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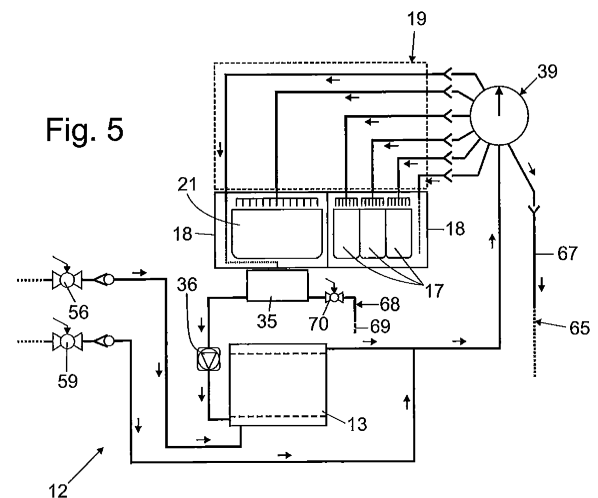
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(54) **OPERATING METHOD OF A LAUNDRY WASHING MACHINE AND LAUNDRY WASHING MACHINE IMPLEMENTING SUCH METHOD**

(57) Operating method of a laundry washing machine (1) comprising: an internal water softening device (13) which is crossed by the fresh water directed towards the washing tub (3) and/or the detergent dispenser (10), and which is filled with a water softening agent capable of reducing the hardness degree of the fresh water flowing through the same water softening device (13); a regeneration-agent container (21) containing a given amount of consumable salt or other regeneration agent; a first water-supply line (19) for selectively channelling a flow of fresh water into said regeneration-agent container (21) to form a brine capable of regenerating the water softening properties of said water softening agent; and a storage tank (35) which is fluidically connected to said regeneration-agent container (21) for receiving and accumulating the brine formed into said regeneration-agent container (21), and to said water softening device (13) for delivering said brine to the water softening device (13); the operating method of the laundry washing machine (1) comprising the steps of: channelling, via said first water-supply line (19), a given amount of fresh water into the regeneration-agent container (21) so as to form a given amount of brine that flows and accumulates into said storage tank (35); fluidically connecting the water softening device (13) in closed loop to said storage tank (35) bypassing said regeneration-agent container (21); circulating, for a given recirculation time period, said given amount of brine in closed loop through the water softening device (13) and the storage tank (35) while bypassing said regeneration-agent container (21); and lastly removing, after a given regeneration time period encompassing said recirculation time period, the brine from said water softening device (13).



Description

[0001] The present invention relates to an operating method of a laundry washing machine and to a laundry washing machine implementing such method.

[0002] More specifically, the present invention relates to the operating method of a home laundry washing machine provided with a water softening device which is capable of reducing the hardness degree of the tap water used during the washing cycle.

[0003] As is known, laundry washing machines may have an internal water softening device which is capable of reducing the hardness degree of the tap water used during the washing cycle, because the use of softened fresh water during the washing cycle significantly improves cleaning performances.

[0004] This water softening device is generally located inside the appliance casing, along the fresh-water supply circuit which is structured for selectively drawing fresh water from the water mains according to the washing cycle manually-selected by the user, and channelling said fresh water towards the detergent dispenser or directly towards the washing tub of the laundry washing machine.

[0005] Nowadays the water softening device generally consists of a watertight closed container which is filled with 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, and which is located along the fresh-water supply circuit so as to be crossed by the tap water directed towards the detergent dispenser and/or the washing tub of the laundry washing machine.

[0006] In addition to the above, since the water softening capabilities of the ion-exchange resins are used to quickly drop down after a limited number of washing cycles due to saturation of calcium and magnesium ions (Ca^{++} and Mg^{++}), these laundry washing machines are structured to periodically channel, into the water softening device, an amount of brine (i.e. salt water) sufficient to regenerate the water softening capabilities of the ion-exchange resins located therein. Salt water, in fact, is able to remove from the ion-exchange resins the calcium and magnesium ions (Ca^{++} and Mg^{++}) previously combined/fixed to said resins.

[0007] More in detail, in addition to the water softening device, these high-end laundry washing machines generally also include a regeneration-agent reservoir adapted to contain a given amount of salt grains (NaCl), and the fresh-water supply circuit of the laundry washing machine is capable of selectively channelling a flow of tap water into the regeneration-agent reservoir so as to form therein a given amount of brine (i.e. salt water) sufficient for regenerating the ion-exchange resins. These high-end laundry washing machines are moreover provided with a small electric pump which is capable of moving the brine from the regeneration-agent reservoir to the water softening device.

[0008] When regeneration of the ion-exchange resins is to be performed, the fresh-water supply circuit of the laundry washing machine channels the tap water into the regeneration-agent reservoir so as to form an amount of brine (i.e. salt water) sufficient to completely fill the water softening device, and the electric pump moves said brine from the regeneration-agent reservoir to the water softening device. The brine (i.e. salt water) then remains stationary into the water softening device for a time period normally ranging between 10 to 15 minutes, so as to completely remove calcium and magnesium ions (Ca^{++} and Mg^{++}) from the ion-exchange resins.

[0009] Unfortunately experimental tests revealed that, due to the prolonged stay inside the water softening device, the salt distribution of the brine (i.e. salt water) tends to stratify inside the water softening device thus causing poor regeneration of the ion-exchange resins located close to the top of the water softening device.

[0010] Aim of the present invention is to prevent the brine to form, on the bottom of the drawer housing of the regeneration-agent drawer, salt deposits capable of impairing operation of the electric pump assembly.

[0011] In compliance with the above aims, according to the present invention there is provided an operating method of a laundry washing machine comprising: an internal water softening device which is crossed by the fresh water directed towards the washing tub and/or the detergent dispenser, and which is filled with a water softening agent capable of reducing the hardness degree of the fresh water flowing through the same water softening device; a regeneration-agent container containing a given amount of a consumable salt or other regeneration agent; a first water-supply line for selectively channelling a flow of fresh water into said regeneration-agent container to form a brine capable of regenerating the water softening properties of said water softening agent; and a storage tank which is fluidically connected to said regeneration-agent container for receiving and accumulating the brine formed into said regeneration-agent container, and to said water softening device for delivering said brine to the water softening device;

[0012] the operating method of the laundry washing machine being **characterized by** comprising the steps of: channelling, via said first water-supply line, a first amount of fresh water into the regeneration-agent container so as to form a corresponding amount of brine that flows and accumulates into the storage tank; fluidically connecting the water softening device in closed loop to said storage tank bypassing said regeneration-agent container; circulating, for a given recirculation time period, the brine in closed loop through the water softening device and the storage tank while bypassing said regeneration-agent container; and lastly removing the brine from said water softening device.

[0013] Preferably, though not necessarily, the operating method is furthermore characterized in that the step of removing the brine from the water softening device is performed at the end a given regeneration time period

which encompasses said recirculation time period and which is sufficient to finalize the regeneration process of the water softening properties of said water softening agent.

[0014] Preferably, though not necessarily, the operating method is furthermore characterized by additionally comprising, between the step of channelling the first amount of fresh water into the regeneration-agent container and the step of fluidically connecting the water softening device in closed loop to said storage tank, also the step of moving the brine accumulated into the storage tank, from said storage tank to said water softening device.

[0015] Preferably, though not necessarily, the operating method is furthermore characterized by additionally comprising, before the step of moving the brine accumulated into the storage tank from said storage tank to said water softening device, also the step of putting a water outlet of the water softening device in fluid communication with the washing tub or with a water discharge assembly so as to channel the water pushed out from the water softening device by the brine towards the washing tub or towards the water discharge assembly.

[0016] Preferably, though not necessarily, the operating method is furthermore characterized in that the step of moving the brine from the storage tank to the water softening device and/or the step of circulating the brine in closed loop through the water softening device and the storage tank is/are performed by means of a pump assembly which is interposed between the storage tank and the water softening device and is capable of pumping the brine from said storage tank to said water softening device.

[0017] Preferably, though not necessarily, the operating method is furthermore characterized in that the step of fluidically connecting the water softening device in closed loop to said storage tank includes the step of putting a water outlet of the water softening device in fluid communication with said storage tank bypassing said regeneration-agent container.

[0018] Preferably, though not necessarily, the operating method is furthermore characterized in the step of removing the brine from the water softening device comprises the step of putting a water outlet of the water softening device in fluid communication with the washing tub or a water drain-line; and the step of channelling new fresh water into a water inlet of the water softening device thus to push the brine out of the water softening device via the water outlet of the same water softening device.

[0019] Preferably, though not necessarily, the operating method is furthermore characterized in that said first amount of fresh water is sufficient for accumulating into said storage tank an amount of brine sufficient for almost completely filling up the water softening device.

[0020] Preferably, though not necessarily, the operating method is furthermore characterized by additionally comprising, between the step of moving the brine from the storage tank to the water softening device and the

step of fluidically connecting the water softening device in closed loop to said storage tank, also the step of channelling a second amount of fresh water into the regeneration-agent container so as to form further brine that flows and accumulates into the storage tank.

[0021] Preferably, though not necessarily, the operating method is furthermore characterized in that said second amount of fresh water is lower than or equal to said first amount of fresh water.

[0022] Preferably, though not necessarily, the operating method is furthermore characterized by additionally comprising, after the step of removing the brine from the water softening device, the steps of: channelling, via second water-supply line, a given amount of fresh water into said storage tank bypassing the regeneration-agent container; moving said fresh water from the storage tank to the water softening device; and lastly removing said fresh water from said water softening device.

[0023] Preferably, though not necessarily, the operating method is furthermore characterized in that said recirculation time period is shorter than said regeneration time period.

[0024] Preferably, though not necessarily, the operating method is furthermore characterized in that said recirculation time period ranges between 1 to 5 minutes.

[0025] According to the present invention there is additionally provided a laundry washing machine having an outer casing and comprising, inside said outer casing: a washing tub; a rotatable drum which is housed in axially rotatable manner inside the washing tub and is structured for housing the laundry to be washed; a motor assembly capable of driving into rotation said rotatable drum inside the washing tub; a detergent dispenser which is structured for supplying detergent into the washing tub; a fresh-water supply circuit which is structured for selectively channelling a flow of fresh water from the water mains towards the detergent dispenser and/or the washing tub; an internal water softening device which is connected to said detergent dispenser and/or said fresh-water supply circuit for being crossed by the fresh water directed towards the detergent dispenser and/or the washing tub, and is filled with a water softening agent capable of reducing the hardness degree of said fresh water; a regeneration-agent container fillable with a consumable salt or other regeneration agent; a first water-supply line for selectively channelling a flow of fresh water into said regeneration-agent container to form a brine capable of regenerating the water softening properties of said water softening agent; a storage tank which is fluidically connected to said regeneration-agent container for receiving and accumulating the brine formed into said regeneration-agent container, and to said water softening device for delivering said brine to the water softening device; and an electronic control unit which controls the motor assembly, the detergent dispenser, the fresh-water supply circuit and said first water-supply line, and is adapted to implement a washing cycle selected by the user;

[0026] the laundry washing machine being characterized in that said electronic control unit is also configured to implement an operating method comprising the steps of: channelling, via said first water-supply line, a first amount of fresh water into the regeneration-agent container so as to form a corresponding amount of brine that flows and accumulates into the storage tank; fluidically connecting the water softening device in closed loop to said storage tank bypassing said regeneration-agent container; circulating, for a given recirculation time period, the brine in closed loop through the water softening device and the storage tank while bypassing said regeneration-agent container; and lastly removing the brine from said water softening device.

[0027] Preferably, though not necessarily, the laundry washing machine is furthermore characterized by additionally comprising a pump assembly which is interposed between the storage tank and the water softening device and is capable of pumping the brine from said storage tank to said water softening device.

[0028] A non-limiting embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

- Figure 1 is a perspective view of a laundry washing machine realized in accordance with the teachings of the present invention, with parts removed for clarity;
- Figures 2 is a side view of the Figure 1 laundry washing machine, with parts removed for clarity;
- Figure 3 is an enlarged perspective view of the top of the Figure 1 laundry washing machine, with parts removed for clarity;
- Figure 4 is a partly exploded perspective view of the detergent dispensing assembly of the Figure 1 laundry washing machine, with parts removed for clarity;
- Figure 5 is a schematic view of the Figure 4 detergent dispensing assembly;
- Figure 6 is a partly exploded perspective view of the Figure 4 detergent dispensing assembly, with parts removed for clarity;
- Figure 7 is a sectioned front view of the detergent dispensing assembly shown in Figures 4 and 6, with parts removed for clarity;
- Figure 8 is a partially exploded perspective view of the detergent drawer of the detergent dispensing assembly shown in Figures 4 and 6, with parts removed for clarity;
- Figure 9 is a sectioned side view of the detergent drawer shown in Figure 8, with parts removed for clarity;
- Figure 10 is a perspective view of the upper lid of the drawer housing of the detergent dispensing assembly shown in Figures 6 and 7; whereas
- Figures 11 and 12 are sectioned perspective views of the detergent dispensing assembly shown in Figures 4, 6 and 7, in two different working configurations and with parts removed for clarity.

[0029] With reference to Figures 1, 2 and 3, reference number 1 indicates as a whole a laundry washing machine 1 which preferably basically comprises: a preferably substantially parallelepiped-shaped, boxlike outer casing 2 structured for resting on the floor; a preferably substantially horizontally-oriented, approximately cylindrical washing tub 3 which is arranged inside the casing 2 with the mouth directly facing a laundry loading/unloading opening formed on the outer casing 2; a substantially cylindrical, rotatable drum (not shown) which is structured for housing the laundry to be washed, and is fitted in axially rotatable manner inside the washing tub 3 so as to be able to freely rotate about its longitudinal axis inside the washing tub 3; a door 5 which is hinged to the outer casing 2 so as to be manually movable to and from a closing position in which the door 5 closes the laundry loading/unloading opening on casing 2 for watertight sealing the washing tub 3; and an electrically-powered motor assembly 6 which is structured for driving into rotation the rotatable drum (not shown) about its longitudinal axis inside the washing tub 3.

[0030] In the example shown, in particular, the washing tub 3 preferably has a front mouth and is arranged inside the outer casing 2 with the front mouth directly facing a laundry loading/unloading opening realized on a front wall 4 of casing 2; whereas the door 5 is preferably hinged to the front wall 4 so as to be manually movable to and from a closing position in which the door 5 closes the laundry loading/unloading opening on front wall 4 for watertight sealing the washing tub 3.

[0031] Moreover, the washing tub 3 is preferably suspended in floating manner inside the casing 2 via a suspension system that preferably, though not necessarily, comprises at least one, and preferably a couple of upper coil springs 7 connecting the upper portion of washing tub 3 to the top of casing 2, and preferably at least one, and preferably a couple of vibration dampers 8 connecting the bottom portion of washing tub 3 to the bottom of casing 2. The laundry washing machine 1 furthermore preferably also comprises a substantially cylindrical elastically-deformable bellows (not shown) which watertight connects the mouth of washing tub 3 to the laundry loading/unloading opening preferably realized on front wall 4 of casing 2.

[0032] The rotatable drum, in turn, is preferably substantially cup-shaped and is fitted in axially rotatable manner inside the washing tub 3 with the concavity facing the front opening or mouth of washing tub 3. Preferably the rotatable drum (not shown) is moreover arranged inside washing tub 3 with the drum rotation axis locally substantially coaxial to the longitudinal axis of washing tub 3, i.e. oriented substantially horizontally, and with the circular front opening or mouth of the drum directly aligned and faced to the circular front opening or mouth of washing tub 3, so as to receive the laundry to be washed through the laundry loading/unloading opening realized on front wall 4.

[0033] With reference to Figures 1, 2, 3 and 4, the laun-

dry washing machine 1 furthermore comprises: a detergent dispenser 10 which is located inside the casing 2 preferably above the washing tub 3 and preferably, though not necessarily, immediately underneath the upper worktop or top wall 11 of casing 2, and is structured for selectively feeding into the washing tub 3, 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; a main fresh-water supply circuit 12 which is connectable directly to the water mains, and is structured for selectively channelling, according to the washing cycle manually-selected by the user, a flow of fresh water from the water mains to the detergent dispenser 10 and/or directly to the washing tub 3; and an internal water softening device 13 which is located inside the boxlike casing 2, along the fresh-water supply circuit 12 or the detergent dispenser 10, and is structured for selectively reducing, during each washing cycle, the hardness degree of the tap water that fresh-water supply circuit 12 channels towards detergent dispenser 10 or washing tub 3.

[0034] More in detail, the water softening device 13 preferably basically consists in a closed container which has a water inlet and a water outlet fluidically connected to the fresh-water supply circuit 12 and/or the detergent dispenser 10 so as to be crossed by the tap water directed towards the washing tub 3, and which is furthermore filled with 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.

[0035] In the example shown, in particular, the water softening device 13 is preferably located inside the outer casing 2 adjoined to the detergent dispenser 10, and is preferably fluidically connected directly to detergent dispenser 10 so as to be crossed by the fresh water flowing towards the washing tub 3 via the same detergent dispenser 10.

[0036] With reference to Figures 1 and 3, in addition to the above, the laundry washing machine 1 furthermore comprises: a main electronic control unit 14 which is located inside the casing 2 and controls the motor assembly 6, the detergent dispenser 10 and the fresh-water supply circuit 12; and preferably also a control panel 15 which electronically communicates with control unit 14 and is structured to allow the user to manually select the desired washing cycle among a number of available washing cycles.

[0037] In the example shown, in particular, electronic control unit 14 is preferably located inside the casing 2 adjacent to a side wall of casing 2, and preferably also immediately underneath the upper worktop or top wall 11.

[0038] The control panel 15, in turn, is preferably located on front wall 4 of casing 2, above the laundry loading/unloading opening and preferably also immediately beneath the upper worktop or top wall 11 of casing 2.

[0039] With reference to Figures 1-12, detergent dis-

penser 10 in turn basically comprises: a detergent drawer 16 which is provided with one or more substantially basin-shaped, detergent compartments 17 (three detergent compartments 17 in the example shown) each structured for being manually fillable with a given amount of detergent, softener or other washing agent, and which is fitted/inserted in manually extractable manner into a corresponding preferably substantially basin-shaped, drawer housing 18 which, in turn, is located/recessed inside the casing 2 above washing tub 3, and whose entrance is preferably located on front wall 4 of casing 2, above the laundry loading/unloading opening; and a drawer flush circuit 19 which is structured for receiving the fresh water of the water mains from the fresh-water supply circuit 12, and for selectively channelling/pouring, when the detergent drawer 16 is completely fitted/inserted into the drawer housing 18, said fresh water into any one of the detergent compartments 17 of detergent drawer 16, so as to selectively flush the detergent, softener or other washing agent out of the same detergent compartment 17 and down onto the bottom of drawer housing 18.

[0040] With reference to Figures 3, 4 and 6, in the example shown, in particular, the detergent drawer 16 is preferably movable inside the drawer housing 18 parallel to the substantially horizontally-oriented, longitudinal axis L of same drawer housing 18 between:

- a retracted position (see Figures 2 and 11) in which detergent drawer 16 is completely fitted/inserted into drawer housing 18, so as to be almost completely recessed into the front wall 4 of casing 2; and
- a completely extracted position (see Figures 1, 3, 4 and 6) in which detergent drawer 16 partly juts out from the front wall 4 of casing 2, so as to expose the one or more detergent compartments 17 at once.

[0041] In other words, detergent drawer 16 is movable inside the drawer housing 18 in a substantially horizontally-oriented, displacement direction d which is locally substantially parallel to the longitudinal axis L of both drawer housing 18 and detergent drawer 16, between:

- a retracted position (see Figures 2 and 11) in which detergent drawer 16 is almost completely recessed into the front wall 4 of casing 2 and the one or more detergent compartments 17 of detergent drawer 16 are inaccessible to the user; and
- a completely extracted position (see Figures 1, 3, 4 and 6) in which detergent drawer 16 partly juts out from the front wall 4 of casing 2, so that all detergent compartments 17 of detergent drawer 16 are fully accessible to the user at same time.

[0042] In the example shown, furthermore, the entrance of drawer housing 18 is preferably located on front wall 4 of casing 2, immediately underneath the upper worktop or top wall 11 of casing 2 and substantially horizontally aligned beside the appliance control panel 15.

Moreover the longitudinal axis L of detergent drawer 16 and drawer housing 18, and as a consequence the displacement direction d of detergent drawer 16, is preferably locally substantially perpendicular to front wall 4 of casing 2.

[0043] Preferably each detergent compartment 17 is additionally dimensioned to contain a given amount of detergent, softener or other washing agent sufficient for performing only a single washing cycle.

[0044] In addition to the above, in the examples shown the detergent drawer 16 preferably has, on the bottom or on a sidewall of a first detergent compartment 17, a large through opening which is suitably shaped/dimensioned to allow the mixture of water and detergent, softener or other washing agent formed inside the same detergent compartment 17 to freely fall on the bottom of drawer housing 18. Preferably the detergent drawer 16 moreover has, inside each of the remaining detergent compartments 17, a siphon assembly suitably structured/designed to selectively channel the mixture of water and detergent, softener or other washing agent formed inside the detergent compartment 17 out of the same detergent compartment 17 and down onto the bottom of drawer housing 18.

[0045] The drawer flush circuit 19, in turn, is preferably structured for directly pouring, when detergent drawer 16 is placed in the retracted position, a shower of water droplets by gravity selectively and alternatively into any one of the detergent compartments 17 of detergent drawer 16, so as to selectively flush the detergent, softener or other washing agent out of the same detergent compartment 17 and down onto the bottom of drawer housing 18.

[0046] In addition to the above, with reference to Figures 3 to 11, detergent drawer 16 is preferably moreover provided with a substantially basin-shaped, regeneration-agent compartment 21 which is located beside the one or more detergent compartments 17, and is structured for being manually fillable with a given quantity of consumable salt grains (NaCl) or other regeneration agent suitable to be used in the regeneration process of the ion-exchange resins of the water softening device 13.

[0047] The drawer flush circuit 19, in turn, is preferably also structured for selectively and separately channeling, when detergent drawer 16 is in the retracted position, the fresh water of the water mains also into the regeneration-agent compartment 21, so that said fresh water can dissolve some of the salt grains contained into the regeneration-agent compartment 21 to form the brine (i.e. salt water).

[0048] More in details, the regeneration-agent compartment 21 is preferably arranged, on detergent drawer 16, beside the one or more detergent compartments 17 transversally to the displacement direction d of detergent drawer 16, i.e. transversally to the longitudinal axis L of detergent drawer 16, so that both detergent compartment/s 17 and regeneration-agent compartment 21 are allowed to almost contemporaneously come out from the front wall 4 of casing 2 when detergent drawer 16 moves

from the retracted position to the extracted position.

[0049] Detergent drawer 16 is therefore movable inside drawer housing 18 in displacement direction d between:

- a retracted position (see Figures 2 and 11) in which detergent drawer 16 is completely recessed into the front wall 4 of casing 2, so that both detergent compartment/s 17 and regeneration-agent compartment 21 are inaccessible to the user; and
- a completely extracted position (see Figures 1, 3, 4 and 6) in which detergent drawer 16 partly juts out from the front wall 4 of casing 2, so that both detergent compartment/s 17 and regeneration-agent compartment 21 are simultaneously fully exposed and accessible to the user.

[0050] Preferably the regeneration-agent compartment 21 is moreover dimensioned to accommodate/contain an amount of consumable salt grains (NaCl) or other regeneration agent sufficient for performing a plurality of regeneration processes of the ion-exchange resins of the water softening device 13.

[0051] With reference to Figure 9, in addition to the above the detergent drawer 16 preferably has, on the bottom of regeneration-agent compartment 21, a large pass-through draining opening 22 which is suitably shaped/dimensioned to allow the brine (i.e. salt water) formed inside the regeneration-agent compartment 21 to freely fall on the bottom of drawer housing 18.

[0052] The drawer flush circuit 19, in turn, is preferably structured for selectively and separately pouring/channeling, when the detergent drawer 16 is completely fitted/inserted into drawer housing 18, the fresh water arriving from the water mains into any one of the detergent compartments 17 and also into the regeneration-agent compartment 21.

[0053] In case of detergent compartment/s 17, the poured fresh water serves to selectively flush the contents of the detergent compartment 17 out of the same compartment 17 and down on the bottom of drawer housing 18 via the corresponding through opening or siphon assembly.

[0054] In case of regeneration-agent compartment 21, the poured fresh water serves to dissolve some salt grains contained into the regeneration-agent compartment 21 to form the brine (i.e. salt water) that falls on the bottom of drawer housing 18 via draining opening 22.

[0055] With reference to Figures 4, 6, 7, 8 and 9, in the example shown, in particular, detergent drawer 16 preferably comprises: a drawer main body 23 which is preferably made in a one piece construction, via an injection moulding process, and is fitted/inserted in axially sliding manner into the drawer housing 18; and a manually-sizable front panel 24 which is arranged/located on a front side of the drawer main body 23, so as to close the entrance of drawer housing 18 when detergent drawer 16 is placed in the retracted position (see Figure 2). The one

or more basin-shaped detergent compartments 17 and the basin-shaped regeneration-agent compartment 21 are formed directly on the drawer main body 23 one side by side the other.

[0056] With reference to Figures 7, 8 and 9, the detergent drawer 16 is preferably additionally provided with a preferably manually-removable, water-permeable partitioning septum 25 which extends inside the regeneration-agent compartment 21 immediately above the bottom of regeneration-agent compartment 21 and its large pass-through opening 22, and has a water-permeable structure designed for preventing the grains of consumable salt to come out from the bottom of the regeneration-agent compartment 21 via the draining opening 22 and, at same time, for allowing the brine to freely trickle onto the bottom of the regeneration-agent compartment 21 and then flow by gravity towards the draining opening 22.

[0057] Preferably the partitioning septum 25 furthermore has a water-permeable structure suitably designed to slow down the outflow of the brine from the regeneration-agent compartment 21 via the draining opening 22 thus to cause a temporarily stagnation of the water poured into the regeneration-agent compartment 21, above the same partitioning septum 25.

[0058] In other words, the water-permeable partitioning septum 25 is arranged above the draining opening 22 so as to completely cover the latter, and is preferably structured to allow the passage of the water/brine through the same partitioning septum 25 with a flowrate which is lower than that of the fresh water channelled/ poured into the regeneration-agent compartment 21 by the drawer flush circuit 19, thus to cause the stagnation of the fresh water above the partitioning septum 25.

[0059] Preferably the water-permeable partitioning septum 25 furthermore extends inside regeneration-agent compartment 21 slightly spaced from, and preferably also locally substantially parallel to, the bottom of regeneration-agent compartment 21, so as to form a thin air gap immediately above the bottom of regeneration-agent compartment 21.

[0060] In the example shown, in particular, the water-permeable partitioning septum 25 preferably consists in a rigid platelike member 25 preferably made of plastic material, which substantially copies the shape of the bottom of regeneration-agent compartment 21, and has a microperforated structure which is suitably dimensioned to cause a prolonged stagnation of the water poured into the regeneration-agent compartment 21 above the plate-like member 25.

[0061] More in detail, the central portion of the platelike member 25 is preferably provided with a plenty of substantially evenly distributed, transversal pass-through microslots or microholes each preferably having a cross-sectional area lower than 3 mm^2 (square millimetres), so as to allow the flow/passage of the brine/water through the platelike member 25 with a flowrate preferably ranging between 0,4 and 1 litre/min (litre per minute). The flowrate of the fresh water poured into the regeneration-

agent compartment 21 instead preferably ranges between 5 and 8 litre/min (litre per minute).

[0062] In addition to the above, with reference to Figures 3, 4, 6, 7, 8 and 9, the detergent drawer 16 preferably additionally comprises a manually openable, upper lid assembly 26 which is firmly fitted on the drawer main body 23, on top of the regeneration-agent compartment 21, and is structured to selectively close the upper mouth of regeneration-agent compartment 21, preferably so as to almost completely cover the upper mouth of regeneration-agent compartment 21. Furthermore, this upper lid assembly is additionally structured so as to be able to receive, from drawer flush circuit 19 and at least when detergent drawer 16 is placed in the retracted position, a flow of fresh water and to channel said water into the beneath-located regeneration-agent compartment 21, preferably while spreading out the same fresh water inside the regeneration-agent compartment 21.

[0063] In other words, the upper lid assembly 26 is preferably provided with a water inlet which is faced to the outside of regeneration-agent compartment 21 and is structured to allow the fresh water to enter into the same upper lid assembly 26, and with one or more water outlets which are faced to the inside of regeneration-agent compartment 21, fluidically communicate with said water inlet, and are finally suitably structured to allow the water previously entered into the upper lid assembly 26 through the water inlet to come out of the lid assembly 26 and fall into the regeneration-agent compartment 21.

[0064] The drawer flush circuit 19, in turn, is preferably structured to selectively channel, when detergent drawer 16 is placed in the retracted position, a flow of fresh water towards the water inlet of the upper lid assembly 26.

[0065] In other words, drawer flush circuit 19 is preferably additionally structured to selectively channel, when detergent drawer 16 is placed in the retracted position, the fresh water arriving from fresh-water supply circuit 12 towards the water inlet of lid assembly 26 which, in turn, is structured to distribute the fresh water arriving from drawer flush circuit 19 into the regeneration-agent compartment 21, so as to dissolve some of the consumable salt grains (NaCl) contained into the regeneration-agent compartment 21 and form the brine (i.e. the salt water) that falls on the bottom of drawer housing 18 via the draining opening 22.

[0066] Drawer flush circuit 19 is therefore directly connected to the fresh-water supply circuit 12 for receiving the fresh water of the water mains, and is preferably suitably structured for selectively and alternatively channeling, when the detergent drawer 16 is completely fitted/inserted into drawer housing 18, the fresh water arriving from the fresh-water supply circuit 12 towards any one of the detergent compartments 17, or towards the water inlet of the upper lid assembly 26.

[0067] In addition to the above, in the example shown the water inlet of lid assembly 26 is preferably furthermore structured to selectively couple in a stable, though easy detachable manner, with the drawer flush circuit 19 for

receiving the fresh water arriving from fresh-water supply circuit 12, only when the detergent drawer 16 is placed in the retracted position; whereas the upper lid assembly 26 is preferably structured to drip the fresh water into the regeneration-agent compartment 21.

[0068] With reference to Figures 3, 4, 6, 8 and 9, in the example shown, in particular, the upper lid assembly 26 preferably comprises: a platelike member 27 which is structured to rigidly fit into the upper rim of the regeneration-agent compartment 21 to substantially completely cover/close the upper mouth of the regeneration-agent compartment 21; and a manually-movable trapdoor 28 which is arranged to close a preferably substantially rectangular-shaped, large pass-through opening which is preferably formed roughly at centre of platelike member 27, and which is preferably suitably shaped/dimensioned to allow the user to easily manually pour the consumable salt grains (NaCl) or other regeneration agent into the regeneration-agent compartment 21.

[0069] The platelike member 27 preferably has a hollow structure and is preferably provided with a water inlet 29 which is suitably structured to watertight couple, when detergent drawer 16 is placed in the retracted position, with the drawer flush circuit 19 thus to allow the fresh water to enter into the platelike member 27; and with one or more water-outlets 30 which are arranged on the lower face of platelike member 27, preferably all around the central pass-through opening closed by trapdoor 28, so as to face the inside of regeneration-agent compartment 21.

[0070] The drawer flush circuit 19 is preferably structured to selectively couple, when detergent drawer 16 is placed in the retracted position, with the water inlet 29 of platelike member 27, so as to be able to channel the fresh water of the water mains into the platelike member 27 of lid assembly 26. Each water-outlet 30, in turn, allows the fresh water previously entered into the platelike member 27 to slowly come out of platelike member 27 and freely fall into the regeneration-agent compartment 21. Preferably the water-outlets 30 of platelike member 27 are furthermore suitably shaped/structured to pour a shower of water droplets by gravity into the regeneration-agent compartment 21.

[0071] The manually-movable trapdoor 28, in turn, is preferably flag-hinged to platelike member 27 at one of the two major sides of central pass-through opening, so as to be able to rotate about a rotation axis A locally substantially coplanar to platelike member 27.

[0072] As regards instead drawer housing 18, with reference to Figures 3, 6, 7, 11 and 12, the bottom of drawer housing 18 is preferably divided into two separated and substantially basin-shaped, bottom portions 31 and 32 which are located, when detergent drawer 16 is placed in retracted position, one underneath all detergent compartments 17 of detergent drawer 16 and the other underneath the regeneration-agent compartment 21 of detergent drawer 16.

[0073] More in detail, the bottom of drawer housing 18

is preferably divided into two separated and substantially basin-shaped bottom portions 31 and 32, which are arranged side by side to one another transversally to the displacement direction d of detergent drawer 16 inside drawer housing 18, i.e. transversally to the longitudinal axis L of drawer housing 18. The basin-shaped bottom portion 31 is vertically aligned, when detergent drawer 16 is placed in the retracted position, beneath the one or more detergent compartments 17 of detergent drawer 16. The basin-shaped bottom portion 32, in turn, is vertically aligned, when detergent drawer 16 is placed in the retracted position, beneath the regeneration-agent compartment 21 of detergent drawer 16.

[0074] With reference to Figures 6 and 7, in the example shown, in particular, drawer housing 18 preferably comprises a substantially vertical, partitioning wall 33 that protrudes upwards from the bottom of drawer housing 18 while remaining locally substantially parallel to the displacement direction d of detergent drawer 16, i.e. parallel to the longitudinal axis L of drawer housing 18, and the basin-shaped bottom portions 31 and 32 of drawer housing 18 are arranged on opposite sides of partitioning wall 33.

[0075] In other words the vertical partitioning wall 33 is arranged between the two basin-shaped bottom portions 31 and 32 of drawer housing 18.

[0076] Detergent drawer 16, in turn, is preferably arranged astride the partitioning wall 33 and the drawer main body 23 is designed so that the one or more detergent compartments 17 and the regeneration-agent compartment 21 are located on opposite sides of partitioning wall 33. Preferably detergent drawer 16, or better the drawer main body 23, is furthermore structured to additionally abut in sliding manner on the straight upper crest line of partitioning wall 33.

[0077] With reference to Figures 2 and 6, the basin-shaped bottom portion 31 is structured for receiving the mixture of fresh water and detergent, softener or other washing agent falling down from any one of the detergent compartments 17 of detergent drawer 16, and directly communicates with the inside of washing tub 3 preferably via a connecting duct 34 that branches off from the basin-shaped bottom portion 31 of drawer housing 18 and ends directly into the beneath-located washing tub 3, so as to allow the mixture of water and detergent, softener or other washing agent to quickly flow by gravity directly into the washing tub 3.

[0078] With reference to Figures 4, 5, 6, 7, 11 and 12, the basin-shaped bottom portion 32, in turn, is structured for receiving the brine (i.e. the salt water) trickling/ falling down from the regeneration-agent compartment 21 of detergent drawer 16 via opening 22, and directly communicates with the inside of a preferably discrete, small unpressurized storage tank 35 which is dimensioned to catch and accumulate a given amount of brine preferably greater than 100 ml (millilitres), and is arranged immediately underneath the same basin-shaped bottom portion 32 so as to allow the brine to quickly fall/flow by gravity

directly into the storage tank 35 and to accumulate therein.

[0079] Preferably said storage tank 35 moreover fluidically communicates with the inside of the water softening device 13 via a small, electrically-powered pump assembly 36 which is preferably directly interposed between storage tank 35 and water softening device 13, and is capable of selectively pumping the brine (i.e. the salt water) accumulated into the storage tank 35, from storage tank 35 to water softening device 13. Preferably, when deactivated, pump assembly 36 is moreover capable of watertight isolating storage tank 35 from water softening device 13.

[0080] The laundry washing machine 1 is therefore additionally provided with an unpressurized storage tank 35 which is dimensioned to contain a given amount of brine (i.e. the salt water) preferably greater than 100 ml (millilitres), and is adapted to catch and accumulate the brine falling down from regeneration-agent compartment 21 of detergent drawer 16; and with a small pump assembly 36 having the suction connected to the storage tank 35 and the delivery connected to the water softening device 13, thus to be able to selectively move/pump the brine from storage tank 35 to water softening device 13.

[0081] Preferably, storage tank 35 is moreover dimensioned to contain a given amount of brine preferably roughly equal to or greater than the minimum amount of brine necessary and sufficient for performing the regeneration process of the ion-exchange resins located into the water softening device 13.

[0082] More in detail, storage tank 35 is preferably dimensioned to contain a given amount of brine preferably roughly equal to or greater than the whole amount of brine necessary for filling up the water softening device 13 preferably almost completely.

[0083] In other words, storage tank 35 is preferably dimensioned to contain a given amount of brine preferably roughly equal to or greater than the nominal ullage of the water softening device 13, i.e. the ullage of the water softening device 13 solely containing the ion-exchange resins.

[0084] In the example shown, in particular, tank 35 is preferably dimensioned to contain an amount of brine overapproximating, i.e. slightly greater than, the whole amount of brine to be pumped into the internal water softening device 13 for almost completely filling up the water softening device 13, i.e. for successfully performing the regeneration process of the ion-exchange resins located inside the same water softening device 13.

[0085] More in detail, assuming for example that the overall amount of brine to be pumped into the water softening device 13 for filling up the water softening device 13 is preferably equal to 250 cm³ (cubic centimeters), in the example shown storage tank 35 is preferably dimensioned to contain a maximum amount of brine preferably equal to 270 cm³ (cubic centimeters).

[0086] With reference to Figures 4, 5, 6, 7, 10, 11 and 12, the drawer flush circuit 19, in turn, preferably comprises:

prises:

- a platelike water conveyor 38 which is suitably structured to form the upper lid of the substantially basin-shaped drawer housing 18, so as to be located immediately above the detergent drawer 16 when the latter is placed in the retracted position, i.e. when the latter is completely inserted/ recessed into drawer housing 18, and is provided with a number of water-delivery portions each suitably structured to allow the outflow of water from platelike water conveyor 38 towards the beneath-located detergent drawer 16; and
- an electrically-operated, water distributor 39 which is coupled/associated to the platelike water conveyor 38, is connected to the fresh-water supply circuit 12 and/or to the internal water softening device 13 for receiving a flow of softened or unsoftened fresh water, and is suitably structured to selectively channel the softened fresh water arriving from the water softening device 13 or the unsoftened fresh water arriving from fresh-water supply circuit 12, towards any one of the water-delivery portions of the platelike water conveyor 38.

[0087] More in detail, with particular reference to Figure 10, the platelike water conveyor 38 preferably has, on its lower face (i.e. on the side directly facing the inside of drawer housing 18), a group of first water-delivery portions 40 which are locally substantially vertically aligned, when detergent drawer 16 is placed in the retracted position, each to a respective detergent compartment 17 of detergent drawer 16, and are each suitably structured to allow the slow outflow of the fresh water from the water conveyor 38 towards the beneath-located detergent compartment 17.

[0088] In the example shown, in particular, each water-delivery portion 40 of platelike water conveyor 38 is preferably structured to pour by gravity a shower of water droplets directly into the beneath-located detergent compartment 17 of detergent drawer 16.

[0089] Preferably the platelike water conveyor 38 furthermore has, on its lower face, a second water-delivery portion 41 which is locally substantially vertically aligned, when detergent drawer 16 is placed in the retracted position, to the regeneration-agent compartment 21 of detergent drawer 16, and is suitably structured to allow the outflow of the fresh water from the platelike water conveyor 38 towards the beneath-located regeneration-agent compartment 21.

[0090] More in detail, with reference to Figures 6, 10, 11 and 12, in the example shown the water-delivery portion 41 preferably consists in a male or female hydraulic connector which protrudes from the lower face of platelike water conveyor 38 locally parallel to displacement direction d and is suitably arranged to couple, when detergent drawer 16 is placed in the retracted position, in detachable manner with a complementary second hy-

draulic connector which is incorporated into the water inlet 29 of the upper lid assembly 26, or better into the water inlet 29 of platelike member 27, so as to put the upper lid assembly 26 in fluid communication with the platelike water conveyor 38.

[0091] In addition to the above, the platelike water conveyor 38 preferably also includes a water deflector device which is capable of intercepting and deflecting downwards any jet of water accidentally coming out from the mouth of the hydraulic connector of water-delivery portion 41 when the water inlet 29 of upper lid assembly 26 is detached/uncoupled from said water-delivery portion 41.

[0092] More in detail, with reference to Figures 10, 11 and 12, the platelike water conveyor 38 preferably includes a movable flap 42 which is located on the lower face of water conveyor 38, aligned in front of the hydraulic connector of water-delivery portion 41, and is freely movable between a lowered position (see Figures 10 and 12) in which the movable flap 42 extends downwards from the lower face of water conveyor 38 spaced apart in front of the hydraulic connector of water-delivery portion 41, so as to intercept and deflect downwards any jet of water coming out from the mouth of the hydraulic connector of water-delivery portion 41; and a raised position (see Figure 11) in which the movable flap 42 is arranged substantially coplanar to the lower face of water conveyor 38, above the detergent drawer 16 in retracted position, so as to allow any movement of detergent drawer 16 inside the drawer housing 18. Preferably, when arranged in the raised position, the movable flap 42 is furthermore almost completely recessed into a corresponding receiving seat 43 specifically formed in the water conveyor 38.

[0093] In the example shown, in particular, the movable flap 42 is preferably flag-hinged to water conveyor 38, adjacent to the hydraulic connector of water-delivery portion 41 and preferably also inside the receiving seat 43, so as to be able to freely swing about a rotation axis B substantially horizontal and locally substantially perpendicular to the displacement direction d of detergent drawer 16. The movable flap 42 remains by gravity in the lowered position (see Figures 10 and 12) when the detergent drawer 16 is at least partially extracted or completely removed from drawer housing 18, and is pushed upwards in the raised position (see Figure 11) by the detergent drawer 16 moving from the completely extracted position to the retracted position.

[0094] With particular reference to Figure 10, preferably the platelike water conveyor 38 moreover has, on its lower face (i.e. on the side directly facing the inside of drawer housing 18), a third water-delivery portion 44 which is both vertically aligned to the basin-shaped bottom portion 32 of drawer housing 18 and misaligned to the detergent drawer 16 placed in retracted position, and is structured to allow the outflow of the water from the platelike water conveyor 38 directly towards the bottom of drawer housing 18, or better towards the basin-shaped bottom portion 32 of drawer housing 18, without affect-

ing/reaching the regeneration-agent compartment 21 of detergent drawer 16.

[0095] The drawer flush circuit 19 is therefore capable of selectively channelling any kind of water directly into storage tank 35 while bypassing the regeneration-agent compartment 21 of detergent drawer 16.

[0096] Preferably the platelike water conveyor 38 finally has, on its lower face (i.e. on the side directly facing the inside of drawer housing 18), a fourth water-delivery portion 45 which is both vertically aligned to the basin-shaped bottom portion 31 of drawer housing 18 and misaligned to the detergent drawer 16 placed in retracted position, and is structured to allow the outflow of the water from the platelike water conveyor 38 directly towards the bottom of drawer housing 18, or better towards the basin-shaped bottom portion 31 of drawer housing 18, without affecting/reaching anyone of the detergent compartments 17 of detergent drawer 16.

[0097] The drawer flush circuit 19 is therefore capable of selectively channelling any kind of water directly into washing tub 3 while bypassing all detergent compartments 17 of detergent drawer 16.

[0098] With reference to Figures 4, 6 and 10, the electrically-operated, water distributor 39, in turn, is capable of selectively channelling the softened fresh water arriving from water softening device 13 and/or the unsoftened fresh water arriving from fresh-water supply circuit 12 towards any one of the water-delivery portions 40, 41, 44 and 45 of platelike water conveyor 38.

[0099] More in detail, the electrically-operated, water distributor 39 is preferably discrete from platelike water conveyor 38, and preferably consists in a discrete, electrically-operated, flow-diverter module 39 which is firmly attached to the outside of platelike water conveyor 38, at a coupling socket 46 preferably realized on the lower face of the platelike water conveyor 38.

[0100] This flow-diverter module 39 preferably has a water inlet which directly communicates with the water softening device 13 for directly receiving softened fresh water, and preferably also with the fresh-water supply circuit 12 for also directly receiving unsoftened fresh water; and a number of water outlets 48 which are located, preferably one side by side the other, at the interface portion of flow-diverter module 39 suited to couple with coupling socket 46 of platelike water conveyor 38.

[0101] Preferably the electrically-operated, flow-diverter module 39 furthermore internally accommodates a rotatable flow diverter (not shown) which is capable of channeling, according to its angular position, the water entering into flow-diverter module 39 via the water inlet towards any one of the water outlets 48 of the same flow-diverter module 39.

[0102] In addition to the above, the flow-diverter module 39 preferably comprises an electrically-operated internal driver assembly (not shown) which is mechanically connected to the rotatable flow diverter for controlling the angular position of the same flow diverter; and optionally also an internal electronic control unit (not shown) which

is structured to directly power and control the electrically-operated driver assembly according to electric signals arriving from electronic control unit 14.

[0103] With reference to Figure 10, the platelike water conveyor 38, on the other hand, is provided with a number of water inlets 49 which are located at coupling socket 46 and separately communicate each with a respective water-delivery portion 40, 41, 44, 45 of water conveyor 38 via a corresponding internal water channel extending inside the body of the same water conveyor 38. Each water outlet 48 of flow-diverter module 39 is structured to watertight couple/connect, at coupling socket 46, with a corresponding water inlet 49 of water conveyor 38, preferably with the interposition of a corresponding annular sealing gasket.

[0104] The flow-diverter module 39 is therefore capable of selectively channelling, on command, the water entering into the same flow-diverter module 39 via its water inlet towards any one of the water inlets 49 of platelike water conveyor 38.

[0105] As an alternative, the electrically-operated, water distributor 39 may consist in a valve assembly comprising a number of electrically-operated on-off valves capable of selectively channeling the unsoftened fresh water arriving from fresh-water supply circuit 12 or the softened fresh water arriving from water softening device 13, towards any one of the water inlets 49 of the platelike water conveyor 38.

[0106] In addition to the above, with reference to Figures 2, 4, 6, 7, 11 and 12, in the example shown the water softening device 13 is preferably directly connected to the platelike water conveyor 38 of drawer flush circuit 19, and the platelike water conveyor 38 preferably has a number of internal water channels structured to channel the unsoftened fresh water arriving from the fresh-water supply circuit 12 towards the water inlet of water softening device 13, and to channel the softened fresh water coming out from the water outlet of water softening device 13 towards the water inlet of flow-diverter module 39.

[0107] More in detail, in the example shown the water softening device 13 preferably comprises a substantially platelike, discrete closed container or cartridge 50 which is provided with a water inlet and a water outlet, and is filled with 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 cartridge 50.

[0108] This cartridge 50 is preferably furthermore rigidly attached to a sidewall of drawer housing 18 preferably by means of one or more anchoring screws and/or one or more releasable mechanical couplings, so as to extend downwards in cantilever manner beyond the bottom of drawer housing 18 and next to storage tank 35, preferably while remaining locally substantially parallel and tangent to a vertical sidewall of the outer casing 2.

[0109] Preferably the water inlet and a water outlet of cartridge 50 are furthermore fluidically connected directly to platelike water conveyor 38 of drawer flush circuit 19,

preferably via appropriate hydraulic connectors suited to watertight couple with complementary hydraulic connectors that protrude downwards from the lower face of the platelike water conveyor 38 outside of drawer casing 18, so that the cartridge 50 is crossable by the unsoftened fresh water that arrives from fresh-water supply circuit 12 and flows inside the drawer flush circuit 19 directed towards the detergent drawer 16.

[0110] With reference to Figures 4, 6, 7, 11 and 12, storage tank 35 in turn is preferably firmly attached directly to the bottom of drawer housing 18, preferably locally substantially vertically aligned to the basin-shaped bottom portion 32 of drawer housing 18 and preferably by means of one or more anchoring screws and/or one or more releasable mechanical couplings.

[0111] Preferably storage tank 35 is moreover adjacent to cartridge 50 of water softening device 13, and is preferably rigidly attached also to cartridge 50, preferably by means of one or more anchoring screws and/or one or more releasable mechanical couplings.

[0112] More in detail, in the example shown storage tank 35 preferably directly communicates with the basin-shaped bottom portion 32 of drawer housing 18 via a first vertical pipe-extension 51 that protrudes downwards from the bottom of drawer housing 18 and directly fits, preferably in a substantially airtight and/or watertight manner, into a complementary brine inlet opening 51a formed on top wall of the same storage tank 35 preferably with the interposition of a corresponding annular sealing gasket.

[0113] In the example shown, in particular, the vertical pipe-extension 51 is preferably vertically aligned to the third water-delivery portion 44 of platelike water conveyor 38 which, in turn, is preferably structured to project a jet of water downwards, directly into the upper mouth of the vertical pipe-extension 51, thus to form an air-break.

[0114] More in detail, the third water-delivery portion 44 of platelike water conveyor 38 preferably comprises a nozzle which is locally substantially vertically aligned to the upper mouth of the vertical pipe-extension 51, and is suitably structured to direct/project/spout a jet of fresh water directly towards the upper mouth of the vertical pipe-extension 51 thus to reach storage tank 35 preferably without wetting the basin-shaped bottom portion 32 of drawer housing 18.

[0115] In addition to the above, storage tank 35 preferably directly communicates with the basin-shaped bottom portion 32 of drawer housing 18 also via a second vertical pipe-extension 52 that protrudes downwards from the bottom of drawer housing 18 and directly fits, preferably in a substantially airtight and/or watertight manner, into a complementary air vent opening 52a formed on top wall of storage tank 35, beside the brine inlet opening 51a, preferably with the interposition of a corresponding annular sealing gasket.

[0116] Furthermore, with reference to Figures 7 and 12, in the example shown vertical pipe-extension 52 preferably additionally protrudes upwards into drawer hous-

ing 18 within the perimeter of the basin-shaped bottom portion 32, so as to arrange its upper mouth at a given high above the bottom of drawer housing 18 and thus prevent the brine arriving into the basin-shaped bottom portion 32 from normally freely falling into storage tank 35 via the same vertical pipe-extension 52.

[0117] As a result, the brine preferably falls into storage tank 35 solely via the vertical pipe-extension 51, and the vertical pipe-extension 52 allows free ventilation of storage tank 35 and moreover the selective overflow into storage tank 35 of the exceeding brine (i.e. salt water) that may accidentally stagnate on the basin-shaped bottom portion 32 of drawer housing 18.

[0118] With reference to Figures 4, 11 and 12, the pump assembly 36, in turn, is preferably interposed between storage tank 35 and cartridge 50 so as to remain unmovably trapped between storage tank 35 and cartridge 50 when they are rigidly attached to one another.

[0119] Moreover pump assembly 36 preferably basically comprises an electrically-powered membrane pump or other electrically-powered volumetric pump, which has the suction of the pump connected to storage tank 35, preferably via a first duckbill valve (not shown), so as to be able to suck the brine from the inside of storage tank 35, and the delivery of the pump connected to the cartridge 50 of water softening device 13, preferably via a second duckbill valve (not shown), so as to be able to feed the brine into the water softening device 13.

[0120] With reference to Figures 7, 11 and 12, preferably the laundry washing machine 1 furthermore comprises a detector assembly 53 which is associated to storage tank 35 and is capable of monitoring the salinity degree of the brine (i.e. salt water) stored into storage tank 35 and/or of detecting the level of the fresh water or brine (i.e. salt water) stored inside storage tank 35. Preferably the detector assembly 53 moreover electronically communicates with the electronic control unit 14.

[0121] More in detail, the detector assembly 53 is preferably capable of detecting when the salinity degree of the brine (i.e. salt water) stored into storage tank 35 exceeds a predetermined minimum salinity value, and/or of detecting when the level of the fresh water or brine (i.e. salt water) stored inside storage tank 35 is equal to or higher than a predetermined threshold value L_0 .

[0122] Preferably said predetermined minimum salinity value is furthermore equal to or higher than the minimum salinity value required to successfully perform the regeneration process of the ion-exchange resins contained into the water softening device 13, or better into the cartridge 50.

[0123] Detector assembly 53 therefore is preferably capable of detecting whether the salinity degree of the brine (i.e. salt water) currently stored into storage tank 35 is equal to or exceeds a predetermined minimum salinity value sufficient to successfully perform the regeneration process of the ion-exchange resins contained into the water softening device 13.

[0124] More in detail, in the example shown the detec-

tor assembly 53 is preferably capable of detecting whether the salinity degree of the brine (i.e. salt water) currently stored into storage tank 35 is higher than 8% (i.e. preferably having more than 8 grams of dissolved salts per litre of water). In other words, the predetermined minimum salinity value is preferably equal to 8% (i.e. preferably having more than 8 grams of dissolved salts per litre of water).

[0125] However, in a different embodiment the predetermined minimum salinity value could be preferably equal to any value ranging between 6% to 15%.

[0126] The threshold value L_0 , in turn, preferably corresponds to a storage tank 35 completely filled up with fresh water or brine (i.e. salt water), i.e. filled up with an amount of brine sufficient to successfully perform the regeneration process of the ion-exchange resins contained into the water softening device 13.

[0127] Detector assembly 53 therefore is preferably capable of detecting whether the current level of brine inside storage tank 35 is sufficient to successfully perform the regeneration process of the ion-exchange resins contained into the water softening device 13.

[0128] More in detail, assuming that storage tank 35 is preferably dimensioned to contain a maximum amount of brine preferably equal to 270 cm³ (cubic centimeters), the threshold value L_0 preferably corresponds to 270 cm³ (cubic centimeters) of fresh water or brine into storage tank 35.

[0129] With reference to Figures 7, 11 and 12, in the example shown, in particular, detector assembly 53 is preferably at least partially accommodated inside storage tank 35, and is preferably structured for detecting, at same time, whether the salinity degree of the brine (i.e. salt water) stored into storage tank 35 exceeds said minimum salinity value, and whether the level of the fresh water or brine (i.e. salt water) stored inside storage tank 35 is equal to or higher than said predetermined threshold value L_0 .

[0130] More in detail, in the example shown detector assembly 53 preferably comprises: a salinity detector device which is capable of detecting when the salinity degree of the brine inside storage tank 35 is equal to or exceeds said minimum salinity value; and a water-level detector device which is capable of detecting when the level of the water or brine inside storage tank 35 is equal to or exceeds the threshold value L_0 . Preferably both the salinity detector device and the water-level detector device moreover electronically communicate with electronic control unit 14.

[0131] With particular reference to Figures 4, 5, 6, 10 11 and 12, the fresh-water supply circuit 12 of laundry washing machine 1, in turn, preferably comprises: a first water delivery line which is structured to channel the unsoftened fresh water of the water mains towards the water inlet of water softening device 13 preferably via the plate-like water conveyor 38 which, in turn, channels the softened fresh water coming out from the water softening device 13 directly to the water inlet of water distributor

39; and optionally also a second water delivery line which is structured to channel the unsoftened fresh water of the water mains directly to the water inlet of water distributor 39 bypassing water softening device 13.

[0132] Both first and second water delivery lines are preferably directly controlled by electronic control unit 14.

[0133] More in detail, the first water delivery line of fresh-water supply circuit 12 preferably basically comprises: a first electrically-operated on-off valve 56 which is connectable to the water mains and is preferably directly controlled by electronic control unit 14; and a first connecting tube 57 or other piping which fluidically connects the on-off valve 56 to a corresponding pipe-fitting 58 on platelike water conveyor 38.

[0134] The pipe-fitting 58 of platelike water conveyor 38, in turn, communicates with the water inlet of the water softening device 13, or better with the water inlet of cartridge 50, via a corresponding internal water channel; whereas the water outlet of water softening device 13, or better the water outlet of cartridge 50, communicates with the water inlet of water distributor 39 via a further internal water channel extending inside the body of plate-like water conveyor 38 up to coupling socket 46.

[0135] The second water delivery line of fresh-water supply circuit 12, in turn, preferably basically comprises: a second electrically-operated on-off valve 59 which is connectable to the water mains and is preferably directly controlled by electronic control unit 14; and a second connecting tube 60 or other piping which fluidically connects the on-off valve 59 directly to the water inlet of water distributor 39.

[0136] In addition to the above, with reference to Figures 4, 6, 11 and 12, in the example shown the fresh-water supply circuit 12 preferably additionally comprises a third water delivery line which is structured to channel the hot unsoftened fresh water towards the drawer flush circuit 19.

[0137] Alike first and second water delivery lines, third water delivery line is preferably directly controlled by the electronic control unit 14.

[0138] More in detail, the third water delivery line of fresh-water supply circuit 12 preferably basically comprises: a further independent electrically-operated, on-off valve 61 which is separately connectable to a source of hot water (namely the hot branch of the piping, fittings, and fixtures involved in the distribution and use of hot water in the domestic building), and is preferably directly controlled by electronic control unit 14; and a further connecting tube 62 or other piping which fluidically connects the on-off valve 61 to a second pipe-fitting 63 that preferably protrudes from platelike water conveyor 38 preferably next to pipe-fitting 58.

[0139] In the example shown, this second pipe-fitting 63 preferably directly communicates, via a further internal water channel extending inside platelike water conveyor 38, with the water inlet of the water softening device 13, or better with the water inlet of cartridge 50, thus to channel a flow of hot, unsoftened fresh water towards the wa-

ter inlet of the water softening device 13.

[0140] As an alternative, pipe-fitting 63 of platelike water conveyor 38 may directly communicate, via a corresponding internal water channel, with the water inlet of water distributor 39, thus to be able to channel a flow of hot, unsoftened fresh water towards the water inlet of water distributor module 39 bypassing the water softening device 13.

[0141] With reference to Figures 2 and 5, the laundry washing machine 1 is preferably additionally provided with a first water drain line 65 that branches off from the drawer flush circuit 19 and is capable of selectively channelling any kind of water that enters into the same drawer flush circuit 19 towards the drain sump 66 of washing tub 3, or even directly towards the suction of the electric pump that drains the waste water or washing liquor outside the laundry washing machine 1; and the drawer flush circuit 19 is capable of selectively channelling, towards the water drain line 65, any kind of water that enters into the same drawer flush circuit 19.

[0142] In the example shown, in particular, the water drain line 65 preferably comprises a drain tube 67 or other piping which has a first end connected to the platelike water conveyor 38 of drawer flush circuit 19 and a second end connected to the drain sump 66 of washing tub 3; and the water distributor 39 is capable of selectively channelling, towards the drain tube 67, any kind of water that enters into the drawer flush circuit 19.

[0143] With particular reference to Figures 2 and 5, the laundry washing machine 1 is preferably finally provided also with a second water drain line 68 that branches off from tank 35 and ends into the drain sump 66 of washing tub 3, or even directly into the suction of the electric pump that drains the waste water or washing liquor outside the laundry washing machine 1. Preferably the auxiliary water drain line 65 is moreover directly controlled by electronic control unit 14.

[0144] In the example shown, in particular, the second water drain line 68 preferably comprises: a tube 69 or other piping, that branches off from the bottom of storage tank 35 and ends directly into drain sump 66; and an electrically-operated, on-off valve 70 which is arranged along tube 69 for controlling the outflow of the water or brine from storage tank 35 towards the drain sump 66, and is preferably directly controlled by the electronic control unit 14.

[0145] General operation of the laundry washing machine 1 is easily inferable from the description above. The electronic control unit 14 controls the motor assembly 6, the detergent dispenser 10 and the fresh-water supply circuit 12 so as to perform the washing cycle previously selected by the user via the control panel 15.

[0146] In addition to the above, the electronic control unit 14 controls, preferably via a traditional electronic water-meter (not shown) located along the fresh-water supply circuit 12, the water consumption of the laundry washing machine 1 as from the last regeneration process of the ion-exchange resins of water softening device 13, i.

e. the number of liters of fresh water entering into the laundry washing machine 1 as from the last regeneration process of the ion-exchange resins of water softening device 13, so as to determine when the regeneration process of the ion-exchange resins of water softening device 13 is to be performed again.

[0147] When determines that the regeneration process of the ion-exchange resins is to be performed, the electronic control unit 14 of laundry washing machine 1 is configured to implement an operating method basically comprising the steps of:

- channelling a given amount of fresh water into the regeneration-agent container, i.e. the regeneration-agent compartment 21 of detergent drawer 16, so as to form a corresponding amount of brine that flows and accumulates into the storage tank 35;
- fluidically connecting the water softening device 13 in closed loop to the storage tank 35 bypassing the regeneration-agent container, i.e. the regeneration-agent compartment 21 of detergent drawer 16;
- circulating, for a given recirculation time period, said brine in closed loop through the water softening device 13 and the storage tank 35 while bypassing said regeneration-agent container, i.e. the regeneration-agent compartment 21 of detergent drawer 16; and lastly
- removing the brine from the water softening device 13.

[0148] More in detail, removal of the brine from the water softening device 13 takes place at the end of a given regeneration time period which is sufficient to finalize the regeneration process of the water softening properties of the ion-exchange resins contained into the water softening device 13.

[0149] Said regeneration time period moreover encompasses/comprises/includes the recirculation time period. In other words, the length of the regeneration time period is equal to or longer than that of the recirculation time period.

[0150] In the example shown, in particular, the recirculation time period is preferably shorter than the regeneration time period.

[0151] The electronic control unit 14, therefore, preferably activates the pump assembly 36 to circulate the brine in closed loop through water softening device 13 and storage tank 35 for a given recirculation time period shorter than the regeneration time period, and subsequently deactivates the pump assembly 36 so as to leave the brine stationary into the water softening device 13 for the rest of the regeneration time period, i.e. until the regeneration process of the ion-exchange resins of water softening device 13 is completed.

[0152] Preferably the recirculation time period moreover ranges between 1 to 5 minutes. Preferably the regeneration time period in turn ranges between 10 and 30 minutes.

[0153] More in detail, when regeneration process of the ion-exchange resins is to be performed, the electronic control unit 14 firstly operates the water distributor 39 so as to channel, towards water-delivery portion 41 and thus towards the regeneration-agent compartment 21, any water entering into the drawer flush circuit 19, and then opens for a short time either the on-off valve 56 or the on-off valve 59 of the fresh-water supply circuit 12, so as to pour/channel a given amount of fresh water, for example 100 cm³ (cubic centimeters) of fresh water, into the regeneration-agent compartment 21.

[0154] Due to the presence of water-permeable partitioning septum 25, the softened or unsoftened fresh water poured into the regeneration-agent compartment 21 temporarily accumulates above the partitioning septum 25 wherein can dissolve a great amount of salt grains and form the brine.

[0155] The brine formed into the regeneration-agent compartment 21, above the partitioning septum 25, slowly passed across the partitioning septum 25 and then trickles into the basin-shaped bottom portion 32 of drawer housing 18. From the basin-shaped bottom portion 32, the 100 cm³ (cubic centimeters) of brine then quickly falls into tank 35 wherein accumulates.

[0156] Preferably, if detector assembly 53 detects that in storage tank 35 there is room for other brine, electronic control unit 14 opens again for a short time either the on-off valve 56 or the on-off valve 59 of the fresh-water supply circuit 12, so as to pour some more fresh water, for example another 100 cm³ (cubic centimeters) of fresh water, into the regeneration-agent compartment 21, so as to form further 100 cm³ of brine that, again, slowly moves into storage tank 35.

[0157] Sequential quantum supplying of fresh water into the regeneration-agent compartment 21 continues until storage tank 35 is completely filled with brine, i.e. the level of the brine into brine tank 60 is equal to or exceeds the threshold value L_0 .

[0158] In other words, electronic control unit 14 continues feeding fresh water into the regeneration-agent compartment 21 until storage tank 35 contains an amount of brine sufficient for successfully performing the regeneration process of the ion-exchange resins located inside the same water softening device 13, i.e. an amount of brine preferably sufficient for completely filling up the water softening device 13.

[0159] The overall amount of fresh water currently channelled into the regeneration-agent container 21 is, therefore, preferably roughly equal to or greater than the nominal ullage of the water softening device 13.

[0160] When detector assembly 53 detects that level of the brine into storage tank 35 is equal to or exceeds the threshold value L_0 and that the salinity value of the brine inside storage tank 35 is equal to or higher than said predetermined minimum salinity value, i.e. when storage tank 35 contains an amount of brine roughly sufficient for performing the regeneration process of the ion-exchange resins of water softening device 13, the elec-

tronic control unit 14 operates the water distributor 39 so as to channel any water entering into the drawer flush circuit 19 towards the water-delivery portion 45, and thus towards the washing tub 3, or towards the water drain line 65; and afterwards activates the pump assembly 36 to move the brine from storage tank 35 to water softening device 13 so as to almost completely fill up the water softening device 13 with brine. Thus the regeneration process of the ion-exchange resins is allowed to start.

[0161] Since the water outlet of the water softening device 13 is at the moment in fluid communication with the water-delivery portion 45 or with the water drain line 65, the fresh water pushed out from the water softening device 13 by the brine arriving from storage tank 35 is channeled towards the washing tub 3 or towards the drain sump 66 for being discharged out of the washing machine 1.

[0162] After having moved the brine from storage tank 35 to the water softening device 13, preferably the electronic control unit 14 operates the water distributor 39 so as to channel, towards water-delivery portion 41 and thus towards the regeneration-agent compartment 21, any water entering into the drawer flush circuit 19, and then opens again for a short time either the on-off valve 56 or the on-off valve 59 of the fresh-water supply circuit 12, so as to pour/channel a given second amount of fresh water, for example 100-150 cm³ (cubic centimeters) of fresh water, into the regeneration-agent compartment 21.

[0163] Again this fresh water forms a corresponding amount of brine that flows into the storage tank 35 and therein accumulates.

[0164] Preferably this second amount of fresh water is moreover lower than or equal to the first amount of fresh water previously channeled into the regeneration-agent compartment 21 and/or lower than or equal to the nominal ullage of the water softening device 13.

[0165] After having closed the on-off valve 56 or the on-off valve 59 of the fresh-water supply circuit 12 and preferably also immediately after the detector assembly 53 has detected that new amount of brine has accumulated into storage tank 35, the electronic control unit 14 operates the water distributor 39 so as to channel any water entering into the drawer flush circuit 19 towards the water-delivery portion 44 and thus directly towards the storage tank 35 bypassing the regeneration-agent compartment 21.

[0166] As a consequence, the water outlet of water softening device 13 is now in fluid communication with storage tank 35, and any water coming out from the water softening device 13 is channelled back into the storage tank 35 and can restore the water level into the same storage tank 35.

[0167] The electronic control unit 14 therefore operates the water distributor 39 so as to put the water outlet of water softening device 13 in fluid communication with the storage tank 35 while bypassing the regeneration-agent container, so as to allow the closed-loop circulation

of the brine through water softening device 13 and storage tank 35 bypassing the regeneration-agent container.

[0168] In view of the fact that the water coming out from the water softening device 13 now continuously restores the water level into storage tank 35, the electronic control unit 14 is allowed to keep the pump assembly 36 continuously active for circulating the brine in closed loop through water softening device 13 and storage tank 35 while bypassing the regeneration-agent container, i.e. the regeneration-agent compartment 21 of detergent drawer 16.

[0169] Therefore, after having put the water outlet of water softening device 13 in fluid communication with the storage tank 35 for allowing closed-loop circulation and after the detector assembly 53 has detected that new brine has accumulated into storage tank 35, preferably the electronic control unit 14 activates again the pump assembly 36 and keeps it active for a predetermined recirculation time period preferably ranging between 1 to 5 minutes thus to circulate the brine in closed loop through both water softening device 13 and storage tank 35, and subsequently deactivates the pump assembly 36 thus to leave the brine stationary into the water softening device 13 for the rest of the regeneration time period.

[0170] As an alternative, the electronic control unit 14 may activate the pump assembly 36 for a predetermined recirculation time period roughly equal to the regeneration time period, so that circulation of the brine in closed loop through water softening device 13 and storage tank 35 continues until the regeneration process of the ion-exchange resins into the water softening device 13 is completed and the brine is to be drawn out of water softening device 13.

[0171] In other words, the electronic control unit 14 may keep the pump assembly 36 active for continuously circulating the brine in closed loop through both water softening device 13 and storage tank 35 until the end of the regeneration time period.

[0172] After the regeneration time period has expired, the electronic control unit 14 assumes that the regeneration process of the ion-exchange resins is completed and operates again the water distributor 39 so as to channel any water entering into the drawer flush circuit 19 towards the water-delivery portion 45, and thus towards the washing tub 3, or towards the water drain line 65; and then temporarily activates again the pump assembly 36 to substantially empty storage tank 35 and move the corresponding brine into the water softening device 13. Since the water outlet of water softening device 13 is now in fluid communication with washing tub 3 or water drain line 65, the brine previously contained into the water softening device 13 is pushed out from the water softening device 13 by the brine arriving from storage tank 35, and flows towards the washing tub 3 or the water drain line 65.

[0173] As an alternative, when regeneration time period has expired, the electronic control unit 14 may temporarily activate the on-off valve 70 of water drain line 68

to drain the brine out of the water softening device 13; and then activate again the pump assembly 36 to substantially empty the storage tank 35 and move the corresponding brine into the water softening device 13.

[0174] When storage tank 35 is substantially empty, the electronic control unit 14 deactivates the pump assembly 36 and preferably opens again for a short time either the on-off valve 56 or the on-off valve 59 of the fresh-water supply circuit 12, so as to channel new fresh water into the water inlet of water softening device 13 and push the remaining brine out of the water softening device 13, towards the washing tub 3 or the water drain line 65.

[0175] As an alternative, when storage tank 35 is substantially empty, the electronic control unit 14 may temporarily activate once more the on-off valve 70 of water drain line 68 to drain the remaining brine out of the water softening device 13.

[0176] Preferably, after removing the brine out of the water softening device 13, the electronic control unit 14 additionally performs at least one rinsing cycle of storage tank 35 that basically comprises the steps of:

- channelling a given amount of fresh water into the storage tank 35 bypassing the regeneration-agent container, i.e. the regeneration-agent compartment 21 of detergent drawer 16;
- moving said fresh water from storage tank 35 to water softening device 13; and lastly
- removing said fresh water from the water softening device 13.

[0177] More in detail, for rinsing the storage tank 35, the electronic control unit 14 firstly operates the water distributor 39 so as to channel, towards water-delivery portion 44 and thus towards the storage tank 35 bypassing the regeneration-agent compartment 21 of detergent drawer 16, any water entering into the drawer flush circuit 19, and then opens for a short time either the on-off valve 56 or the on-off valve 59 of the fresh-water supply circuit 12, so as to channel new softened or unsoftened fresh water into storage tank 35.

[0178] When detector assembly 53 detects that storage tank 35 contains a sufficient amount of fresh water, the electronic control unit 14 operates the water distributor 39 so as to channel any water entering into the drawer flush circuit 19 towards the water-delivery portion 45, and thus towards the washing tub 3, or towards the water drain line 65; and then temporarily activates again the pump assembly 36 to substantially empty storage tank 35 and move the rising water into the water softening device 13.

[0179] When storage tank 35 is substantially empty, the electronic control unit 14 deactivates the pump assembly 36, and preferably opens again for a short time either the on-off valve 56 or the on-off valve 59 of the fresh-water supply circuit 12, so as to channel new fresh water into the water inlet of water softening device 13

and push the rinsing water out of the water softening device 13, towards the washing tub 3 or the water drain line 65.

[0180] When regeneration process of the ion-exchange resins of the water softening device 13 and optionally also rinsing cycle of storage tank 35 is/are completed, the electronic control unit 14 restarts operating the water distributor 39 so as to carry out the washing cycle selected by the user.

[0181] The advantages resulting from circulating the brine in closed loop through the water softening device 13 and the storage tank 35 while bypassing said regeneration-agent container are large in number.

[0182] First of all, experimental tests revealed that, after closed-loop circulation of the brine, the brine is much more evenly distributed inside the water softening device 13 thus significantly improving efficiency in regeneration of the ion-exchange resins of the water softening device 13.

[0183] Furthermore production of further brine before the closed-loop circulation of the brine avoids excessive dilution of the brine remaining inside the water softening device 13, thus again significantly improving efficiency of the regeneration process of the ion-exchange resins.

[0184] Therefore closed-loop circulation of the brine allows to significantly reduce the length of the regeneration process of the ion-exchange resins.

[0185] Moreover, thanks to the water-permeable partitioning septum 25, the brine formed into the regeneration-agent compartment 21 of detergent drawer 16 takes a few minutes to move from the regeneration-agent compartment 21 to storage tank 35, and therefore it can dissolve a greater amount of salt grains, thus increasing the salinity degree of the brine arriving in storage tank 35.

[0186] Clearly, changes may be made to the operating method of laundry washing machine 1 and to laundry washing machine 1 without, however, departing from the scope of the present invention.

[0187] For example, according to an alternative embodiment of the operating method implemented by the electronic control unit 14, the electronic control unit 14, after detector assembly 53 detects that level of the brine into storage tank 35 is equal to or exceeds the threshold value L_0 and that the salinity value of the brine inside storage tank 35 is equal to or higher than said predetermined minimum salinity value, operates the water distributor 39 so as to channel any water entering into the drawer flush circuit 19 towards the water-delivery portion 44 and thus directly towards the storage tank 35 bypassing the regeneration-agent compartment 21.

[0188] Therefore the water outlet of water softening device 13 is immediately placed in fluid communication with storage tank 35 for allowing closed-loop circulation of the brine through water softening device 13 and storage tank 35 while bypassing the regeneration-agent compartment 21, and the fresh water pushed out from the water softening device 13 by the brine entering for the first time into the water softening device 13 is now

directly channelled into storage tank 35.

[0189] After having put the water outlet of water softening device 13 in fluid communication with the storage tank 35 for allowing closed-loop circulation of the brine, the electronic control unit 14 activates the pump assembly 36 for moving the brine from storage tank 35 to water softening device 13 and keep activated the pump assembly 36 for immediately circulating the brine in closed loop through both water softening device 13 and storage tank 35.

[0190] In other words, in this alternative embodiment, closed-loop circulation of the brine starts immediately after the brine is moved for the first time from storage tank 35 to water softening device 13, and there is no further supply of fresh water into the regeneration-agent compartment 21 for producing additional brine.

[0191] Moreover, according to a further alternative embodiment, the operating method implemented by electronic control unit 14 may provide to repeat several times, during a same regeneration time period, the steps of:

- channelling a given amount of fresh water into the regeneration-agent container, i.e. the regeneration-agent compartment 21 of detergent drawer 16, so as to form some brine that flows and accumulates into the storage tank 35;
- fluidically connecting the water softening device 13 in closed loop to the storage tank 35 bypassing the regeneration-agent container, i.e. the regeneration-agent compartment 21 of detergent drawer 16;
- circulating, for a given recirculation time period, said brine in closed loop through the water softening device 13 and the storage tank 35 while bypassing said regeneration-agent container, i.e. the regeneration-agent compartment 21 of detergent drawer 16; and lastly
- removing the brine from the water softening device 13.

[0192] This variation may be helpful when storage tank 35 of laundry washing machine 1 is dimensioned to contain a given quantity of brine insufficient for successfully performing all at once the regeneration process of the water softening functions of the water softening agent in the water softening device 13.

[0193] In other words, the capacity of storage tank 35 may be less than the nominal ullage of the water softening device 13.

[0194] Furthermore, in a not-shown alternative embodiment the laundry washing machine 1 may have a first independent water supply line which is discrete and separated from drawer flush circuit 19, and is capable of channelling the fresh water of the water mains directly into the regeneration-agent compartment 21 of detergent drawer 16; and or a second independent water supply line which is discrete and separated from drawer flush circuit 19, and is capable of channelling the fresh water of the water mains directly into the storage tank 35 while

bypassing the regeneration-agent compartment 21 of detergent drawer 16.

[0195] Furthermore, in a further not-shown alternative embodiment the regeneration-agent compartment 21 is located/incorporated into a corresponding manually extractable, regeneration-agent drawer which is discrete from detergent drawer 16, and is fitted/inserted in manually extractable manner into a corresponding substantially basin-shaped, drawer housing which is preferably located/recessed inside casing 2 horizontally beside the detergent dispenser 10.

[0196] Lastly, in a non-shown alternative embodiment of laundry washing machine 1, the laundry loading/unloading opening may be located on the upper worktop or top wall 11 of boxlike casing 2. Preferably moreover the washing tub 3 may be arranged inside casing 2 with the mouth directly facing the upper worktop or top wall 11, and the rotatable drum may be fitted vertically into washing tub 3 with the concavity facing the upper mouth of washing tub 3, so as to be able to rotate about a substantially vertically-oriented, longitudinal axis.

Claims

1. Operating method of a laundry washing machine (1) comprising: an internal water softening device (13) which is crossed by the fresh water directed towards the washing tub (3) and/or the detergent dispenser (10), and which is filled with a water softening agent capable of reducing the hardness degree of the fresh water flowing through the same water softening device (13); a regeneration-agent container (21) containing a given amount of a consumable salt or other regeneration agent; a first water-supply line (19) for selectively channelling a flow of fresh water into said regeneration-agent container (21) to form a brine capable of regenerating the water softening properties of said water softening agent; and a storage tank (35) which is fluidically connected to said regeneration-agent container (21) for receiving and accumulating the brine formed into said regeneration-agent container (21), and to said water softening device (13) for delivering said brine to the water softening device (13);
the operating method of the laundry washing machine (1) being **characterized by** comprising the steps of:

- channelling, via said first water-supply line (19), a first amount of fresh water into the regeneration-agent container (21) so as to form a corresponding amount of brine that flows and accumulates into the storage tank (35);
- fluidically connecting the water softening device (13) in closed loop to said storage tank (35) bypassing said regeneration-agent container (21);

- circulating, for a given recirculation time period, the brine in closed loop through the water softening device (13) and the storage tank (35) while bypassing said regeneration-agent container (21); and lastly
- removing the brine from said water softening device (13).
2. Operating method according to Claim 1, **characterized in that** the step of removing the brine from the water softening device (13) is performed at the end of a given regeneration time period which encompasses said recirculation time period and which is sufficient to finalize the regeneration process of the water softening properties of said water softening agent.
 3. Operating method according to Claim 1 or 2, **characterized by** additionally comprising, between the step of channelling the first amount of fresh water into the regeneration-agent container (21) and the step of fluidically connecting the water softening device (13) in closed loop to said storage tank (35), also the step of moving the brine accumulated into the storage tank (35), from said storage tank (35) to said water softening device (13).
 4. Operating method according to Claim 3, **characterized by** additionally comprising, before the step of moving the brine accumulated into the storage tank (35) from said storage tank (35) to said water softening device (13), also the step of putting a water outlet of the water softening device (13) in fluid communication with the washing tub (3) or with a water discharge assembly (65, 66) so as to channel the water pushed out from the water softening device (13) by the brine towards the washing tub (3) or towards the water discharge assembly (65, 66).
 5. Operating method according to any one of the preceding claims, **characterized in that** the step of moving the brine from the storage tank (35) to the water softening device (13) and/or the step of circulating the brine in closed loop through the water softening device (13) and the storage tank (35) is/are performed by means of a pump assembly (36) which is interposed between the storage tank (35) and the water softening device (13) and is capable of pumping the brine from said storage tank (35) to said water softening device (13).
 6. Operating method according to any one of the preceding claims, **characterized in that** the step of fluidically connecting the water softening device (13) in closed loop to said storage tank (35) includes the step of putting a water outlet of the water softening device (13) in fluid communication with said storage tank (35) bypassing said regeneration-agent container (21).
 7. Operating method according to any one of the preceding claims, **characterized in that** the step of removing the brine from the water softening device (13) comprises the step of putting a water outlet of the water softening device (13) in fluid communication with the washing tub (3) or a water drain-line (65); and the step of channelling new fresh water into a water inlet of the water softening device (13) thus to push the brine out of the water softening device (13) via the water outlet of the same water softening device (13).
 8. Operating method according to any one of the preceding claims, **characterized in that** said first amount of fresh water is sufficient for accumulating into said storage tank (35) an amount of brine sufficient for almost completely filling up the water softening device (13).
 9. Operating method according to any one of Claims 3 to 8, **characterized by** additionally comprising, between the step of moving the brine from the storage tank (35) to the water softening device (13) and the step of fluidically connecting the water softening device (13) in closed loop to said storage tank (35), also the step of channelling a second amount of fresh water into the regeneration-agent container (21) so as to form further brine that flows and accumulates into the storage tank (35).
 10. Operating method according to Claim 9, **characterized in that** said second amount of fresh water is lower than or equal to said first amount of fresh water.
 11. Operating method according to any one of the preceding claims, **characterized by** additionally comprising, after the step of removing the brine from the water softening device (13), the steps of:
 - channelling, via second water-supply line (19), a given amount of fresh water into said storage tank (35) bypassing the regeneration-agent container (21);
 - moving said fresh water from the storage tank (35) to the water softening device (13); and lastly
 - removing said fresh water from said water softening device (13).
 12. Operating method according to any one of Claims 2 to 11, **characterized in that** said recirculation time period is shorter than said regeneration time period.
 13. Operating method according to Claim 12, **characterized in that** said recirculation time period ranges between 1 to 5 minutes.
 14. Laundry washing machine (1) having an outer casing (2) and comprising, inside said outer casing (2): a

washing tub (3); a rotatable drum which is housed in axially rotatable manner inside the washing tub (3) and is structured for housing the laundry to be washed; a motor assembly (6) capable of driving into rotation said rotatable drum inside the washing tub (3); a detergent dispenser (10) which is structured for supplying detergent into the washing tub (3); a fresh-water supply circuit (12) which is structured for selectively channelling a flow of fresh water from the water mains towards the detergent dispenser (10) and/or the washing tub (3); an internal water softening device (13) which is connected to said detergent dispenser (10) and/or said fresh-water supply circuit (12) for being crossed by the fresh water directed towards the detergent dispenser (10) and/or the washing tub (3), and is filled with a water softening agent capable of reducing the hardness degree of said fresh water; a regeneration-agent container (21) fillable with a consumable salt or other regeneration agent; a first water-supply line (19) for selectively channelling a flow of fresh water into said regeneration-agent container (21) to form a brine capable of regenerating the water softening properties of said water softening agent; a storage tank (35) which is fluidically connected to said regeneration-agent container (21) for receiving and accumulating the brine formed into said regeneration-agent container (21), and to said water softening device (13) for delivering said brine to the water softening device (13); and an electronic control unit (14) which controls the motor assembly (6), the detergent dispenser (10), the fresh-water supply circuit (12) and said first water-supply line (19), and is adapted to implement a washing cycle selected by the user; the laundry washing machine (1) being **characterized in that** said electronic control unit (14) is also configured to implement the operating method according to any one of Claims 1 to 13.

15. Laundry washing machine according to Claim 14, **characterized by** additionally comprising a pump assembly (36) which is interposed between the storage tank (35) and the water softening device (13) and is capable of pumping the brine from said storage tank (35) to said water softening device (13).

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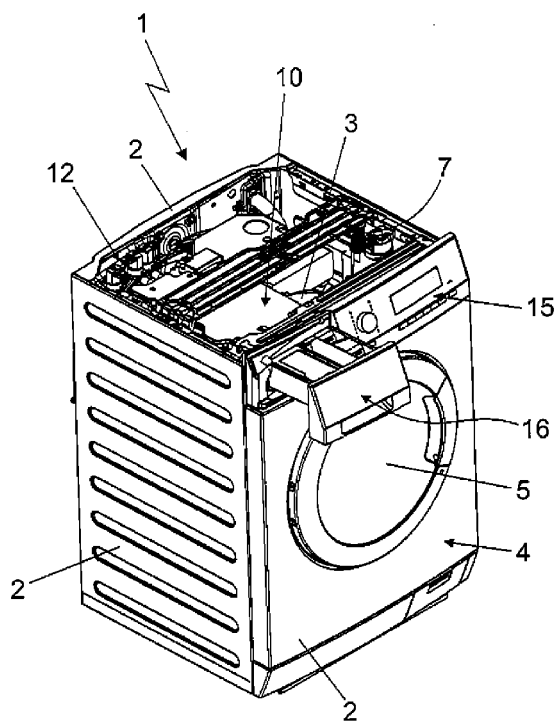


Fig. 1

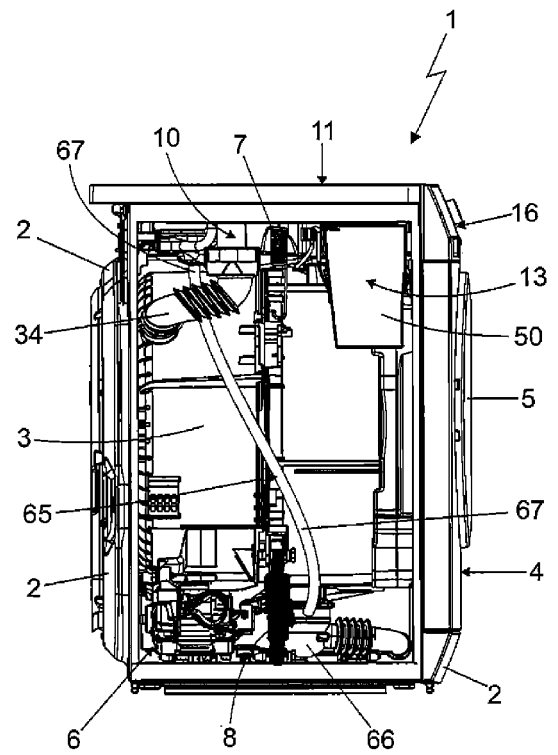


Fig. 2

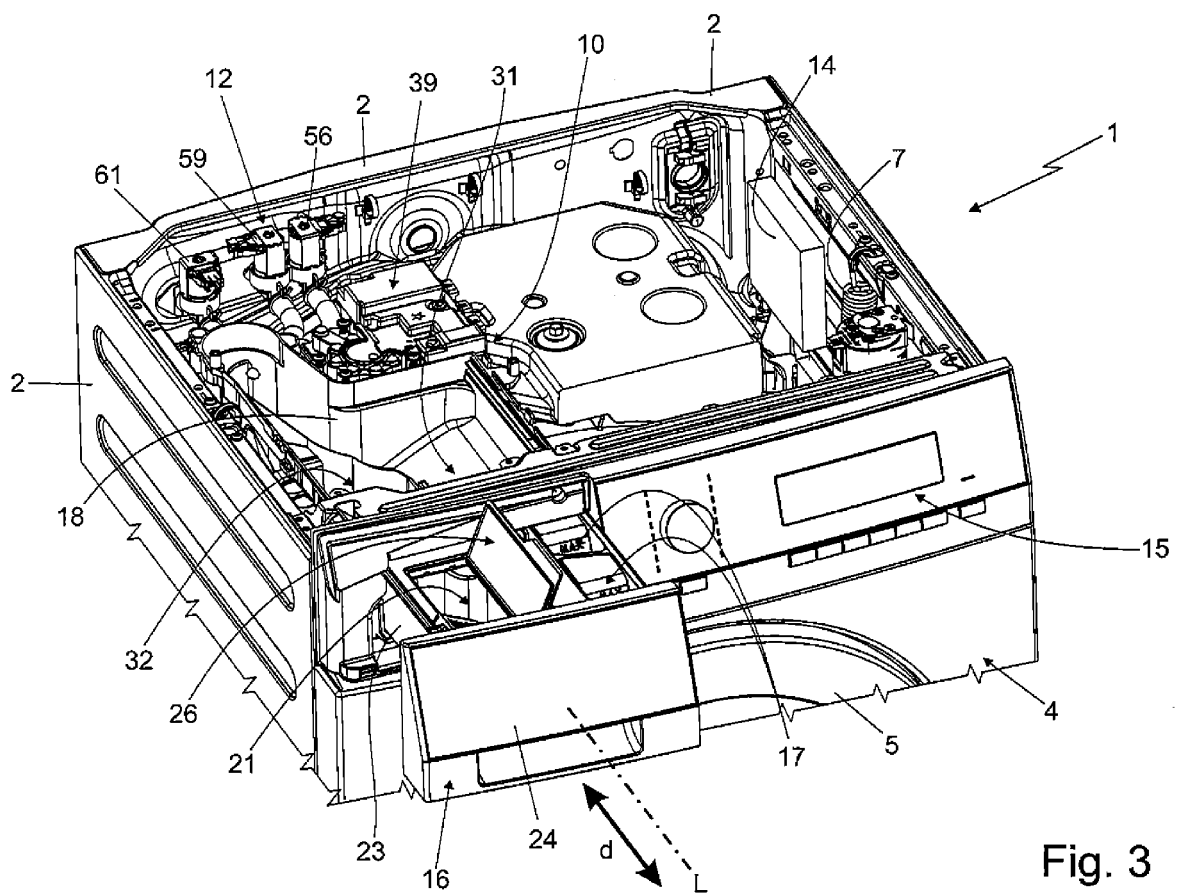
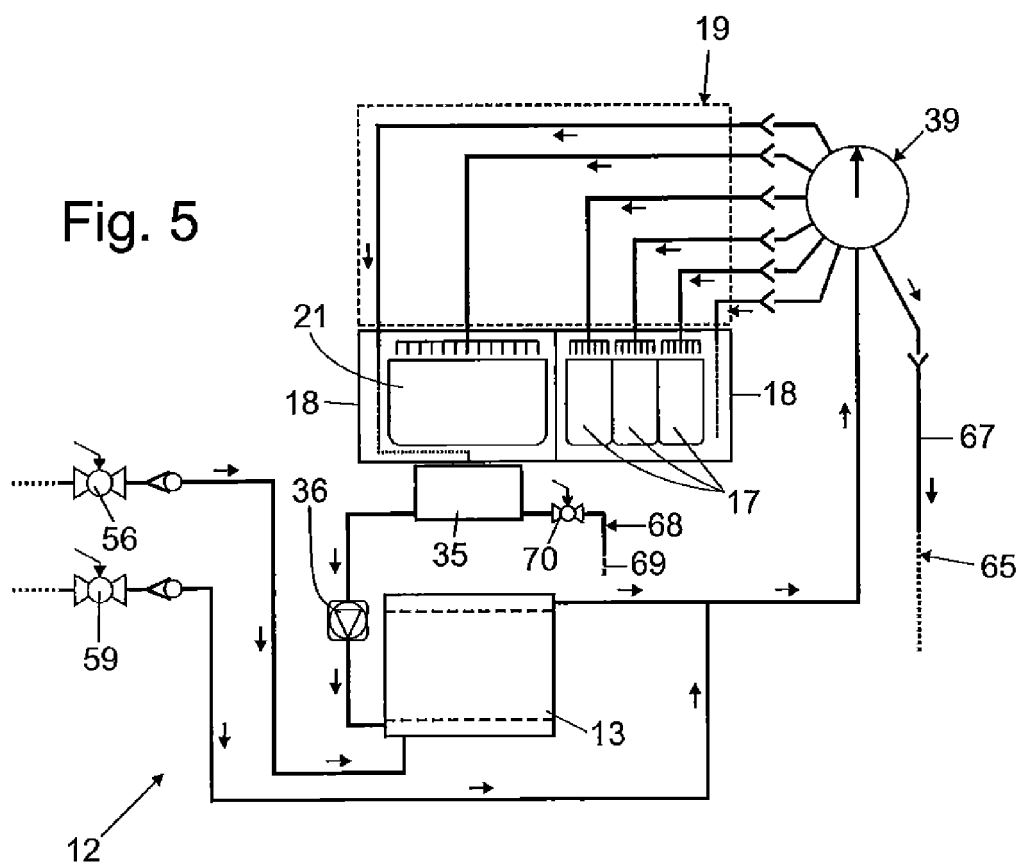
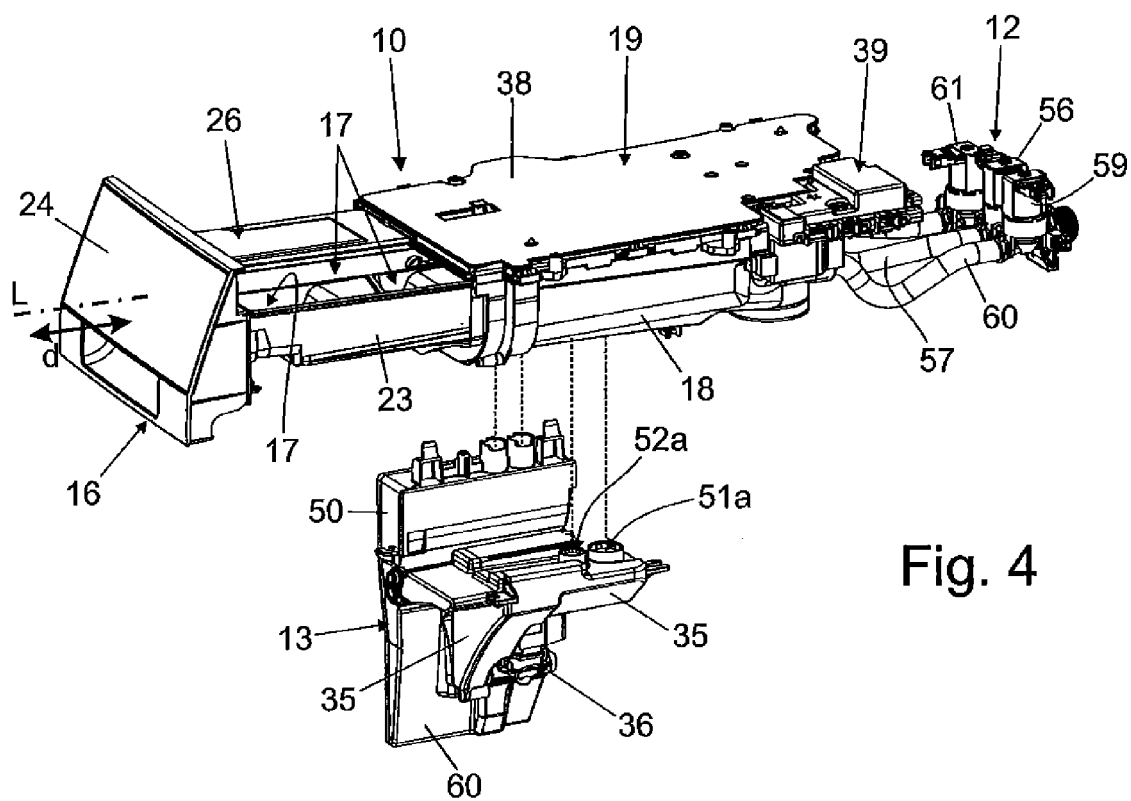


Fig. 3



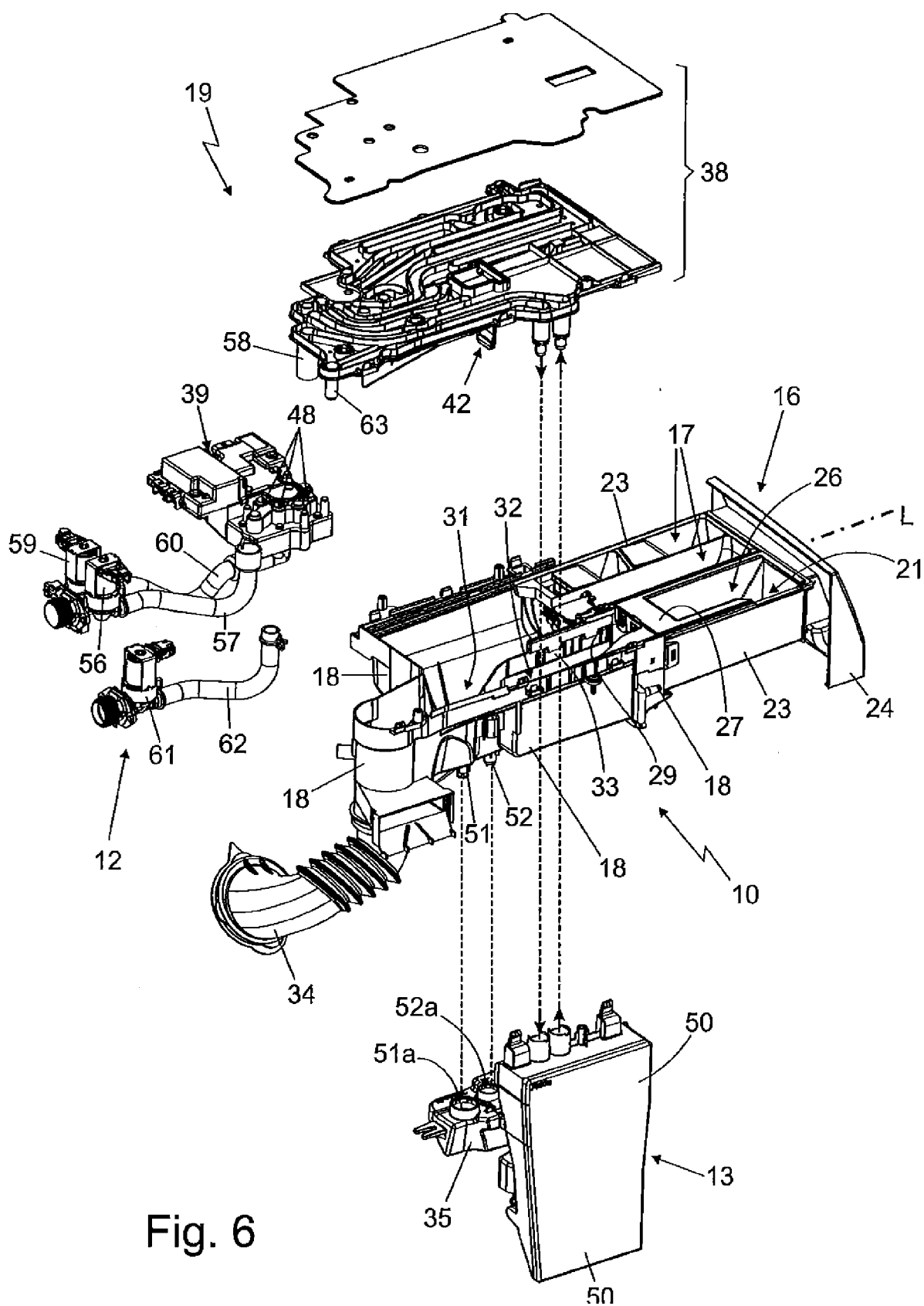
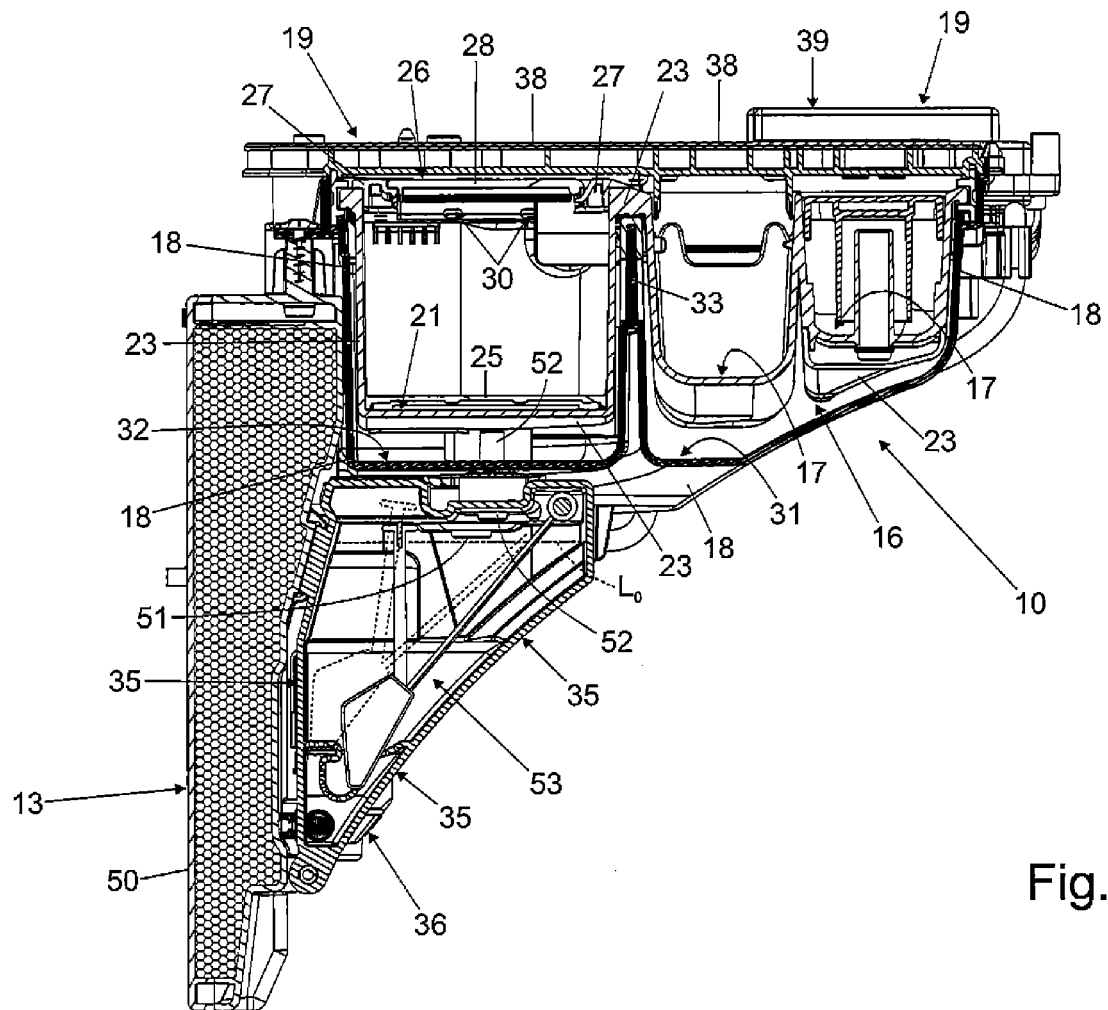


Fig. 6



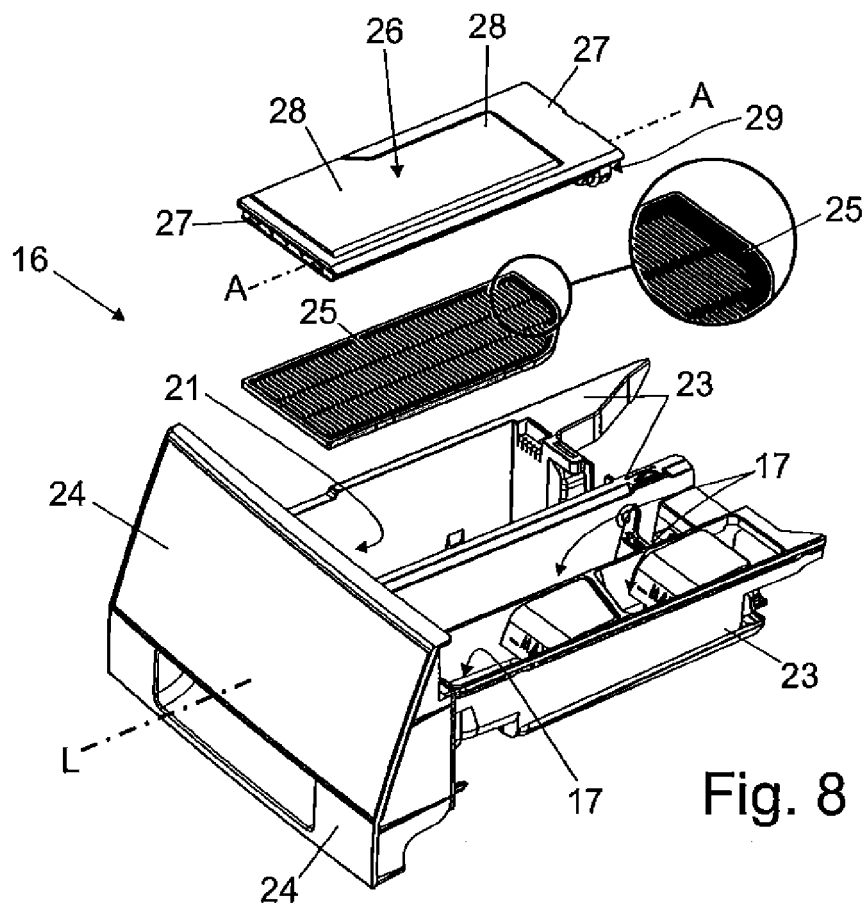


Fig. 8

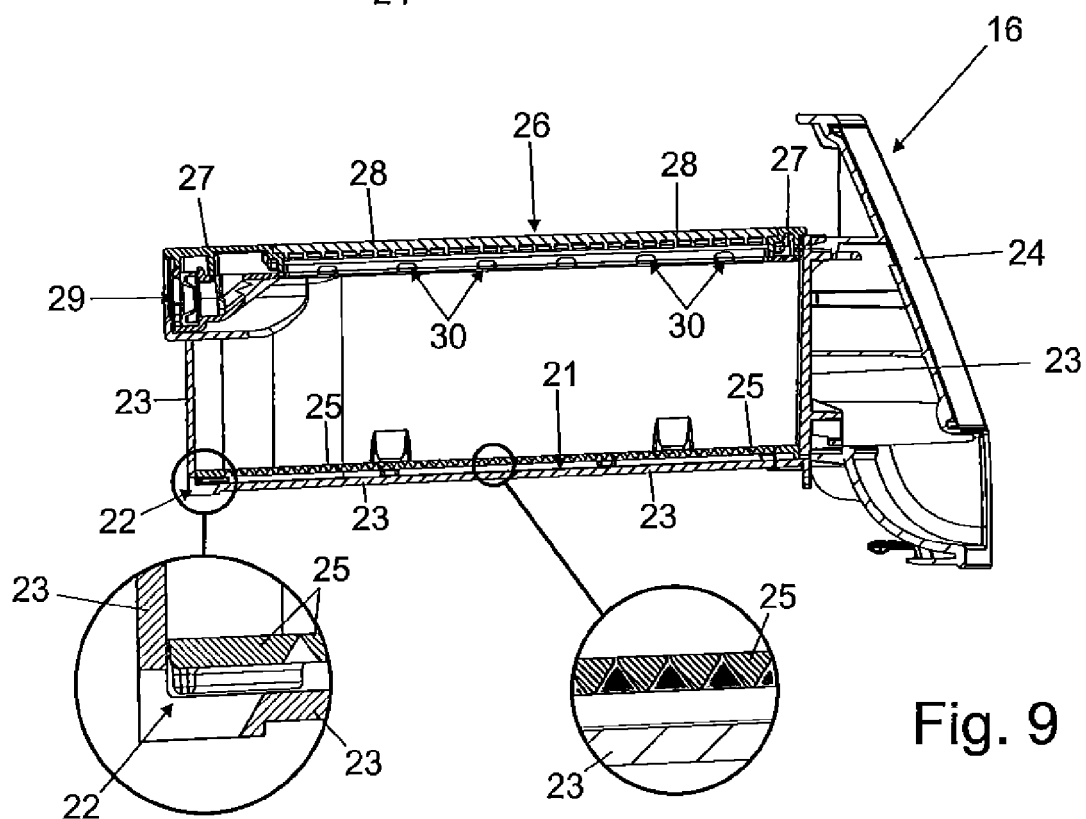


Fig. 9

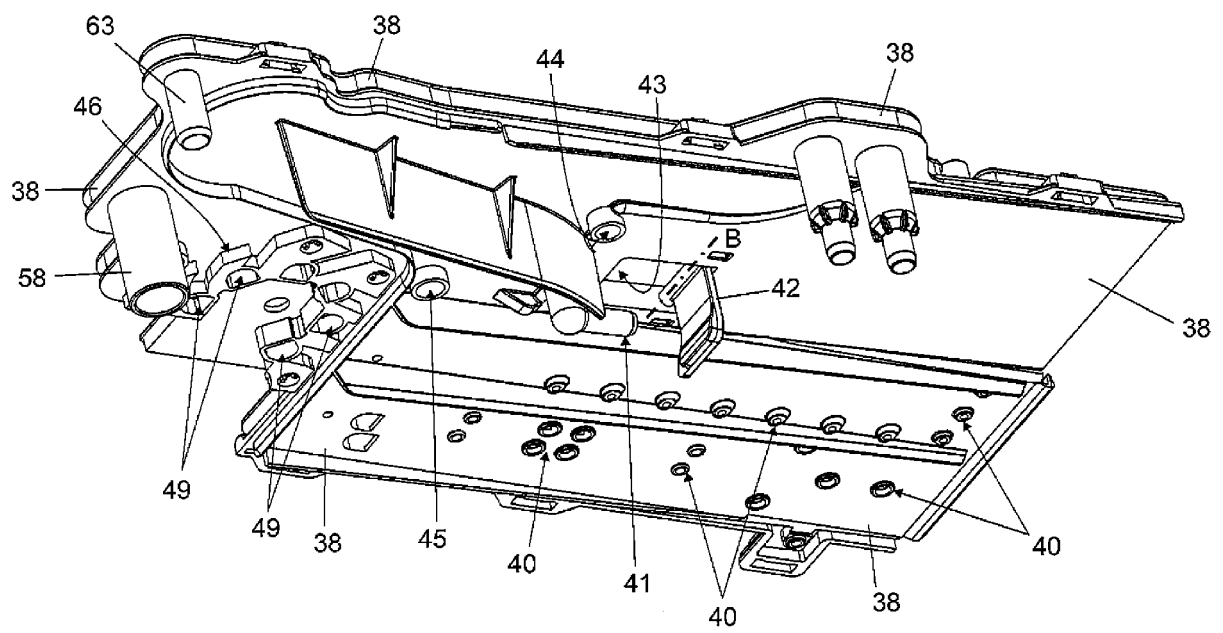


Fig. 10

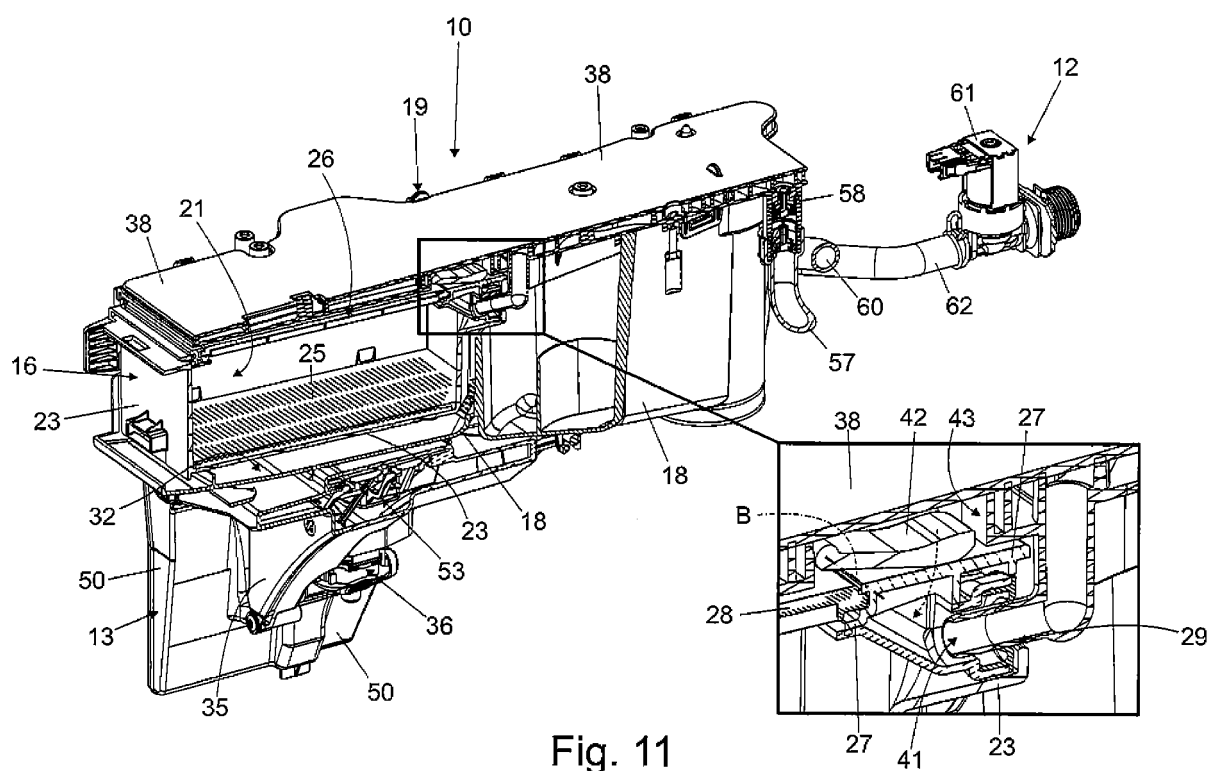
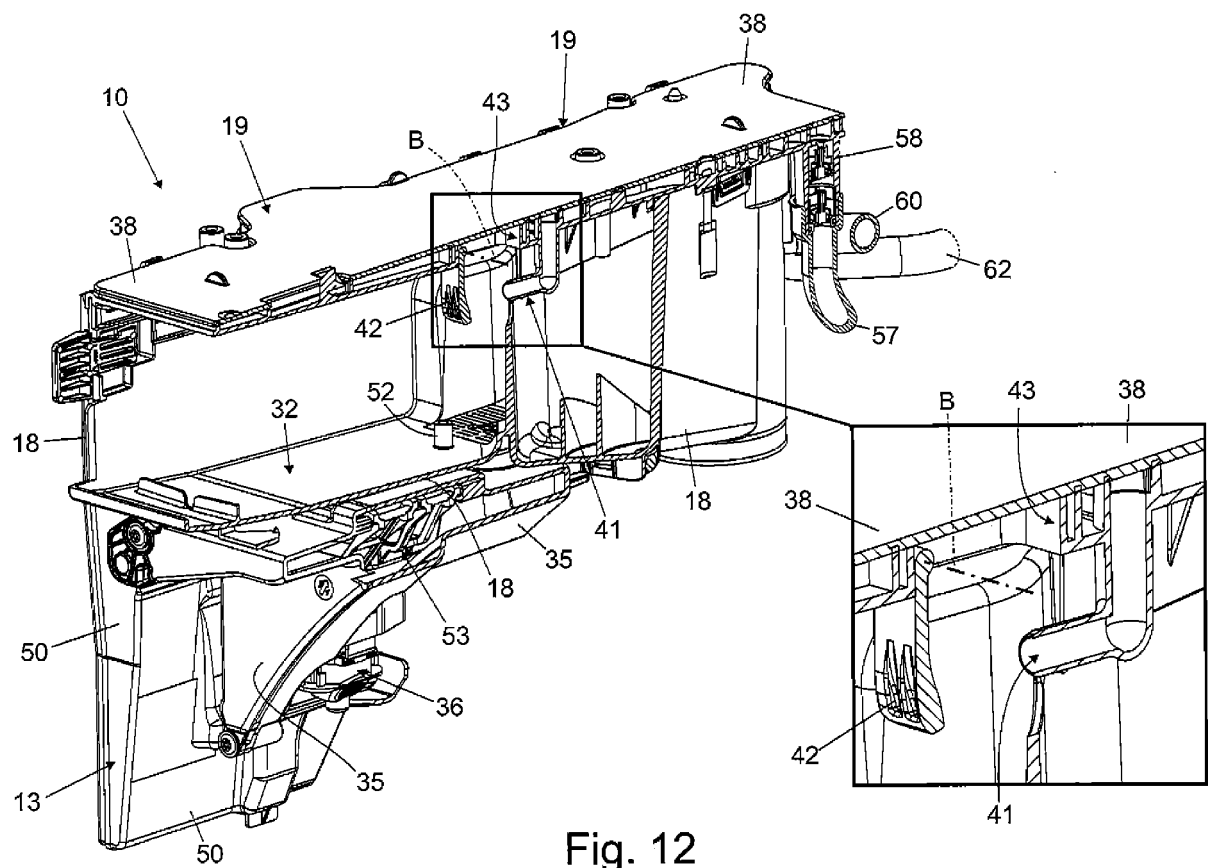


Fig. 11





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Application Number
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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 4 January 2017	Examiner Kising, Axel
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