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(54) **LAUNDRY WASHING MACHINE**

(57) A laundry washing machine (1) comprising: an outer casing (2); a washing tub (3) located inside the casing (2); an internal water delivery circuit (12) which is located inside the casing (2) and is configured for channelling a flow of water towards said washing tub (3); an external water-feeding line (13) which extends outside the casing (2), is connectable to the water mains (100) and is configured for channelling the water coming out of the water mains (100) to said internal water delivery circuit (12); an electrically-operated valve assembly (14) which comprises at least one electrically-operated main valve (20) interposed between the internal water delivery circuit (12) and the external water-feeding line (13) for controlling the flow of water entering into the casing (2); and an electrically-operated, auxiliary valve (15) which is interposed between the water mains (100) and the ex-

ternal water-feeding line (13) for directly controlling the passage of water from the water mains to the external water-feeding line (13); and an electronic control unit (28) which controls said electrically-operated main valve (20) and said electrically-operated auxiliary valve (15), and which is configured to open said main valve (20) and said auxiliary valve (15) following a predetermined opening sequence, and/or to close said main valve (20) and said auxiliary valve (15) following a predetermined closing sequence; said opening sequence providing to open the main valve (20), then to wait until a predetermined opening delay-time (ΔT_O) has passed, and then to open the auxiliary valve (15); the closing sequence providing to close the auxiliary valve (15), then to wait until a predetermined closing delay-time (ΔT_C) has passed, and then to close the main valve (20).

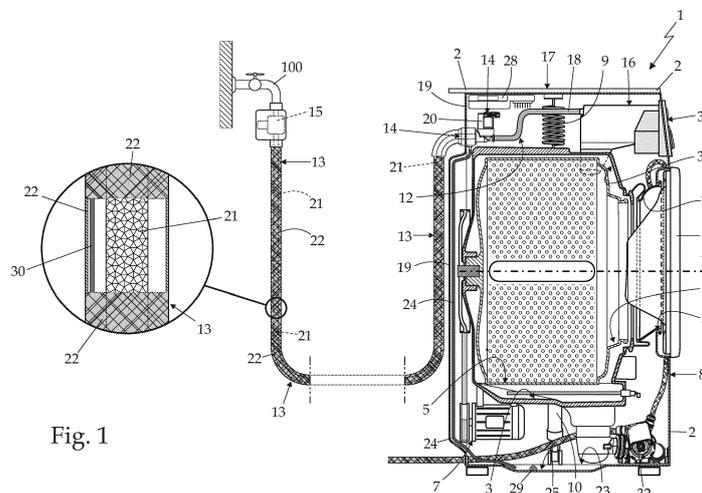


Fig. 1

Description

[0001] The present invention relates to a laundry washing machine.

[0002] More in particular, the present invention relates to a laundry home washing machine and to the operating method of such laundry washing machine, use to which the following description refers purely by way of example without this implying any loss of generality.

[0003] As is known, a home laundry washing machine generally comprises: a substantially parallelepiped-shaped, outer boxlike casing structured for resting on the floor; an approximately cylindrical washing tub which is usually suspended in floating manner inside the casing either vertically or horizontally, with the mouth directly facing a laundry loading-unloading through opening realized either in the top or in the front wall of the casing; a substantially cylindrical, cup-shaped rotatable drum structured for housing the laundry to be washed, and which is fitted in axially rotatable manner inside the washing tub; an elastically-deformable bellows which watertight connects the mouth of the washing tub to the laundry loading-unloading opening formed in the top or front wall of the casing; a manually-operated door which is hinged to the top or front wall of the casing so as to be able to rotate to and from a closing position in which the door closes the laundry loading-unloading opening for watertight sealing the washing tub; and an electrically-powered motor assembly which is capable of driving into rotation the rotatable drum about its longitudinal axis inside the washing tub.

[0004] Inside the casing, the home laundry washing machine furthermore comprises: an electrically-operated detergent dispenser which is generally located immediately above the washing tub, and is structured for selectively feeding into the washing tub a given amount of detergent, softener and/or other washing agent suitably mixed with the water arriving from the water mains; an electrically-operated, water supply circuit which is connectable to the water mains via an external water-feeding line, and is structured for selectively channelling the water of the water mains towards the detergent dispenser or directly towards the washing tub according to the washing cycle manually-selected by the user; and an electronic control unit which controls the motor assembly, the detergent dispenser and the water supply circuit so as to perform the washing cycle selected by the user via an appliance control panel generally located on front wall of the casing.

[0005] More specifically, the water supply circuit generally comprises an electrically-operated valve assembly which is usually attached to the rear wall of the casing, and a series of short connection pipes which connect said valve assembly to the detergent dispenser and to the washing tub.

[0006] The external water-feeding line, in turn, basically consists in a long flexible hosepipe having a distal end suitably structured to watertight couple in detachable

manner with the tap of the water mains, and a proximal end suitably structured to watertight couple with the water inlet of the electrically-operated valve assembly, at the rear wall of the casing.

[0007] To prevent water leakages, in high-end laundry washing machines the distal end of the flexible hosepipe is provided with a normally-closed, auxiliary solenoid valve which is directly controlled by the electronic control unit and is interposed between the tap of the water mains and the flexible hosepipe for directly controlling the entry of water into the flexible hosepipe.

[0008] Generally the flexible hosepipe is furthermore surrounded for the whole length by an outer tubular sheath which channels any water leakage of the hosepipe towards the valve assembly. The valve assembly, in turn, is structured to drain/ channel the water leakages flowing along the outer tubular sheath onto the bottom of the boxlike casing wherein the water accumulates.

[0009] For safety reasons, the electronic control unit opens the solenoid valve at the distal end of the flexible hosepipe only when loading of water is requested by the washing cycle and only contemporaneously to any of the solenoid valves of the valve assembly of the water supply circuit.

[0010] Moreover, when detects the presence of water on the bottom the boxlike casing during the loading of water, the electronic control unit is additionally configured to immediately close the solenoid valve to watertight isolate the flexible hosepipe from the water mains, to stop the washing cycle, to activate the drain pump of the laundry washing machine, and finally to alert the user by activating a warning light on the control panel.

[0011] Unfortunately the abrupt closure of the solenoid valve at the distal end of the flexible hosepipe when the laundry washing machine is drawing water from the water mains occasionally produces a water hammer that, in long term, can seriously damage the flexible hosepipe and/or the valve assembly inside the washing machine with all the problems that this entails.

[0012] Furthermore, the contemporaneous closure of both the valve assembly and the auxiliary solenoid valve at the distal end of the flexible hosepipe always leaves the flexible hosepipe full of pressurized water with all problems that this entails in case of hosepipe breaking.

[0013] Aim of the present invention is to avoid the water hammer to take place.

[0014] In compliance with the above aims, according to the present invention there is provided a laundry washing machine comprising: an outer casing; a washing tub located inside the casing; an internal water delivery circuit which is located inside the casing and is configured for channelling a flow of water towards said washing tub; an external water-feeding line which extends outside the casing, is connectable to the water mains and is configured for channelling the water coming out of the water mains to said internal water delivery circuit; an electrically-operated valve assembly which comprises at least one, electrically-operated main valve interposed be-

tween the internal water delivery circuit and the external water-feeding line for controlling the flow of water entering into the internal water delivery circuit; an electrically-operated, auxiliary valve which is interposed between the water mains and the external water-feeding line for directly controlling the passage of water from the water mains to the external water-feeding line; and an electronic control unit which controls said electrically-operated valve assembly and said electrically-operated auxiliary valve;

the laundry washing machine being characterized in that said electronic control unit is configured to open said main valve and said auxiliary valve following a predetermined opening sequence, and/or to close said main valve and said auxiliary valve following a predetermined closing sequence; said opening sequence providing to open the main valve, then to wait until a predetermined opening delay-time has passed, and then to open the auxiliary valve; the closing sequence providing to close the auxiliary valve, then to wait until a predetermined closing delay-time has passed, and then to close the main valve.

[0015] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that said opening delay-time and/or said closing delay-time is/are greater than 0,5 seconds.

[0016] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that said opening delay-time and/or said closing delay-time range/s between 1 and 3 seconds.

[0017] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that said opening delay-time and/or said closing delay-time is/are equal to approximately 2 seconds.

[0018] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that said main valve and/or said auxiliary valve is/are a normally-closed, electrically-operated on-off valve/s.

[0019] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that said external water-feeding line comprises a flexible hosepipe which has a distal end structured to watertight couple with the water mains, and a proximal end structured to watertight couple with a water inlet of said electrically-operated valve assembly; the auxiliary valve being located at the distal end of said flexible hosepipe for controlling the entry of the water of the water mains into the same flexible hosepipe.

[0020] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that said external water-feeding line additionally comprises an outer tubular sheath which surrounds the flexible hosepipe substantially for the whole length of the same hosepipe so as to collect and channel any water leakage of the flexible hosepipe inside the casing.

[0021] Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that said outer tubular sheath channels any water leakage of the flexible hosepipe towards the casing, and said elec-

trically-operated valve assembly or said water feeding-line is structured to channel the water leakages arriving from said outer tubular sheath towards the bottom of said casing.

5 **[0022]** Preferably, though not necessarily, the laundry washing machine is furthermore characterized by additionally comprising a water sensor which electronically communicates with the electronic control unit, and is capable of detecting the presence / level of water on the
10 bottom of the casing; said electronic control unit being configured to close said main valve and said auxiliary valve according to said closing sequence when the water sensor detects the presence of water on the bottom of the casing.

15 **[0023]** Preferably, though not necessarily, the laundry washing machine is furthermore characterized in that said electronic control unit is configured to detect a malfunctioning of the main valve, and to close said main valve and said auxiliary valve according to said closing sequence in case of malfunctioning of the main valve.

20 **[0024]** Moreover according to the present invention there is provided an operating method of a laundry washing machine that comprises: an outer casing; a washing tub located inside the casing; an internal water delivery

25 circuit which is located inside the casing and is configured for channelling a flow of water towards said washing tub; an external water-feeding line which extends outside the casing, is connectable to the water mains and is configured for channelling the water coming out of the water

30 mains to said internal water delivery circuit; an electrically-operated valve assembly which comprises at least one electrically-operated main valve interposed between the internal water delivery circuit and the external water-feeding line for controlling the flow of water entering into the

35 casing; and an electrically-operated, auxiliary valve which is interposed between the water mains and the external water-feeding line for directly controlling the passage of water from the water mains to the external water-feeding line;

40 said operating method being characterized by comprising the step of opening said main valve and said auxiliary valve following a predetermined opening sequence that provides to open the main valve, then to wait until a predetermined opening delay-time has passed, and then to

45 open the auxiliary valve; and/or the step of closing said main valve and said auxiliary valve following a predetermined closing sequence that provides to close the auxiliary valve, then to wait until a predetermined closing delay-time has passed, and then to close the main valve.

50 **[0025]** Preferably, though not necessarily, the operating method is furthermore characterized in that said opening delay-time and/or said closing delay-time is/are greater than 0,5 seconds.

[0026] Preferably, though not necessarily, the operating method is furthermore characterized in that said opening delay-time and/or said closing delay-time range/s between 1 and 3 seconds.

[0027] Preferably, though not necessarily, the operat-

ing method is furthermore characterized in that said opening delay-time and/or said closing delay-time is/are equal to approximately 2 seconds.

[0028] Finally according to the present invention there is provided an operating method of a laundry washing machine characterized by comprising, in case of detection of a water leakage from the external water-feeding line of the laundry washing machine, the step of closing the valves located upstream and downstream of said water-feeding line according to a predetermined closing sequence that provides to close the upstream valve, then to wait until a predetermined closing delay-time has passed, and then to close the downstream valve.

[0029] Preferably, though not necessarily, the operating method is furthermore characterized in that said closing delay-time is greater than 0,5 seconds.

[0030] Preferably, though not necessarily, the operating method is furthermore characterized in that said closing delay-time ranges between 1 and 3 seconds.

[0031] Preferably, though not necessarily, the operating method is furthermore characterized in that said closing delay-time is equal to approximately 2 seconds.

[0032] 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 side view of a laundry washing machine realized in accordance with the teachings of the present invention, with parts removed for clarity; whereas
- Figures 2 and 3 are respective flowcharts disclosing respective operations performed by the Figure 1 laundry washing machine.

[0033] With reference to Figure 1, reference number 1 indicates as a whole a laundry washing machine 1 which preferably basically comprises: a preferably substantially parallelepiped-shaped, outer boxlike casing 2 structured for resting on the floor; an approximately cylindrical washing tub 3 which is arranged into the casing 2 with the mouth watertight communicating with a laundry loading-unloading through opening 4 realized on a wall of the casing 2; a substantially cylindrical, cup-shaped rotatable drum 5 structured for housing the laundry to be washed, and which is fitted in axially rotatable manner inside the washing tub 3; a manually-operated door 6 which is hinged to the casing 2 so as to be able to rotate to and from a closing position in which the door 6 closes the laundry loading-unloading opening 4 to watertight sealing the washing tub 3; and an electrically-powered motor assembly 7 which is capable of driving into rotation the rotatable drum 5 about its longitudinal axis L inside the washing tub 3.

[0034] In the example shown, in particular, laundry washing machine 1 is preferably a front-loading home laundry washing machine, therefore the washing tub 3 is preferably arranged inside the casing 2 with the mouth directly facing a laundry loading-unloading through open-

ing 4 realized in a front wall 8 of the casing 2.

[0035] Preferably the washing tub 3 is moreover suspended in floating manner inside the casing 2 via a suspension system which preferably, though not necessarily, comprises at least one and preferably a couple of upper coil springs 9 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 10 connecting the bottom portion of washing tub 3 to the bottom of boxlike casing 2.

[0036] In addition, the laundry washing machine 1 preferably furthermore comprises an elastically-deformable tubular bellows 11 which watertight connects the mouth of washing tub 3 to the laundry loading-unloading opening 4 formed in front wall 7 of casing 2.

[0037] The rotatable drum 4, in turn, is preferably arranged inside the washing tub 3 with its longitudinal axis L oriented substantially horizontally and preferably also locally substantially coaxial to the washing tub 3, so that the circular front mouth of the drum is locally substantially horizontally aligned and faced to the laundry loading-unloading opening 4 on front wall 8.

[0038] The door 6, on the other hand, is preferably hinged to the front wall 8 of casing 2 so as to be manually rotatable about a preferably substantially vertically-oriented, reference axis to and from a closing position in which the door 6 abuts against the front wall 8 of casing 2 so as to watertight seal the laundry loading-unloading opening 4.

[0039] With reference to Figure 1, the laundry washing machine 1 furthermore comprises: an internal water delivery circuit 12 which is located inside the casing 2, and is configured for channelling the water of the water mains towards at least the washing tub 3; an external water-feeding line 13 which extends outside the casing 2, is connectable to the water mains, and is configured for channelling the water coming out from the water mains to the internal water delivery circuit 12; an electrically-operated valve assembly 14 which is interposed between the internal water delivery circuit 12 and the external water-feeding line 13 for directly controlling the flow of water entering into the casing 2; and an electrically-operated on-off valve 15, such as for example a solenoid valve, which is interposed between the water mains and the external water-feeding line 13 for directly controlling the passage of water from the water mains to the external water-feeding line 13.

[0040] More in detail, in the example shown the laundry washing machine 1 preferably comprises a detergent dispenser 16 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 17 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 water. The internal water delivery circuit 12, on the other hand, preferably comprises a first water sup-

ply line 18 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 17 of casing 2, and is configured for selectively channelling the water arriving from the external water-feeding line 13 towards the detergent dispenser 16; and preferably also a second water supply line (not shown) which is configured for selectively channelling the water arriving from the external water-feeding line 13 directly towards the washing tub 3.

[0041] The electrically-operated valve assembly 14, in turn, is preferably interposed between the external water-feeding line 13 and the inner water supply line/s of the internal water delivery circuit 12.

[0042] With reference to Figure 1, furthermore the electrically-operated valve assembly 14 is preferably attached to a rear wall 19 of casing 2, preferably inside the casing 2, and comprises at least one electrically-operated on-off valve 20, such as for example a solenoid valve, which is interposed between the external water-feeding line 13 and the internal water delivery circuit 12 for directly controlling the flow of water entering into the internal water delivery circuit 12 directed towards the detergent dispenser 16 and / or towards the washing tub 3. Preferably said at-least-one electrically-operated on-off valve 20 is furthermore a normally-closed on-off valve that opens when energized.

[0043] More specifically, in the example shown the electrically-operated valve assembly 14 preferably comprises two electrically-operated on-off valves 20. A first electrically-operated on-off valve 20 is interposed between the external water-feeding line 13 and the water supply line 18 of the internal water delivery circuit 12 for controlling the flow of water towards the detergent dispenser 16 according to the washing cycle manually-selected by the user. The second electrically-operated on-off valve (not shown) is preferably interposed between the external water-feeding line 13 and the second water supply line (not shown) of the internal water delivery circuit 12 for controlling the flow of water towards the washing tub 3 according to the washing cycle manually-selected by the user.

[0044] According to a non-shown alternative embodiment, however, the at-least-one electrically-operated on-off valve/s 20 of valve assembly 14 could be attached to the rear wall 19, outside of casing 2.

[0045] With reference to Figure 1, the external water-feeding line 13, in turn, preferably basically comprises a long flexible hosepipe 21 which has a distal end suitably structured to watertight couple, preferably in easy detachable manner, with a generic tap 100 of the water mains, and a proximal end suitably structured to watertight couple, preferably in easy detachable manner, with the water inlet of the valve assembly 14, preferably at rear wall 19, so as to be able to channel the water coming out from tap 100 to the water inlet of valve assembly 14, or better to the on-off valve/s 20.

[0046] More in detail, the distal end of flexible hosepipe

21 is preferably provided with a manually-operated, screw connecting member or snap-on connecting member allowing the watertight detachable coupling of flexible hosepipe 21 to tap 100.

[0047] The electrically-operated on-off valve 15 is preferably located at the distal end of hosepipe 21, immediately downstream of tap 100, and directly controls, by opening and closing, the entry of the water of the water mains into the flexible hosepipe 21. Preferably furthermore the electrically-operated on-off valve 15 is a normally-closed on-off valve that opens when energized.

[0048] In addition to the above, the external water-feeding line 13 preferably also comprises an outer tubular sheath 22 which surrounds the flexible hosepipe 21 substantially for the whole length of the same hosepipe 21, i.e. from the distal end to the proximal end of the hosepipe, so as to collect and channel any water leakage of the flexible hosepipe 21 into the casing 2.

[0049] More specifically, the outer tubular sheath 22 is preferably structured to collect and channel any water leakage of the flexible hosepipe 21 toward the casing, preferably to the electrically-operated valve assembly 14. The electrically-operated valve assembly 14, in turn, is preferably structured to channel the water leakages arriving from the outer tubular sheath 22 towards the bottom 23 of the casing 2 preferably via a drain pipe 24 that branches off from the same valve assembly 14 and extends downwards inside the casing 2 preferably up to reach a substantially basin-shaped bottom portion 25 of boxlike casing 2.

[0050] According to a further non-shown alternative embodiment, however, the outer tubular sheath 22 could be hydraulically connected directly to drain pipe 24, bypassing the valve assembly 14.

[0051] With reference to Figure 1, the laundry washing machine 1 furthermore comprises: an electronic control unit 28 which is preferably located inside the casing 2, preferably, though not necessarily, immediately beneath the upper worktop or top wall 17, and is configured to control the motor assembly 7, the valve assembly 14, the auxiliary on-off valve 15 and, if possible, also the detergent dispenser 16, so as to automatically perform the washing cycle; and optionally also a water sensor 29 connected with the electronic control unit 28 which switches / electronically communicates with the electronic control unit 28 and is capable of detecting the presence / level of water on the bottom 23 of the boxlike casing 2, or better into the basin-shaped bottom portion 25 of casing 2.

[0052] According to a non-shown alternative embodiment, however, the electrically-operated on-off valve 15 could be directly controlled by an auxiliary electronic control unit which is preferably located on the distal end of flexible hosepipe 21, close to on-off valve 15, and electronically communicates with electronic control unit 28. Said auxiliary electronic control unit is therefore discrete from electronic control unit 28.

[0053] In the example shown, in particular, electronic control unit 28 is preferably electrically connected to the

on-off valve 15 via a power cable 30 extending inside the outer tubular sheath 22, for the whole length of flexible hosepipe 21, and is configured to control at least the motor assembly 7, the on-off valve 15, the on-off valve/s 20 of valve assembly 14 and, if possible, also the detergent dispenser 16, so as to automatically perform the washing cycle manually-selected by the user preferably via an appliance control panel 31 which is preferably located on front wall 8 of the outer casing 2, preferably, though not necessarily, immediately underneath the upper worktop or top wall 17.

[0054] In addition to the above, at least when loading of water from the water mains is requested by the washing cycle, the electronic control unit 28 is furthermore configured to open the on-off valve 15 and the on-off valve/s 20 of valve assembly 14 following a predetermined opening sequence, and/or to close the on-off valve 15 and the on-off valve/s 20 of valve assembly 14 following a predetermined closing sequence.

[0055] The opening sequence basically provides to firstly open the on-off valve/s 20 located downstream of flexible hosepipe 21, then to wait until a predetermined opening delay-time ΔT_O preferably greater than 0,5 s (seconds) has passed, and lastly to open the on-off valve 15 located upstream of flexible hosepipe 21.

[0056] The closing sequence, in turn, basically provides to firstly close the on-off valve 15 located upstream of flexible hosepipe 21, then to wait until a predetermined closing delay-time ΔT_C preferably greater than 0,5 s (seconds) has passed, and lastly to close the on-off valve/s 20 located downstream of flexible hosepipe 21 to watertight isolate the flexible hosepipe 21.

[0057] More in detail, when determines that the condition to start drawing water from the water mains are met, the electronic control unit 28 of laundry washing machine 1 operates the opening sequence disclosed in Figure 2.

[0058] In step 101, the electronic control unit 28 opens, preferably energizes, the on-off valve/s located downstream of flexible hosepipe 21, i.e. the on-off valve/s 20 of valve assembly 14, thus to put the internal water delivery circuit 12 in fluid communication with the flexible hosepipe 21.

[0059] In step 102, the electronic control unit 28 waits until the actual time as from the opening of the downstream on-off valve 19 is equal to delay-time ΔT_O .

[0060] And finally in step 103, the electronic control unit 28 opens, preferably energizes, the on-off valve located upstream of flexible hosepipe 21, i.e. the on-off valve 15, so as to allow the water coming out from tap 100 to freely flow along flexible hosepipe 21 up to the internal water delivery circuit 12 which, in turn, supplies said water to the detergent dispenser 16 and/or the washing tub 3.

[0061] In the example shown, in particular, the opening delay-time ΔT_O preferably ranges between 1 s and 3 s (seconds). More specifically, the opening delay-time ΔT_O is preferably, though not necessarily, equal to approximately 2 s (seconds).

[0062] As an alternative, the value of the opening delay-time ΔT_O is settable according to the length of the flexible pipe 21 and/or of the type and/or the response time of the electronically-operated on-off valve 15 and/or 19.

[0063] When instead determines that the condition to stop drawing water from the water mains are met, the electronic control unit 28 of laundry washing machine 1 operates the closing sequence disclosed in Figure 3.

[0064] In step 201, the electronic control unit 28 closes, preferably stops energizing, the on-off valve located upstream of flexible hosepipe 21, i.e. the on-off valve 15, to watertight isolate the flexible hosepipe 21 from the water mains.

[0065] In step 202, the electronic control unit 28 waits until the actual time as from the opening of the upstream on-off valve 16 is equal to delay-time ΔT_C .

[0066] And finally in step 203, the electronic control unit 28 closes, preferably stops energizing, the on-off valve located downstream of flexible hosepipe 21, i.e. the on-off valve/s 20 of valve assembly 14, so as to watertight isolate the flexible hosepipe 21 also from the water delivery circuit 12.

[0067] In the example shown, in particular, the closing delay-time ΔT_C preferably ranges between 1 s and 3 s (seconds). More specifically, the closing delay-time ΔT_C is preferably, though not necessarily, equal to approximately 2 s (seconds).

[0068] As an alternative, the value of the closing delay-time ΔT_C is settable according to the actual length of the flexible pipe 21 and/or of the type and/or the response time of the electronically-operated on-off valve 15 and/or 19.

[0069] More specifically, the value of the closing delay-time ΔT_C could be settable thus to substantially reaching a low pressure of water inside the flexible pipe 21.

[0070] Preferably, though not necessarily, the opening delay-time ΔT_O and the closing delay-time ΔT_C could also be equal to one another.

[0071] General operation of the laundry washing machine 1 is clearly inferable from the description above.

[0072] In addition, when the water sensor 29 detects the presence of water on the bottom 23 of casing 2 (for example the level of water on the bottom 23 exceeds a given threshold value) during loading of water, the electronic control unit 28 is additionally configured to immediately close the on-off valve 15 and the on-off valve 20 of valve assembly 14, preferably according to the aforesaid closing sequence, thus to watertight isolate the laundry washing machine 1 from the water mains, and then to stop the washing cycle. Afterwards the electronic control unit 28 is configured to preferably activate the drain pump 32 thus to quickly drain the water out of washing tub 3, and to alert the user preferably by activating a warning light on the control panel 31.

[0073] If instead the water sensor 29 detects the presence / level of water on the bottom 23 of casing 2 in any other step of the washing cycle, the electronic control

unit 28 is configured to keep the on-off valve 15 and the on-off valve/s 20 closed, to preferably activate the drain pump 32, and finally to alert the user preferably by activating a warning light on the control panel 31.

[0074] In addition to the above, the electronic control unit 28 is preferably additionally configured to detect any malfunctioning of the on-off valve/s 20 of valve assembly 14, and to immediately close the on-off valve 15 and the on-off valve 20 of valve assembly 14, preferably according to the aforesaid closing sequence, in case of unexpected malfunctioning of the on-off valve/s 20 of valve assembly 14.

[0075] More specifically, the electronic control unit 28 is preferably capable of monitoring the operation of the electrically-operated on-off valve/s 20 of valve assembly 14 via a traditional electronic flow-meter or pressure-switch or pressure gauge (not shown) preferably incorporated into the valve assembly 14 or alternatively divided / distinct from said valve assembly 14, either upstream or downstream of said on-off valve/s 20, and is preferably configured to immediately close the on-off valve 15 and the on-off valve 20, preferably according to the aforesaid closing sequence, when detects a malfunctioning of the on-off valve/s 20 of valve assembly 14.

[0076] The advantages resulting from driving the on-off valve 15 and the on-off valve/s 20 according to the opening sequence and/or closing sequence are highly remarkable.

[0077] The applicant has found that the aforesaid opening sequence and closing sequence can avoid the drawbacks related to the water hammer, thus reducing the every-day mechanical stresses to the hydraulic system of the laundry washing machine 1. Furthermore the closing sequence leaves, at the end of the water loading phase of the washing cycle, the flexible hosepipe 21 unpressurized and almost empty of water, thus significantly reducing the risks of flooding the roof in case of breaking of the hosepipe 21 or in case of machine servicing.

[0078] Clearly, changes may be made to the laundry washing machine 1 without, however, departing from the scope of the present invention.

[0079] For example, rather than to suddenly interrupt the washing cycle in case of unexpected malfunctioning of the on-off valve 20 of valve assembly 14, the electronic control unit 28 may be configured to temporarily keep the on-off valve 20 wide opened and use solely the on-off valve 15 to directly control the supply of water of the water mains to the detergent dispenser 16 and/or the washing tub 3 thus to correctly finalize the washing cycle.

Claims

1. A laundry washing machine (1) comprising: an outer casing (2); a washing tub (3) located inside the casing (2); an internal water delivery circuit (12) which is located inside the casing (2) and is configured for channelling a flow of water towards said washing tub

(3); an external water-feeding line (13) which extends outside the casing (2), is connectable to the water mains (100) and is configured for channelling the water coming out of the water mains (100) to said internal water delivery circuit (12); an electrically-operated valve assembly (14) which comprises at least one electrically-operated main valve (20) interposed between the internal water delivery circuit (12) and the external water-feeding line (13) for controlling the flow of water entering into the internal water delivery circuit (12); an electrically-operated, auxiliary valve (15) which is interposed between the water mains (100) and the external water-feeding line (13) for directly controlling the passage of water from the water mains to the external water-feeding line (13); and an electronic control unit (28) which controls said electrically-operated valve assembly (14) and said electrically-operated auxiliary valve (15); the laundry washing machine (1) being **characterized in that** said electronic control unit (28) is configured to open said main valve (20) and said auxiliary valve (15) following a predetermined opening sequence, and/or to close said main valve (20) and said auxiliary valve (15) following a predetermined closing sequence; said opening sequence providing to open the main valve (20), then to wait until a predetermined opening delay-time (ΔT_O) has passed, and then to open the auxiliary valve (15); the closing sequence providing to close the auxiliary valve (15), then to wait until a predetermined closing delay-time (ΔT_C) has passed, and then to close the main valve (20).

2. Laundry washing machine according to Claim 1, **characterized in that** said opening delay-time (ΔT_O) and/or said closing delay-time (ΔT_C) is/are greater than 0,5 seconds.
3. Laundry washing machine according to Claim 2, **characterized in that** said opening delay-time (ΔT_O) and/or said closing delay-time (ΔT_C) range/s between 1 and 3 seconds.
4. Laundry washing machine according to Claim 3, **characterized in that** said opening delay-time (ΔT_O) and/or said closing delay-time (ΔT_C) is/are equal to approximately 2 seconds.
5. Laundry washing machine according to any one of the preceding claims, **characterized in that** said main valve (20) and/or said auxiliary valve (15) is/are a normally-closed, electrically-operated on-off valve/s.
6. Laundry washing machine according to any one of the preceding claims, **characterized in that** said external water-feeding line (13) comprises a flexible hosepipe (21) which has a distal end structured to

- watertight couple with the water mains (100), and a proximal end structured to watertight couple with a water inlet of said electrically-operated valve assembly (14); the auxiliary valve (15) being located at the distal end of said flexible hosepipe (21) for controlling the entry of the water of the water mains (100) into the same flexible hosepipe (21).
7. Laundry washing machine according to Claim 6, **characterized in that** said external water-feeding line (13) additionally comprises an outer tubular sheath (22) which surrounds the flexible hosepipe (21) substantially for the whole length of the same hosepipe (21) so as to collect and channel any water leakage of the flexible hosepipe (21) inside the casing (2).
 8. Laundry washing machine according to Claim 7, **characterized in that** said outer tubular sheath (22) channels any water leakage of the flexible hosepipe (21) towards the casing (2), and said electrically-operated valve assembly (14) or said water feeding line (13) is structured to channel the water leakages arriving from said outer tubular sheath (22) towards the bottom (23) of said casing (2).
 9. Laundry washing machine according to any one of the preceding claims, **characterized by** additionally comprising a water sensor (29) which electronically communicates with the electronic control unit (28), and is capable of detecting the presence of water on the bottom (23) of the casing (2); said electronic control unit (28) being configured to close said main valve (20) and said auxiliary valve (15) according to said closing sequence when the water sensor (29) detects the presence / level of water on the bottom (23) of the casing (2).
 10. Laundry washing machine according to any one of the preceding claims, **characterized in that** said electronic control unit (28) is configured to detect a malfunctioning of the main valve (20), and to close said main valve (20) and said auxiliary valve (15) according to said closing sequence in case of malfunctioning of the main valve (20).
 11. Operating method of a laundry washing machine (1) that comprises: an outer casing (2); a washing tub (3) located inside the casing (2); an internal water delivery circuit (12) which is located inside the casing (2) and is configured for channelling a flow of water towards said washing tub (3); an external water-feeding line (13) which extends outside the casing (2), is connectable to the water mains (100) and is configured for channelling the water coming out of the water mains (100) to said internal water delivery circuit (12); an electrically-operated valve assembly (14) which comprises at least one electrically-operated main valve (20) interposed between the internal water delivery circuit (12) and the external water-feeding line (13) for controlling the flow of water entering into the casing (2); and an electrically-operated, auxiliary valve (15) which is interposed between the water mains (100) and the external water-feeding line (13) for directly controlling the passage of water from the water mains to the external water-feeding line (13); said operating method being **characterized by** comprising the step of opening said main valve (20) and said auxiliary valve (15) following a predetermined opening sequence that provides to open the main valve (20), then to wait until a predetermined opening delay-time (ΔT_O) has passed, and then to open the auxiliary valve (15); and/or the step of closing said main valve (20) and said auxiliary valve (15) following a predetermined closing sequence that provides to close the auxiliary valve (15), then to wait until a predetermined closing delay-time (ΔT_C) has passed, and then to close the main valve (20).
 12. Operating method according to Claim 11, **characterized in that** said opening delay-time (ΔT_O) and/or said closing delay-time (ΔT_C) is/are greater than 0,5 seconds.
 13. Operating method according to Claim 12, **characterized in that** said opening delay-time (ΔT_O) and/or said closing delay-time (ΔT_C) range/s between 1 and 3 seconds.
 14. Operating method according to Claim 13, **characterized in that** said opening delay-time (ΔT_O) and/or said closing delay-time (ΔT_C) is/are equal to approximately 2 seconds.
 15. Operating method of a laundry washing machine (1) **characterized by** comprising, in case of detection of a water leakage from the external water-feeding line (13) of the laundry washing machine (1), the step of closing the valves (15, 20) located upstream and downstream of said water-feeding line (13) according to any one of Claims from 11 to 14.

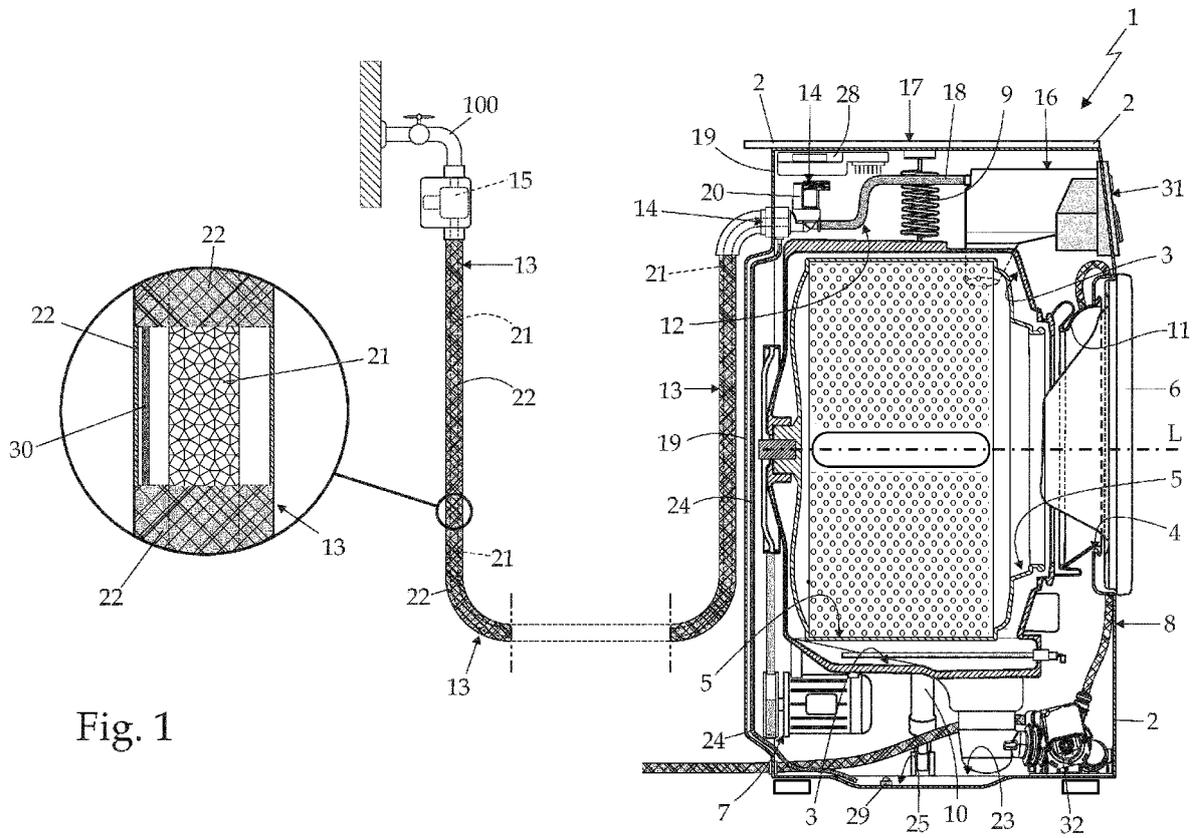


Fig. 1

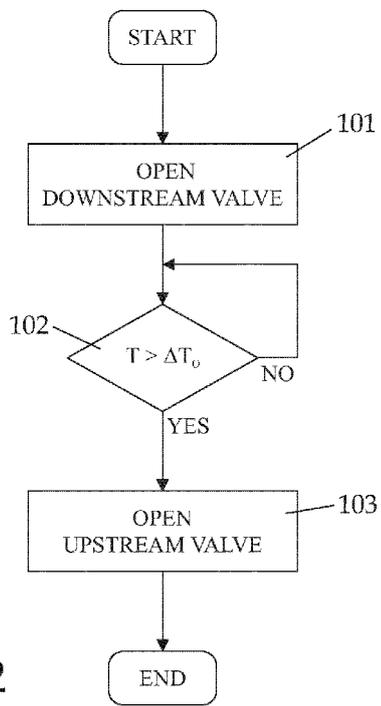


Fig. 2

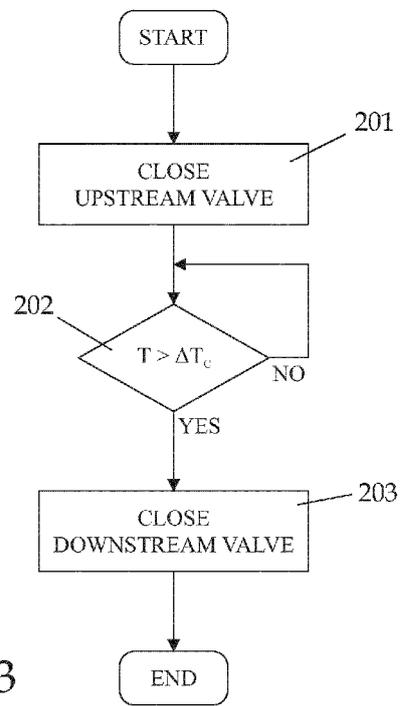


Fig. 3



EUROPEAN SEARCH REPORT

Application Number
EP 15 17 9234

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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 8 October 2015	Examiner Sabatucci, Arianna
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The members are as contained in the European Patent Office EDP file on
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