine of the type comprising:

- a washing tub external to a rotatable washing drum adapted to receive laundry;
- a water supply circuit to supply water into said washing tub;
- a washing/rinsing products supplier to supply washing/rinsing products into said washing tub;
- a draining device comprising a draining pump for draining liquid from said washing tub;

the method comprising at least a draining phase for draining liquid from said washing tub by means of said draining device, wherein said draining phase comprises the steps of:

a) activating said draining pump;
b) checking the drainage flow rate of the liquid flowing through said draining pump;

if said drainage flow rate of the liquid flowing through said draining pump is above or equal to a minimum flow rate threshold, then

d) operating said draining pump and de-activating said draining pump when an end-draining condition is reached,

if said drainage flow rate of the liquid flowing through said draining pump is below a minimum flow rate threshold, then:

e1) operating said draining pump for an on-time period;
e2) de-activating said draining pump;
e3) stopping said draining pump for an off-time period; and
e4) going back to step a).

According to the invention, said step e3) is performed two or more times, the off-time period used in each of said steps e3) performed as second or following being varied with respect of the off-time period used in a step e3) previously performed. According to the invention said step e3) is performed two or more times, and the off-time period used in each of the steps e3) performed as second or following is varied by adding an incremental time period to the off-time period used in a step e3) previously performed.

[0035] In a preferred embodiment of the invention, the incremental time period is a constant value.

[0036] In another preferred embodiment of the invention, the incremental time period is varied according to the drainage flow rate.

[0037] Preferably, if the drainage flow rate does not increases, the incremental time period is increased or if said drainage flow rate increases, the incremental time period is decreased.

[0038] According to a preferred embodiment of the invention, the minimum flow rate threshold is a value lower

than the nominal flow rate of the draining pump.

[0039] In a preferred embodiment of the invention, the end-draining condition occurs when the liquid inside said washing tub goes below a minimum liquid level.

[0040] Preferably, the minimum liquid level corresponds to the lower point of the washing tub.

[0041] In a further preferred embodiment of the invention, the end-draining condition occurs at the expiration of a prefixed time period.

[0042] According to a preferred embodiment of the invention, the prefixed time period is the time which is sufficient to empty the washing tub when full of water if the draining pump is working at its nominal flow rate.

[0043] According to another preferred embodiment of the invention, the prefixed time period is evaluated on the base of the liquid level detected in a further step a1), carried out before said step a), of detecting the liquid level inside the washing tub.

[0044] In the method according to the invention, preferably, the drainage flow rate is evaluated on the base of the detected/measured value of the liquid level inside the washing tub over the time.

[0045] In a different preferred embodiment, the drainage flow rate is evaluated by means of a flowmeter arranged downstream of the draining pump.

[0046] Preferably, the draining device is suitable for draining liquid from the washing tub to the outside of the washing machine.

[0047] In a preferred embodiment of the invention, the end-draining condition occurs when the liquid inside said washing tub goes below a minimum liquid level.

[0048] Preferably, the minimum liquid level corresponds to the lower point of the washing tub.

[0049] In a further preferred embodiment of the invention, the end-draining condition occurs at the expiration of a prefixed time period.

[0050] According to a preferred embodiment of the invention, the prefixed time period is the time which is sufficient to empty the washing tub when full of water if the draining pump is working at its nominal flow rate.

[0051] According to another preferred embodiment of the invention, the prefixed time period is evaluated on the base of the liquid level detected in a further step c1), carried out before said step c), of detecting the liquid level inside the washing tub.

[0052] Preferably, the draining device is suitable for draining liquid from the washing tub to the outside of the washing machine.

BRIEF DESCRIPTION OF THE DRAWINGS

[0053] 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 schematic front view of a laundry washing machine implementing the method according to the invention;
- Figure 2 shows a perspective view of a washing tub with a draining device associated therein of a laundry washing machine implementing the method according to the invention;
- Figure 3 shows the lower section of the washing tub unit and the draining device of Figure 2 in a partially sectioned view;
- Figure 4 shows the exploded view of Figure 3;
- Figure 5 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 an embodiment of the invention;
- Figure 6 shows in detail an operation of the flow chart of Figure 5;
- Figure 7 shows the driving signal of the draining pump as a function of the time according to an example not falling under the scope of the invention;
- Figure 8 shows the water level in the washing tub as a function of the time according to an example not falling under the scope of the invention;
- Figure 9 shows in detail an operation of the flow chart of Figure 5 according to an embodiment according to the invention;
- Figure 10 shows the driving signal of the draining pump as a function of the time according to an embodiment of the method of the invention;
- Figure 11 shows the water level in the washing tub as a function of the time according an embodiment of the method of invention;
- Figure 12 shows in detail an operation of the flow chart of Figure 5 according to an example not falling under the scope of the invention;
- Figure 13 shows the driving signal of the draining pump as a function of the time according to an example not falling under the scope of the invention;
- Figure 14 shows the water level in the washing tub as a function of the time according to an example not falling under the scope of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0054] 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.

[0055] 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).

[0056] In the present description, therefore, the term "laundry washing machine" will refer to both simple laundry washing machines and laundry washing-drying machines.

[0057] With reference to Figure 1 a laundry washing machine 1 is illustrated, in which a method according to

an embodiment of the invention is advantageously implemented.

[0058] The laundry washing machine 1 comprises an external casing or housing 2, in which a washing tub 3 is provided that contains a washing drum 4 where the laundry to be treated can be loaded.

[0059] The washing tub 3 and the washing drum 4 both preferably have a substantially cylindrical shape. A hollow space 12 is defined between the washing tub 3 and the washing drum 4.

[0060] The washing tub 3 is preferably basically assembled from two parts, in this case a front tub part 3a and a rear tub part 3b, which are tightly connected in order to form the washing tub 3, as shown in Figure 2.

[0061] The housing 2 is advantageously provided with a loading/unloading door which, not illustrated, allows access to the washing drum 4.

[0062] The washing 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, not illustrated.

[0063] The washing drum 4 is advantageously rotated by an electric motor which preferably transmits the rotating motion to the shaft of the washing 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 washing drum 4.

[0064] A water supply circuit 5 is arranged in the upper part of the laundry washing machine 1 and is suited to supply water into the washing tub 3. The water supply circuit of a laundry washing machine is well known in the art, and therefore it will not be described in detail.

[0065] The laundry washing machine 1 advantageously comprises a removable drawer 6 provided with various compartments suited to be filled with washing and/or rinsing products (i.e. detergent, softener, etc.).

[0066] In a preferred embodiment, the water is supplied into the washing tub 3 from the water supply circuit 5 by making it flow through the drawer 6 and then through a supply pipe 9.

[0067] Advantageously the water which reaches the washing tub 3 can, in this case, 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 washing tub 3 directly, bypassing the compartments of the drawer 6.

[0068] In an alternative embodiment of the invention, a further separate water supply pipe can be provided, which supplies exclusively clean water into the washing tub 3.

[0069] The water supply circuit 5 also preferably comprises a water flow sensor, for example a flowmeter, which makes it possible to calculate the quantity of water supplied into the washing tub 3.

[0070] In the washing tub bottom 3c a sump 15 is formed, better visible in Figures 3 and 4, so that washing liquid in the washing tub 3 can be collected and drained in the sump 15 under the influence of gravity.

[0071] Laundry washing machine 1 advantageously comprises a draining device 25 suitable for withdrawing liquid from the washing tub bottom 3c, preferably from the sump 15. The draining device 25 advantageously comprises a draining pump 26, a draining conduit 27 fluidly connecting the sump 15 to the draining pump 26 and an outlet pipe 28 ending outside the housing 2. The draining device 25 is suited to drain the liquid, i.e. dirty water or water mixed with washing and/or rinsing products, from the washing tub 3 to the outside.

[0072] The draining device 25 is shown in greater detail in figures 2 to 4. Adjacent to the sump 15 and arranged at least partly lower than the sump 15 there is the draining conduit 27 of the draining device 25. The draining conduit 27 has, next to the sump 15, a mainly cylindrical circumferential wall 17 in which an opening is formed as a sump outlet 11 through which the sump 15 is in fluid connection with the draining conduit 27.

[0073] The draining device 25 advantageously comprises a filtering device 75, not illustrated in Figure 3, placed upstream of the draining pump 26 and 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.) which could damage or obstruct the draining pump 26.

[0074] The draining pump 26 preferably comprises a pump wheel 72, or impeller, as well as a pump drive 71, usually an electric motor with or without a gear and preferably with, usually electronic, control of the rotational speed, for rotating the impeller 72 about a rotational axis, which is preferably the central axis of the draining conduit 27.

[0075] Within the draining conduit 27 the filtering device 75 is advantageously arranged and comprises a filter element 76 having a filtering section 77 for filtering out objects of specific size and/or dimensions, in particular large and/or long objects, from the draining liquid to prevent them from reaching the impeller 72. The filtering section 77 is arranged essentially within the circumferential wall 17 of the draining conduit 27 when the filter element 76 is mounted.

[0076] The impeller 72 works like a centrifugal pump to convey liquid to a draining outlet 74, which advantageously consists of a short pipe or tube connected to outlet pipe 28, the latest not shown in Figure 2. In the advantageous embodiment illustrated in attached Figures, filter element can't be removed for cleaning,

[0077] In a different advantageous embodiment, not illustrated, the filter element can be removed, and then for example cleaned, through a gate placed advantageously on the front of the housing of the laundry washing machine.

[0078] In an advantageous embodiment, the laundry washing machine may further comprise a recirculation circuit, not illustrated, adapted to drain liquid from the tub bottom 3c and to re-admit such a liquid into an upper region of the washing tub.

[0079] Advantageously, laundry washing machine 1

comprises a device 19 suited to sense (or detect) the liquid level inside the washing tub 3.

[0080] The device 19 preferably comprises a pressure sensor which senses the pressure in the washing tub 3. Figures 2 to 4 show a level detection tube 19a of the level detection device 19, which communicates with the sump 15. In further advantageous embodiments, laundry washing machine comprises a preferably mechanical, electro-mechanical, or optical, level sensor adapted to sense (or detect) the liquid level inside the washing tub 3.

[0081] Laundry washing machine 1 advantageously comprises a control unit 22 which 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, to the draining device 25, in particular to the draining pump 26 and its pump drive 71, and is advantageously configured for receiving pieces of information from the various sensors provided on the laundry washing machine 1, like the flowmeter of the water inlet circuit 5, the pressure sensor 19, temperature sensors, etc.

[0082] The control unit 22 is advantageously connected also to an interface unit 22a which is accessible to the user and by means of which the user selects and sets the washing parameters from time to time, in particular the desired washing program. Advantageously, other parameters can optionally be inserted by the user, for example the washing temperature, the spinning speed, the load in terms of weight of the laundry to be washed, the type of fabric of the load, etc. The interface unit 22a preferably displays machine working conditions, such as the remaining cycle time, alarm signals, etc. For this purpose the interface unit 22a preferably comprises a display. An embodiment of the washing method according to the invention is described here below with reference to Figure 5.

[0083] The laundry to be washed is first placed inside the washing drum 4 (step 100 of Figure 5). By operating on the interface unit 22a the user selects the desired washing program (step 110) depending, for example, on the type and on the dirty-level of the products to wash. Furthermore, as said before, in a preferred embodiment it is possible for the user to insert some parameters directly by the interface unit 22a, for example the value of the washing temperature, the rotating speed of the washing drum 4 in the spinning phase, the duration of washing program, etc.

[0084] Once the user has selected the desired washing program, the control unit sets the laundry washing machine 1 so that it starts the washing program.

[0085] In a further embodiment, the selection of the desired washing program (step 110) may be performed before placing the laundry into the washing drum 4 (step 100).

[0086] Successively, the washing program performs different phases for washing the laundry.

[0087] Preferably, the washing program comprises a laundry wetting phase (step 120) wherein a proper amount of water and detergent is introduced in the washing tub 3 so that at the end of the phase the laundry is preferably completely drenched.

[0088] The washing program then preferably proceeds with a main washing phase (step 130) during which the washing drum 4 is rotated and the water contained therein is heated to a predetermined temperature based on the washing program selected by the user.

[0089] A successive step of the cycle typically comprises a rinsing phase, globally indicated with 140, which usually comprises one or more rinsing cycles (steps 145). In a rinsing cycle clean, rinse water is first added to the laundry (step 146), the washing drum 4 is then rotated to extract dirty water from the laundry (step 147) and finally the dirty water extracted from the laundry is drained from the washing tub 3 to the outside (step 148).

[0090] Before the dirty water is drained from the washing tub 3 (step 148), the dirty water fills the washing tub 3, in particular the hollow space 12, up to a predetermined level L. The level L will depend on the quantity of water previously added and/or on the amount of water absorbed by the laundry. This, in turn, may depend on the quantity (i.e. weight) of loaded laundry and on the type of laundry. In fact, for example, cotton absorbs more water than synthetic fibres, and therefore a certain quantity of laundry made of cotton requires more water than a same quantity of laundry made of synthetic fibres.

[0091] The water level will also depend on the number of rinsing cycles (steps 145) which have been already performed.

[0092] According to a preferred embodiment of the invention, the draining phase (step 148) is carried out by firstly operating the draining pump 26 and comprises a step of stopping it for a predetermined period of time. According to the invention, the stopping phase for the draining pump 26 is cyclically repeated. Preferably, the stopping phases are cyclically repeated on the base of the drainage flow rate FR of the liquid flowing through the draining pump 26. An example of the draining phase (step 148) not falling under the scope of the present invention in shown in detail in Figure 6 (indicated with block 148). Figure 7 depicts the driving signal of the draining pump 26, e.g. the driving signal for the pump drive 71, during the the draining phase (step 148).

[0093] In a first step (step 182), the draining pump 26 is activated (at time t=t1; t=t3; t=t5) and the drainage flow rate FR of the liquid flowing through the draining pump 26 is checked (step 185).

[0094] Checking of the drainage flow rate FR (step 185) of the liquid flowing through the draining pump 26 may be carried out in different ways. In a first example, the drainage flow rate FR may be directly detected and/or measured by means of a flowmeter preferably arranged downstream of the draining pump 26, for example arranged along the outlet pipe 28.

[0095] In another example the drainage flow rate FR may be estimated by means of the detection/measure of the variation (decreasing) of the liquid level inside the

washing tub 3 during the time. The liquid level inside the washing tub 3, and therefore its variations (decreasing), may be preferably obtained by means of the level detection device 19, in particular the pressure sensor 19. In this preferred embodiment, advantageously, the flowmeter device is not necessary and hence the method may be preferably carried out in the laundry washing machine 1 shown in Figure 1.

[0096] In a successive step, a control of the drainage flow rate FR is performed (step 187).

[0097] If the drainage flow rate FR is above, or equal to, a minimum flow rate FR_min (exit "No" of step 187) the draining pump 26 is operated (step 199) until its final de-activation (at time t=tf - step 196).

[0098] The minimum flow rate FR_min is preferably a value at which the draining pump 26 is considered to be working properly. For example, the minimum flow rate FR_min may be set as the nominal flow rate of the draining pump 26, or preferably a value less than the nominal flow rate.

[0099] The final de-activation of the draining pump 26 (at time t=tf - step 196) preferably takes place upon evaluation/determination of an end-draining condition (step 194).

[0100] In a preferred embodiment of the invention, the end-draining condition (step 194) corresponds to a condition at which the washing tub 3 is empty, or substantially empty or the liquid inside it is below a minimum liquid level. Determination of such end condition is preferably obtained by means of the level detection device 19, in particular the pressure sensor 19.

[0101] In a further preferred embodiment, the end-draining condition (step 194) preferably corresponds to the expiration of a prefixed time period.

[0102] Said prefixed time period may be, for example, a fixed value which is considered sufficient to empty the washing tub 3 in case it is completely full of water and the draining pump 26 is working properly at its nominal flow rate. This may guarantee that any quantity of water in the washing tub 3 is drained outside at the end of the prefixed time period.

[0103] In further advantageous embodiments, said prefixed time period may be differently determined. For example, the prefixed time period may be estimated before activation of the draining pump 26 (step 182) on the base of the water level detected, preferably obtained by means of the level detection device 19.

[0104] The prefixed time period may be set, advantageously, as a value sufficient to empty the washing tub 3 containing the detected level of water.

[0105] If the drainage flow rate FR is below the minimum flow rate FR_min (exit "Yes" of step 187), the draining pump 26 is operated for a period of time TON (step 184), or on-time period TON. The on-time period TON is preferably a pre-fixed period of time, preferably few seconds (for example 5sec). In a successive step (step 186) the draining pump 26 is de-activated (at time t=t2; t=t4 - step 186).

[0106] The draining pump 26 is then stopped for a period of time TOFF (step 188), or off-time period TOFF. The off-time period TOFF is preferably a pre-fixed period of time, preferably few seconds (for example 2sec).

[0107] Successively, the draining phase proceeds going back to the draining pump activation (step 182).

[0108] The steps above described of operating and stopping the draining pump 26 (steps 184 and 188) are therefore cyclically repeated. They are cyclically repeated until the drainage flow rate FR is above, or equal to, the minimum flow rate FR_min (exit "No" of step 187) and the draining pump 26 is definitely de-activated (at time t=tf - step 196), as explained above. This happens when the draining pump 26 is considered to be working properly, preferably when the draining pump 26 is draining liquid at its nominal flow rate.

[0109] According to an advantageous aspect of the invention, the provision of two or more off-time periods TOFF after the activation of the draining pump 26, guarantees that the draining pump 26 is working properly, i.e. the water is expelled from the washing tub 3 at a proper/nominal drainage flow rate.

[0110] In fact, the drainage flow rate could be reduced due to the presence of air, or air bubbles, trapped at the draining pump 26 inlet, in particular at the impeller 72.

[0111] Ingestion of air into the draining pump 26 causes, in fact, loss of prime for the draining pump 26.

[0112] By providing one or more pauses of few seconds for the draining pump 26, for example 2sec for the off-time period TOFF, just after its activation, for example 5sec for the on-time period TON, the air trapped at the impeller 72 may be expelled. This allows a correct priming of the draining pump 26, after one of said pauses, and the drainage flow rate may advantageously reach its nominal flow rate.

[0113] Furthermore, the presence of air, or air bubbles, which reduced the drainage flow rate, is not interpreted by the laundry washing machine 1, in particular by the control unit 22, as a malfunctioning of the draining device 25 (for example a draining pump failure). The control unit 22 does not advantageously interrupt the washing program and/or display any alarm notification at the interface unit 22a.

[0114] Therefore a wrong alarm is not notified to the user.

[0115] Figure 8 exemplary shows the water level in the washing tub 3 as a function of the time in said draining phase (step 148), assuming that the draining pump 26 at its first activation (time t=t1) is not working properly due to air, or bubble air, at the impeller 72.

[0116] Before the draining phase, the water level in the washing tub 3 is at a first value L1. At time t=t1 the draining pump 26 is activated and it is operated for an on-time period TON. During the on-time period TON the water level decreases at a low flow rate and reaches a second value L2, lower than the first value L1. At the end of the on-time period TON the draining pump 26 is de-activated (at time t=t2) and stopped for an off-time period TOFF.

During the off-time period TOFF the water level remains stable. At the end of the off-time period TOFF the draining pump 26 is activated again (at time t=t3) and the draining pump 26 is operated for an on-time period TON. In the embodiment here described, during the on-time period TON the water level still decreases at a low flow rate and reaches a third value L3, lower than the second value L2. This means that the draining pump 26 is still not working properly due to air, or bubble air, at the impeller 72.

[0117] At the end of the on-time period TON the draining pump 26 is de-activated (at time t=t4) and stopped again for an off-time period TOFF. During the off-time period TOFF the water level remains stable. At the end of the off-time period TOFF the draining pump 26 is activated (at time t=t5) and the draining pump 26 is operated until its final de-activation (at time t=tf), when the washing tub 3 is empty (water level=0). It has to be noted that during the final on-time period TON (t>t5) the water level decreases at a higher flow rate than before, preferably at its nominal flow rate. This means that the draining pump 26 is now working properly, preferably at its nominal flow rate, and the air, or bubble air, at the impeller 72 has been advantageously expelled.

[0118] The total draining time Td, i.e. Td=tf-t1, is advantageously maintained at low value, and in particular at a lower value than a situation where the draining pump 26 is operated continuously one time and it is not working properly (as indicated with dashed line W).

[0119] Once the draining phase (step 148) of the last rinsing cycle (step 145) terminates, the washing program is completed. At this point, the user may take the laundry out. In case the washing program is performed in a laundry washing-drying machine, after the last rinsing cycle, the laundry may be advantageously subjected to a drying phase inside the washing drum 4 (step 170 in figure 5).

[0120] With reference to the flow chart of Figure 9 an embodiment of the draining phase (step 148') of the method of the invention is illustrated.

[0121] This embodiment differs from that previously described example with reference to Figure 6 by the fact that the off-time period during which the draining pump 26 is cyclically stopped vary from a stopping phase and a subsequent stopping phase.

[0122] Figure 10 depicts an example of the driving signal of the draining pump 26, more in particular the driving signal for the pump drive 71, during the preferred embodiment of the draining phase (step 148').

[0123] First of all a temporary variable "n" is set to 1 (step 181'). The variable "n" will be used as a counter.

[0124] In a successive step (step 182'), the draining pump 26 is activated (at time t=t1; t=t3; t=t5; t=t7) and the drainage flow rate FR of the liquid flowing through the draining pump 26 is checked (step 185').

[0125] Checking of the drainage flow rate FR (step 185') of the liquid flowing through the draining pump 26 may be carried out in different ways, as already explained above for the first preferred embodiment.

[0126] In a successive step, a control of the drainage flow rate FR is performed (step 187').

[0127] If the drainage flow rate FR is above, or equal to, a minimum flow rate FR_min (exit "No" of step 187') the draining pump 26 is operated (step 199') until its final de-activation (at time t=tf - step 196').

[0128] The minimum flow rate FR_min is preferably a value at which the draining pump 26 is considered to be working properly. For example, the minimum flow rate FR_min may be set as the nominal flow rate of the draining pump 26, or preferably a value less than the nominal flow rate.

[0129] The final de-activation of the draining pump 26 (at time t=tf - step 196') preferably takes place upon evaluation/determination of an end-draining condition (step 194').

[0130] In a preferred embodiment of the invention, the end-draining condition (step 194') corresponds to a condition at which the washing tub 3 is empty, or substantially empty or the liquid level inside it is below a minimum liquid level.

[0131] Determination of such end condition is preferably obtained by means of the level detection device 19, in particular the pressure sensor 19.

[0132] In a further preferred embodiment, the end-draining condition (step 194') preferably corresponds to the expiration of a prefixed time period.

[0133] Said prefixed time period may be, for example, a fixed value which is considered sufficient to empty the washing tub 3 in case it is completely full of water and the draining pump 26 is working properly at its nominal flow rate. This may guarantee that any quantity of water in the washing tub 3 is drained outside at the end of the prefixed time period.

[0134] In further embodiments, said prefixed time period may be differently determined.

[0135] For example, the prefixed time period may be estimated before activation of the draining pump 26 (step 182') on the base of the water level detected, preferably obtained by means of the level detection device 19. The prefixed time period may be set, advantageously, as a value sufficient to empty the washing tub 3 containing the detected level of water.

[0136] If the drainage flow rate FR is below the minimum flow rate FR_min (exit "Yes" of step 187'), the draining pump 26 is operated for a period of time TON (step 184'), or on-time period TON. The on-time period TON is preferably a pre-fixed period of time, preferably few seconds (for example 5sec). In a successive step (step 186') the draining pump 26 is de-activated (at time t=t2; t=t4; t=t6 - step 186').

[0137] The draining pump 26 is then stopped for a period of time TOFF(n) (step 188'), or off-time period TOFF(n). The off-time period TOFF(n) depends on the number of time (n-1 times) that the draining pump has been already activated.

[0138] The value of the off-time period TOFF(n) is preferably determined in steps 189', 190' and 191', as explained below.

[0139] In step 189', a control of the counter n is performed.

[0140] If the counter n is equal to 1 (exit "Yes" of step 189'), i.e. when the draining pump 26 has been activated for the first time, the off-time period TOFF(n)=TOFF(1) is set to a fixed value T0 (step 190'), preferably few seconds (for example 2sec).

[0141] If the counter n is greater than to 1 (exit "No" of step 189'), i.e. when the draining pump 26 has been already activated at least one time, the off-time period TOFF(n) is set to a value which is calculated by adding an incremental value $\Delta(n)$ to the off-time period TOFF(n-1) utilized for stopping the draining pump 26 in a previous activation, i.e. $TOFF(n)=TOFF(n-1)+\Delta(n)$. It has to be noted that the incremental value $\Delta(n)$ may be either positive or negative.

[0142] In a preferred embodiment, the incremental value $\Delta(n)$ may be set as a fixed value, for example $\Delta(n)=\Delta$, preferably few seconds (for example $\Delta(n)=\Delta$=2sec).

[0143] In a further preferred embodiment, the incremental value $\Delta(n)$ may be successively and constantly incremented, for example $\Delta(n)=\Delta(n-1)+K$ wherein K is a constant (for example K=2sec).

[0144] In a further preferred embodiments, the incremental value $\Delta(n)$ may be linked to the detected/measured flow rate FR. For example, if the detected/measured flow rate FR does not increases in successive activation and de-activation, the incremental value $\Delta(n)$ may be increased and if the detected/measured flow rate FR increases the incremental value $\Delta(n)$ may be decreased.

[0145] It is clear that any other criterion may be used to determine said incremental value $\Delta(n)$.

[0146] Successively, the draining phase proceeds going back to the draining pump activation (step 182') while the counter n is incremented (step 192').

[0147] The steps above described of operating and stopping the draining pump 26 (steps 184' and 188') are therefore cyclically repeated. They are cyclically repeated until the drainage flow rate FR is above, or equal to, the minimum flow rate FR_min (exit "No" of step 187') and the draining pump 26 is definitely de-activated (at time t=tf - step 196'), as explained above. This happens when the draining pump 26 is considered to be working properly, preferably when the drying pump 26 is draining liquid at its nominal flow rate.

[0148] According to a preferred advantageous aspect of the invention, the provision of two or more off-time periods TOFF(n) after the activation of the draining pump 26, guarantees that the draining pump 26 is working properly, i.e. the water is expelled from the washing tub 3 at a proper/nominal drainage flow rate.

[0149] In fact, as said above, the drainage flow rate could be reduced due to the presence of air, or air bubbles, trapped at the draining pump 26 inlet, in particular at the impeller 72.

[0150] By providing two or more pauses of few seconds for the draining pump 26, for the off-time period TOFF(n), just after its activation, for the on-time period TON, the air trapped at the impeller 72 may be expelled. This allows a correct priming of the draining pump 26, after one of said pauses, and the drainage flow rate may advantageously reach its nominal flow rate.

[0151] Furthermore, the presence of air, or air bubbles, which reduced the drainage flow rate, is not interpreted by the laundry washing machine 1, in particular by the control unit 22, as a malfunctioning of the draining device 25 (for example a draining pump failure). The control unit 22 does not interrupt the washing program and/or display any alarm notification at the interface unit 22a.

[0152] Therefore a wrong alarm is not notified to the user.

[0153] Figure 11 exemplary shows the water level in the washing tub 3 as a function of the time in said draining phase (step 148'), assuming that the draining pump 26 at its first activation (time t=t1) is not working properly due to air, or bubble air, at the impeller 72.

[0154] Before the draining phase, the water level in the washing tub 3 is at a first value L1. At time t=t1 the draining pump 26 is activated and it is operated for an on-time period TON. During the on-time period TON the water level decreases at a low flow rate and reaches a second value L2, lower than the first value L1. At the end of the on-time period TON the draining pump 26 is de-activated (at time t=t2) and stopped for a first off-time period TOFF(1). During the first off-time period TOFF(1) the water level remains stable. At the end of the first off-time period TOFF(1) the draining pump 26 is activated again (at time t=t3) and the draining pump 26 is operated for an on-time period TON. In the embodiment here described, during the on-time period TON the water level still decreases at a low flow rate and reaches a third value L3, lower than the second value L2. This means that the draining pump 26 is still not working properly due to air, or bubble air, at the impeller 72.

[0155] At the end of the on-time period TON the draining pump 26 is de-activated (at time t=t4) and stopped again for a second off-time period TOFF(2). The second off-time period TOFF(2) is preferably greater than the first off-time period TOFF(1), for example $TOFF(2)=TOFF(1)+\Delta$. During the second off-time period TOFF(2) the water level remains stable. At the end of the second off-time period TOFF(2) the draining pump 26 is activated (at time t=t5) and the draining pump 26 is operated for an on-time period TON. In the embodiment here described, during the on-time period TON the water level still decreases at a low flow rate and reaches a fourth value L4, lower than the third value L3. This means that the draining pump 26 is still not working properly due to air, or bubble air, at the impeller 72.

[0156] At the end of the on-time period TON the draining pump 26 is de-activated (at time t=t6) and stopped for a third off-time period TOFF(3). The third off-time period TOFF(3) is preferably greater than the second off-time period TOFF(2), for example $TOFF(3)=TOFF(2)+\Delta$. During the third off-time period TOFF(3) the water level remains stable.

[0157] At the end of the third off-time period TOFF(3) the draining pump 26 is activated (at time t=t7) and the draining pump 26 is operated until its final de-activation (at time t=tf), when the washing tub 3 is empty (water level=0). It has to be noted that during the final on-time period TON (t>t7) the water level decreases at a higher flow rate than before, preferably at its nominal flow rate. This means that the draining pump 26 is now working properly, preferably at its nominal flow rate, and the air, or bubble air, at the impeller 72 has been advantageously expelled.

[0158] The total draining time Td, i.e. Td=tf-t1, is advantageously maintained at low value, and in particular at a lower value than a situation where the draining pump 26 is operated continuously one time and it is not working properly (as indicated with dashed line W).

[0159] With reference to the flow chart of Figure 12 another example of the draining phase (step 148") not falling under the scope of the invention is illustrated.

[0160] According to this example, the draining phase (step 148") is carried out by firstly operating the draining pump 26 and comprises a step of stopping it for a predetermined period of time before operating it until the end of the draining phase.

[0161] Figure 13 depicts the driving signal of the draining pump 26, more in particular the driving signal for the pump drive 71, during this of the draining phase (step 148").

[0162] In a first step (step 182"), the draining pump 26 is activated (at time t=t1). The draining pump 26 is operated for a period of time TON1 (step 184"), or first on-time period TON1. The first on-time period TON1 is preferably a pre-fixed period of time, preferably few seconds (for example 5sec).

[0163] The draining pump 26 is then de-activated (at time t=t2 - step 186"). The draining pump 26 is stopped for a period of time TOFF1 (step 188"), or first off-time period TOFF1. The first off-time period TOFF1 is preferably a pre-fixed period of time, preferably few seconds (for example 2sec).

[0164] The draining pump 26 is then activated (at time t=t3 - step 190"). The draining pump 26 is operated for a period of time TON2 (step 192"), or second on-time period TON2. The draining pump 26 is then definitely de-activated (at time t=tf - step 196") at the end of the second on-time period TON2.

[0165] The final de-activation of the draining pump 26 (at time t=tf) and therefore the duration of the second on-time period TON2, preferably takes place upon evaluation/determination of an end-draining condition (step 194").

[0166] In a preferred embodiment of the invention, the end-draining condition (step 194") corresponds to a condition at which the washing tub 3 is empty, or substantially empty or the liquid level inside it is below a minimum liquid level.

[0167] Determination of such end condition is preferably obtained by means of the level detection device 19, in particular the pressure sensor 19.

[0168] In a further preferred embodiment, the end-draining condition (step 194") preferably corresponds to the expiration of a prefixed second on-time period TON2.

[0169] Said second on-time period TON2 may be, for example, a fixed value which is considered sufficient to empty the washing tub 3 in case it is completely full of water and the draining pump 26 is working properly at its nominal flow rate. This may guarantee that any quantity of water in the washing tub 3 is drained outside at the end of the second on-time period TON2.

[0170] In further embodiments, said second on-time period TON2 may be differently determined. For example, the second on-time period TON2 may be estimated at the beginning of the draining phase, for example at time t=t1, on the base of the water level detected, preferably obtained by means of the level detection device 19. The second on-time period TON2 may be set, advantageously, as a value sufficient to empty the washing tub 3 containing the detected level of water.

[0171] According to this example, the provision of the first off-time period TOFF1 after the first activation of the draining pump 26, guarantees that the draining pump 26 is working properly, i.e. the water is expelled from the washing tub 3 at a proper/nominal drainage flow rate.

[0172] In fact, as said above, the drainage flow rate could be reduced due to the presence of air, or air bubbles, trapped at the draining pump 26 inlet, in particular at the impeller 72.

[0173] By providing a pause of few seconds for the draining pump 26, for example 2sec for the first off-time period TOFF1, just after its first activation, for example 5sec for the first on-time period TOFF1, the air trapped at the impeller 72 may be expelled. This allows a correct priming of the draining pump 26, after the pause, and the drainage flow rate may advantageously reach its nominal flow rate.

[0174] Furthermore, the presence of air, or air bubbles, which reduced the drainage flow rate, is not interpreted by the laundry washing machine 1, in particular by the control unit 22, as a malfunctioning of the draining device 25 (for example a draining pump failure). The control unit 22 does not interrupt the washing program and/or display any alarm notification at the interface unit 22a.

[0175] Therefore a wrong alarm is not notified to the user.

[0176] Furthermore, advantageously, after a short period of time, for example 7 seconds which is the sum of the first on-time period TON1 and the first off-time period TOFF1 (i.e. time t=t3), the draining pump 26 in made work properly and the drainage flow rate of the water from the washing tub 3 has its nominal value.

[0177] Preferably, the sum of the first on-time period TON1 and the first off-time period TOFF1 is kept at low values, preferably lower than the second on-time period TON2, in particular when the second on-time period TON2 is a pre-fixed period of time.

[0178] According to an advantageous aspect of the in-

vention, the first operation of the draining pump 26 is always followed by a stopping phase for the first off-time period TOFF1, independently of the drainage flow rate during the first on-time period TON1.

[0179] From the above it follows that the first operation of the draining pump 26 is always followed by a stopping phase for a first off-time period TOFF1 and this stopping phase is always carried out before evaluation of the end-draining condition, i.e. t3<tf.

[0180] Figure 14 exemplary shows the water level in the washing tub 3 as a function of the time in the draining phase (step 148") above described assuming that the draining pump 26 at its first activation (time t=t1) is not working properly due to air, or bubble air, at the impeller 72.

[0181] Before the draining phase, the water level in the washing tub 3 is at a first value L1. At time t=t1 the draining pump 26 is activated and it is operated for a first on-time period TON1. During the first on-time period TON1 the water level decreases at a low flow rate and reaches a second value L2, lower than the first value L1. At the end of the first on-time period TON1 the draining pump 26 is de-activated (at time t=t2) and stopped for a first off-time period TOFF1. During the first off-time period TOFF1 the water level remains stable. At the end of the first off-time period TOFF1 the draining pump 26 is activated (at time t=t3) and the draining pump 26 is operated for a second on-time period TON2 until its final de-activation (at time t=tf), when the washing tub 3 is empty (water level = 0). It has to be noted that during the second on-time period TON2 the water level decreases at a higher flow rate than before, preferably at its nominal flow rate.

[0182] This means that the draining pump 26 is now working properly and the air, or bubble air, at the impeller 72 has been expelled.

[0183] The total draining time Td, i.e. Td=TON1+TOFF1+TON2, is advantageously maintained at low value, and in particular at a lower value than a situation where the draining pump 26 is operated continuously one time and it is not working properly (as indicated with dashed line W).

[0184] It has thus been shown that the present invention allows all the set objects to be achieved. In particular, it makes it possible to avoid that the washing program lasts longer than desired due to presence of air at the draining pump inlet, as it happens in the laundry washing machines of the prior art.

[0185] It is underlined that the laundry washing machine illustrated in the enclosed figures, and with reference to which some embodiments of the method according to the invention have been described, is preferably 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.

[0186] Furthermore, the draining phase of the method above illustrated has been described as the last phase of a rinsing cycle. Nevertheless, the present invention may be applied at any draining phase in a method for washing laundry wherein liquid must be expelled from the washing tub.

[0187] It has to noted that, furthermore, that the method preferably comprises control steps for monitoring the correct working of the laundry washing machine. For example, the method may interrupt the washing program and displays an alarm message if the time duration of the washing program exceeds a maximun allowed duration (timeout).

[0188] While the present invention has been described with reference to the particular embodiments and examples 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 and examples described herein fall within the scope of the present invention, which is defined in the claims.

Claims

1. Method for washing laundry in a laundry washing machine (1) of the type comprising:

- a washing tub (3) external to a rotatable washing drum (4) adapted to receive laundry;
- a water supply circuit (5) to supply water into said washing tub (3);
- a washing/rinsing products supplier (6) to supply washing/rinsing products into said washing tub (3);
- a draining device (25) comprising a draining pump (26) for draining liquid from said washing tub (3);

the method comprising at least a draining phase (148; 148'; 148") for draining liquid from said washing tub (3) by means of said draining device (25), wherein said draining phase (148; 148'; 148") comprises the steps of:

a) activating (182; 182') said draining pump (26);

b) checking (185; 185') the drainage flow rate (FR) of the liquid flowing through said draining pump (26),

and

- if said drainage flow rate (FR) of the liquid flowing through said draining pump (26) is above or equal to a minimum flow rate threshold, then

d) operating (199; 199') said draining pump (26) and de-activating (186; 186') said draining pump (26) when an end-draining condition is reached (194; 194'),

- if said drainage flow rate (FR) of the liquid flow-

ing through said draining pump (26) is below a minimum flow rate threshold, then

e1) operating (184; 184') said draining pump (26) for an on-time period (TON);
e2) de-activating (186; 186') said draining pump (26);
e3) stopping (188; 188') said draining pump (26) for an off-time period (TOFF; TOFF(n)); and
e4) going back to step a)

characterized in that said step e3) is performed two or more times, said off-time period (TOFF; TOFF(n)) used in each of said steps e3) performed as second or following being varied with respect of the off-time period (TOFF; TOFF(n-1)) used in a step e3) previously performed.

2. Method according to claim 1, **characterized in that** said off-time period (TOFF; TOFF(n)) used in each of said steps e3) performed as second or following being varied by adding an incremental time period (Δ(n)) to the off-time period (TOFF; TOFF(n)) used in a step e3) previously performed.

3. Method according to claim 2, **characterized in that** said incremental time period (Δ(n)) is a constant value (Δ).

4. Method according to claim 2, **characterized in that** said incremental time period (Δ(n)) is varied according to said drainage flow rate (FR).

5. Method according to claim 4, **characterized in that** if said drainage flow rate (FR) does not increase, said incremental time period (Δ(n)) is increased.

6. Method according to claim 4, **characterized in that** if said drainage flow rate (FR) increases, said incremental time period (Δ(n)) is decreased.

7. Method according to any of the preceding claims, **characterized in that** said minimum flow rate threshold is a value lower than the nominal flow rate of said draining pump (26).

8. Method according to any of the preceding claims, **characterized in that** said end-draining condition occurs when the liquid inside said washing tub (3) goes below a minimum liquid level.

9. Method according to any of the preceding claims, **characterized in that** said end-draining condition occurs at the expiration of a prefixed time period.

10. Method according to claim 9, **characterized in that** said prefixed time period is evaluated on the base of the liquid level detected in a further step a1), carried out before said step a), of detecting the liquid level inside said washing tub (3).

11. Method according to any of the preceding claims, **characterized in that** said drainage flow rate (FR) is evaluated on the base of the detected/measured value of the liquid level inside the washing tub (3) over the time.

12. Method according to any of the preceding claims, **characterized in that** said drainage flow rate (FR) is evaluated by means of a flowmeter arranged downstream of said draining pump (26).

Patentansprüche

1. Verfahren zum Waschen von Wäsche in einer Wäsche-Waschmaschine (1) des Folgendes umfassenden Typs:

- einen von einer drehbaren Waschtrommel (4), die ausgelegt ist, um Wäsche aufzunehmen, externen Waschtrog (3);
- einen Wasserversorgungskreislauf (5) zum Zuführen von Wasser in den Waschtrog (3);
- eine Wasch-/Spülmittelzufuhr (6) zum Zuführen von Wasch-/Spülmittel in den Waschtrog (3);
- eine eine Entleerungspumpe (26) umfassende Entleerungsvorrichtung (25) zum Entleeren von Flüssigkeit aus dem Waschtrog (3);

wobei das Verfahren wenigstens eine Entleerungsphase (148; 148'; 148") zum Entleeren von Flüssigkeit aus dem Waschtrog (3) mittels der Entleerungsvorrichtung (25) umfasst, wobei die Entleerungsphase (148; 148'; 148") die folgenden Schritte umfasst:

a) Aktivieren (182; 182') der Entleerungspumpe (26);
b) Überprüfen (185; 185') der Entleerungsfließgeschwindigkeit (FR) der durch die Entleerungspumpe (26) fließenden Flüssigkeit,

und

- wenn die Entleerungsfließgeschwindigkeit (FR) der durch die Entleerungspumpe (26) fließenden Flüssigkeit auf oder über einer Mindestfließgeschwindigkeitsschwelle liegt, d) Betätigen (199; 199') der Entleerungspumpe (26) und Deaktivieren (186; 186') der Entleerungspumpe (26), wenn eine Entleerung-beenden-Bedingung erreicht ist (194; 194'),
- wenn die Entleerungsfließgeschwindigkeit

(FR) der durch die Entleerungspumpe (26) fließenden Flüssigkeit unterhalb einer Mindestfließgeschwindigkeitsschwelle liegt,

e1) Betätigen (184; 184') der Entleerungspumpe (26) für eine Einschaltzeitdauer (TON);
e2) Deaktivieren (186; 186') der Entleerungspumpe (26);
e3) Anhalten (188; 188') der Entleerungspumpe (26) für eine Ausschaltzeitdauer (TOFF; TOFF(n)); und
e4) Zurückkehren zu Schritt a)

dadurch gekennzeichnet, dass der Schritt e3) zweimal oder öfter vorgenommen wird und die in jedem der Schritte e3), die als zweites Mal oder Folgemal vorgenommen werden, verwendete Ausschaltzeitdauer (TOFF; TOFF(n)) bezogen auf die in einem zuvor vorgenommenen Schritt e3) verwendete Ausschaltzeitdauer (TOFF; TOFF(n-1)) variiert wird.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** die Ausschaltzeitdauer (TOFF; TOFF(n)), die in jedem der als zweites Mal oder Folgemal vorgenommenen Schritte e3) verwendet wird, durch Hinzufügen einer inkrementellen Zeitdauer (Δ(n)) zu der in einem zuvor vorgenommenen Schritt e3) verwendeten Ausschaltzeitdauer (TOFF; TOFF(n)) variiert wird.

3. Verfahren nach Anspruch 2, **dadurch gekennzeichnet, dass** die inkrementelle Zeitdauer (Δ(n)) ein Konstantwert (Δ) ist.

4. Verfahren nach Anspruch 2, **dadurch gekennzeichnet, dass** die inkrementelle Zeitdauer (Δ(n)) gemäß der Entleerungsfließgeschwindigkeit (FR) variiert wird.

5. Verfahren nach Anspruch 4, **dadurch gekennzeichnet, dass** die inkrementelle Zeitdauer (Δ(n)) erhöht wird, wenn sich die Entleerungsfließgeschwindigkeit (FR) nicht erhöht.

6. Verfahren nach Anspruch 4, **dadurch gekennzeichnet, dass** die inkrementelle Zeitdauer (Δ(n)) verringert wird, wenn sich die Entleerungsfließgeschwindigkeit (FR) erhöht.

7. Verfahren nach einem beliebigen der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die Mindestfließgeschwindigkeitsschwelle ein Wert ist, der niedriger als die Soll-Fließgeschwindigkeit der Entleerungspumpe (26) ist.

8. Verfahren nach einem beliebigen der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die Entleerung-beenden-Bedingung auftritt, wenn die Flüssigkeit innerhalb des Waschtrogs (3) unterhalb eines Mindestflüssigkeitspegels absinkt.

9. Verfahren nach einem beliebigen der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die Entleerung-beenden-Bedingung bei Ablauf einer zuvor festgelegten Zeitdauer auftritt.

10. Verfahren nach Anspruch 9, **dadurch gekennzeichnet, dass** die zuvor festgelegte Zeitdauer auf Grundlage des Flüssigkeitspegels beurteilt wird, der in einem weiteren vor dem Schritt a) durchgeführten Schritt a1) zum Ermitteln des Flüssigkeitspegels innerhalb des Waschtrogs (3) ermittelt wird.

11. Verfahren nach einem beliebigen der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die Entleerungsfließgeschwindigkeit (FR) auf Grundlage des ermittelten/gemessenen Werts des Flüssigkeitspegels innerhalb des Waschtrogs (3) im Zeitverlauf beurteilt wird.

12. Verfahren nach einem beliebigen der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die Entleerungsfließgeschwindigkeit (FR) mittels eines der Entleerungspumpe (26) nachgelagert angeordneten Durchflussmessers beurteilt wird.

Revendications

1. Procédé pour laver du linge dans une machine à laver (1) du type comprenant :

- une cuve de lavage (3) à l'extérieur d'un tambour de lavage (4) rotatif apte à recevoir du linge ;
- un circuit (5) d'alimentation en eau pour amener de l'eau dans ladite cuve de lavage (3) ;
- un alimentateur (6) de produits de lavage/rinçage pour amener des produits de lavage/rinçage dans ladite cuve de lavage (3) ;
- un dispositif de vidange (25) comprenant une pompe de vidange (26) pour vidanger le liquide de ladite cuve de lavage (3),

le procédé comprenant au moins une phase de vidange (148 ; 148' ; 148") pour vidanger le liquide de ladite cuve de lavage (3) au moyen du dispositif de vidange (25),
dans lequel la phase de vidange (148 ; 148' ; 148") comprend les étapes consistant à :

a) activer (182 ; 182') ladite pompe de vidange (26) ;
b) vérifier (185 ; 185') le débit (FR) de vidange

du liquide s'écoulant à travers ladite pompe de vidange (26), et

- si ledit débit (FR) de vidange du liquide s'écoulant à travers ladite pompe de vidange (26) est supérieur ou égal à un seuil minimal de débit, alors

d) faire fonctionner (199 ; 199') ladite pompe de vidange (26) et désactiver (186 ; 186') ladite pompe de vidange (26) quand on a atteint un état (194 ; 194') de fin de vidange,

- si ledit débit (FR) de vidange du liquide s'écoulant à travers ladite pompe de vidange (26) est inférieur à un seuil minimal de débit, alors

e1) faire fonctionner (184 ; 184') ladite pompe de vidange (26) pendant une période à l'heure (TON) ;
e2) désactiver (186 ; 186') ladite pompe de vidange (26) ;
e3) arrêter (188 ; 188') ladite pompe de vidange (26) pendant une période de marche à vide (TOFF ; TOFF(n)) ; et
e4) revenir à l'étape a),

caractérisé en ce qu'on effectue l'étape e3) deux fois ou plus, ladite période de marche à vide (TOFF ; TOFF(n)) utilisée dans chacune desdites étapes e3) et effectuée pour la seconde fois ou plus étant modifiée par rapport à la période de marche à vide (TOFF ; TOFF(n-1)) utilisée dans une étape e3) effectuée auparavant.

2. Procédé selon la revendication 1, **caractérisé en ce que** on fait varier ladite période de marche à vide (TOFF ; TOFF(n)) utilisée dans chacune desdites étapes e3) et effectuée pour la seconde fois ou plus en ajoutant par petits pas une période (Δ(n)) à la période de marche à vide (TOFF ; TOFF(n)) utilisée dans une étape e3) effectuée auparavant.

3. Procédé selon la revendication 2, **caractérisé en ce que** ladite période de temps incrémentielle (Δ(n)) est une valeur constante (Δ).

4. Procédé selon la revendication 2, **caractérisé en ce que** on fait varier ladite période de temps incrémentielle (Δ(n)) selon ledit débit (FR) de vidange.

5. Procédé selon la revendication 4, **caractérisé en ce que**, si ledit débit (FR) de vidange n'augmente pas, on augmente ladite période de temps incrémentielle (Δ(n)).

6. Procédé selon la revendication 4, **caractérisé en ce que**, si ledit débit (FR) de vidange augmente, on diminue ladite période de temps incrémentielle (Δ(n)).

7. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** ledit seuil minimal de débit est une valeur inférieure au débit nominal de ladite pompe de vidange (26).

8. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** ledit état de fin de vidange se produit quand le liquide à l'intérieur de ladite cuve de lavage (3) descend en dessous d'un niveau minimal de liquide.

9. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** ledit état de fin de vidange se produit à l'expiration d'une période prédéterminée.

10. Procédé selon la revendication 9, **caractérisé en ce que** ladite période prédéterminée est évaluée sur la base du niveau de liquide détecté dans une autre étape a1), exécutée avant ladite étape a), de détection du niveau de liquide à l'intérieur de ladite cuve de lavage (3).

11. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** ledit débit (FR) de vidange est évalué sur la base de la valeur détectée/mesurée du niveau de liquide à l'intérieur de ladite cuve de lavage (3) au fil du temps.

12. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** ledit débit (FR) de vidange est évalué au moyen d'un débitmètre disposé en aval de ladite pompe de vidange (26).

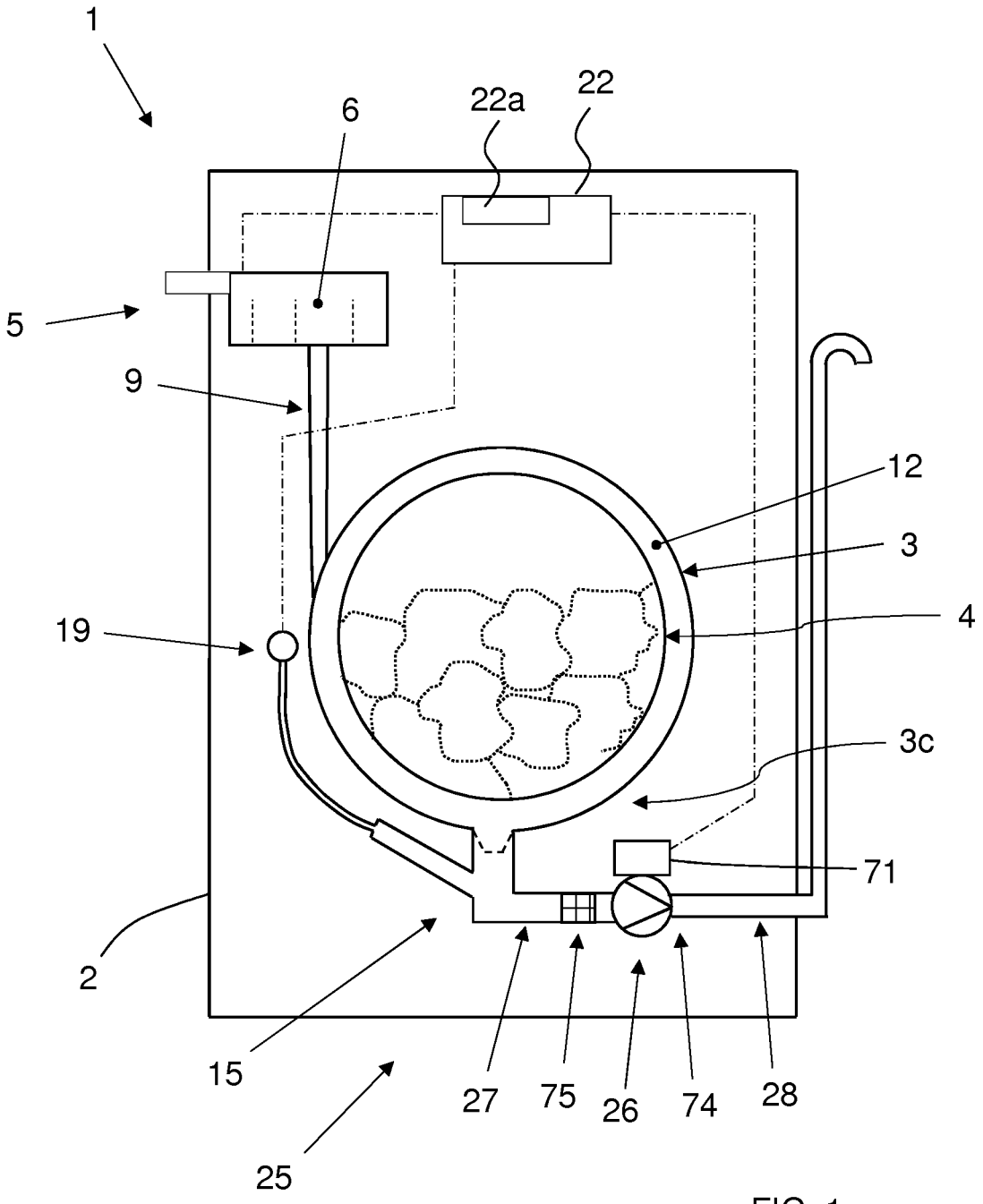


FIG. 1

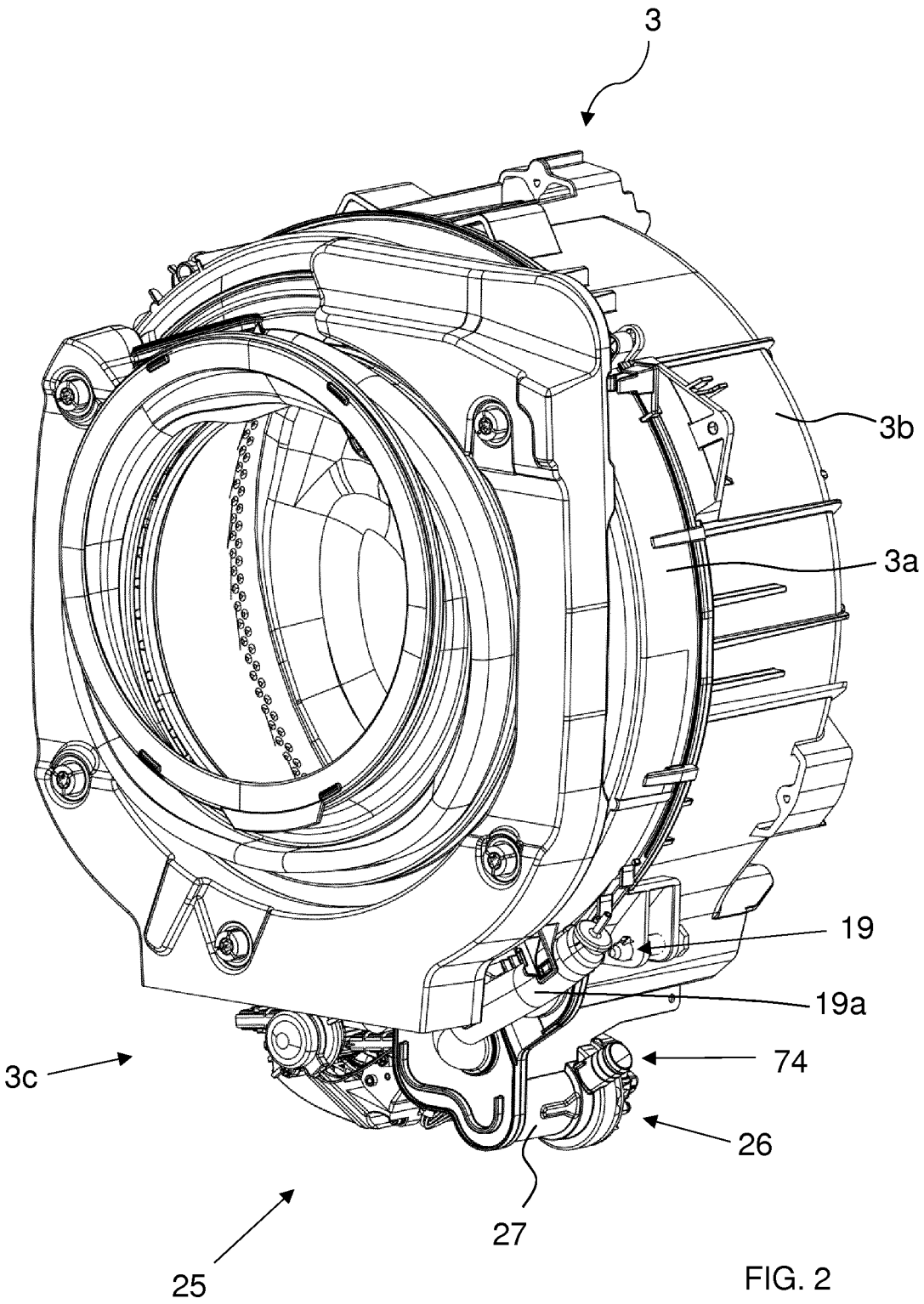


FIG. 2

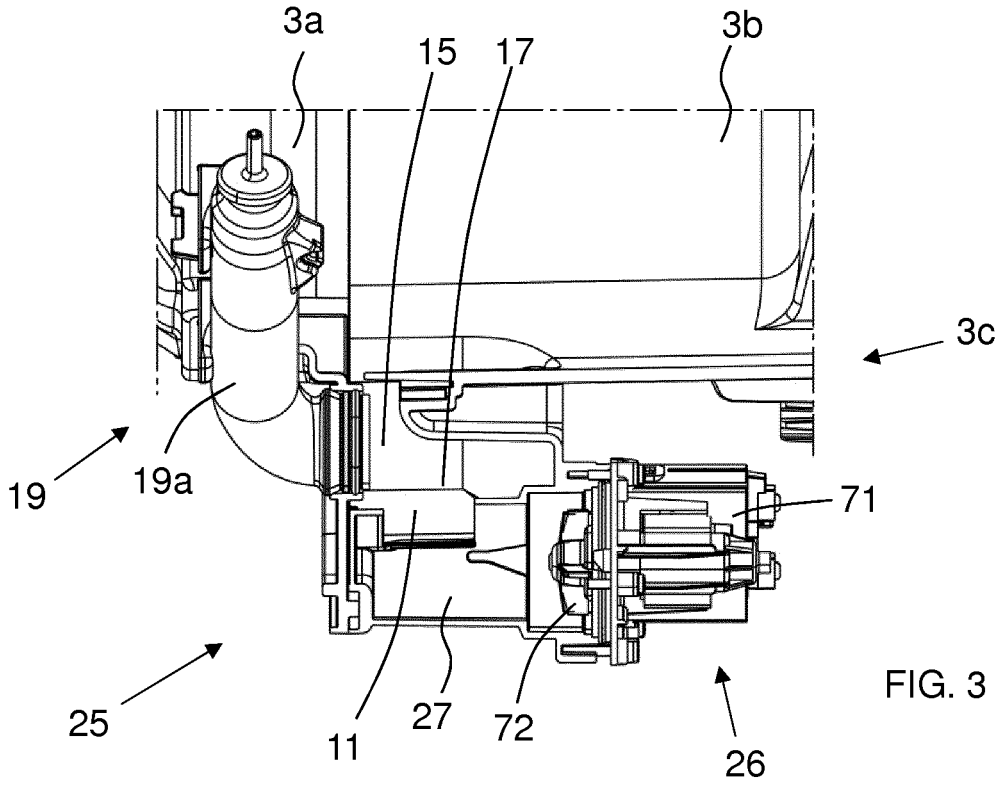

3a
15
17
3b
3c
19
19a
71
25
11
27
72
26

FIG. 3

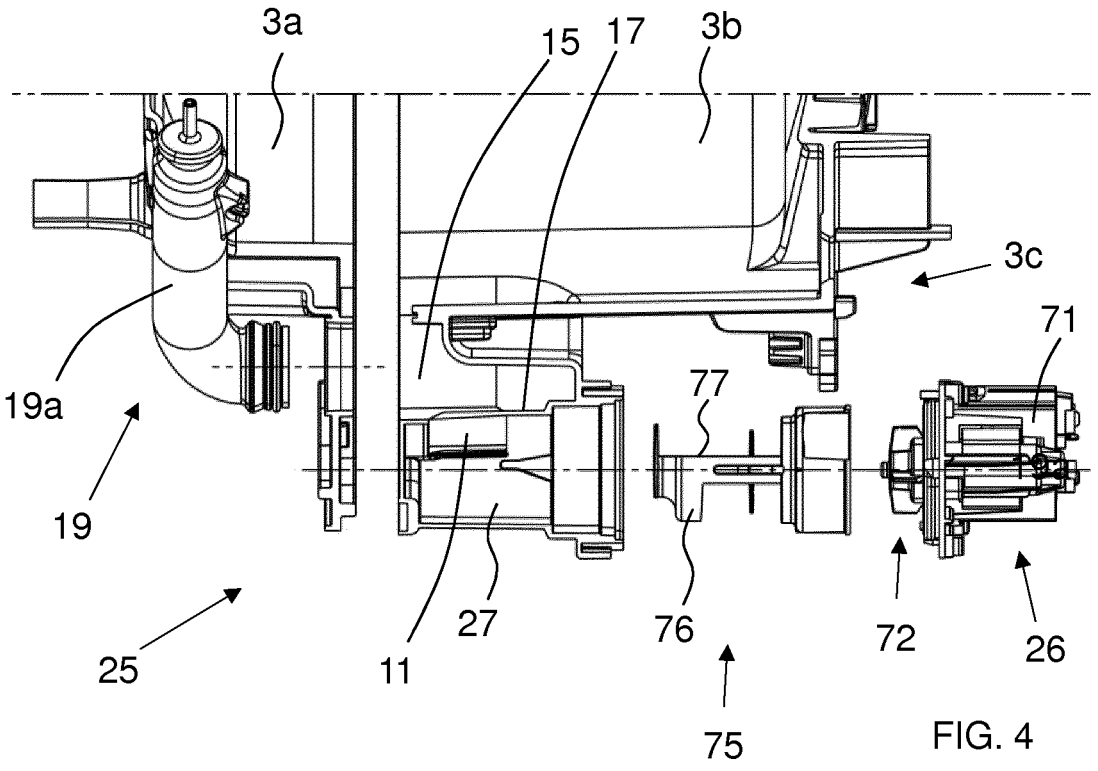

3a
15
17
3b
3c
71
19a
77
19
25
11
27
76
72
26
75

FIG. 4

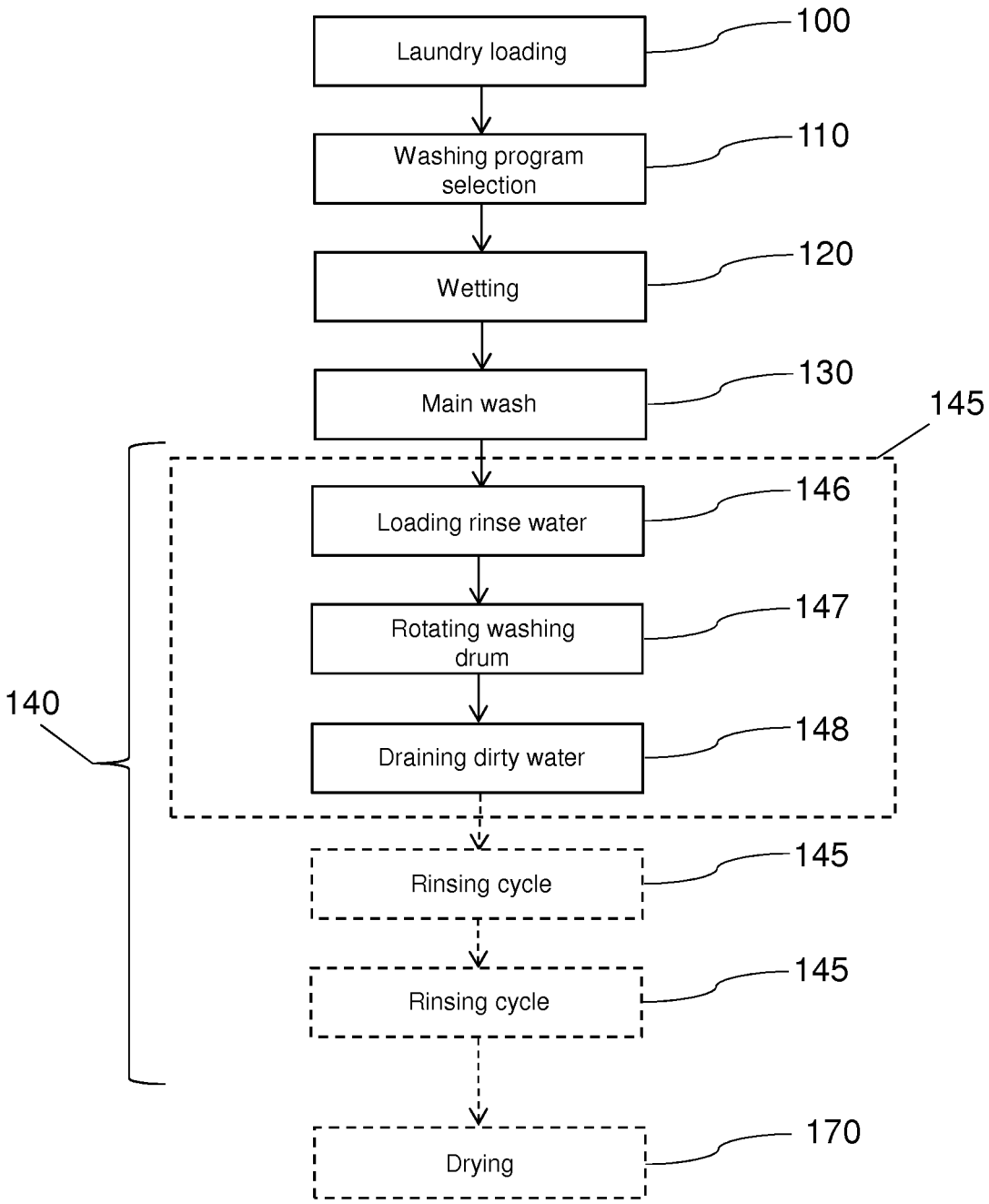

Laundry loading
100
Washing program selection
110
Wetting
120
Main wash
130
145
Loading rinse water
146
Rotating washing drum
147
140
Draining dirty water
148
Rinsing cycle
145
Rinsing cycle
145
Drying
170

FIG. 5

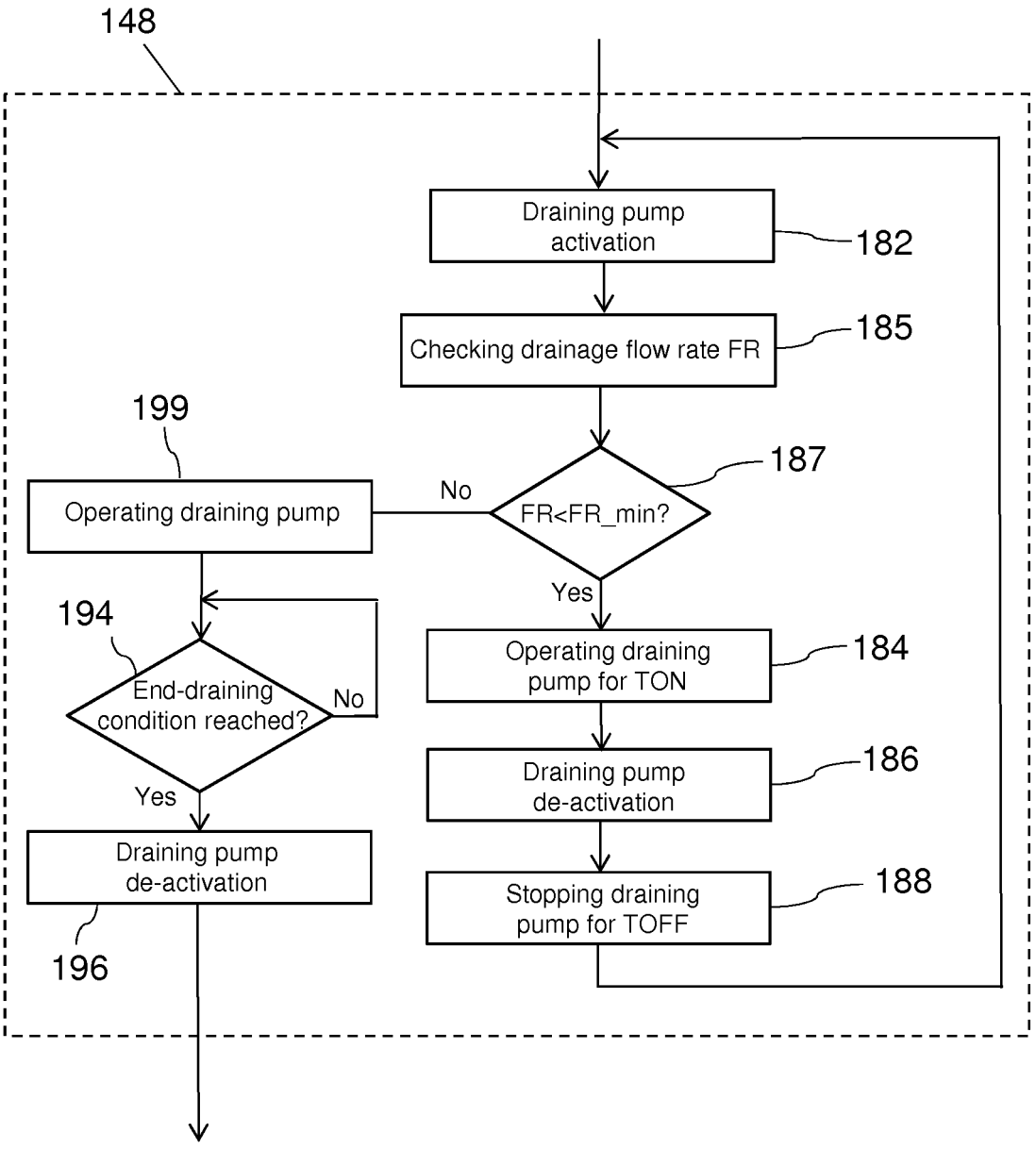

148
Draining pump activation
182
Checking drainage flow rate FR
185
199
187
Operating draining pump
No
FR<FR_min?
Yes
194
Operating draining pump for TON
184
End-draining condition reached?
No
Draining pump de-activation
186
Yes
Draining pump de-activation
Stopping draining pump for TOFF
188
196

FIG. 6

FIG. 7

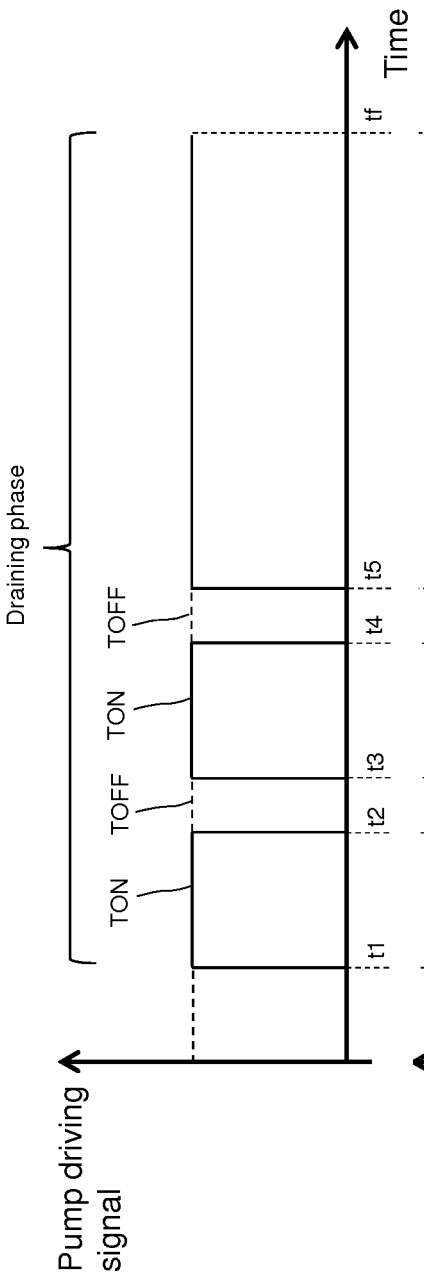
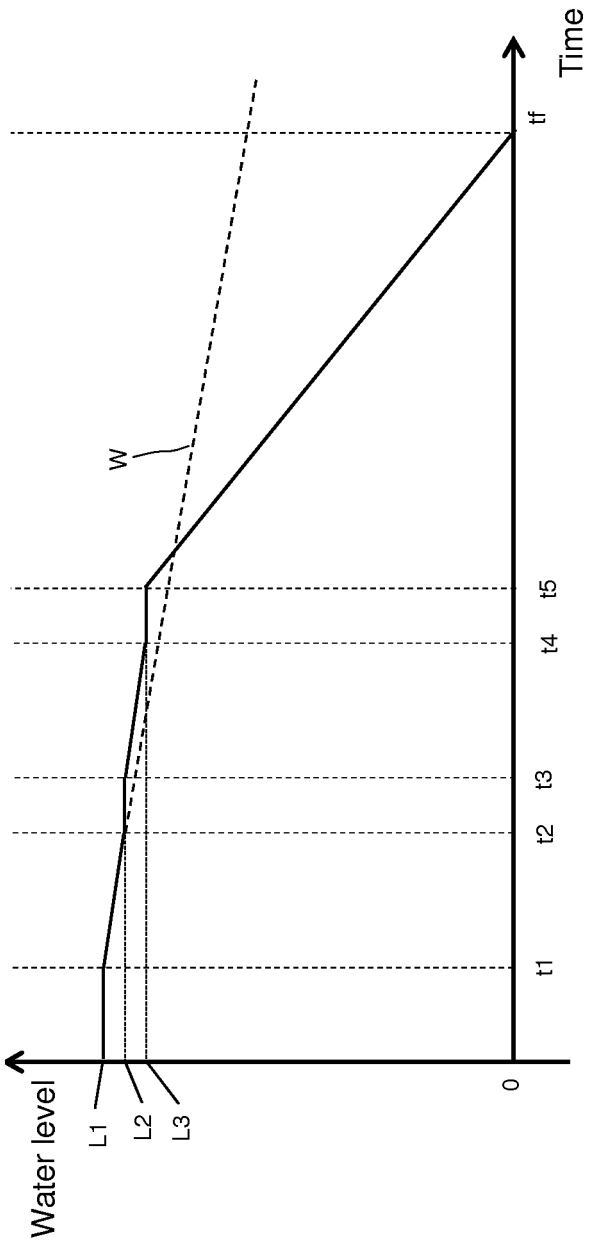

Draining phase
TON
TOFF
TON
TOFF
t1
t2
t3
t4
t5
tf
Time
Pump driving signal

FIG. 8


W
L1
L2
L3
t1
t2
t3
t4
t5
tf
0
Time
Water level

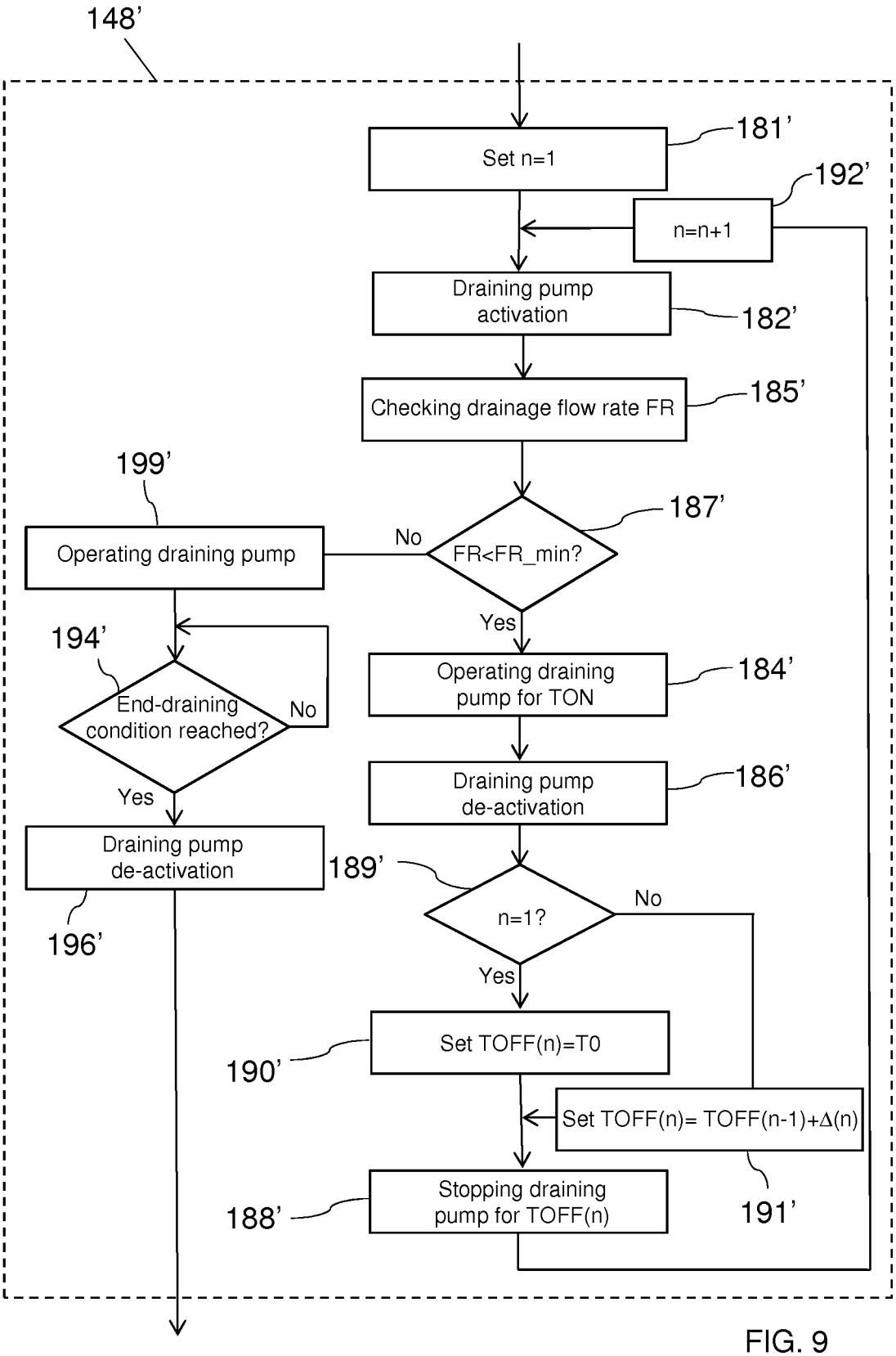

148'
Set n=1
181'
192'
n=n+1
Draining pump activation
182'
Checking drainage flow rate FR
185'
199'
187'
Operating draining pump
No
FR<FR_min?
Yes
194'
End-draining condition reached?
No
Operating draining pump for TON
184'
Yes
Draining pump de-activation
186'
Draining pump de-activation
189'
n=1?
No
196'
Yes
Set TOFF(n)=T0
190'
Set TOFF(n)= TOFF(n-1)+Δ(n)
Stopping draining pump for TOFF(n)
188'
191'

FIG. 9

FIG. 10

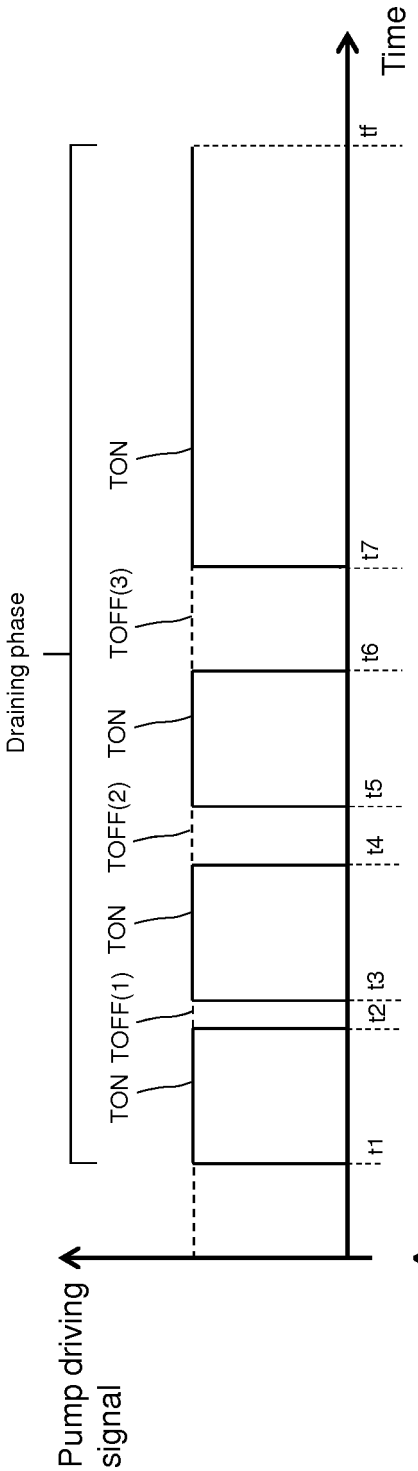
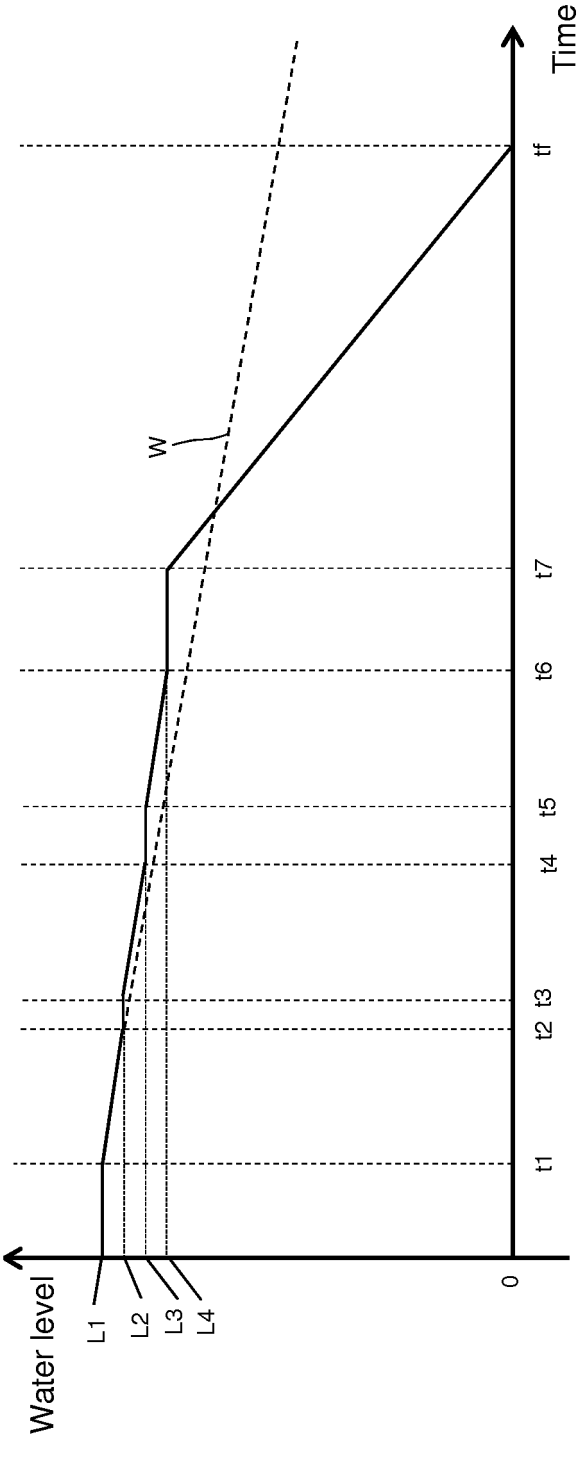

Draining phase
Pump driving signal
Time
TON
TOFF(1)
TON
TOFF(2)
TON
TOFF(3)
TON
t1
t2
t3
t4
t5
t6
t7
tf

FIG. 11


Water level
Time
W
L1
L2
L3
L4
0
t1
t2
t3
t4
t5
t6
t7
tf

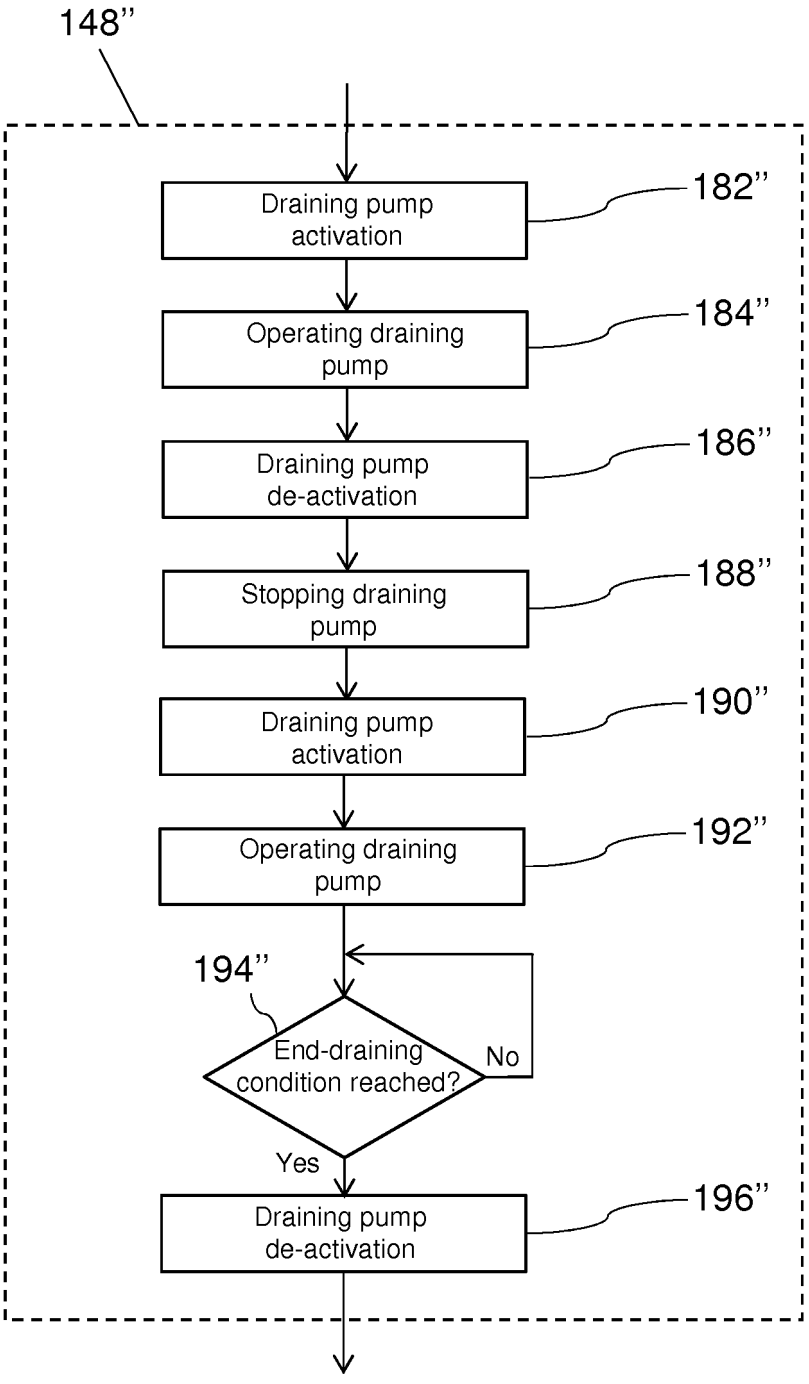

148''
Draining pump activation
182''
Operating draining pump
184''
Draining pump de-activation
186''
Stopping draining pump
188''
Draining pump activation
190''
Operating draining pump
192''
194''
End-draining condition reached?
No
Yes
Draining pump de-activation
196''

FIG. 12

FIG. 13

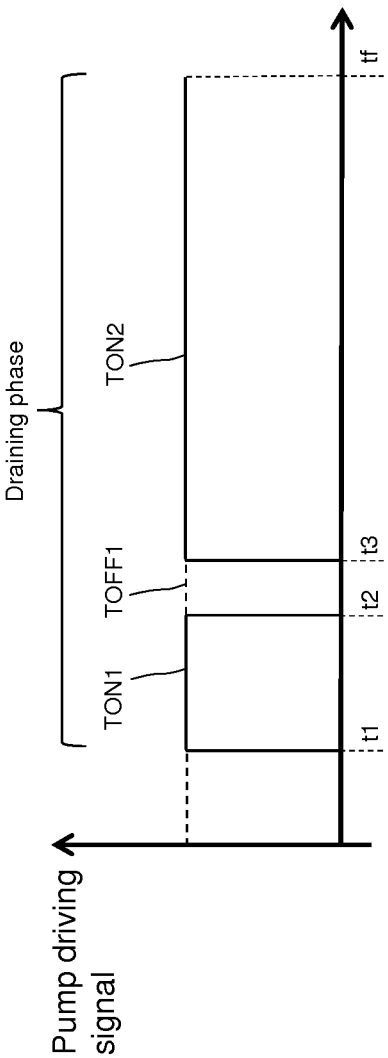
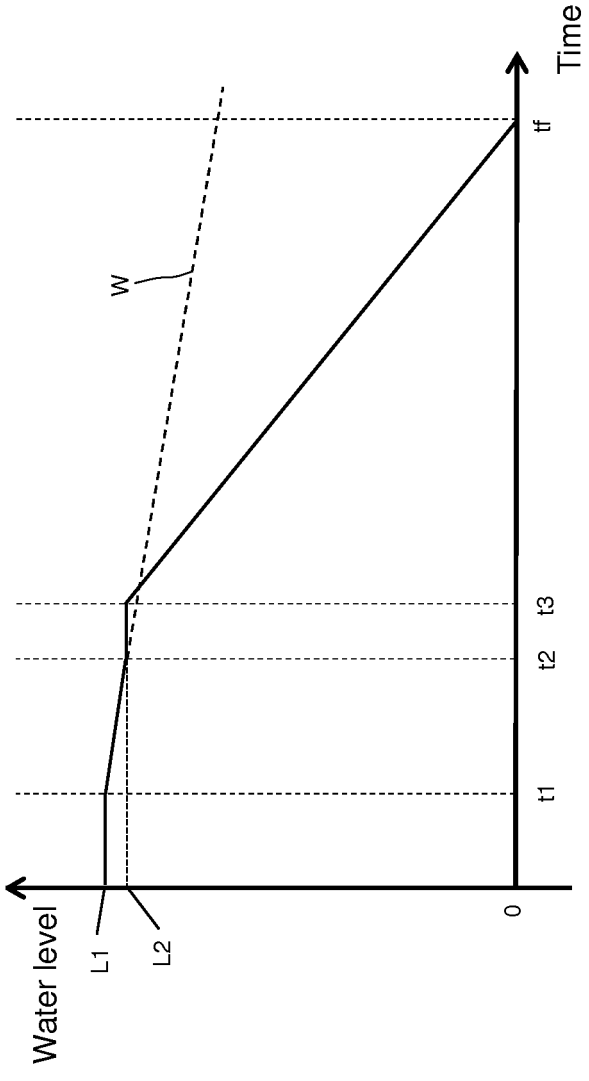

Draining phase
TON2
TOFF1
TON1
t1
t2
t3
tf
Pump driving signal

FIG. 14


W
L1
L2
Water level
0
t1
t2
t3
tf
Time

REFERENCES CITED IN THE DESCRIPTION

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