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(54) **LAUNDRY TREATING MACHINE AND METHOD FOR CONTROLLING THEREOF**

(57) The present invention relates to a laundry treating machine (1) comprising an outer casing (2), a washing tub (3), which is arranged inside the casing (2), a rotatable drum (4), which is arranged in axially rotating manner inside the washing tub (3) and is designed to receive laundry to be washed, a softening device (10) provided with: a ion exchanger (11) designed to receive fresh water from a water mains (9) and reduce the hardness degree of the fresh water in order to supply softened water to the washing tub (3), and a regeneration device (12) designed to perform a regeneration cycle to regenerate the ion exchanger device (11); a control panel (13) configured to allow the user to select a washing program comprising a number of washing phases; an electronic control device (15) configured to control the regeneration device

(12) in order to perform the regeneration cycle. The control panel (13) is further configured to allow an operator to input first data which are indicative of the hardness of said fresh water and/or input second data which are indicative of supplying softened water or, alternately, fresh water to the washing tub (3) during one or more washing phases of the selected washing program. The electronic control device (15) being further configured to change the amount of the softened water to be used during the selected washing program based on said first and/or second data, determine the amount of softened water which has been provided by the ion exchanger (11), and control the regeneration device (12) in order to activate the regeneration cycle based on the determined softened water.

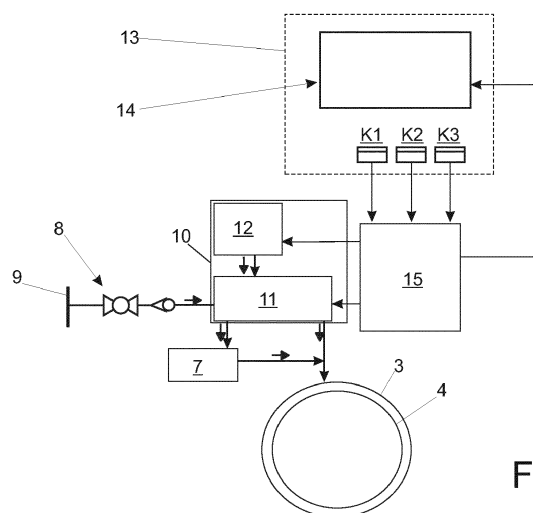


Fig. 2

Description

[0001] The present invention concerns the field of laundry washing techniques. In particular, the present invention refers to a laundry washing machine wherein a water softening process is performed.

BACKGROUND ART

[0002] Nowadays the use of laundry treating machines, both "simple" laundry washing machines (i.e. laundry washing machines which can only wash and rinse laundry) and washing-drying machines (i.e. laundry washing machines which can also dry laundry), is widespread.

[0003] In this respect, in the present description, where not stated differently, the term "laundry treatment machine" can be referred indiscriminately to a laundry washing machine, or to a laundry washing and drying machines, or to a laundry drying machine.

[0004] As is known, laundry treating machines generally comprise a detergent dispenser which is located inside a boxlike casing, immediately above a washing tub, and is structured for selectively feeding into the washing tub, according to the washing cycle manually-selected by the user, a given amount of detergent, softener and/or other washing agent suitably mixed with fresh water arriving from a water mains.

[0005] This type of home laundry washing machine further comprise a fresh-water supply circuit which is structured for selectively drawing fresh water from the water mains and channelling said fresh water to the detergent dispenser or directly to the washing tub; and an appliance control panel which is generally located on the front wall of the casing, above the laundry loading/unloading opening, and is structured for allowing the user to manually select the desired washing-program/cycle.

[0006] In addition to the above, some type of laundry washing machines have an internal water softening device which is located along the fresh-water supply circuit, and is structured to reduce, on command, the hardness degree of the fresh water channelled towards the detergent dispenser and the washing tub. The use of softened water during the washing cycle, in fact, significantly improves cleaning performances.

[0007] The water softening device comprises a ion exchanger which is internally provided with a given amount of ion-exchange resins which are capable of retaining the calcium and magnesium ions (Ca^{++} and Mg^{++}) dissolved in the water flowing through the same water softening device, so as to reduce the hardness degree of the fresh water directed towards the detergent dispenser and the washing tub.

[0008] Since the water softening capabilities of the ion-exchange resins are used to quickly drop away after a number of washing program/cycles, the water softening device generally comprises a resin regeneration device, which is designed to perform regeneration cycles to re-

generate the ion-exchange resins. More specifically, the regeneration unit generally comprises an internal reservoir of salt (NaCl) to be used for selectively producing some brine (i.e. salt water) which, during a regeneration cycle, is channeled into the ion exchanger to regenerate the ion-exchange resins located therein. Salt water, in fact, is able to remove from the ion-exchange resins during the regeneration cycle the calcium and magnesium ions previously combined/fixed to said resins.

[0009] During the regeneration cycles the salt becomes consumed leading to a reduction and finally to a complete consumption of the salt. Hence, the user must refill the internal reservoir of salt from time to time. The consumption of the salt depends on the frequency of the regeneration cycle, and, accordingly, the filling must be effected the more often the more the regeneration cycles are activated; i.e. the more often the ion exchange resin must be regenerated.

[0010] However there is the need to hold the regeneration cycles at a minimum while guaranteeing the effectiveness of the softening during the overall washing process.

[0011] To this end some washing machines are provided with electrical sensors for determining the effectiveness of the softening process and/or of the state of the ion exchange resin.

[0012] In this regard, DE 19 841 568 discloses a laundry washing machine comprising an electrical conductivity sensor which measures the electrical conductivity of water both before and after water is passed through the ion exchanger. The electrical conductivity sensor cooperates with an electronic system, which compares the difference with previous values of conductivity from earlier treatment cycles detected by the sensor and performs the regeneration based on results of comparison.

[0013] Moreover, EP 1 252 855 discloses a laundry washing machine comprising a conductivity sensor that measures the conductivity of the ion exchanger and determine when to perform the regeneration cycle based on the measured value.

[0014] Although efficient, the use of conductivity sensors in the laundry washing machine increases the manufacturing costs of the latter.

[0015] The aim of the present invention is to provide a simple and cheap sensor-less system, which is able to correctly perform the regeneration cycles while guaranteeing the effectiveness of the softening.

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

DISCLOSURE OF INVENTION

[0017] According to the present invention, it is provided a laundry treating machine comprising: an outer casing, a washing tub, which is arranged inside the casing, a rotatable drum, which is arranged in axially rotating manner inside the washing tub and is designed to receive

laundry to be washed, a softening device provided with ion exchanger device designed to receive fresh water from a water mains and reduce the hardness degree of the fresh water in order to supply softened water to said washing tub, and a regeneration device designed to perform a regeneration cycle to regenerate said ion exchanger device, a control panel configured to allow the user to select a washing program comprising a number of washing phases, an electronic control device configured to control said regeneration device in order to perform said regeneration cycle, said laundry treating machine being characterized by the fact that: said control panel is further configured to allow an operator to: input first data which are indicative of the hardness of said fresh water and/or input second data which are associated to a softener configuration indicative of supplying softened water or, alternately, fresh water to the washing tub during one or more washing phases, said electronic control device being further configured to: change the amount of the softened water to be used during a washing program based on said first and/or second data, determine the amount of softened water which has been produced by said ion exchanger device, control said regeneration device in order to activate said regeneration cycle based on the determined amount of softened water.

[0018] Preferably, said first and/or second data cause said electronic control device to change the instant of activation of said regeneration cycle.

[0019] Preferably, said electronic control device is further configured to: memorize a hardness value of the fresh water associated with an instant of activation of said regeneration cycle; delay said instant of activation of said regeneration cycle, when the hardness of the fresh water selected by the user is lower than the memorized hardness value.

[0020] Preferably, said electronic control device is further configured to: memorize an hardness value of the fresh water associated with an instant of activation of said regeneration cycle; anticipate the instant of activation of said regeneration cycle, when the hardness of the fresh water selected by the user is higher than the memorized hardness value.

[0021] Preferably, said electronic control device is further configured to: memorize a quantity threshold which is indicative of the maximum quantity of softened water which the ion exchanger device is able to produce before being unable to soft fresh water having said prefixed hardness; change said prefixed threshold based on said first data; determine the amount of softened water produced by said ion exchanger device during the performing of one or more washing program/s; compare said determined amount of softened water with said changed quantity threshold; determine the instant of activation of said regeneration cycle based on said comparison.

[0022] Preferably, said electronic control device is further configured to change the softener configuration based on said second data, and change the regeneration frequency of the regeneration cycle and/or a prefixed in-

stant of activation of the regeneration cycle based on said changed softener configuration.

[0023] Preferably, said electronic control device is further configured to increase the regeneration frequency of the regeneration cycle and/or anticipate said instant of activation of the regeneration cycle based on an increase of washing phases using the softened water.

[0024] Preferably, said electronic control device is further configured to decrease the regeneration frequency and/or delay the instant of activation of the regeneration cycle according to a decrease of the washing phases using the softened water.

[0025] Preferably, said electronic control device is further configured to: compare a prefixed regeneration interval of the regeneration cycle with the remaining time of the washing program, which the laundry treating machine is performing; and activate the regeneration cycle during the current washing program or postpone the instant of activation of said regeneration cycle in a next washing program, based on the result of said comparison.

[0026] Preferably, said control panel comprises at least two switch devices for allowing the user to input said first data and/or second data; said electronic control device being configured to: enter in a water softener set-up mode condition when the user switches at the same time said two switch devices; set-up the hardness level of the fresh water, on the basis of the command performed by the user by a first switch device; set up the kind of water, among fresh water or softened water, to be supplied to the washing tub during the washing phases of the washing program on the basis of the command performed by the user by a second switch device.

[0027] Preferably, one of said switch devices is configured to cause said electronic control device to set-up a condition in which said ion exchange device are disabled during the washing program.

[0028] Preferably, the laundry treating machine comprises a third switch device configured to cause said electronic control device to start performing said washing program.

[0029] The present invention further relates to a method for controlling a laundry treating machine comprising an outer casing, a washing tub, which is arranged inside the casing, a rotatable drum, which is arranged in axially rotating manner inside the washing tub and is designed to receive laundry to be washed, a softening device provided with ion exchanger device designed to receive fresh water from a water mains and reduce the hardness degree of the fresh water in order to supply softened water to said washing tub, and a regeneration device designed to perform a regeneration cycle to regenerate said ion exchanger device, a control panel configured to allow the user to select a washing program comprising a number of washing phases, said method controls said regeneration device in order to perform said regeneration cycle and being characterized by: inputting by said control panel first data which are indicative of the hardness

of said fresh water and/or input second data which are associated to a softener configuration indicative of supplying softened water or, alternately, fresh water to the washing tub during one or more washing phases, changing the amount of the softened water to be used during a washing program based on said first and/or second data, determining the amount of softened water which has been produced by said ion exchanger device, and controlling said regeneration device in order to activate said regeneration cycle based on the determined amount of softened water.

[0030] Preferably said first data and/or said second data cause the instant of activation of said regeneration cycle to be changed.

[0031] Preferably, the method further comprises the steps of: memorizing an hardness value of the fresh water associated with an instant of activation of said regeneration cycle; delaying said instant of activation of said regeneration cycle, when the hardness of the fresh water selected by the user is lower than the memorized hardness value; anticipating said instant of activation of said regeneration cycle, when the hardness of the fresh water selected by the user is higher than the memorized hardness value.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] Further characteristics and advantages of the present invention will be highlighted in greater detail in the following detailed description of some of its preferred embodiments, provided with reference to the enclosed drawings. In the drawings, corresponding characteristics and/or components are identified by the same reference numbers.

[0033] In particular:

- Figure 1 shows a perspective view of a laundry treating machine made according to the present invention;
- Figure 2 is a schematic view of the control panel, the water softening device, the electronic control device and some other components/parts of the laundry treating machine illustrated in Figure 1;
- Figures from 3 to 10 schematically illustrates some selections which an user may perform by the control panel of the laundry treating machine to set-up the first and the second data.

DETAILED DESCRIPTION OF THE INVENTION

[0034] The present invention has proved to be particularly advantageous because allowing to hold the regeneration cycles at a minimum so as to cause a low salt consumption, while guaranteeing the effectiveness of the softening and overall washing process, without using in the machine, additional expensive sensors for measuring the hardness of the water.

[0035] With reference to Figures 1 and 2, number 1

indicates as a whole a laundry treating machine comprising a preferably, though not necessarily, parallelepiped-shaped outer box casing 2 resting on the floor; a laundry treating group which is placed within said casing 2 and comprises preferably in turn a substantially bell-shaped laundry washing tub 3 suspended in floating manner inside casing 2 via a suspension system comprising a number of coil springs (not illustrated) preferably, though not necessarily, combined with one or more vibration dampers (not illustrated) and a substantially bell-shaped laundry washing drum 4 for housing the laundry to be washed and/or dried, and which is fixed in axially rotating manner inside washing tub 3 for rotating about a longitudinal axis. As can be appreciated, the present invention can be conveniently applied to any kind of laundry treatment machines, like for example laundry washing machine (washing machine) and washing and drying machines (called also washer-driers) or laundry drying machines (called also drier), wherein one or more steps of introducing water and/or steam and/or hot/cool air inside a laundry tub is required.

[0036] In the example illustrated in Figure 1, the laundry treating machine 1 is a front loading laundry washing machine. The present invention has proved to be particularly successful when applied to front loading laundry treating machines. It should in any case be understood that the present invention is not limited to this type of application. On the contrary, the present invention can be usefully applied to different types of laundry treating machines, for example top loading laundry washing machines or top loading laundry washing and drying machines.

[0037] According to the exemplary embodiment, the laundry washing tub 3 is suspended in floating manner inside the casing 2, with the front opening of the laundry washing tub 3 directly faced to a laundry loading and unloading opening formed in the front face of casing 2. Rotating drum 4, in turn, is housed into laundry washing tub 3 so as that its longitudinal axis is preferably oriented substantially horizontally, and coincides with the longitudinal axis of laundry washing tub 3. It is understood that in alternative embodiment not shown, rotation axis may be vertical or inclined.

[0038] In a exemplary embodiment, the front opening of washing tub 3 may be connected to opening on the front face of casing 2 via a cylindrical elastic-deformable bellows, and washing machine 1 is also provided with a door 5 which is preferably hinged to the front face of casing 2 to rotate to and from a rest position (illustrated in Figure 1) in which door 5 closes opening of casing 2 to seal washing tub 3.

[0039] As illustrated in the schematic embodiment of Figure 2, the laundry treating machine 1 is further provided with a detergent dispenser apparatus 7 for dispensing detergent to the washing tub 3 to be used in washing the laundry according to a selected washing program, a main fresh-water supply circuit 8 which is connectable directly to a water mains 9, and is structured for chan-

nelling a flow of fresh water from the water mains 9 to the washing tub 3. Preferably, the main fresh-water supply circuit 8 may be structured for selectively channelling, according to the washing cycle manually-selected by the user, a flow of fresh water from the water mains 9 to the detergent dispensing apparatus 7 and/or directly to the washing tub 3.

[0040] According to a preferred embodiment, the detergent dispensing apparatus 7 may comprise a dispenser which may be a single use dispenser, a bulk dispenser or a combination of a single and bulk dispenser. Regardless of the type of dispenser used, the dispenser may be configured to dispense detergent directly to the laundry washing tub 3 or mixed with water from the detergent dispensing apparatus 7 through a dispensing outlet conduit (not illustrated).

[0041] With reference to Figure 2, the laundry treating machine 1 is further provided with an internal water softening device 10 which is located inside the boxlike casing 2, along the fresh-water supply circuit 8 and is structured for reducing, on command, during a washing program/cycle, the hardness degree of the fresh/tap water that fresh-water supply circuit 8 channels towards detergent dispenser apparatus 7 or washing tub 3.

[0042] According to the present invention, the water softening device 10 may comprise a ion exchanger device 11 structured for reducing the hardness degree of the fresh/tap water in order to provide softened water to the washing tub 3 and/or the detergent dispenser apparatus 8, and a regeneration device 12 designed to perform a regeneration cycle of the ion exchanger device 11.

[0043] According to a preferred embodiment, the ion exchanger device 11 of the water softening device 10 may preferably comprise a closed container which has a water inlet and a water outlet fluidically connected to the fresh-water supply circuit 8 and/or the detergent dispenser apparatus 7 so as to be crossed by the fresh/tap water directed towards the washing tub 3, and comprises a given amount of ion-exchange resins capable of retaining the calcium and magnesium ions (Ca^{++} and Mg^{++}) dissolved in the water flowing through the same container, so as to reduce the hardness degree of the tap water directed towards the washing tub 3. It should in any case be understood that the present invention is not limited to the above disclosed ion exchanger device 11, but could envisage of using other kind of known ion exchanger designed to perform a reduction of the hardness of the water for providing softened water.

[0044] With regards to the regeneration device 12, it may comprise an amount of consumable salt (NaCl) (or other regeneration agent) and is configured to perform a regeneration cycle of the ion-exchange resins contained in the ion exchanger device 11. During a regeneration cycle, the water pass through the regeneration device mixing with the consumable salt, and the resulting salt water is supplied, on command, to the ion exchanger device 11 in order to remove from the ion-exchange resins the calcium and magnesium ions previously com-

bined/fixed to said resins.

[0045] As illustrated in the schematic embodiment of Figures 1 and 2, the laundry treating machine 1 further comprise an user control panel 13, which may be preferably, although not necessarily, arranged in the front wall of the casing 2 and is structured/configured to allow the user to input information being indicative of a washing program to be performed. The user control panel 13 may preferably comprise at least a display 14 which illustrates washing information (as hereinafter disclosed).

[0046] The laundry treating machine 1 further comprise an electronic control device 15, i.e. an electronic control circuit, which is electrically connected to the control panel 13 and to the display 14, and is configured to: receive the information inputted by the user by the user control panel 13, provide washing information to the user via the display 14, and controls operation performed by the laundry treating machine 1 according to the washing program selected by the user.

[0047] According to the present invention, the electronic control device 15 is further configured to control the amount of the softened water supplied by the softening device 10 to the washing tub 3 during the washing program. According to an exemplary embodiment, the electronic control device 15 may regulate the amount of fresh water supplied to the water inlet of the closed container of ion exchanger device 11 in order to provide in the water outlet a determined amount of softened water. It is understood that the amount of the softened water supplied by the softening device 10 to the washing tub 3 may depend on the washing program selected by the user and/or preferably on the weight/amount of the clothing loaded in the drum 4.

[0048] According to an exemplary embodiment, the electronic control device 15 may be configured to memorize a prefixed amount/quantity of softened water associated with a washing program and change the prefixed amount/quantity on the basis of the weight/amount of the clothing loaded in the drum 4. In this regard, the electronic control device 15 may be provided with electronic apparatuses and/or sensors (not illustrated) configured to determine the weight/amount of the clothing loaded in the drum 4.

[0049] According to an exemplary embodiment, the electronic control device 15 may be further configured to determine the actual amount of softened water supplied to the tub 3/drum 4 by the internal water softening device 10. According to an exemplary embodiment the electronic control device 15 may be provided with electronic apparatuses (not illustrated) which senses/measures the amount of water crossing the water outlet of the ion exchanger device 11 and determine the overall actual amount of softened water supplied to the tub 3/drum 4 based on sensed/measured values.

[0050] The electronic control device 15 may be further configured to control the regeneration device 12 in order to perform a regeneration cycle. According to an exemplary embodiment, the electronic control device 15 may

activate the regeneration device 12 in order to supply, at a certain activation instant, a prefixed amount of salt water to the ion exchanger device 11 in order to remove from the ion-exchange resins the calcium and magnesium ions previously combined/fixed to said resins.

[0051] The electronic control device 15 is further configured to control the regeneration device 12 in order to finish the regeneration cycle after a prefixed regeneration interval. According to an exemplary embodiment, the electronic control device 15 may memorize a quantity threshold which is indicative of the maximum quantity of softened water which the ion exchanger device 11 may produce before being unable to soft fresh water having a prefixed hardness. More specifically, the quantity threshold may correspond to the amount/quantity of the softened water that the ion exchanger device 11 has provided until the resins are exhausted, i.e. resins are unable to absorb the calcium and magnesium ions.

[0052] The electronic control device 15 may be further configured to compare the actual amount of softened water provided by the ion exchanger device 11 with the quantity threshold and determine the instant of activation of the regeneration cycle based on said comparison. For example, electronic control device 15 may set the instant of activation of the regeneration cycle when the actual amount of softened water provided by the ion exchanger device 11 reaches the quantity threshold.

[0053] According to an exemplary embodiment, the electronic control device 15 may determine the remaining time of the washing program and check whether the regeneration cycle may be performed during the current washing program or it may be performed in a next washing program. For example the electronic control device 15 may compare the remaining washing time with the regeneration interval, and if the remaining time is lower than the regeneration interval, it programs the instant of activation in a predetermined washing phase of the next washing program. On the contrary, if the remaining time is higher than the regeneration interval, the electronic control device 15 may set up the instant of activation in a predetermined washing phase of the current washing program.

[0054] According to the present invention, the control panel 13 is further configured to allow an operator to input first data which are indicative of the hardness of the fresh water and/or input second data which are indicative of supplying softened water or, alternately, fresh water to the washing tub 3 during one or more washing phases of a selected washing program.

[0055] The electronic control device 15 is further configured to: change/vary the amount of the softened water to be used during the selected washing program based on the first and/or the second data, determine the amount of softened water which the ion exchanger device 11 has supplied (produced) to the tub 3/drum 4, and control the regeneration device 12 in order to activate the regeneration cycle, or set the instant of activation of the regeneration cycle, based on the determined amount of soft-

tened water.

[0056] According to an exemplary embodiment of the present invention, the electronic control device 15 may contain, for example in a memory device (not illustrated), data indicative of a prefixed hardness level of the fresh water supplied by the water mains 9 to the fresh-water supply circuit 8 and a quantity threshold. Preferably, the quantity threshold may be approximately the maximum quantity of softened water which the ion exchanger device 11 produces before being unable to soft fresh water when the fresh water has said memorized hardness level.

[0057] The electronic control device 15 may further contain data relating to the softener configuration of the washing program. The softener configuration indicates the kind of water, i.e. fresh water or softened water which should be supplied to the washing tube 3 during the washing phases of the washing program.

[0058] It should be understood that in the present description with "washing program", it will be understood a laundry washing cycle comprising one or more a "washing phases", while with "washing phases" will be understood the laundry wash phases and the laundry rinse phases or alternatively or additionally a soaking phase, a steam phase, etc. A laundry wash phase may comprises, for example: a wetting phase (step of loading water and detergent into the washing tub), a maintenance phase (step of tumbling the laundry for detergent action) and preferably, although not necessarily, a spin phase (step of spinning the drum). Rinse phase following a laundry wash phase, may comprise a water loading phase (loading water into the washing tub), and eventual addition of a rinsing agent (through the water flow on a compartment collecting said agent), a rinse maintenance phase (eventually tumbling the laundry), a drain phase, and preferably a spin phase. Thus the present invention is not limited to the selection/set-up of softened water only during the laundry wash phase and laundry rinse phase, but it can be extended or alternatively performed during other phases of the washing program, such as a soaking phase, a steam phase, etc.

[0059] According to a preferred embodiment, the electronic control device 15 may be configured to compare the hardness level, selected by the user via the control panel 13, with the memorized hardness level and changes the quantity threshold based on the results of comparison. It is understood that according to an exemplary embodiment, the electronic control device 15 is configured to conveniently change the instant of activation of the regeneration cycle based on at least the first data provided by user. In detail, the instant of activation of the regeneration cycle is determined by the electronic control device 15 on the basis of comparison between the quantity threshold and the actual amount of softened water, which in turn is changed according to the first data, i.e. the hardness value inputted by the user; indeed when the user changes the hardness value, the electronic control device 15 varies the quantity threshold, and accordingly causes the instant of activation of the regeneration

cycle to be changed.

[0060] For example, the electronic control device 15 may increase the quantity threshold if the water hardness level selected by the user is lower than the memorized hardness level. In this case, the electronic control device 15 will delay the instant of activation of the regeneration cycle based on the reduction of the hardness value inputted by user.

[0061] Vice versa, the electronic control device 15 may decrease the quantity threshold if the water hardness level selected by the user is higher than memorized hardness level. In this case, the electronic control device 15 will anticipate the instant of activation of the regeneration cycle in response to the increase of the hardness value inputted by user.

[0062] According to an exemplary embodiment illustrated in Figures 3, 4 and 5, the predetermined water hardness levels selectable by the user via the control panel 13 may be: soft level, medium level, hard level; it should be understood that according to alternative embodiments, a different number of predetermined water hardness levels can be selectable, i.e. 2 or more than 3 levels.

[0063] The predetermined water hardness levels selectable by the user may be illustrated by the display 14 by means of respective graphic icons or any other graphics. In the exemplary embodiment illustrated in Figures 3, 4 and 5 the hardness levels selectable by the user are illustrated by a number of respective horizontal parallel lines superimposed on to the other wherein each lines is associated with a corresponding water hardness level.

[0064] It should be understood that the "soft level" may be associated with a hardness degree lower than about 15 FH (150 ppm CaCO_3), the "medium level" may be associated with a hardness degree comprised between about 15 and about 25 FH, whereas the "hard level" may be associated with a hardness degree higher than 25 FH. It is pointed out that "FH" is the unit of measurement of water hardness degree corresponding to French degree, wherein 1 FH = 10 ppm CaCO_3 (Calcium Carbonate).

[0065] Preferably, although not necessarily, the electronic control device 15 may be configured to memorize by default the medium level. For example, the medium level may be set during the installation of the machine 1 and/or during its manufacturing. According to this embodiment, the user may change by the control panel 13 the prefixed medium level with the soft level or alternately the hard level.

[0066] If the user selects the soft level, the electronic control device 15 may increase the memorized quantity threshold associated with the medium level. The increase of the memorized quantity threshold causes the instant of activation of the regeneration cycle to be delayed. Vice versa, if the user selects the hard level, the electronic control device 15 may reduce the memorized quantity threshold. The reduction of the memorized quantity threshold causes the instant of activation of the regen-

eration cycle to be anticipated.

[0067] With regard to the second input data, they are indicative of the washing phases using softened water, hereinafter called "softener configuration". According to the present invention, the user may selectively set the washing phase/s which uses/use the softened water. Preferably, the user may set-up the use of softened water during one or more washing phases in order to define the softener configuration and the electronic control device 15 may be configured to: memorize the softener configuration selected by the user and preferably, applies, by default, the memorized softener configuration to the washing programs selected by the user. The electronic control device 15 may be further configured to allow the user to change the memorized softener configuration by selecting or deselecting the use of softened water during any washing phase. The user may select the washing program, the electronic control device 15 may applies the memorized softener configuration to the selected washing program, and the user may change the softener configuration applied to the program, before starting the washing program.

[0068] For example, the memorized softener configuration may comprise the use of soft water during the washing phase and during the rinse phase, the user may deselect the use of soft water during the washing phase, and the electronic control device 15 performs the washing program based on the user selection.

[0069] Therefore the electronic control device 15 changes the memorized softener configuration based on the second data selected by the user. However, the change of the softener configuration of the washing program causes a modification of the instant of activation of the regeneration device 12 as well as the regeneration frequency of the regeneration cycle. It is pointed out that the amount of softened water used during a washing program depends on the number of washing phase using the softened water. It follows that the actual amount of softened water provided by the water softening device 10 depends on the softener configuration, i.e. the second data.

[0070] Therefore, in use, the electronic control device 15 increases the regeneration frequency and anticipate the instant of activation of the regeneration cycle based on an increase of the number of washing phases using the softened water.

[0071] Vice versa, the electronic control device 15 decreases the regeneration frequency and delay the instant of activation of the regeneration cycle according to a decrease of the number of washing phases using the softened water.

[0072] According to an exemplary embodiment, the basic softener configuration of the washing program memorized in the electronic control device 15 may comprise the use of softener water during the laundry wash phase and the use of fresh water during the rinse phase. If, in addition of the use of softened water during the wash phase, the user sets up the use of the softened water

also in the rinse phase, the overall amount of softened water supplied during the washing program increases, i.e. it is redoubled. It follows that if the basic softener configuration is changed as above supposed, the quantity of the softened water reaches in advance the quantity threshold, compared to the case of the basic softener configuration, consequently, the instant of activation of the regeneration cycle is anticipated too. Vice versa, if the user deselects the use of the softened water in the wash phase, the overall amount of softened water supplied during the washing program is hardly reduced (i.e. zero) and consequently the instant of activation of the regeneration cycle is hardly delayed causing a conveniently reduction of regeneration frequency.

[0073] It is pointed out that the first data indicative of the water hardness level as well as the second data indicative of the washing phases using the softened water, cause the electronic control device 15 to change the instant of activation of the regeneration cycle and change of the regeneration frequency. Indeed, as above disclosed, the actual amount of softened water produced by the water softening device 10 changes according to the hardness value of the water and the use of the softening water during the washing phases.

[0074] Figures 2, 3, 4 and 5, illustrate a convenient example of the operation performed by the control panel 13, wherein the control panel 13 may comprise three switches devices, preferably three buttons K1, K2 and K3 and the water hardness levels selectable by the user are soft, medium and hard. It is understood that equivalent devices can be used instead of the buttons; for example, common "touch switches" can be provided.

[0075] Moreover, soft, medium and hard levels may be illustrated by the display 14 by using three horizontal segments. For example, the electronic control device 15 may be configured to enter in a "set-up mode" of the softener configuration, when detects that user maintains two buttons K1 and K2 pressed at the same time (Figure 3) preferably for a determined interval (i.e. 2 seconds).

[0076] In the set up mode, electronic control device 15 may be configured to command the display 14 in order to illustrate an water hardness level (i.e. hard level and three segments in Figure 3). For example, once entered in water softener setup mode by pressing together buttons K1 and K2 for a predetermined interval, the display 14 will switch off all LEDs/icons/digits except the ones used to show two icons associated with water softener parameters.

[0077] It is possible to press button K1 to change water hardness level in the range "hard" (showed in Figure 3), "medium" (Figure 4), "soft" (Figure 5). In the examples illustrated in the Figures 3-5, the abbreviation "CO" stays for water conductivity.

[0078] Regarding to the second data, the user may change, by the control panel 13, the softener configuration of the washing program, i.e. the kind of water, i.e. fresh water in softened water or vice versa, to be used during the washing phases of the washing program.

[0079] According to the present invention, washing programs may have basic configurations wherein the softened water is used in a prefixed phase of the programs. For example the basic configurations of the washing programs may comprise the use of softened water during the wash phase and the use of fresh water during the rinse phase. As illustrated in Figure 6, the electronic control device 15 may be configured to illustrate to the user by the display 14, the basic configuration associated with a selected washing program. In the example of Figure 6, the basic configuration of the selected washing program is set-up so that the softened water is used only during the washing phase. In this regards, the display 14 illustrates a icons 14a which indicates that the softened water will be used during the washing phase.

[0080] By means of the control panel 13, the user may change the basic softener configuration and select, for example the use of softened water during the rinse phase (Figure 7), or the use of the softened water during the washing phase and the rinse phase (Figure 8), or he may deselect the use of softened water (Figure 9).

[0081] Since the quantity of the water to be softened during the washing program depends on the second data selected by the user, and because according to an embodiment of the present invention the electronic control device 15 activates the regeneration cycle on the basis of comparison between the amount of softened water supplied to the washing tub 3 during the washing programs, and a prefixed threshold, it follows that the instant of activation of the regeneration device and the regeneration frequency depend on the second data selected by the user too.

[0082] Indeed the selection of the second data impacts the quantity of water to be softened allowing the consumer to use it, in the whole washing program, part of it, or even switch it off (Figure 9). It follows that salt consumed by the regeneration device 12 may be high, low, or even no consumption at all if the user deselected the use of softened water in the washing program. When the user set-up the use of softener water during the rinse phase, the display 14 may illustrates a icons 14b.

[0083] Figures 6, 7, 8 and 9 illustrates a preferred embodiment of the present invention in which the buttons K1 and K2 of the control panel 13 are configured to allow the user to select the use of the softened water during the several phase of the washing program. For example the electronic control device 15 may be configured in order that in the setup mode, the user may select the use of the softened water in the washing/rinse phases by pushing the button K2. For example if the user press the button K2 once, the electronic control device 15 sets-up the use of the softened water during the wash phase changes the memorized basic configuration based on the selection and shows by the display 14 the first icon 14a associated with the wash phase (Figure 6). If the user press the button K2 twice, the electronic control device 15 sets-up the use of the softened water during the rinse phase, changes the memorized basic configuration

based on the selection and shows by the display 14 the second icon 14b associated with the wash phase (Figure 7). Preferably, if the user press the button K2 three times, the electronic control device 15 sets-up the use of the softened water during both the washing and rinse phase, changes the memorized basic configuration based on the selection and shows by the display 14 the first 14a and the second icon 14b (Figure 8).

[0084] If the user press the button K2 a further time, the electronic control device 15 disables the use of the softened water both during the washing phase and the rinse phase (figure 9).

[0085] Once desired selections are done, the electronic control device 15 may exit the water softener setup mode and go back to normal program selection, when button K1 and button K2 are pressed together for a prefixed time (i.e. two seconds). Alternately the electronic control device 15 may exit the water softener setup mode and go back to normal program selection, when button K3 is pressed (Figure 10).

[0086] The electronic control device 15 may be further configured to start the washing program when the button K3 is pushed.

[0087] The advantages of the washing machine object of the present invention are represented by the fact that the regeneration cycle is completely controlled by the electronic control device which is conveniently "sensor-less".

[0088] 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. Laundry treating machine (1) comprising:

- an outer casing (2),
- a washing tub (3), which is arranged inside the casing (2),
- a rotatable drum (4), which is arranged in axially rotating manner inside the washing tub (3) and is designed to receive laundry to be washed,
- a softening device (10) provided with ion exchanger device (11) designed to receive fresh water from a water mains (9) and reduce the hardness degree of the fresh water in order to supply softened water to said washing tub (3), and a regeneration device (12) designed to perform a regeneration cycle to regenerate said ion exchanger device (11),
- a control panel (13) configured to allow the user to select a washing program comprising a number of washing phases,

- an electronic control device (15) configured to control said regeneration device (12) in order to perform said regeneration cycle,

said laundry treating machine being **characterized by** the fact that:

- said control panel (13) is further configured to allow an operator to: input first data which are indicative of the hardness of said fresh water and/or input second data which are associated to a softener configuration indicative of supplying softened water or, alternately, fresh water to the washing tub (3) during one or more washing phases,
- said electronic control device (15) being further configured to:
- change the amount of the softened water to be used during a washing program based on said first and/or second data,
- determine the amount of softened water which has been produced by said ion exchanger device (11),
- control said regeneration device (12) in order to activate said regeneration cycle based on the determined amount of softened water.

2. Laundry treating machine according to claim 1, wherein said first and/or second data cause said electronic control device (15) to change the instant of activation of said regeneration cycle.

3. Laundry treating machine according to claim 1, wherein said electronic control device (15) is further configured to:

- memorize a hardness value of the fresh water associated with an instant of activation of said regeneration cycle;
- delay said instant of activation of said regeneration cycle, when the hardness of the fresh water selected by the user is lower than the memorized hardness value.

4. Laundry treating machine according to claim 1, wherein said electronic control device (15) is further configured to:

- memorize an hardness value of the fresh water associated with an instant of activation of said regeneration cycle;
- anticipate the instant of activation of said regeneration cycle, when the hardness of the fresh water selected by the user is higher than the memorized hardness value.

5. Laundry treating machine according to claim 3 or 4, wherein said electronic control device (15) is further

configured to:

- memorize a quantity threshold which is indicative of the maximum quantity of softened water which the ion exchanger device (11) is able to produce before being unable to soft fresh water having said prefixed hardness;
 - change said prefixed threshold based on said first data;
 - determine the amount of softened water produced by said ion exchanger device (11) during the performing of one or more washing program/s;
 - compare said determined amount of softened water with said changed quantity threshold;
 - determine the instant of activation of said regeneration cycle based on said comparison.
6. Laundry treating machine according to claim 2, wherein said electronic control device (15) is further configured to change the softener configuration based on said second data, and change the regeneration frequency of the regeneration cycle and/or a prefixed instant of activation of the regeneration cycle based on said changed softener configuration.
7. Laundry treating machine according to claim 6, wherein said electronic control device (15) is further configured to increase the regeneration frequency of the regeneration cycle and/or anticipate said instant of activation of the regeneration cycle based on an increase of washing phases using the softened water.
8. Laundry treating machine according to claim 6, wherein said electronic control device (15) is further configured to decrease the regeneration frequency and/or delay the instant of activation of the regeneration cycle according to a decrease of the washing phases using the softened water.
9. Laundry treating machine according to claim 1, wherein said electronic control device (15) is further configured to:
- compare a prefixed regeneration interval of the regeneration cycle with the remaining time of the washing program, which the laundry treating machine is performing; and
 - activate the regeneration cycle during the current washing program or postpone the instant of activation of said regeneration cycle in a next washing program, based on the result of said comparison.
10. Laundry treating machine according to claim 1, wherein said control panel (13) comprises at least two switch devices (K1, K2) for allowing the user to

input said first data and/or second data;

said electronic control device (15) being configured to:

- enter in a water softener setup mode condition when the user switches at the same time said two switch devices (K1, K2);
 - set-up the hardness level of the fresh water, on the basis of the command performed by the user by a first switch device (K1);
 - set up the kind of water, among fresh water or softened water, to be supplied to the washing tub during the washing phases of the washing program on the basis of the command performed by the user by a second switch device (K2).
11. Laundry treating machine according to claim 10, wherein one of said switch device (K1, K2) is configured to cause said electronic control device (15) to set-up a condition in which said ion exchange device (11) are disabled during the washing program.
12. Laundry treating machine according to claim 7 comprising a third switch device (K3) configured to cause said electronic control device (15) to start performing said washing program.
13. Method for controlling a laundry treating machine (1) comprising an outer casing (2), a washing tub (3), which is arranged inside the casing (2), a rotatable drum (4), which is arranged in axially rotating manner inside the washing tub (3) and is designed to receive laundry to be washed, a softening device (10) provided with ion exchanger device (11) designed to receive fresh water from a water mains (9) and reduce the hardness degree of the fresh water in order to supply softened water to said washing tub (3), and a regeneration device (12) designed to perform a regeneration cycle to regenerate said ion exchanger device (11), a control panel (13) configured to allow the user to select a washing program comprising a number of washing phases, said method controls said regeneration device (12) in order to perform said regeneration cycle and being **characterized by:**
- inputting by said control panel (13) first data which are indicative of the hardness of said fresh water and/or input second data which are associated to a softener configuration indicative of supplying softened water or, alternately, fresh water to the washing tub (3) during one or more washing phases,
 - changing the amount of the softened water to be used during a washing program based on said first and/or second data,
 - determining the amount of softened water which

has been produced by said ion exchanger device (11), and
controlling said regeneration device (12) in order
to activate said regeneration cycle based on the
determined amount of softened water.

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- 14.** Method according to claim 13, wherein said first data
and/or said second data cause the instant of activation
of said regeneration cycle to be changed.

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- 15.** Method according to claim 13, comprising the steps
of:

- memorizing an hardness value of the fresh water associated with an instant of activation of said regeneration cycle;
- delaying said instant of activation of said regeneration cycle, when the hardness of the fresh water selected by the user is lower than the memorized hardness value;
- anticipating said instant of activation of said regeneration cycle, when the hardness of the fresh water selected by the user is higher than the memorized hardness value.

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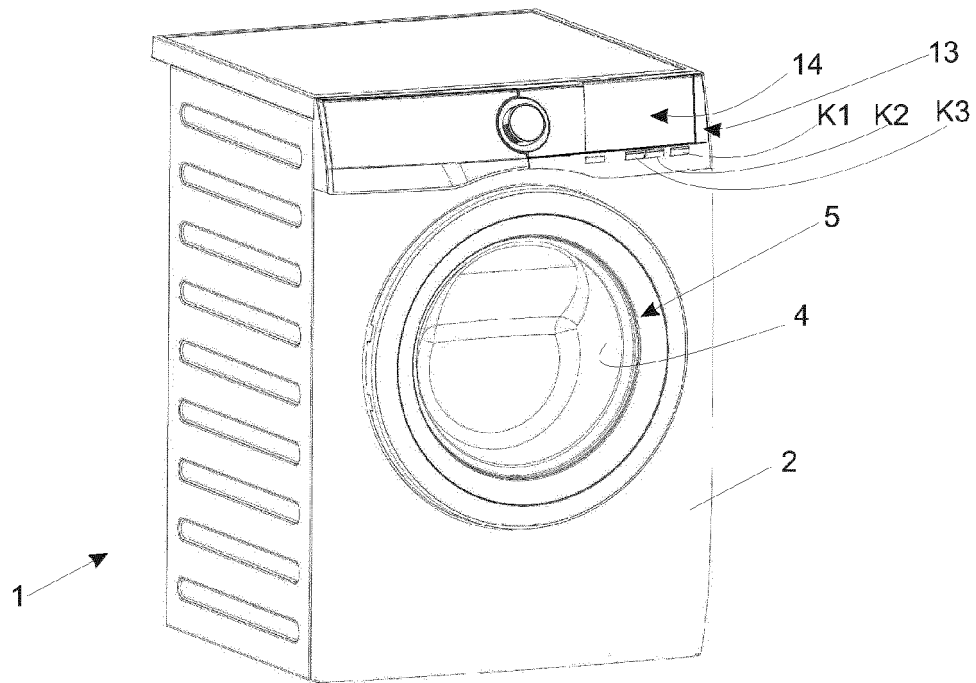


Fig. 1

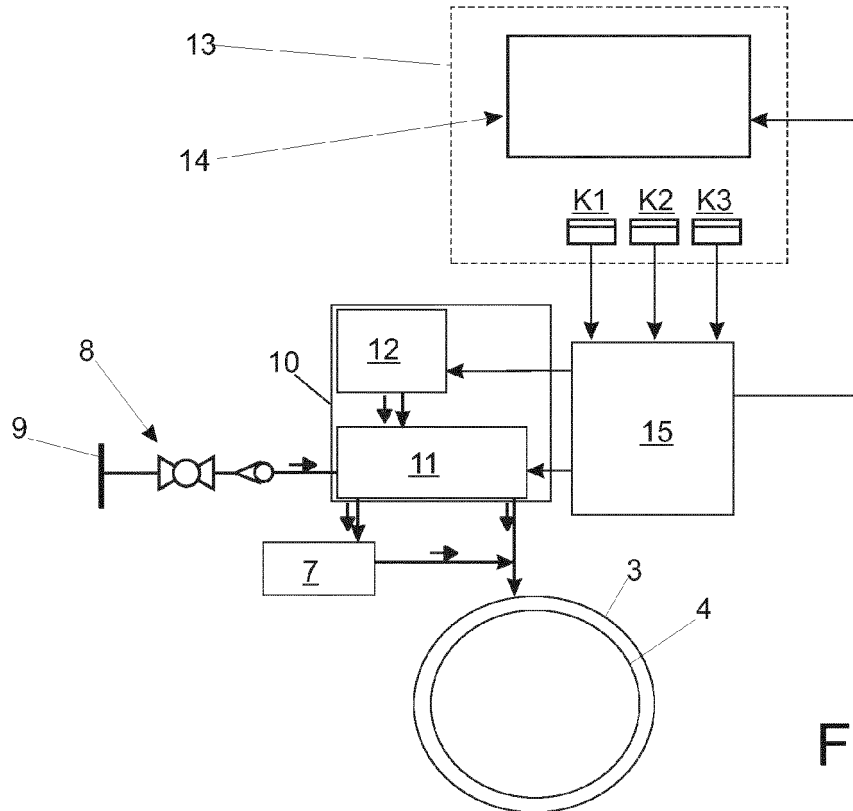


Fig. 2

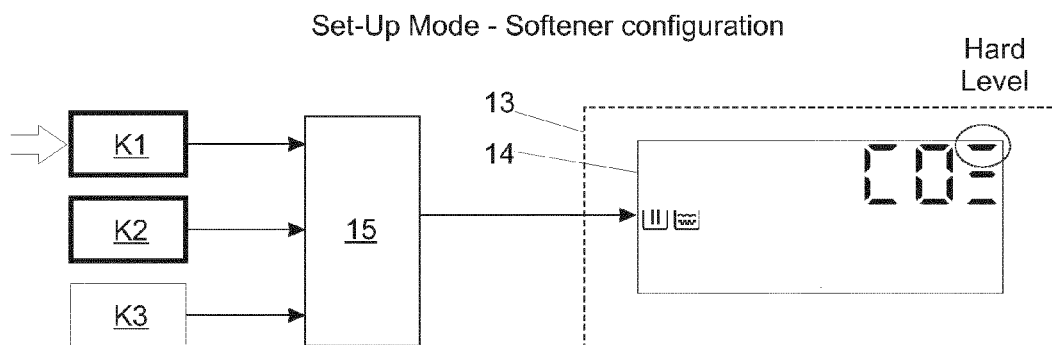


Fig. 3

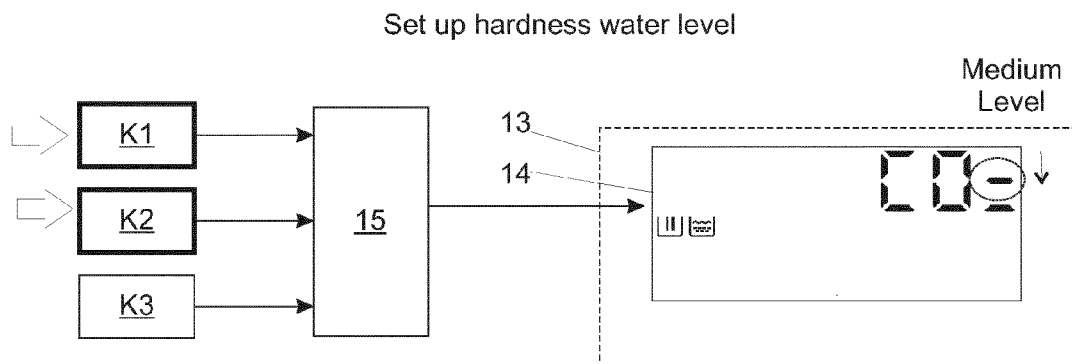


Fig. 4

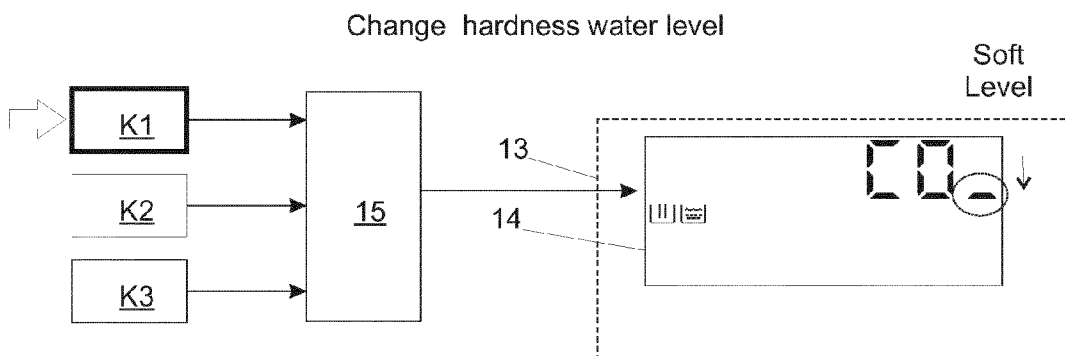


Fig. 5

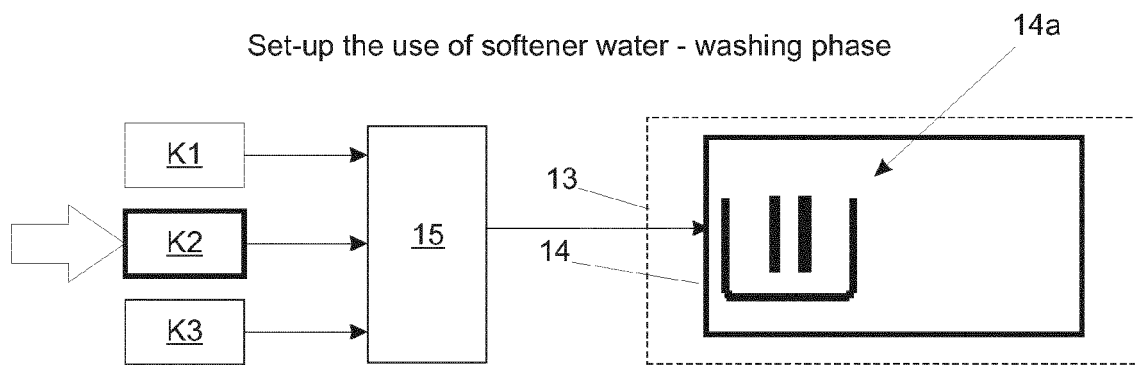


Fig. 6

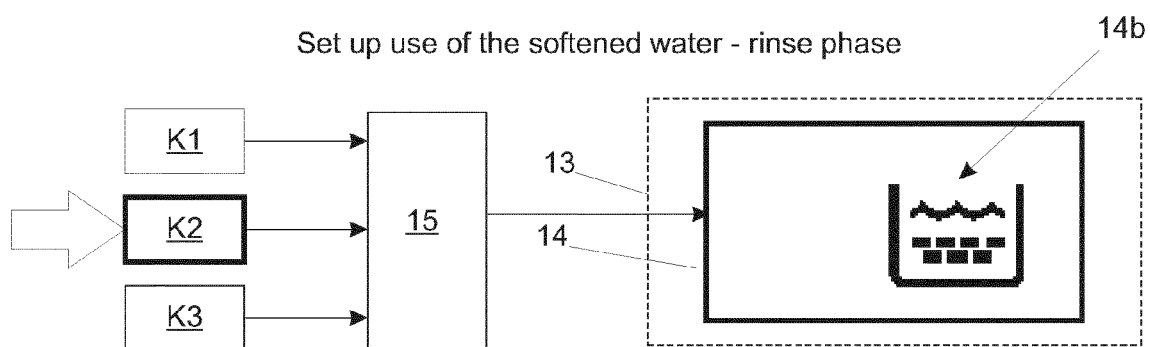


Fig. 7

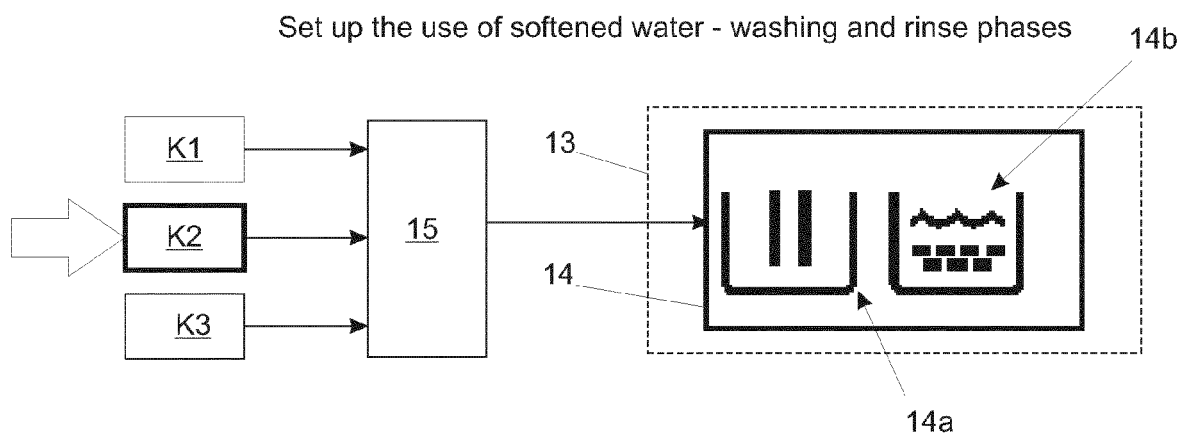


Fig. 8

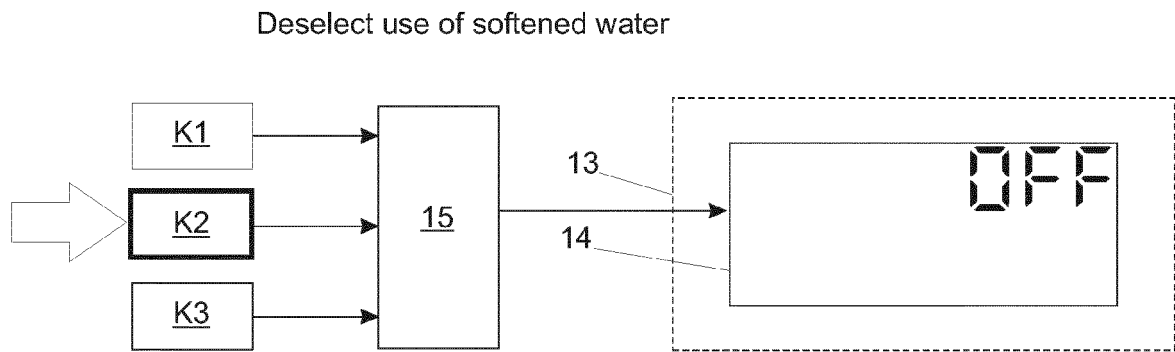


Fig. 9

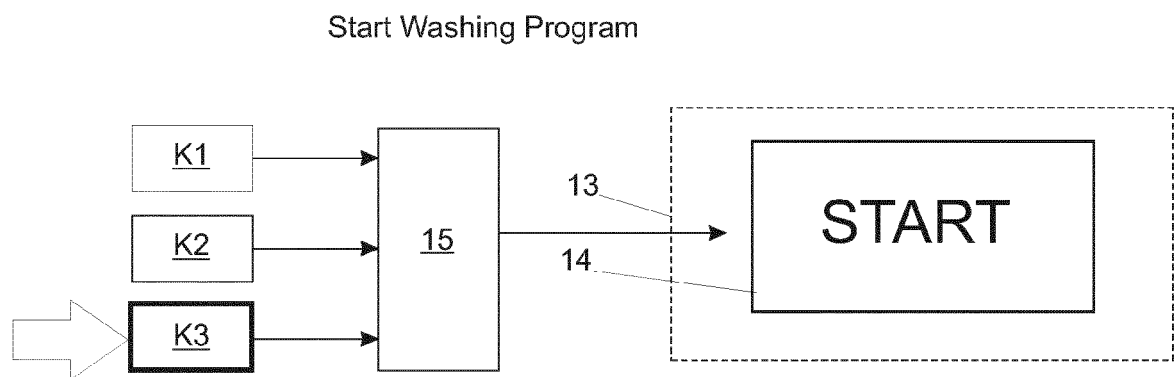


Fig. 10



EUROPEAN SEARCH REPORT

Application Number
EP 16 16 3682

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 3 August 2016	Examiner Weidner, Maximilian
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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