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# (54) LAUNDRY TREATMENT APPLIANCE WITH WATER SOFTENING SYSTEM

(57) A laundry treatment appliance is provided. The laundry treatment appliance comprises:
- a water inlet (122) configured to receive water from an external water supply;
- a washing tub (110) housing a rotatable drum adapted to receive laundry to be treated;
- an apparatus (125) for supplying process water into the washing tub;
- a water softening system (150) configured to receive water from the water inlet and to supply soft water to the apparatus for supplying process water into the washing tub, wherein said water softening system comprises:
- a water softening agent container (155) storing a water softening agent capable of reducing hardness of water, said water softening agent container having a first input (175) fluidly coupled to the water inlet to receive water and an output (180) to provide soft water obtained from the received water, and
- a water tank (160) having an input (182) configured to be selectively in fluid communication with said output of the water softening agent container and a first output (184) in fluid communication with said apparatus for supplying process water into the washing tub, said water tank being configured for storing a reserve of soft water and for supplying with soft water said apparatus for supplying process water into the washing tub.

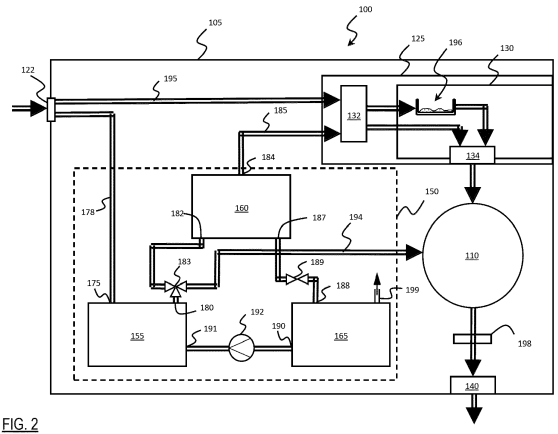


FIG. 2

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## Description

### Field of the invention

**[0001]** The present invention generally relates to the field of laundry treatment appliances (hereinafter, concisely, "laundry appliances"), and particularly to laundry appliances for treating, *e.g*. washing, laundry, such as laundry washing appliances and laundry washing appliances also implementing laundry drying functions (also referred to as washers/dryers).

### Background of the invention

**[0002]** Laundry appliances are configured to treat laundry located in a (*e.g.,* rotatable) drum by providing process water in a washing tub housing the rotatable drum.

**[0003]** By process water it is generally intended plain water or water mixed with proper (*e.g.*, liquid and powder) treatment agents, including, but not limited to, washing detergents, rinsing detergents, bleaches and softeners detergents, softeners, bleaches, dyes.

**[0004]** The hardness of the water may negatively affect the performance of a laundry appliance. Indeed, laundry treated using excessively hard water may require higher temperatures, and even if high temperatures are used, the result of the laundry treatment can be not satisfactory. Moreover, laundry treated using hard water may become stiff, subjected to premature tear and wear, and cause skin irritation. In addition, the parts of the laundry appliance that are in direct contact with water (*e.g.,* ducts, tanks, valves, heater resistors) may become encrusted with limestone, impairing the correct operation of the laundry appliance.

**[0005]** For that reason, it is known to equip the laundry appliance with a water softening system configured to reduce hardness of water, so that the laundry can be advantageously treated with softer water. A water softening system comprises a container containing a water softening agent (*e.g., a* ion-exchange resin) capable of reducing hardness of water by promoting exchange of the minerals dissolved in water causing hardness (*e.g*., calcium and magnesium) for a soft mineral that does not build up on surfaces, such as sodium. After several uses, the water softening agent get exhausted, strongly reducing the water softening performances. For that reason, the water softening system further comprises a (refillable) container for storing a regenerating agent, usually salt, to be used for regenerating the exhausted softening agent during a water softening agent regeneration procedure.

**[0006]** According to a solution known in the art, the water softening system is provided at the drawer of the laundry appliance where compartments for containing the treatment agents are located, for example directly integrated in the drawer itself and/or in a drawer seat of the laundry appliance for slidably housing the drawer.

**[0007]** Another solution known in the art is disclosed in EP0190675. EP0190675 discloses a washing machine having a detergent supply box and a water softening device. The water softening device comprises a softening part, a replenishable salt container and a water chamber, which is to be filled with fresh water and has a means for preventing back-flow incorporated therein, which means is connected upstream of the softening part. The softening part and the salt container are disposed in a lower region of the machine and are connected to the water chamber, situated thereabove, by means of pipes in that the soft water outlet of the softening part is connected to the detergent supply box, situated in an upper portion of the machine, by means of a pipe, and in that a branch is fitted in this connection pipe and a pipe extends from said branch to the discharge system of the washing machine.

### Summary of invention

**[0008]** The Applicant has realized that the known solutions for implementing water softening systems for laundry appliances are not satisfactory.

**[0009]** A drawback affecting the solution in which the water softening system is provided at the drawer of the laundry appliance is the scarce space available for the water softening agent container and the salt container. Because of that, a user of the laundry appliance is disadvantageously forced to refill the salt container with new salt with a relatively high frequency.

**[0010]** The solution provided in EP1960675 provides that fresh water provided from an external water supply is stored in a water chamber before being supplied to the softening part for reducing the hardness thereof. Directly storing - possibly hard - fresh water coming from an external water supply in a water chamber is not efficient because it may cause the formation of limestone on the walls of the water chamber, capable of impairing the correct operation of the laundry appliance.

**[0011]** In view of the above, the Applicant has devised a solution for implementing a water softening system for a laundry appliance that is not affected by the abovementioned drawbacks.

**[0012]** Particularly, an aspect of the present invention relates to a laundry treatment appliance comprising:

- a water inlet configured to receive water from an external water supply;
- a washing tub housing a rotatable drum adapted to receive laundry to be treated;
- an apparatus for supplying process water into the washing tub;
- a water softening system configured to receive water from the water inlet and to supply soft water to the apparatus for supplying process water into the washing tub, wherein said water softening system comprises:
- a water softening agent container storing a water softening agent capable of reducing hardness of wa-

ter, said water softening agent container having a first input fluidly coupled to the water inlet to receive water and a output to provide soft water obtained from the received water, and

- a water tank having an input configured to be selectively in fluid communication with said output of the water softening agent container and a first output in fluid communication with said apparatus for supplying process water into the washing tub, said water tank being configured for storing a reserve of soft water and for supplying with soft water said apparatus for supplying process water into the washing tub.

**[0013]** In this way, the process water fed into the washing tub used for treating laundry advantageously comprises soft water.

**[0014]** The proposed laundry treatment appliance comprises a water softening system arranged in such a way that water is softened just after it reaches the laundry treatment appliance through the water inlet. Indeed, since the water tank is fluidly coupled downstream the water softening agent container, the water softening agent container only stores soft water. The peculiar arrangement of the water softening agent container and of the water tank with respect to each other and also with respect to the water inlet are such to reduce the number of components of the laundry treatment appliance that can be in contact with hard water. In this way, formation of limestone on laundry appliance components (such as on the walls of the water tank) that can potentially impair the correct operation of the laundry appliance are avoided or at least strongly reduced.

**[0015]** According to an embodiment of the invention, the laundry treatment appliance further comprises a container for storing a regenerating agent, preferably salt.

**[0016]** According to an embodiment of the invention, the salt container is configured to be selectively in fluid communication with a second output of the water tank for receiving soft water.

**[0017]** According to an embodiment of the present invention, the water softening agent container, the water tank and/or the salt container are located on or close to a bottom of the laundry treatment appliance.

**[0018]** According to an embodiment of the present invention, the water softening agent container is located on the bottom at a rear portion of the laundry treatment appliance, the salt container is located on the bottom at a front portion of the laundry treatment appliance, and the water tank is located above the water softening agent container.

**[0019]** In this way, it is advantageously possible to use a water softening agent container, a water tank and/or a salt container having a substantially large size, improving the user experience without impairing the performance of the laundry treatment.

**[0020]** According to an embodiment of the present invention, said container for storing salt comprises an output fluidly connected to a second input of the water softening agent container to provide brine to the water softening agent container during a water softening agent regeneration procedure for regenerating said water softening agent.

**[0021]** According to an embodiment of the present invention, said brine comprises soft water received from the soft water tank mixed with stored salt.

**[0022]** According to an embodiment of the present invention, the water softening agent container is configured to be selectively in fluid communication with a drain of the laundry treatment appliance for allowing brine mixed with residuals of the water softening agent regeneration contained in the water softening agent container to be discharged into the drain.

**[0023]** In this way, the brine mixed with residuals of the water softening agent regeneration, before reaching the drain, can be advantageously filtered by a drain filter element located upstream the drain, so that anti-pollution standards can be respected.

**[0024]** According to an embodiment of the present invention, the water softening system further comprises a soft water tank valve at the second output of the soft water tank configured to be selectively opened during said water softening agent regeneration procedure for selectively causing soft water stored in the soft water tank flow into the salt container thus generating said brine.

**[0025]** According to an embodiment of the present invention, the water softening system further comprises a pump device configured to be selectively activated during said water softening agent regeneration procedure for selectively causing brine generated in said salt container be pumped in the water softening agent container through the second input thereof.

**[0026]** According to an embodiment of the present invention, the water softening system further comprises a water softening agent container valve arranged at the output of the water softening agent container.

**[0027]** According to an embodiment of the present invention, said water softening agent container valve is configured to be switched between a first operating mode and a second operating mode.

**[0028]** According to an embodiment of the present invention, when the water softening agent container valve is in the first operating mode, the output of the water softening agent container is in fluid communication with the input of the water tank.

**[0029]** According to an embodiment of the present invention, when the water softening agent container valve is in the second operating mode, the output of the water softening agent container is in fluid communication with said drain of the laundry treatment appliance for allowing brine mixed with residuals of the water softening agent regeneration in the water softening agent container reach said laundry treatment appliance drain.

**[0030]** According to an embodiment of the present invention, when the water softening agent container valve is in the second operating mode, the output of the water softening agent container is in fluid communication with

said drain of the laundry treatment appliance through the washing tub for allowing brine mixed with residuals of the water softening agent regeneration in the water softening agent container reach said laundry treatment appliance drain.

**[0031]** According to an embodiment of the present invention, the water softening agent container valve is configured to be switched in the second operating mode during or after said water softening agent regeneration procedure.

**[0032]** According to an embodiment of the present invention, said water softening agent container valve is further configured to be switched in a third operating mode in which fluid communication between the output of the water softening agent container and the input of the water tank, and fluid communication between the output of the water softening agent container and the drain of the laundry treatment appliance are prevented.

**[0033]** According to an embodiment of the present invention, the laundry treatment appliance further comprises a first duct for allowing fluid communication between the water softening agent container and the drain when the water softening agent container valve is in the second operating mode.

**[0034]** According to an embodiment of the present invention, said water tank is formed in a single piece with said first duct.

**[0035]** According to an embodiment of the present invention, the laundry treatment appliance further comprises a second duct for allowing fluid communication between the water inlet and the first input of the water softening agent container.

**[0036]** According to an embodiment of the present invention, said water tank is formed in a single piece with said first duct and with said second duct.

**[0037]** According to an embodiment of the present invention, said pump device is configured to be temporally deactivated for a predetermined time for allowing brine contained in the water softening agent container to regenerate said water softening agent.

**[0038]** According to an embodiment of the present invention the pump device is configured to be reactivated once said water softening agent container valve is in the second operating mode to pump brine mixed with residuals of the water softening agent regeneration in the water softening agent container towards said laundry treatment appliance drain.

**[0039]** According to an embodiment of the present invention, the salt container comprises an air vent duct configured to allow air inside the salt container exit the salt container by a pressure of soft water coming into the salt container from the water tank.

**[0040]** In this way, the salt container can be filled with soft water in an efficient way, avoiding or at least strongly reducing the formation of undesired air bubbles trapped inside the salt container.

**[0041]** According to an embodiment of the present invention said water softening agent comprises an ion exchange resin.

**[0042]** According to an embodiment of the present invention, said salt container is a refillable salt container adapted to be refilled with amounts of salt.

**[0043]** According to an embodiment of the present invention, said process water deliver apparatus comprises at least one compartment adapted to contain a treatment agent for laundry treatment, and is configured to mix soft water supplied by said soft water tank with said treatment agent.

**[0044]** In this way, the process water fed into the washing tub used for treating laundry may advantageously comprise soft water mixed with treatment agent.

**[0045]** According to an embodiment of the present invention, said laundry treatment appliance is a laundry washing machine or a laundry washing and drying machine.

**[0046]** Another aspect of the present invention relates to a method for operating a laundry treatment appliance. The method comprises:

- supplying a water softening agent container of the laundry treatment appliance storing a water softening agent capable of reducing hardness of water with water received from an external water supply;
- supplying a water tank of the laundry treatment appliance with soft water generated by the water softening agent container from the received water; and
- supplying an apparatus for supplying process water into a washing tub of the laundry treatment appliance with soft water contained in said water tank.

**[0047]** According to an embodiment of the present invention, the method further comprises, during a water softening agent regeneration procedure for regenerating said water softening agent:

- supplying a container for storing salt with soft water contained in said water tank, and
- supplying the water softening agent container with brine comprising soft water received from the soft water tank mixed with stored salt.

**Brief description of the annexed drawings**

**[0048]** These and other features and advantages of the present invention will be made apparent by the following description of some exemplary and non-limitative embodiments thereof; for its better intelligibility, the following description should be read making reference to the attached drawings, wherein:

**Figure 1** is a partially transparent side view of a laundry appliance according to embodiments of the invention, and

**Figure 2** shows in terms of simplified functional blocks an hydraulic circuit of a water softening system of the laundry appliance of **Figure 1** according

to an embodiment of the present invention.

**Detailed description of preferred embodiments of the invention**

**[0049]** With reference to the drawings, **Figure 1** is a, partially transparent, side view of a laundry appliance **100** according to an embodiment of the present invention.

**[0050]** According to the exemplary, not limiting, embodiment herein considered, the laundry appliance **100** is a washing machine. In any case, although in the following description explicit reference will be made to a washing machine, this should not to be construed as a limitation; indeed, the present invention applies to other types of laundry appliances (for example combined washers/dryers, i.e. washing machines also having laundry drying functions).

**[0051]** The laundry appliance **100** comprises a *(e.g.,* parallepiped-shaped) cabinet **105,** which preferably accommodates a washing tub **110.** The washing tub **110** houses a rotatable drum (not shown in the figures) adapted to receive laundry to be treated *(e.g.,* to be washed).

**[0052]** A cabinet front surface has a loading opening **115** providing an access to the drum for loading/unloading the laundry, a door **120** (shown in a closed position in **Figure 1**) being provided for sealable closing the loading opening **115** during the operation of the laundry appliance **100.**

**[0053]** The laundry appliance **100** comprises a water inlet **122** - for example located on a top portion of a back side of the cabinet **105** - configured to receive water from an external water supply.

**[0054]** According to an embodiment of the present invention, the laundry appliance **100** comprises an apparatus **125** for supplying process water into the washing tub 110. According to an embodiment of the present invention, the apparatus **125** for supplying process water comprises a drawer **130** having compartments (not visible in **Figure 1**) for containing one or more treatment agents - such as liquid and powder treatment agents including, but not limited to, washing detergents, rinsing detergents, bleaches and softeners -, a water distribution system **132** for supplying water to the drawer **130** in order to obtain the process water, and a process water outlet **134** for providing the process water obtained in the drawer **130** to the washing tub **110.** The water distribution system **132** is advantageously configured in such a way that water provided to the drawer **130** may be selectively:

- mixed with *(e.g.,* an amount of) a selected one of the treatment agents stored in the compartments of the drawer **130,** so that the process water provided to the washing tub **110** through the process water outlet **134** is water mixed with said selected treatment agent, or
- not mixed with any of the treatment agents stored in the compartments of the drawer **130,** so that the process water provided to the washing tub **110** through the process water outlet **134** is plain water.

**[0055]** According to an embodiment of the present invention, one or more of the compartments of the drawer **130** (briefly referred to as "multi-dose" compartments) are adapted to contain multiple doses of a respective treatment agent for performing multiple washing cycles, so that the laundry appliance **100** is configured to implement an auto-dosing functionality in which, at each washing cycle (and when the auto-dosing functionality is enabled), a predetermined amount of treatment agent is automatically taken *(e.g.* by means of a pumping system) from said multi-dose compartment(s).

**[0056]** According to an embodiment of the present invention one or more of the compartments of the drawer **130** (briefly referred to as "mono-dose" compartments) are adapted to contain a single dose of a respective treatment agent for performing a single washing cycle.

**[0057]** It is pointed out that the concepts of the present invention can be applied to the case in which the drawer **130** only comprises multi-dose compartments, to the case in which the drawer **130** only comprises mono-dose compartments, as well as to the case in which the drawer **130** comprises both multi-dose and mono-dose compartments.

**[0058]** Preferably, the laundry appliance **100** also comprises a drawer seat **136** (preferably provided on a top part of a cabinet front) for housing the drawer **130,** the drawer being advantageously adapted to slide within the drawer seat **136,** along a longitudinal or sliding direction, between an extracted position (not illustrated in **Figure 1**) and a retracted position (shown in **Figure 1**). The sliding direction is for example parallel to a rest surface, such as the floor, on which the laundry appliance **100** preferably rests in operation (*i.e.,* when it is installed in the user premises).

**[0059]** The laundry appliance **100** further comprises a drain **140** for example located on a top portion of a back side of the cabinet **105** - for allowing process water contained in the washing tub **110** to be discharged from the laundry appliance **100.**

**[0060]** Without entering into details well known to those skilled in the art, the laundry appliance **100** also comprises, enclosed in the cabinet **105,** electrical/electronic/mechanical/hydraulic components for the operation of the laundry appliance **100,** such as for example a motor, electromechanical valves, pumps and impellers of the hydraulic apparatus, one or more heating elements for heating water/treatment agents/air.

**[0061]** According to an embodiment of the present invention, the laundry appliance **100** further comprises a water softening system **150** configured to receive water from the water inlet **122** and to supply soft water to the apparatus **125** for supplying process water into the washing tub **110.** In this way, the process water provided by the apparatus **125** for supplying process water into the washing tub **110** is advantageously obtained using soft water, improving the performance of the laundry appli-

ance **100.** Indeed, by using soft water, laundry can be advantageously treated in a satisfactory way without requiring high temperatures, avoiding or at least reducing laundry stiffness, premature tear and wear, and skin irritation caused by the use of excessive hard water.

**[0062]** According to an embodiment of the present invention, the input of the apparatus **125** for supplying process water into the washing tub **110** is also configured to selectively receive water directly from the water inlet **122.** In this way, if the water softening system **150** is not operative, for example because of a malfunctioning, the apparatus **125** for supplying process water into the washing tub **110** can still be supplied with (in this case, not softened) water, bypassing the water softening system **150.**

**[0063]** According to an embodiment of the present invention, the water softening system **150** comprises a water softening agent container **155** configured to store a water softening agent capable of reducing hardness of water.

**[0064]** According to an embodiment of the present invention, the water softening agent comprises an ion-exchange resin.

**[0065]** According to an embodiment of the present invention, the water softening system **150** further comprises a water tank **160** configured to store a reserve of soft water - generated by the water softening agent contained in the water softening agent container **155** - and for supplying with soft water the apparatus **125** for supplying process water into the washing tub **110.**

**[0066]** According to a preferred embodiment of the present invention, the water softening system **150** further comprises a salt container **165** configured to store salt. The salt stored in the salt container **165** is advantageously used for regenerating the water softening agent contained in the water softening agent container **155** during a water softening agent regeneration procedure.

**[0067]** According to an embodiment of the invention, the main components of the water softening system **150** are advantageously located in a bottom portion of the volume enclosed by the casing **105.**

**[0068]** According to an embodiment of the present invention, the water softening agent container **155** is located at a bottom and rear portion of the volume enclosed by the casing **105.**

**[0069]** According to an embodiment of the present invention, the water tank **160** is located (*e.g.*, just) above the water softening agent container **155.**

**[0070]** According to an embodiment of the present invention, the salt container **165** is located at the bottom portion of the volume enclosed by the casing **105,** in front of the water softening agent container **155** so that the salt container **165** can be accessed through an opening **170** provided on the front surface of the casing **105** for allowing the refilling of the salt container **165** with new amounts of salt.

**[0071]** In this way, by exploiting the available space at the bottom and/or rear portions of the volume defined by the casing **105,** it is advantageously possible to use a water softening agent container **155,** a water tank **160** and/or a salt container **165** having a substantially large size, improving the user experience without impairing the performance of the laundry treatment.

**[0072]** According to an embodiment of the present invention, a door **172** is advantageously provided on the front surface of the casing **105** for selectively opening/closing the opening **170.**

**[0073]** According to an embodiment of the present invention, the salt container **165** is advantageously configured to be extracted from the casing **105** through the opening **170** for allowing an easy refilling of salt.

**[0074]** In order to describe in greater detail the water softening system **150** according to the embodiments of the present invention, reference will be made to **Figure 1** together with **Figure 2**, showing, in terms of simplified functional blocks, an hydraulic circuit depicting how the main components of the water softening system **150** are interconnected to each other, and how the water softening system **150** is connected to the apparatus **125** for supplying process water into the washing tub **11** and to the water inlet **122.**

**[0075]** According to an embodiment of the present invention, the water softening agent container **155** has a first input **175** fluidly coupled to the water inlet **122** for receiving water from the latter. According to an embodiment of the invention, the first input of the water softening agent container **155** is fluidly coupled to the water inlet **122** through a duct element **178.** For example, the duct element **178** may be a, *e.g.,* rigid, pipe vertically extending from the bottom portion of the of the volume enclosed by the casing **105** where the water softening agent container **155** is located up to the top portion of the back side of the cabinet **105** wherein the water inlet **122** is located.

**[0076]** According to an embodiment of the present invention, the water softening agent container **155** has an output **180** for providing soft water obtained from the water received from the first input **175** through the water softening agent.

**[0077]** According to an embodiment of the present invention, the water tank **160** has an input **182** configured to be selectively in fluid communication with the output **180** of the water softening agent container **155.** According to an embodiment of the present invention, the fluid communication between the output **180** of the water softening agent container **155** and the input **182** of the water tank **160** is selectively enabled by properly driving a water softening agent container valve **183** arranged at the output **180** of the water softening agent container **155,** which will be described in greater detail in the following.

**[0078]** According to an embodiment of the present invention, the water tank **160** has a first output **184** in fluid communication with the apparatus **125** for supplying process water into the washing tub **110,** so that the apparatus **125** for supplying process water into the washing tub **110** can be supplied with soft water contained in the water tank **160.** According to an embodiment of the invention, the first output **184** of the water tank **160** is fluidly

coupled to the apparatus **125** for supplying process water into the washing tub **110** through a duct element **185.** For example, the duct element **185** may be a, *e.g.,* rigid, pipe vertically extending from the first output **184** of the water tank **160** to the apparatus **125** for supplying process water into the washing tub **110.**

**[0079]** According to an embodiment of the present invention, the salt container **165** is configured to be selectively in fluid communication with the water tank **160** for receiving (soft) water from the latter.

**[0080]** For this purpose, according to an embodiment of the present invention, a second output **187** of the water tank **160** is configured to be selectively in fluid communication with an input **188** of the salt container **165.** According to an embodiment of the present invention, a soft water tank valve **189** is provided at the second output **187** of the water tank **160** configured to be selectively opened during the water softening agent regeneration procedure for selectively causing the second output **187** of the water tank **160** to be in fluid communication with the input **188** of the salt container **165.**

**[0081]** According to an embodiment of the present invention, the salt container **165** comprises an output **190** fluidly connected to a second input **191** of the water softening agent container **155.**

**[0082]** According to an embodiment of the present invention, a pump device **192** is provided for selectively causing liquid coming from the output **190** of the salt container **165** be pumped in the second input **191** of the water softening agent container **155.**

**[0083]** According to an embodiment of the present invention, the output **180** of the water softening agent container **155** is configured to be selectively fluidly coupled to the washing tub **110** through a duct element **194.** For example, the duct element **194** may be a, *e.g.,* rigid, pipe vertically extending from the output **180** of the water softening agent container **155** to the upper portion of the casing **105** and then reaching the washing tub **110.**

**[0084]** According to the embodiment of the invention, the water tank **160** is advantageously formed in a single piece with the duct element **178** and/or the duct element **194.** By "formed in a single piece" it is herein intended that the water tank **160** and the duct element(s) **178** and/or **194** are manufactured - *e.g.,* through a single moulding step - so as to form a single assembly. By making reference to the exemplary embodiment of the invention illustrated in **Figure 1,** said single assembly provides for having the duct element **194** that is attached to a rear external surface of the water tank **160,** and the duct element **178** that is attached to a rear external surface of the duct element **194.** Similar considerations apply in case the water tank **160,** the duct elements **178** and/or the duct element **194** are attached to each other in a different way.

**[0085]** According to another embodiment of the invention (not illustrated), the duct elements **178, 194** and the water tank **160** are not attached to each other to form a single assembly, but instead the duct elements **178, 194** are detached from the water tank **160.**

**[0086]** In any case, irrespective of whether or not the duct element **178** and/or the duct element **194** are attached to the water tank **160** to form a single assembly, the fluid connections among these elements and the other elements of the water softening system **150** are arranged as depicted in the hydraulic circuit illustrated in **Figure 2,** or according to modification thereof that will be described in the following.

**[0087]** According to an embodiment of the present invention, the fluid communication between the output **180** of the water softening agent container **155** and the washing tub **110** through the duct element **194** is selectively enabled by properly driving the water softening agent container valve **183** arranged at the output **180** of the water softening agent container **155.**

**[0088]** According to an embodiment of the invention, the water softening agent container valve **183** is configured to be switched between a first operating mode and a second operating mode.

**[0089]** When the water softening agent container valve **183** is in the first operating mode, the output **180** of the water softening agent container **155** is in fluid communication with the input **182** of the water tank **160.** When the water softening agent container valve **183** is in the first operating mode, fluid communication between the output **180** of the water softening agent container **155** and the washing tub **110** is prevented.

**[0090]** When the water softening agent container valve **183** is in the second operating mode, the output **180** of the water softening agent container **155** is in fluid communication with the washing tub **110.** When the water softening agent container valve **183** is in the second operating mode, fluid communication between the output **180** of the water softening agent container **155** and the input **182** of the water tank **160** is prevented.

**[0091]** As will be described in detail in the following, the water softening agent container valve **183** is configured to be switched in the second operating mode during or after the water softening agent regeneration procedure.

**[0092]** According to a preferred embodiment of the invention, the water softening agent container valve **183** is also configured to be switched in a third operating mode in which fluid communication between the output **180** of the water softening agent container **155** and the washing tub **110,** and fluid communication between the output **180** of the water softening agent container **155** and the input **182** of the water tank **160** are prevented.

**[0093]** According to an embodiment of the present invention, a duct element **195** is further provided to allow fluid communication between the water inlet **122** and the apparatus **125** for supplying process water into the washing tub **110.**

**[0094]** According to an embodiment of the present invention, the duct elements **185** and **195** are fluidly coupled to the water delivery system **132** of the apparatus **125** for supplying process water, for example by means

of controllable valve devices not illustrated, so that the water delivery system **132** is fed with:

- soft water coming from the water tank **160,** through the duct element **185,** or

- water directly provided by the water inlet **122** through the duct element **195.** The operation of the water softening system **150** according to an embodiment of the present invention is now described.

**[0095]** Water *(e.g.,* hard water) provided by an external water supply is fed into the laundry appliance **100** through the water inlet **122** *(e.g.,* by controlling proper valve elements not illustrated). According to an embodiment of the present invention, said water flows into the duct element **178** and enters the water softening agent container **155** through the first input **175.**

**[0096]** The water softening agent contained in the water softening agent container **155** causes a reduction of the hardness of the received water.

**[0097]** According to an embodiment of the present invention, the water softening agent container valve **183** is then switched in the first operating mode, while the soft water tank valve **189** is kept closed, so that the output **180** of the water softening agent container **155** is in fluid communication with the water tank **160.** In this situation, the water tank **160** is filled with soft water coming from the water softening agent container **155.**

**[0098]** While soft water is provided through the water softening agent container 155, the level of soft water inside the water tank **160** increases and goes up the duct element **185,** reaching the apparatus **125** for supplying process water. In this situation, the water delivery system **132** of the apparatus **125** for supplying process water is fed with soft water coming from the water tank **160.**

**[0099]** According to an embodiment of the present invention, the water delivery system **132** is configured to selectively cause soft water to be mixed or not with (an amount of) treatment agent contained in one of the compartments of the drawers **130** - schematically identified in **Figure 2** with reference **196** - based on the washing cycle phase actually being carried out by the laundry appliance **100.**

**[0100]** According to an embodiment of the present invention, if the washing cycle phase actually being carried out by the laundry appliance **100** provides for feeding the washing tub **110** with process water comprising only plain water (*e.g.*, during a laundry wetting or laundry rinsing phase), the water delivery system **132** supplies the received soft water to the drawer **130** in such a way that the soft water is prevented to reach the compartments **196** of the drawer **130** or in any case in such a way that the soft water is prevented to be mixed with treatment agent contained in the compartments **196** of the drawer **130.** In this condition, the process water outlet **134** is supplied with process water consisting of soft water only.

**[0101]** According to an embodiment of the present invention, if the washing cycle phase actually being carried out by the laundry appliance **100** provides for supplying the washing tub **110** with process water comprising water mixed with selected *(e.g.,* amount(s) of) treatment agent(s) (for example, during a laundry washing phase), the water delivery system **132** supplies the received soft water to the drawer **130** in such a way that the soft water reaches one or more of selected compartments **196** of the drawer **130** containing treatment agents or, in any case, in such a way that the soft water is mixed with selected (*e.g.*, amount(s) of) treatment agent(s) provided by selected compartments **196** of the drawer **130.** In this condition, the process water outlet **134** is fed with process water comprising soft water mixed with treatment agent(s).

**[0102]** The process water comprising soft water thus reaches the washing tub **110,** wherein the laundry is accordingly treated.

**[0103]** In order to discharge from the laundry appliance **100** the process water contained in the washing tub **110,** the washing tub is put in fluid communication with the drain **140,** for example by activating a proper valve element and/or a drain pump not illustrated in the figures.

**[0104]** Advantageously, before reaching the drain **140,** process water coming from the washing tub **110** is filtered through a corresponding drain filter element, schematically illustrated in **Figure 2** with reference **198.**

**[0105]** The water softening system **150** according to the embodiments of the present invention herein illustrated, provides that water is softened just after it reaches the laundry appliance **100** through the water inlet **122.** Since the water softening agent container **155** is directly fluidly coupled to the water inlet **122,** and the water tank **160** is fluidly coupled downstream the water softening agent container **155,** the water softening agent container **155** only stores soft water. In other words, the peculiar arrangement of the water softening agent container **155** and of the water tank **160** with respect to each other and also with respect to the water inlet **122** are such to reduce the number of components of the laundry appliance **100** that can be in contact with hard water, thus avoiding or at least strongly reducing formation of limestone on laundry appliance components (such as on the walls of the water tank **160**) that can potentially impair the correct operation of the laundry appliance **100.**

**[0106]** According to an embodiment of the present invention, the water softening system **150** can be bypassed, and the water delivery system **132** can be directly fed with water provided by the water inlet **122** through the duct element **195,** for example when the water softening system **150** is not operative because of a malfunctioning of one of its components.

**[0107]** The operation of the water softening system **150** during a water softening agent regeneration procedure directed to regenerate the water softening agent contained in the water softening agent container **155** according to an embodiment of the present invention is now described.

**[0108]** The soft water tank valve **189** at the second output **187** of the water tank **160** is opened, so that soft water stored in the water tank 160 flows into the salt container **165** through the input **188.** The soft water mixes with salt contained in the salt container **165** so as to generate brine.

**[0109]** According to an embodiment of the present invention, the salt container **165** is advantageously provided with an air vent duct **199** configured to allow air inside the salt container **165** exit the salt container **165** by a pressure of soft water coming into the salt container **165** through the input **188.** In this way, the salt container **165** can be filled with soft water in an efficient way, avoiding or at least strongly reducing the formation of undesired air bubbles trapped inside the salt container **165.**

**[0110]** The brine generated by the salt container **165** is provided to the water softening agent container **155.** For this purpose, according to an embodiment of the present invention the pump device **192** is activated to cause brine to be pumped out the salt container **165** from the output **190** and pumped in the water softening agent container **155** through the second input **191** thereof.

**[0111]** The water softening agent contained in the water softening agent container **155** is then regenerated by allowing said water softening agent react with the brine for a predetermined amount of time *RT.* For this purpose, according to an embodiment of the present invention, the water softening agent container valve **183** is switched to the third operating mode to prevent fluid communication with the apparatus **125** for supplying process water and the water tank **160,** and, after that the water softening agent container **155** is filled with brine, the pump device **192** is temporally deactivated during said predetermined amount of time *RT.*

**[0112]** Then, according to an embodiment of the present invention, the water softening agent container valve **183** is switched to the second operating mode to make the output **180** of the water softening agent container **155** be in fluid communication with the washing tub **110,** and the pump device **192** is reactivated.

**[0113]** In this way, brine mixed with residuals of the water softening agent regeneration is pumped through the duct element **194** toward the washing tub **110.**

**[0114]** Then, said brine mixed with residuals of the water softening agent regeneration is discharged by reaching the drain **140** of the laundry appliance **100.**

**[0115]** In this way, brine mixed with residuals of the water softening agent regeneration procedure water reaches the washing tub **110** (and then, the drain **140**) without soiling the compartments **196** of the drawer **130.** This is particularly advantageous, since if the compartments **196** of the drawer **130** were soiled by the residuals of the water softening agent regeneration procedure, the subsequent washing cycles would be compromised (*i.e.,* the treated laundry would be soiled too).

**[0116]** It is pointed out that according to the embodiments of the invention herein described, the brine mixed with residuals of the water softening agent regeneration, before reaching the drain **140,** is advantageously filtered by the drain filter element **198,** so that anti-pollution standards are respected.

**[0117]** According to another embodiment of the invention (not illustrated), instead of being in fluid communication with the washing tub **110,** the duct element **194** is arranged to be in fluid communication with the drain **140** bypassing the washing tub **110.** For example, according to an embodiment of the invention, the duct element **194** may be arranged to be directly in fluid communication with the drain **140** or to be in fluid communication with the drain **140** through the filter element **198.** In this way, it is avoided that the washing tub **110** get soiled with residuals of the water softening agent regeneration procedure.

**[0118]** In the embodiment of the invention illustrated in the figures, the water softening agent container **155** has a single output **180** that can be selectively in fluid communication with the water tank **160** or with the washing tub **110** through a water softening agent container valve **183** configured to be selectively switched between different valve operating modes. According to another embodiment of the invention (not illustrated), the water softening agent container **155** is instead provided with two separate outputs, and particularly:

- a first output that can be selectively in fluid communication with the water tank **160** for supplying soft water to the latter, and
- a second output that can be selectively in fluid communication with the the washing tub **110** for allowing brine mixed with residuals of the water softening agent regeneration procedure to be discharged through the drain **140.**

**[0119]** According to another embodiment of the present invention (not illustrated), the brine mixed with residuals of the water softening agent regeneration procedure is discharged into the drain **140** through the apparatus **125** for supplying process water. For example, the output **180** of the water softening agent container **155** may be selectively put in fluid communication with the water distribution system **132** of the apparatus **125** for supplying process water. In this way, during a water softening agent regeneration procedure, the water delivery system **132** of the apparatus **125** for supplying process water is supplied with brine mixed with residuals of the water softening agent regeneration, coming from the water softening agent container **155.** Then, according to this embodiment of the invention, the water delivery system **132** supplies the received brine mixed with residuals of the water softening agent regeneration to the drawer **130** in such a way that the brine mixed with residuals of the water softening agent regeneration is prevented to reach the compartments **196** of the drawer **130.** In this way, brine mixed with residuals of the water softening agent regeneration procedure water reaches the washing tub **110** (and then, the drain **140**) without soiling the com-

partments **196** of the drawer **130** even if the apparatus **125** for supplying process water is being involved.

**[0120]** Naturally, in order to satisfy local and specific requirements, a person skilled in the art may apply to the invention described above many logical and/or physical modifications and alterations. More specifically, although the invention has been described with a certain degree of particularity with reference to preferred embodiments thereof, it should be understood that various omissions, substitutions and changes in the form and details as well as other embodiments are possible. In particular, different embodiments of the invention may even be practiced without the specific details (such as the numeric examples) set forth in the preceding description for providing a more thorough understanding thereof; on the contrary, well known features may have been omitted or simplified in order not to obscure the description with unnecessary particulars.

## Claims

**1.** A laundry treatment appliance (100) comprising:

- a water inlet (122) configured to receive water from an external water supply;
- a washing tub (110) housing a rotatable drum adapted to receive laundry to be treated;
- an apparatus (125) for supplying process water into the washing tub (110);
- a water softening system (150) configured to receive water from the water inlet (122) and to supply soft water to the apparatus (125) for supplying process water into the washing tub (110), wherein said water softening system (150) comprises:
- a water softening agent container (155) storing a water softening agent capable of reducing hardness of water, said water softening agent container (155) having a first input (175) fluidly coupled to the water inlet (122) to receive water and an output (180) to provide soft water obtained from the received water, and
- a water tank (160) having an input (182) configured to be selectively in fluid communication with said output (180) of the water softening agent container and a first output (184) in fluid communication with said apparatus (125) for supplying process water into the washing tub (110), said water tank (160) being configured for storing a reserve of soft water and for supplying with soft water said apparatus (125) for supplying process water into the washing tub (110).

**2.** The laundry treatment appliance of claim 1, further comprising a container (165) for storing salt, said salt container (165) being configured to be selectively in fluid communication with a second output (187) of the water tank (160) for receiving soft water.

**3.** The laundry treatment appliance of claim 2, wherein said container (165) for storing salt comprises an output (190) fluidly connected to a second input of the water softening agent container (155) to provide brine to the water softening agent container (115) during a water softening agent regeneration procedure for regenerating said water softening agent, said brine comprising soft water received from the soft water tank (160) mixed with stored salt.

**4.** The laundry treatment appliance of claim 3, wherein the water softening agent container (155) is configured:

- to be selectively in fluid communication with a drain (140) of the laundry treatment appliance (100) for allowing brine mixed with residuals of the water softening agent regeneration contained in the water softening agent container (155) to be discharged into the drain (140).

**5.** The laundry treatment appliance of any of claims 2 to 4, wherein the water softening system (150) further comprises a soft water tank valve (189) arranged at the second output (187) of the soft water tank configured to be selectively opened during said water softening agent regeneration procedure for selectively causing soft water stored in the soft water tank (160) flow into the salt container (165) thus generating said brine.

**6.** The laundry treatment appliance of any of claims 2 to 5, wherein the water softening system (150) further comprises a pump device (192) configured to be selectively activated during said water softening agent regeneration procedure for selectively causing brine generated in said salt container be pumped in the water softening agent container (155) through the second input (191) thereof.

**7.** The laundry treatment appliance of claim 4 or any of claims 5, 6 when depending on claim 4, wherein the water softening system (150) further comprises a water softening agent container valve (183) arranged at the output (180) of the water softening agent container (155), said water softening agent container valve (183) being configured to be switched between a first operating mode and a second operating mode, wherein:

- when the water softening agent container valve (183) is in the first operating mode, the output (180) of the water softening agent container (155) is in fluid communication with the input (182) of the water tank (160);
- when the water softening agent container valve

(183) is in the second operating mode, the output (183) of the water softening agent container (155) is in fluid communication with said drain (140) of the laundry treatment appliance (100) for allowing brine mixed with residuals of the water softening agent regeneration in the water softening agent container (155) reach said laundry treatment appliance drain (140).

**8.** The laundry treatment appliance of claim 7, wherein, when the water softening agent container valve (183) is in the second operating mode, the output (180) of the water softening agent container (155) is in fluid communication with said drain (140) of the laundry treatment appliance (100) through the washing tub (110) for allowing brine mixed with residuals of the water softening agent regeneration in the water softening agent container (155) reach said laundry treatment appliance drain (140).

**9.** The laundry treatment appliance of claims 7 or 8, wherein the water softening agent container valve (183) is configured to be switched in the second operating mode during or after said water softening agent regeneration procedure.

**10.** The laundry treatment appliance of claim 7, 8 or 9, wherein said water softening agent container valve (183) is further configured to be switched in a third operating mode in which fluid communication between the output (180) of the water softening agent container (155) and the input (182) of the water tank (160), and fluid communication between the output (180) of the water softening agent container and the drain (140) of the laundry treatment appliance (100) are prevented.

**11.** The laundry treatment appliance of any of claims 7 to 10, further comprising a first duct (194) for allowing fluid communication between the water softening agent container (155) and the drain (140) when the water softening agent container valve (183) is in the second operating mode, said water tank (160) being formed in a single piece with said first duct (194).

**12.** The laundry treatment appliance of claim 11, further comprising a second duct (178) for allowing fluid communication between the water inlet (122) and the first input (175) of the water softening agent container (155), said water tank (160) being formed in a single piece with said first duct (194) and with said second duct (178).

**13.** The laundry treatment appliance of claim 6 or any of claims 7 to 12 when depending on claim 6, wherein said pump device (190) is configured to be temporally deactivated for a predetermined time for allowing brine contained in the water softening agent container (155) to regenerate said water softening agent.

**14.** The laundry treatment appliance of claim 12 when depending on claim 7, wherein said pump device (190) is configured to be reactivated once said water softening agent container valve (183) is in the second operating mode, to pump brine mixed with residuals of the water softening agent regeneration in the water softening agent container (155) towards said laundry treatment appliance drain (140).

**15.** The laundry treatment appliance of any of claims 2 to 14, wherein the salt container (165) comprises an air vent duct (99) configured to allow air inside the salt container (165) exit the salt container (165) by a pressure of soft water coming into the salt container (165) from the water tank (160).

**16.** The laundry treatment appliance of any of the preceding claims, wherein said apparatus (125) for supplying process water comprises at least one compartment adapted to contain a treatment agent for laundry treatment, and is configured to mix soft water supplied by said soft water tank (160) with said treatment agent.

**17.** A method for operating a laundry treatment appliance, comprising:

- supplying a water softening agent container (155) of the laundry treatment appliance storing a water softening agent capable of reducing hardness of water with water received from an external water supply;
- supplying a water tank (160) of the laundry treatment appliance with soft water generated by the water softening agent container (155) from the received water; and
- supplying an apparatus (125) for supplying process water into a washing tub (110) of the laundry treatment appliance with soft water contained in said water tank (160).

**18.** The method of claim 17, further comprising, during a water softening agent regeneration procedure for regenerating said water softening agent:

- supplying a container (165) for storing salt with soft water contained in said water tank (160), and
- supplying the water softening agent container (155) with brine comprising soft water received from the soft water tank (160) mixed with stored salt.

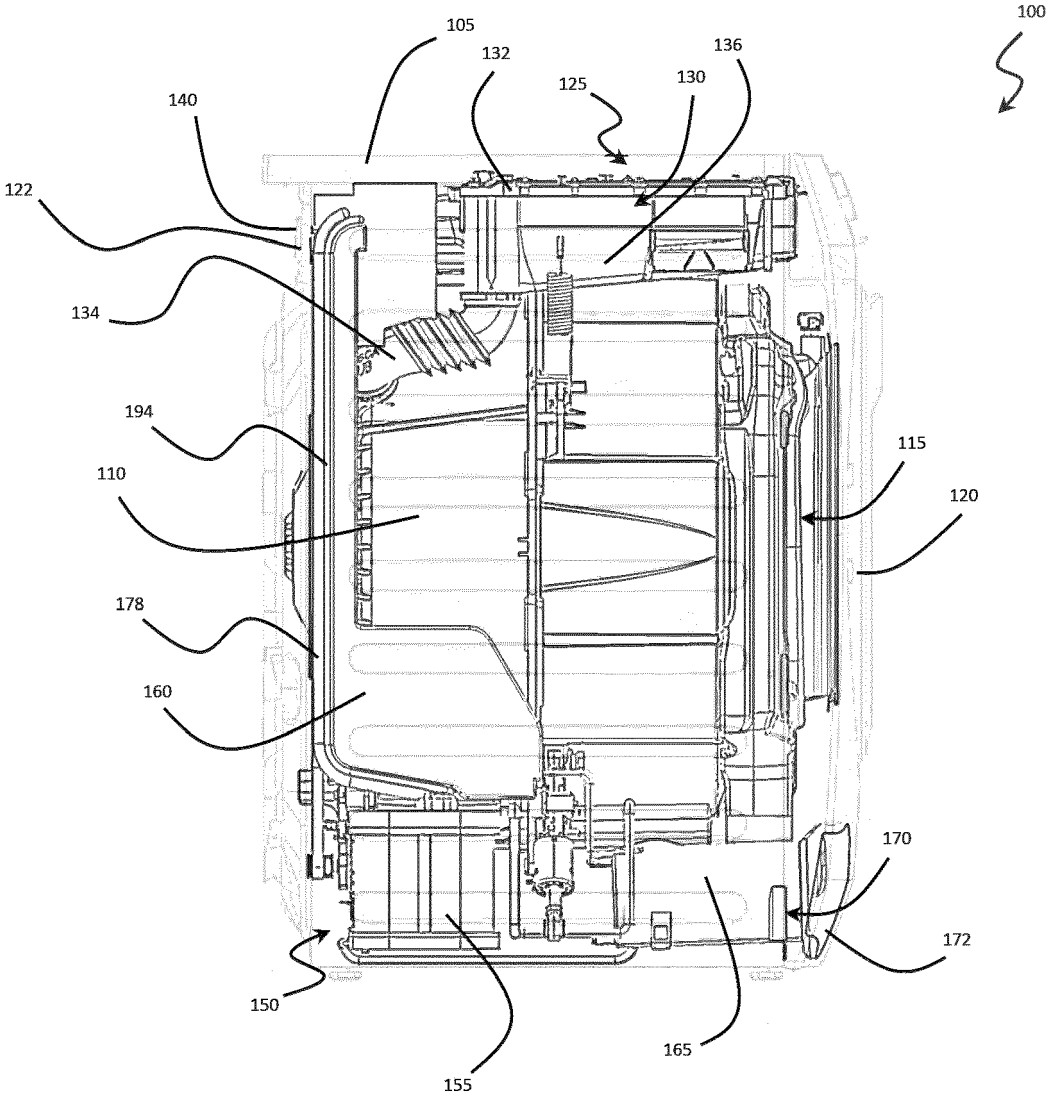
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FIG. 1

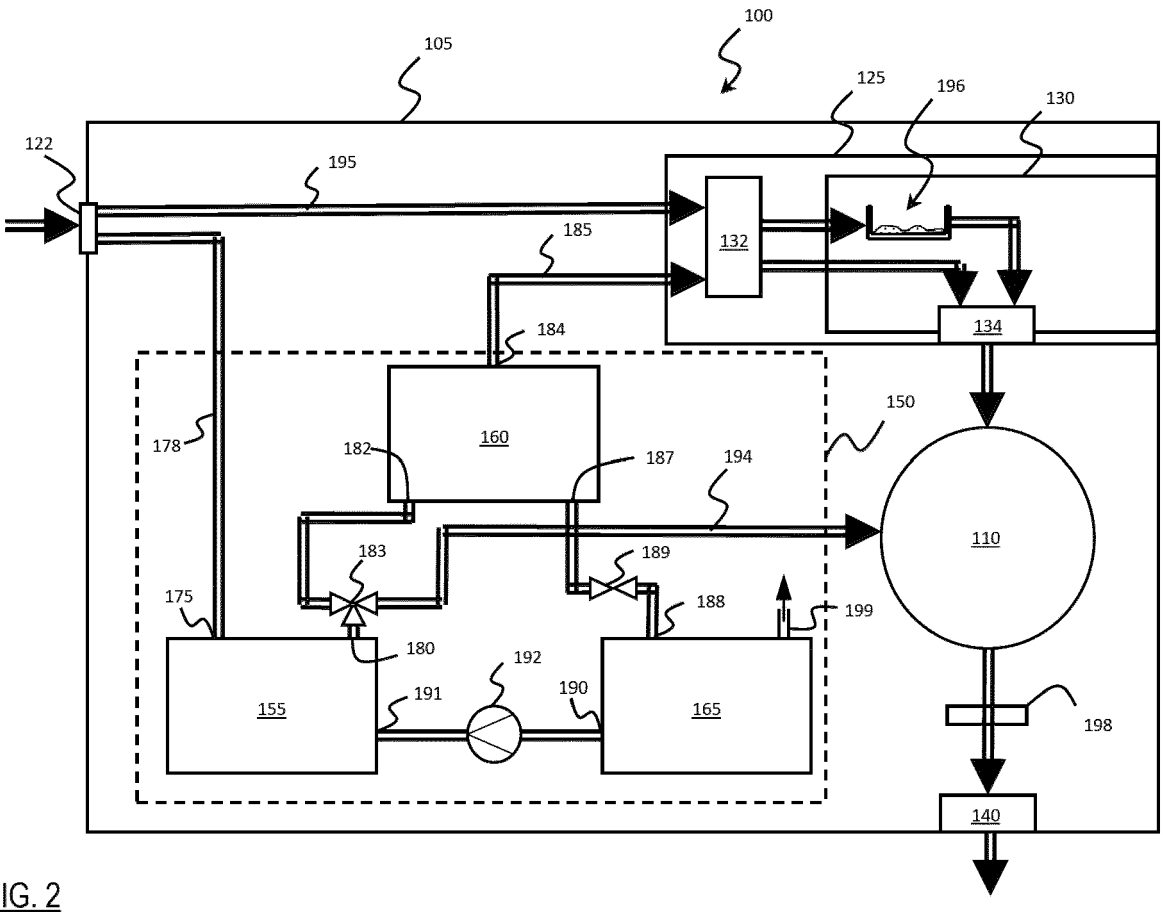
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FIG. 2

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# EUROPEAN SEARCH REPORT

Application Number
EP 21 16 8654

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