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(54) **HOUSEHOLD APPLIANCE FEATURING A WATER SOFTENING SYSTEM AND METHOD OF OPERATING SUCH A HOUSEHOLD APPLIANCE**

(57) A Household appliance (100) is disclosed. The household appliance (100) comprises a water softening system (WSS) configured to receive fresh water having a first level of hardness and to provide softened water having a second level of hardness lower than the first level of hardness. The water softening system comprises:

a water softening agent container (145) configured to store a water softening agent capable of reducing a hardness of the fresh water;
a salt container (150), removably accommodated within the household appliance and hydraulically connected to the water softening agent container when accommodated within the household appliance, the salt container being configured to receive the fresh water, generate a mixture of salt and fresh water to produce a brine, and channel the brine into the water softening agent container to allow a regeneration of the water softening agent;
a salinity detection unit (180) for detecting a salinity level of the brine inside the salt container,
a draining arrangement (155) hydraulically connected to the salt container, and configured to drain the brine from the salt container; and
a control unit (CU) configured to activate the draining arrangement to cause the brine to be drained from the

salt container when the salinity detection unit detects that the salinity level of the brine is below a threshold salinity level.

A method (300) for operating the household appliance is also disclosed.

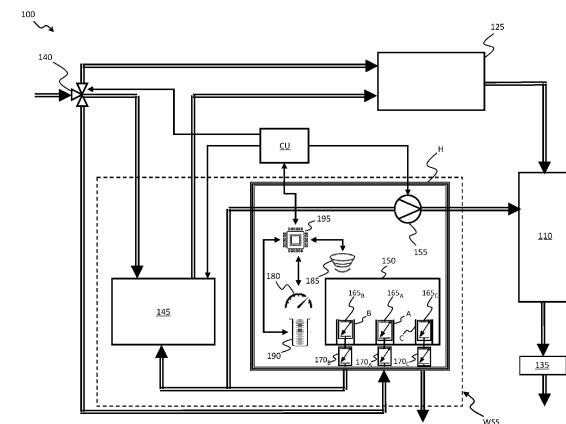


Figure 1B

Description

Technical field

[0001] The present disclosure generally relates to the field of laundry treatment appliances (hereinafter, concisely, "household appliances"), and particularly to household 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), comprising a water softening system.

Background art

[0002] A conventional household appliance is configured to treat laundry located in a (e.g., rotatable) drum by providing process liquids in a washing tub housing the rotatable drum.

[0003] Process liquids may comprise (e.g., depending on a selected treatment cycle and/or on a current phase of the selected treatment cycle) plain water or a treatment mixture comprising water mixed with proper treatment agents, including, but not limited to, washing detergents, rinsing detergents, bleaches and softeners detergents.

[0004] Since the hardness of the water (i.e., the amount of minerals, largely calcium and magnesium, dissolved in the water) may negatively affect the performance of the household appliance (e.g., in that components or parts of the household appliance that are in direct contact with hard or excessively hard water may become encrusted with limestone, thereby prematurely impairing the correct operation thereof) and/or of the treatment cycles (e.g., in that laundry treated by using hard or excessively hard water may become stiff, subjected to premature tear and wear, and cause skin irritation), a modern type of household appliance comprises a water softening system configured to receive fresh water and to provide a softened water having a reduced hardness than the fresh water.

[0005] Typically, the water softening system comprises a water softening agent container configured to store a water softening agent (such as an ion-exchange resin) capable of reducing the hardness of the fresh water by reaction of the fresh water with the water softening agent.

[0006] Typically, the water softening system comprises a salt container configured to store salt, which is used for regenerating the water softening agent contained in the water softening agent container during a water softening agent regeneration procedure. Particularly, the salt container is configured to receive the fresh water, generate a mixture of salt and fresh water to produce a brine, and channel the brine into the water softening agent container to allow regeneration of the water softening agent.

[0007] The salt container is removably accommodated within the household appliance, so as to allow a user to refill it with new amounts of salt.

Summary

[0008] The Applicant has realized that the current household appliances provided with the water softening system are not satisfactory.

[0009] According to the Applicant, this is essentially due to the fact that it is up to the user to manually determine a salt level within the salt container, usually by visual inspection and/or subjective estimation.

[0010] Manual determination of salt level is inconvenient for the user, who must frequently look into the salt container. An inexperienced user may not know how much salt is required per regeneration, which may result in too frequently added salt or in poorly softened water when salt is not added frequently enough.

[0011] To avoid frequent visual inspections, users often prefer household appliances with large capacity of the salt container. However, a large capacity salt container takes up large amounts of space, which results in bulky household appliances that may be prohibitive in small living spaces.

[0012] The use of indicator sticks, similar to rulers, with reference marks to aid the user in judging a depth of the salt within the salt container, is also inaccurate. Indeed, while the brine is being generated, the salt continuously dissolves and redeposits due to chemical equilibrium reactions. During salt deposition, salt bridges may form which may change an appearance of salt volume within the salt container.

[0013] Last but not least, visual inspection and/or subjective estimation to determine the salt level within the salt container, as well as refilling of salt, is performed by extracting the salt container from the household appliance, or from the drawer wherein the salt container is arranged.

[0014] However, brine spills or overflows may arise during the extraction movement, which could be annoying for the user.

[0015] In order to avoid spill or overflow of brine when the salt container is extracted, it is known to provide the salt container with a watertight closure or to provide a water softening device with a specific structure which allows emptying of the salt container from brine before extraction, such as, for example, the structure disclosed in EP3221501 B1.

[0016] EP3221501 B1 discloses a washing machine with a main drawer which is fitted/ inserted in extractable manner into a corresponding substantially basin-shaped drawer housing arranged in the upper portion of the casing of the washing machine, and a water softening device comprising a manually fillable regeneration-agent compartment arranged in the a main drawer, and a brine container located underneath the drawer housing and communicating with the bottom of the drawer housing so as to allow the brine formed in the regeneration-agent compartment to freely flow by gravity from a basin-shaped bottom portion of said drawer housing into the same brine container, so that the regeneration-agent compartment

remains empty after brine has formed.

[0017] In view of the above, the Applicant has devised a household appliance that is not affected by the above-mentioned drawbacks, and particularly a household appliance capable of automatically detecting a salinity level of the brine inside the salt container, and draining the brine from the salt container when the salinity level of the brine is below a threshold salinity level.

[0018] An aspect of the present disclosure relates to a household appliance.

[0019] According to an embodiment, the household appliance comprises a water softening system configured to receive fresh water having a first level of hardness and to provide softened water having a second level of hardness lower than the first level of hardness.

[0020] According to an embodiment, the water softening system comprises a water softening agent container configured to store a water softening agent capable of reducing a hardness of the fresh water.

[0021] According to an embodiment, the water softening system comprises a salt container, removably accommodated within the household appliance and hydraulically connected to the water softening agent container when accommodated within the household appliance.

[0022] According to an embodiment, the salt container is hydraulically connected to a water supply unit when accommodated within the household appliance.

[0023] According to an embodiment, the salt container is hydraulically connected to a draining arrangement when accommodated within the household appliance.

[0024] According to an embodiment, the salt container is configured to allow air to exit the salt container (air venting) when accommodated within the household appliance.

[0025] According to an embodiment, the hydraulic connection between the salt container and the water softening agent container, the hydraulic connection between the salt container and the water supply unit, and the exit of air from the salt container are obtained each one by means of respective one or more check valves.

[0026] According to an embodiment, the hydraulic connection between the salt container and the water softening agent container, the hydraulic connection between the salt container and the water supply unit, and the exit of air from the salt container are obtained each one by means of respective pairs of check valves. According to an embodiment, each pair of check valves comprises a check valve integral with (e.g., housed in) the salt container, and one or more check valves integral with (e.g., housed in) a fixed portion of the water softening system or of the household appliance (the salt container being movable with respect to said fixed portion).

[0027] According to an embodiment, when the salt container is inserted within the household appliance, the pairs of check valves are open (due to interaction or cooperation of the check valves of each pair), thereby allowing said hydraulic connections of the salt container

and said exit of air, whereas when the salt container is extracted from the household appliance, the pairs of check valve are closed (due to interaction or cooperation loss between the check valves of each pair), thereby preventing said hydraulic connections of the salt container and said exit of air.

[0028] According to an embodiment, the salt container is configured to receive the fresh water, generate a mixture of salt and fresh water to produce a brine, and channel the brine into the water softening agent container to allow a regeneration of the water softening agent.

[0029] According to an embodiment, the water softening system comprises a draining arrangement hydraulically connected to the salt container, and configured to drain the brine from the salt container.

[0030] According to an embodiment, the draining arrangement is configured to drain the brine from the salt container into a drain through a washing tub of the household appliance (*i.e.*, by bypassing a process liquid supply apparatus configured to supply process liquids into the washing tub and comprising, for example, a drawer). This avoids that the process liquid supply apparatus gets soiled with the brine and/or impurities thereof.

[0031] According to an alternative embodiment, the draining arrangement may be configured to drain the brine from the salt container into the drain by bypassing both the process liquid supply apparatus and the washing tub. This avoids that both the process liquid supply apparatus and the washing tub get soiled with the brine and/or impurities thereof.

[0032] According to an alternative embodiment, the draining arrangement may be configured to drain the brine from the salt container into the drain through the process liquid supply apparatus and the washing tub. In this embodiment, dedicated channels within the process liquid supply apparatus may be provided for channelling the brine to be discharged.

[0033] According to an embodiment, the brine contained in the salt container is channelled into the water softening agent container by the pressure of the fresh water entering the salt container. According to alternative embodiments, the draining arrangement may be configured to drain the brine from the salt container and to supply the brine to the water softening agent container. In these alternative embodiments, the draining arrangement may be configured to be switched (*e.g.*, under the control of the control unit) into first or second active states allowing the brine to be fed from the salt container to the drain or to the water softening agent container, respectively, or into an inactive state preventing the brine from exiting the salt container. According to further alternative embodiments, a dedicated draining arrangement (other than the draining arrangement) may be provided to drain the brine from the salt container and to supply the brine to the water softening agent container.

[0034] According to an embodiment, the water softening system comprises a salinity detection unit for detecting a salinity level of the brine inside the salt container.

[0035] According to an embodiment, the water softening system comprises a control unit configured to activate the draining arrangement to cause the brine to be drained from the salt container when the salinity detection unit detects that the salinity level of the brine is below a threshold salinity level.

[0036] According to an embodiment, the water softening system further comprises a presence detection unit for detecting a presence or absence of the salt container within the household appliance.

[0037] According to an embodiment, the control unit is configured to activate the draining arrangement to cause the brine to be drained from the salt container when the presence detection unit detects the presence of the salt container within the household appliance, and/or when the salinity detection unit detects that the salinity level of the brine is below a threshold salinity level.

[0038] According to an embodiment, the water softening system comprises a brine level detection unit for detecting a brine level in the salt container.

[0039] According to an embodiment, the control unit is configured to activate the draining arrangement to cause the brine to be drained from the salt container when the brine level detection unit detects that the brine level in the salt container is above a threshold brine level and when the salinity detection unit detects that the salinity level of the brine is below a threshold salinity level.

[0040] The presence detection unit may be omitted in this embodiment.

[0041] According to an embodiment, the control unit is configured to activate the draining arrangement to cause the brine to be drained from the salt container when the salinity detection unit detects that the salinity level of the brine is below a threshold salinity level, the brine level detection unit detects that the brine level in the salt container is above a threshold brine level and the presence detection unit detects the presence of the salt container within the household appliance.

[0042] According to an embodiment, the household appliance comprises warning means configured to communicate with the control unit.

[0043] According to an embodiment, the warning means is configured to provide one or more warning indications to the user.

[0044] According to an embodiment, the warning means comprises one or more warning units of a physical user interface of the household appliance.

[0045] Additionally or alternatively, the warning means comprises one or more warning functions associated with a virtual user interface of the household appliance. According to an embodiment, the virtual user interface may be provided by a mobile application running on an external device (such as a personal digital assistant (PDA), a smartphone, a tablet, a wearable smart device (such as a smartwatch) external to the household appliance and communicably coupled thereto (e.g., through a wireless communication link).

[0046] According to an embodiment, the warning func-

tion(s) may comprise a notification on the external device. The notification may for example be a push notification, such as a banner on the top of the device screen and/or dialog box that interrupts and blocks the view of any running application, and may contain text and/or vocal and/or image message (possibly with the further playing of an alert sound to attract the attention of the user).

[0047] According to an embodiment, the control unit is configured to provide a signal indicative of an empty or substantially empty condition of the salt container once the brine has been drained from the salt container by the draining arrangement, and to activate the warning means to inform a user that the salt container can be extracted from the household appliance to be refilled with salt.

[0048] According to an embodiment, the empty or substantially empty condition of the salt container is checked based on the brine level detection signals from the brine level detection unit. Additionally, or alternatively, the empty or substantially empty condition of the salt container is checked based on a predefined time interval deemed necessary to achieve the empty or substantially empty condition. In this embodiment, the brine level detection unit may be omitted, and the brine may be assumed to be drained from the salt container upon elapsing of the predefined time interval from activation of the draining arrangement.

[0049] According to an embodiment, the water softening system comprises a housing for removably accommodating the salt container therein. According to an embodiment, the housing represents said fixed portion of the water softening system or of the household appliance (the salt container being movable with respect to said housing).

[0050] According to an embodiment, the housing is hydraulically connected to the salt container and to the draining arrangement.

[0051] According to an embodiment, the salinity detection unit is arranged in the housing. According to an alternative embodiment, the salinity detection unit is arranged outside the housing.

[0052] According to an embodiment, the presence detection unit (when provided) is arranged in the housing. According to an alternative embodiment, the presence detection unit (when provided) is arranged outside the housing.

[0053] According to an embodiment, the brine level detection unit (when provided) is arranged in the housing. According to an alternative embodiment, the brine level detection unit when provided) is arranged outside the housing.

[0054] According to an embodiment, the household appliance comprises a processing unit for receiving salinity detection signals from the salinity detection unit, and for providing to the control unit an indication of the salinity level of the brine contained in the salt container.

[0055] The processing unit may be omitted in basic embodiments. In basic embodiments in which the processing unit is omitted, the salinity detection unit may

be electrically connected (e.g., directly) to the control unit. In these embodiments, the salinity detection unit may transmit the salinity detection signals to the control unit, and the control unit may determine an indication of the salinity level of the brine contained in the salt container based on the received salinity detection signals.

[0056] According to an embodiment, the processing unit (when provided) is arranged in the housing. According to an alternative embodiment, the processing unit (when provided) is arranged outside the housing.

[0057] According to an embodiment, the housing comprises a receiving portion for receiving the processing unit.

[0058] According to an embodiment, the processing unit is configured to receive presence detection signals from the presence detection unit, and to provide to the control unit an indication of the presence of the salt container within the household appliance.

[0059] In basic embodiments in which the processing unit is omitted, the presence detection unit (when provided) may be electrically connected (e.g., directly) to the control unit. In these embodiments, the presence detection unit may transmit the presence detection signals to the control unit, and the control unit may determine an indication of the presence or absence of the salt container within the household appliance based on the received presence detection signals.

[0060] According to an embodiment, the processing unit is configured to receive brine level detection signals from the brine level detection unit, and to provide to the control unit an indication of the brine level in the salt container.

[0061] In basic embodiments in which the processing unit is omitted, the brine level detection unit (when provided) may be electrically connected (e.g., directly) to the control unit. In these embodiments, the brine level detection unit may transmit the brine level detection signals to the control unit, and the control unit may determine an indication of the brine level in the salt container based on the received brine level detection signals.

[0062] According to an embodiment, the draining arrangement comprises a draining pump.

[0063] According to an embodiment, the housing comprises a seat for accommodating the draining pump (or, more generally, the draining arrangement) therein. According to an alternative embodiment, the draining pump (or, more generally, the draining arrangement) is arranged outside the housing.

[0064] According to an embodiment, the housing comprises a first housing shell and a second housing shell connected to each other in a removable manner.

[0065] According to an embodiment, the housing is adapted to be fixed to the household appliance.

[0066] According to an embodiment, the housing is adapted to be fixed to the household appliance (such as to the basement portion thereof) by means of a fixing arrangement. Additionally or alternatively, the housing is adapted to be fixed to the household appliance (such as

to the basement portion thereof) by frictional engagement between the housing (e.g., the first or second housing shell thereof) and a housing seat formed in the household appliance (such as a housing seat formed in the basement portion thereof).

[0067] Another aspect of the present disclosure relates to a method of operating a household appliance comprising a water softening agent container configured to store a water softening agent capable of reducing a hardness of fresh water, and a salt container configured to receive the fresh water, generate a mixture of salt and fresh water to produce a brine, and channel the brine into the water softening agent container to allow a regeneration of the water softening agent.

[0068] According to an embodiment, the method comprises detecting a salinity level of the brine inside the salt container.

[0069] According to an embodiment, the method comprises, when the salinity level of the brine is below a threshold salinity level, activating a draining arrangement hydraulically connected to the salt container, to cause the brine to be drained from the salt container.

[0070] According to an embodiment, the method comprises, when the salinity level of the brine is above the threshold salinity level, outputting a message indicative of an adequate salinity level.

[0071] According to an embodiment, the method comprises, if the brine level is below the threshold brine level, outputting a corresponding error message. According to an alternative embodiment, if the brine level is below the threshold brine level, no further actions are performed.

[0072] According to an embodiment, the method comprises checking a presence or absence of the salt container within the household appliance.

[0073] According to an embodiment, the method comprises activating the draining arrangement to cause the brine to be drained from the salt container if the salinity level of the brine is below the threshold salinity level and if the salt container is present within the household appliance.

[0074] According to an embodiment, the method comprises checking the presence of the salt container within the household appliance, and checking the salinity level of the brine within the salt container if the salt container is present within the household appliance. In basic embodiments, the salinity level of the brine within the salt container may be checked without any previous salt container presence checking. Without losing generality, the salt container presence checking may be performed and/or repeated at any suitable phase of the method.

[0075] According to an embodiment, the method comprises checking the presence of the salt container within the household appliance, performing a water softening agent regeneration procedure if the salt container is present within the household appliance, and checking the salinity level of the brine within the salt container after the water softening agent regeneration procedure. Without losing generality, the water softening agent regener-

ation procedure may be omitted, the water softening agent regeneration procedure being for example performed after a treatment cycle end and before the method is run.

[0076] Checking the presence or absence of the salt container within the household appliance may be omitted in basic embodiments.

[0077] According to an embodiment, if the salt container is not present (*i.e.*, absent) in the household appliance, the method ends. According to an embodiment, a message indicative of the absence of the salt container may be output for the user.

Brief description of the annexed drawings

[0078] These and other features and advantages of the present disclosure will be made apparent by the following description of an exemplary and non-limitative embodiment thereof; for its better intelligibility, the following description should be read referring to the attached drawings, wherein:

Figure 1A shows a perspective view of a household appliance according to an exemplary embodiment of the present disclosure;

Figure 1B shows, in terms of simplified functional blocks, a hydraulic/electric circuit of the household appliance of **Figure 1A** according to the exemplary embodiment of the present disclosure;

Figures 2A and **2B** show perspective front views of a housing accommodating a salt container in retracted and partially extracted positions, respectively, according to the exemplary embodiment of the present disclosure;

Figure 2C shows a perspective rear view of the housing according to the exemplary embodiment of the present disclosure;

Figure 2D shows a perspective exploded rear view of a lower shell portion of the housing according to the exemplary embodiment of the present disclosure, and

Figure 3 shows an activity diagram of a method according to the exemplary embodiment of the present disclosure.

Detailed description of an exemplary embodiment

[0079] With reference to the drawings, **Figures 1A** and **1B** show a perspective view of a household appliance **100** and a hydraulic/electric circuit thereof, respectively, according to an exemplary embodiment of the present disclosure.

[0080] In the following, only relevant components of the household appliance **100** (hereinafter, appliance components) deemed relevant for the understanding of the exemplary embodiment of the present disclosure will be discussed for the sake of conciseness.

[0081] In the following, directional terminology (such

as above, below, front, rear, central, side, upper and lower) is only used for describing the household appliance (as well as the appliance components) according to an intended orientation use thereof; therefore, directional terminology should be under no circumstances construed in absolute terms. In particular, the directional terminology is referred to mutually orthogonal reference axes **X**, **Y**, and **Z**.

[0082] In **Figure 1B**, hydraulic connections among the appliance components are graphically represented by double lines. Without losing generality, the hydraulic connections may comprise rigid and/or semi-rigid (flexible) pipes. In **Figure 1B**, electric connections among the appliance components are graphically represented by single lines (so as to distinguish them from the hydraulic connections).

[0083] According to the exemplary embodiment, the household 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 disclosure equivalently applies to other types of household appliances, for example combined washers/dryers (*i.e.*, washing machines also having laundry drying functions).

[0084] According to the exemplary embodiment, the household appliance **100** comprises a control unit **CU** for controlling the household appliance **100**.

[0085] According to the exemplary embodiment, the control unit **CU** is configured to control (*e.g.*, drive, power, interact with and/or exchange data with) the appliance components (or a subset thereof, as will be progressively detailed in the following discussion), in order to manage the execution of selected treatment cycles.

[0086] The implementation of the control unit **CU** is not limiting for the present disclosure.

[0087] Just as an example, the control unit **CU** may comprise a plurality of dedicated electronic sub-units (not shown) each one aimed at controlling one or more respective appliance components, and a central electronic unit (not shown) for coordinating the plurality of dedicated control sub-units.

[0088] Just as another example, the control unit **CU** may comprise a single, common electronic unit.

[0089] In the following, when one or more of the appliance components are said to be operated under the control of the control unit **CU**, it is meant that these appliance components may be equally operated by the respective dedicated electronic units or by the common electronic unit.

[0090] According to the exemplary embodiment, the household appliance **100** comprises a (*e.g.*, parallelepiped-shaped) cabinet **105**.

[0091] According to the exemplary embodiment, the household appliance **100** comprises a basement portion (not shown) provided at a bottom of the household appliance **100** and adapted to receive or accommodate one or more of the appliance components.

[0092] According to the exemplary embodiment, the

household appliance **100** comprises a laundry treatment chamber, such as a washing tub **110** (schematically shown in **Figure 1B**). According to the exemplary embodiment, the washing tub **110** is accommodated within the cabinet **105**, the washing tub **110** for example resting on the basement portion.

[0093] According to the exemplary embodiment, the household appliance **100** comprises a (e.g., rotatable) drum, not shown in the figures, adapted to receive laundry to be treated (e.g., to be washed), or laundry load. According to the exemplary embodiment, the drum is housed within the washing tub **110**.

[0094] According to the exemplary embodiment, the household appliance **100** comprises (e.g., at a cabinet front), a loading opening (not visible in the figures) providing an access to the drum (e.g., for loading/unloading the laundry load).

[0095] According to the exemplary embodiment, the household appliance **100** comprises a porthole **115** (shown in a closed position in **Figure 1A**) for sealably closing the loading opening during the operation of the household appliance **100**.

[0096] According to the exemplary embodiment, the household appliance **100** comprises a user interface.

[0097] According to the exemplary embodiment, the user interface comprises a physical user interface.

[0098] According to the exemplary embodiment, the user interface comprises, e.g., depending on type and/or model of household appliance, one or more interaction units associated with (e.g., for selecting and/or interacting with) corresponding functionalities of the household appliance **100**. According to the exemplary embodiment, the interaction unit(s) comprise(s) one or more among a button or key (or more thereof) **120₁**, a rotary knob (or more thereof) **120₂**, and a display (or more thereof) **120₃**.

[0099] According to the exemplary embodiment, the control unit **CU** is configured to control the household appliance **100** according to instructions received by a user through the user interface of the household appliance **100**.

[0100] According to the exemplary embodiment, the user interface comprises warning means to provide one or more warning indications to the user.

[0101] According to the exemplary embodiment, the warning means comprises one or more warning units of, or associated with, the physical user interface.

[0102] According to the exemplary embodiment, the warning means is configured to communicate with the control unit **CU**. According to the exemplary embodiment, the control unit **CU** is electrically connected to the warning unit(s).

[0103] According to the exemplary embodiment, the warning means may be configured to provide one or more types of warning indications, for example optical and/or acoustical indications. Just as an example, the optical indication(s) may comprise a light and/or a text message and/or a symbol/icon (for example, a static or animated symbol/icon for salt container extraction and/or for salt

refill). Just as an example, the acoustical indication(s) may comprise a beep sound and/or a vocal message.

[0104] Without losing generality, the warning unit(s) may comprise the display **120₃** and/or one or more sound emitters of the household appliance **100** (not shown).

[0105] According to the exemplary embodiment, the household appliance **100** comprises a process liquid supply apparatus for supplying process liquids into the washing tub **110**.

[0106] According to the exemplary embodiment, the process liquids may comprise water (such as fresh water or softened water, as discussed in the following) or a treatment mixture including a treatment agent mixed with water (i.e., a treatment agent mixed with the fresh water or with the softened water).

[0107] According to the exemplary embodiment, the treatment agent may comprise one or more among a washing detergent, a rinsing detergent, a bleach and a softener.

[0108] According to the exemplary embodiment, the process liquid supply apparatus comprises a drawer **125**. According to the exemplary embodiment, the drawer **125** is configured to store an amount of treatment agent sufficient for performing one or more treatment cycles, and to selectively deliver the process liquids (i.e., the water or the treatment mixture) to the washing tub **110**.

[0109] According to the exemplary embodiment, the drawer **125** is adapted to slide within a drawer seat (not shown), along a sliding direction, between an extracted position (not shown) and a retracted position (shown in **Figure 1A**). According to the exemplary embodiment, the sliding direction (identified by the **X** axis) is parallel to a rest surface (identified by the **X-Y** plane), such as the floor, on which the household appliance **100** rests in operation (i.e., when it is installed in the user premises).

[0110] According to the exemplary embodiment, the drawer **125** comprises a water distribution system (not shown) for distributing the water (e.g., the fresh water or the softened water) within the drawer **125** in order to obtain the process liquids. Without losing generality, the water distribution system may comprise a flushing device (not shown) flushing the fresh water or the softened towards specific regions of the drawer **125** (such as compartments and/or channels thereof). According to the exemplary embodiment, as mentioned above, the fresh water or the softened water from the flushing device (or, more generally, from the water distribution system) may be mixed with treatment agent (so that the process liquids provided to the washing tub **110** comprise a corresponding treatment mixture) or not mixed with any treatment agent (so that the process liquids provided to the washing tub **110** comprise plain (fresh or softened water) water).

[0111] According to the exemplary embodiment, the process liquids provided to the washing tub **110** may comprise the treatment mixture or the plain water depending on a current phase of a selected (and ongoing) treatment cycle performed by the household appliance **100**. Just as an example, the process liquids may com-

prise the treatment mixture during pre-washing and washing phases of the treatment cycle, or the plain water during wetting and rinsing phases of the treatment cycle.

[0112] According to the exemplary embodiment, the process liquids provided to the washing tub **110** may comprise the fresh water or the softened water depending on a current phase of a selected (and ongoing) treatment cycle performed by the household appliance **100**. Just as an example, the process liquids may comprise the softened water during pre-washing and washing phases of the treatment cycle, or the fresh water during wetting and rinsing phases of the treatment cycle.

[0113] According to the exemplary embodiment, the household appliance **100** comprises a drain **135** (schematically shown in **Figure 1B**) for allowing the process liquids contained in the washing tub **110** to be discharged from the household appliance **100**. According to the exemplary embodiment, the drain **135** is located at the cabinet back, preferably at a top portion thereof.

[0114] According to the exemplary embodiment, the household appliance **100** comprises a water supply unit **140** (schematically shown in **Figure 1B**) configured to supply fresh water to the household appliance **100**. According to the exemplary embodiment, the water supply unit **140** is located at a cabinet back, preferably at a top portion thereof.

[0115] For the purposes of the present disclosure, the fresh water supplied by the water supply unit **140** has a high or relatively high level of hardness (*i.e.* a high or relatively high amount of dissolved minerals (largely, calcium and magnesium)). For the purposes of the present disclosure, the level of hardness of the fresh water is higher than the level of hardness of the softened water provided by a water softening system (discussed in the following) from the fresh water.

[0116] According to the exemplary embodiment, the water supply unit **140** comprises a valve system.

[0117] According to the exemplary embodiment, the water supply unit **140** is connected to a fresh water hose (not shown). According to the exemplary embodiment, the fresh water hose is located behind the household appliance **100**. According to the exemplary embodiment, the fresh water hose is connected to an external water supply (such as the water mains, not shown). According to the exemplary embodiment, the water supply unit **140** may be operated to allow selective supply of fresh water to the process liquid supply apparatus and/or to a water softening system (discussed in the following), or to prevent the supply of fresh water to both the process liquid supply apparatus and the water softening system.

[0118] According to the exemplary embodiment, the water supply unit **140** is operated under the control of the control unit **CU** (as conceptually represented in the figure by electrical connection between the control unit **CU** and the water supply unit **140**). For the purposes of the present disclosure, the control unit **CU** may be configured to selectively allow or prevent the supply of fresh water from the water supply unit **140** to the process liquid supply

apparatus, to a water softening agent container (discussed in the following) and/or to a salt container (discussed in the following).

[0119] According to the exemplary embodiment, the household appliance **100** comprises a water softening system **WSS** configured to receive the fresh water (*e.g.*, from the water supply unit **140**) and to provide the softened water (*e.g.*, to the process liquid supply apparatus).

[0120] According to the exemplary embodiment, the water softening system **WSS** comprises a water softening agent container **145**.

[0121] According to the exemplary embodiment, the water softening agent container **145** is configured to store a water softening agent capable of reducing a hardness of the fresh water. Without losing generality, the water softening agent may comprise an ion-exchange resin.

[0122] According to the exemplary embodiment, the water softening agent container **145** is configured to provide the softened water obtained from the fresh water (*e.g.*, from the water supply unit **140**) reacting with the water softening agent. In other words, the water softening agent contained in the water softening agent container **145** causes a reduction of the hardness of the received fresh water, thus obtaining the corresponding softened water.

[0123] According to the exemplary embodiment, the water softening agent container **145** is operated under the control of the control unit **CU**. For the purposes of the present disclosure, the control unit **CU** may be configured to selectively allow or prevent the supply of the softened water from the water softening agent container **145** to the process liquid supply apparatus.

[0124] According to the exemplary embodiment, the water softening system **WSS** comprises a salt container **150** configured to store salt. According to the exemplary embodiment, the salt stored in the salt container **150** is used for regenerating the water softening agent contained in the water softening agent container **145** during a water softening agent regeneration procedure. According to the exemplary embodiment, during the water softening agent regeneration procedure the salt container **150** is configured to receive the fresh water, generate a mixture of salt and fresh water to produce a brine, and channel the brine into the water softening agent container **145** to regenerate the water softening agent therein.

[0125] According to the exemplary embodiment, the water softening system **WSS** comprises a draining arrangement **155** configured to drain the brine from the salt container **150** into the drain **135**. Without losing generality, the draining arrangement **155** may comprise a draining pump.

[0126] According to the exemplary embodiment, the draining arrangement **155** is operated under the control of the control unit **CU**. According to the exemplary embodiment, as better discussed in the following, the control unit **CU** is configured to activate the draining arrangement **155** to cause the brine to be drained from the salt container **150** when a salinity level of the brine is below

a threshold salinity level.

[0127] According to the exemplary embodiment, the draining arrangement **155** is configured to drain the brine from the salt container **150** into the drain **135** through the washing tub **110** (i.e., by bypassing the process liquid supply apparatus). This avoids that the process liquid supply apparatus gets soiled with the brine and/or impurities thereof.

[0128] According to the exemplary embodiment, the salt container **150** comprises an inlet channel **A** (not illustrated in the figures) through which it receives the fresh water from the water supply unit **140** to produce the brine.

[0129] According to the exemplary embodiment, the salt container **150** comprises a first outlet channel **B** (not illustrated in the figures) through which the brine is channelled into the water softening agent container **145** (to allow regeneration of the water softening agent) or into the drain **135** (to allow safe and easy salt container extraction to perform salt refill, as better discussed in the following).

[0130] According to the exemplary embodiment, the brine contained in the salt container **150** is channelled through the first outlet channel **B** into the water softening agent container **145** by the pressure of the fresh water entering the salt container **150**, or into the drain **135** by the draining arrangement **155** (i.e., upon activation thereof).

[0131] According to the exemplary embodiment, the salt container **150** comprises a second outlet channel **C** (not illustrated in the figures) to allow air contained inside the salt container **150** to exit the salt container (i.e., to allow air vent).

[0132] According to the exemplary embodiment, the salt container **150** is removably accommodated within the household appliance **100**, for example (as illustrated) at a cabinet bottom. According to the exemplary embodiment, the household appliance **100** comprises (e.g., at a cabinet front) an opening **160** for accessing the salt container **150** and allow a user to refill it with new amounts of salt.

[0133] According to the exemplary embodiment, the household appliance **100** comprises (e.g., at a cabinet front) a door **D** for selectively opening/closing the opening **160**.

[0134] According to the exemplary embodiment, the water softening system **WSS** comprises a housing **H** for removably accommodating the salt container **150** therein.

[0135] According to the exemplary embodiment, the salt container **150** is adapted to slide within the housing **H**, along the sliding direction (identified by the **X** axis) between a retracted position and an extracted position. According to the exemplary embodiment, in the retracted position the salt container **150** is completely enclosed within the cabinet **105**, and in the extracted position the salt container **150** is completely or partially removed from the cabinet **105** through the opening **160** for allowing an easy salt refill.

[0136] Without losing generality, the salt container **150** may be operated between the retracted and extracted positions by means of a push-push mechanism (not shown).

[0137] According to the exemplary embodiment, when accommodated within the household appliance **100** (i.e., when it is in the retracted position within the housing **H**), the salt container **150** is hydraulically connected to the water softening agent container **145** through a respective check valve **165_B** arranged in the first outlet channel **B** of the salt container **150** and through a respective check valve **170_B** arranged in the housing **H**.

[0138] According to the exemplary embodiment, when accommodated within the household appliance **100** (i.e., when it is in the retracted position within the housing **H**), the salt container **150** is hydraulically connected to the water supply unit **140** through a respective check valve **165_A** arranged in the inlet channel **A** of the salt container **150** and through a respective check valve **170_A** arranged in the housing **H**.

[0139] According to the exemplary embodiment, when accommodated within the household appliance **100** (i.e., when it is in the retracted position within the housing **H**), the salt container **150** is hydraulically connected to the draining arrangement **155** through the check valve **165_B** and through the check valve **170_B**.

[0140] According to the exemplary embodiment, when accommodated within the household appliance **100** (i.e., when it is in the retracted position within the housing **H**), the salt container **150** is fluidly connected to a surrounding region or environment being external to the salt container **150** (so as to allow air contained inside the salt container **150** to be vent or exhausted into the surrounding region) through a respective check valve **165_C** arranged in the second outlet channel **C** of the salt container **150** and a respective check valve **170_C** arranged in the housing **H**.

[0141] In the following, the check valves arranged in the salt container **150** (i.e., the check valve **165_A**, the check valve **165_B**, and the check valve **165_C**) will be also denoted as container check valves **165_A-165_C**, and the check valves arranged in the housing **H** (i.e., the check valve **170_A**, the check valve **170_B**, and the check valve **170_C**) will be also denoted as housing check valves **170_A-170_C**.

[0142] According to the exemplary embodiment, when the salt container **150** is inserted within the household appliance **100**, the check valves **165_A**, **170_A**, **165_B**, **170_B**, **165_C**, **170_C** are open (due to interaction or cooperation (e.g., coupling) between each container check valve **165_A-165_C** and the respective housing check valve **170_A-170_C**), thereby allowing the hydraulic connection of the salt container **150** to the water softening agent container **145**, to the draining arrangement **155**, and to the water supply unit **140**, as well as the fluid connection of the salt container **150** to the surrounding region or environment to expel or vent or exhaust the air).

[0143] According to the exemplary embodiment, when

the salt container **150** is extracted from the household appliance **100** (and, at least partially, from the housing **H**), the check valves **165_A, 170_A, 165_B, 170_B, 165_C, 170_C** are closed (due to interaction end or loss (e.g., decoupling) between each container check valve **165_A-165_C** and the respective housing check valve **170_A-170_C**), thereby preventing the hydraulic and fluid connections of the salt container **150** to the water softening agent container **145** and to the water supply unit **140** (due to closing of the housing check valves **170_A** and **170_B**) when the salt container **150** is extracted from the household appliance **100**, the spillage of the content of the water softening agent container **145** into the housing **H** and the flow of fresh water into the housing **H** are respectively prevented.

[0144] According to the exemplary embodiment, each check valve comprises a valve body actuatable to allow passage of fluid (e.g., water or air) therethrough.

[0145] According to the exemplary embodiment, each housing check valve **170_A-170_C** comprises an actuation member (for example, in the form of a pin or stem, visible in **Figures 1B and 2D**) for valve body actuation.

[0146] According to the exemplary embodiment, when the salt container **150** is inserted within the household appliance **100**, each actuation member actuates the valve bodies of the respective check valves **165_A, 170_A, 165_B, 170_B, 165_C, 170_C**, thereby opening the check valves **165_A, 170_A, 165_B, 170_B, 165_C, 170_C** to establish the respective hydraulic and fluid connections, whereas when the salt container **150** is extracted from the household appliance **100**, the actuation members do not interact with the valve bodies of the respective check valves **165_A, 170_A, 165_B, 170_B, 165_C, 170_C**, so that each of the check valves **165_A, 170_A, 165_B, 170_B, 165_C, 170_C** is closed, thereby preventing the respective hydraulic and fluid connections.

[0147] According to the exemplary embodiment, the water softening system **WSS** comprises a salinity detection unit **180** for detecting a salinity level of (i.e., a saltiness or amount of salt dissolved) in the brine inside the salt container **150**. Without losing generality, the salinity detection unit **180** may for example be based on electrical conductivity metering (indeed, a water-salt solution, such as the brine, can conduct more electricity than water) or refractive index metering (indeed, the refractive index increases with solubility in an aqueous solution). According to the exemplary embodiment, as better discussed in the following, the control unit **CU** is configured to activate the draining arrangement **155** to cause the brine to be drained from the salt container **150** if the salinity detection unit **180** detects that the salinity level of the brine is below a threshold salinity level.

[0148] According to the exemplary embodiment, the water softening system **WSS** comprises a presence detection unit **185** for detecting a presence or absence of the salt container **150** within the household appliance **100**. Without losing generality, the presence detection

unit **185** may be based on any suitable detection principle, such as mechanical detection, electrical detection, optical detection or a combination thereof. According to the exemplary embodiment, as better discussed in the following, the control unit **CU** is configured to activate the draining arrangement **155** to cause the brine to be drained from the salt container **150** if the salinity detection unit **180** detects that the salinity level of the brine is below the threshold salinity level and if the presence detection unit **185** detects the presence of the salt container **150** within the household appliance **100**.

[0149] According to the exemplary embodiment, the water softening system **WSS** comprises a brine level detection unit **190** for detecting a brine level in the salt container **150**. Without losing generality, the brine level detection unit **190** may for example comprise a magnetic or a mechanical float configured to displace (i.e., rise and fall) as brine level changes, and to transduce the displacement into a corresponding electric signal, or an electromagnetic, ultrasonic, radar or optical sensor for measuring a time-of-flight of a test signal emitted towards a brine surface. According to the exemplary embodiment, as better discussed in the following, the control unit **CU** is configured to check the salinity level of the brine if the brine level detection unit **190** detects that the brine level in the salt container **150** is above a threshold brine level.

[0150] According to the exemplary embodiment, the water softening system **WSS** comprises a processing unit **195**. Without losing generality, the processing unit **195** may comprise a printed circuit board (PCB) with one or more processors and/or microprocessors and one or more conductive traces and/or connectors for electrical connections.

[0151] According to the exemplary embodiment, the processing unit **195** is electrically connected to the control unit **CU**.

[0152] According to the exemplary embodiment, the processing unit **195** is electrically connected to the salinity detection unit **180**, and is configured to receive salinity detection signals from the salinity detection unit **180**, and to provide to the control unit **CU** the salinity level (or an indication thereof) of the brine contained in the salt container **150**.

[0153] According to the exemplary embodiment, the processing unit **195** is electrically connected to the presence detection unit **185** and is configured to receive presence detection signals from the presence detection unit **185**, and to provide to the control unit **CU** an indication of the presence of the salt container **150** within the household appliance **100**.

[0154] According to the exemplary embodiment, the processing unit **195** is electrically connected to the brine level detection unit **190** and is configured to receive brine level detection signals from the brine level detection unit **190**, and to provide to the control unit **CU** the brine level (or an indication thereof) contained in the salt container **150**.

[0155] According to the exemplary embodiment, as

better discussed in the following, when the brine has been drained from the salt container **150** by the draining arrangement **155** (e.g., as indicated by a brine level detection signal, from the brine level detection unit **190**, indicative of an empty or substantially empty condition of the salt container **150**), the control unit **CU** is configured to activate the warning means to provide corresponding warning indications, for example to inform the user that the salt container **150** can and/or should be extracted from the household appliance **100** to be refilled with salt (the warning indications thus prompting the user to perform salt refill).

[0156] According to the exemplary embodiment, as conceptually represented in **Figure 1B**, the salinity detection unit **180**, the presence detection unit **185**, and the brine level detection unit **190** are arranged in the housing **H**.

[0157] According to the exemplary embodiment, as conceptually represented in **Figure 1B**, the processing unit **195** is arranged in the housing **H**.

[0158] According to the exemplary embodiment, as conceptually represented in **Figure 1B**, the draining arrangement **155** is arranged in the housing **H**.

[0159] **Figures 2A** and **2B** show perspective front views of the housing **H** accommodating the salt container **150** in retracted and partially extracted positions, respectively, according to the exemplary embodiment of the present disclosure.

[0160] According to the exemplary embodiment, the housing **H** comprises a first (e.g., lower) housing shell **205₁** and a second (e.g., upper) housing shell **205₂** (wherein the terms lower and upper refer to lower and upper positions along the **Z** axis).

[0161] According to the exemplary embodiment, the lower housing shell **205₁** is made of a plastic (e.g., rigid or semi rigid) material and/or of a metal material.

[0162] According to the exemplary embodiment, the upper housing shell **205₂** is made of a plastic (e.g., rigid or semi rigid) material and/or of a metal material. Without losing generality, the lower housing shell **205₁** and the upper housing shell **205₂** may be made of same, different, or partially different materials.

[0163] According to the exemplary embodiment, the lower housing shell **205₁** and the upper housing shell **205₂** are connected to each other. According to the exemplary embodiment, the lower housing shell **205₁** and the upper housing shell **205₂** are connected to each other in a removable manner.

[0164] According to the exemplary embodiment, the lower housing shell **205₁** and the upper housing shell **205₂** are connected to each other by means of one or more snap-fit mechanisms, for example a plurality of snap-fit mechanisms provided at (e.g., edge or perimeter portions of) the lower and upper housing shells.

[0165] According to the exemplary embodiment, the lower housing shell **205₁** and the upper housing shell **205₂** are connected to each other by means of one or more cantilever snap-fit mechanisms, for example a plu-

rality of cantilever snap-fit mechanisms. According to the exemplary embodiment, each cantilever snap-fit mechanism comprises a protruding edge **210_E** provided in the upper housing shell **205₂** and a respective snap-in area **210_S** provided in the lower housing shell **205₁**.

[0166] According to the exemplary embodiment, the housing **H** is adapted to be accommodated in a respective housing seat (not shown), the housing seat being for example formed in the basement portion of the household appliance **100**. According to the exemplary embodiment, the housing seat has a profile matching or substantially matching a profile of the lower housing shell **205₁**.

[0167] According to the exemplary embodiment, the housing **H** is adapted to be fixed to the household appliance **100**, so as to stably keep it firm while moving the salt container **150** between the extracted and retracted positions.

[0168] According to the exemplary embodiment, the housing **H** is adapted to be fixed to the basement portion of the household appliance **100**.

[0169] According to the exemplary embodiment, the housing **H** is adapted to be fixed to the household appliance **100** (such as to the basement portion thereof) by means of a fixing arrangement **215**. According to the exemplary embodiment, the fixing arrangement **215** comprises a bracket (or more thereof) and a screw (or more thereof) adapted to be screwed into a corresponding hole of the bracket and a corresponding hole (e.g., a threaded hole), not shown, of the basement portion. According to the exemplary embodiment, the bracket is rigidly connected to the lower housing shell **205₁**, the bracket **215** being for example formed in a single piece with the lower housing shell **205₁**.

[0170] With reference also to **Figures 2C** and **2D**, **Figure 2C** shows a perspective rear view of the housing **H** accommodating the salt container **150** in the retracted position, and **Figure 2D** shows a perspective and exploded rear view of the lower housing shell **205₁**.

[0171] According to the exemplary embodiment, the housing **H** comprises a seat (hereinafter, pump seat) **220** for accommodating the draining pump (or, more generally, the draining arrangement **155**).

[0172] According to the exemplary embodiment, the pump seat **220** comprises a lower pump seat portion **220₁** associated with (e.g., formed in a single piece with) the lower housing shell **205₁** and adapted to house (from below) the draining pump (or, more generally, the draining arrangement **155**), and an upper pump seat portion **220₂** associated with (e.g., formed in a single piece with) the upper housing shell **205₂** and adapted to cover (from above) the draining pump (or, more generally, the draining arrangement **155**). According to the exemplary embodiment, the pump seat **220** is configured to completely enclose the draining pump (or, more generally, the draining arrangement **155**) when the lower housing shell **205₁** and the upper housing shell **205₂** are connected to each other.

[0173] According to the exemplary embodiment, as visible in **Figures 2C** and **2D**, the housing **H** comprises one or more receiving portions for receiving one or more among the salinity detection unit **180**, the presence detection unit **185**, the brine level detection unit **190**, and the processing unit **195**.

[0174] According to the exemplary embodiment, the housing **H** comprises, e.g., at a rear part of the lower housing shell **205₁**, a receiving portion **225** for receiving the salinity detection unit **180**.

[0175] According to the exemplary embodiment, the housing **H** comprises, e.g., at the rear part of the lower housing shell **205₁**, a receiving portion **230** for receiving the presence detection unit **185**.

[0176] According to the exemplary embodiment, the housing **H** comprises, e.g., at the rear part of the lower housing shell **205₁**, a receiving portion **235** for receiving the brine level detection unit **190**.

[0177] According to the exemplary embodiment, each receiving portion **225, 230, 235** is configured (for example, it is shaped and sized) to house the respective component (*i.e.*, the salinity detection unit **180**, the presence detection unit **185**, the brine level detection unit **190**, respectively). According to the exemplary embodiment, each receiving portion **225, 230, 235** is configured (for example, it is shaped and sized) to provide a retention action on the respective component.

[0178] According to the exemplary embodiment, the housing **H** comprises, e.g., at the rear part of the lower housing shell **205₁**, one or more (three, in the example at issue) channels **240_A, 240_B, 240_C** each one configured for receiving a respective housing check valve **170_A, 170_B, 170_C**.

[0179] According to the exemplary embodiment, the channel **240_A** is an inlet channel accommodating the housing check valve **170_A**, configured to receive the fresh water from the water supply unit **140**.

[0180] According to the exemplary embodiment, the channel **240_B** is an outlet channel accommodating the housing check valve **170_B**, configured to channel the brine into the water softening agent container **145** and to channel the brine drained from the salt container **150** when the draining arrangement **155** has been activated.

[0181] According to the exemplary embodiment, the channel **240_C** is an air channel arranged in an inner top region of the housing **H** above the liquid level, accommodating the housing check valve **170_C**, for connecting the salt container **150** to the surrounding region external to the salt container **150** so as to allow air to exit the salt container **150**.

[0182] According to the exemplary embodiment, when the salt container **150** is inserted within the housing **H**, the channel **A** is hydraulically connected to the channel **240_A** due to the coupling between the container check valve **165_A** and the housing check valve **170_A**, the channel **B** is hydraulically connected to the channel **240_B** due to the coupling between the container check valve **165_B** and the housing check valve **170_B**, and the channel **C** is

hydraulically connected to the channel **240_C** due to the coupling between the container check valve **165_C** and the housing check valve **170_C**.

[0183] According to the exemplary embodiment, the housing **H** comprises a closure lid **245** for closing the rear portion of the lower housing shell **205₁**. According to the exemplary embodiment, the closure lid **245** is configured to be fixed to the rear portion of the lower housing shell **205₁**, for example by means of a snap closure.

[0184] According to the exemplary embodiment, the housing **H** comprises a receiving portion **250** for receiving the processing unit **195**. According to the exemplary embodiment, the receiving portion **250** is formed on an external face of the closure lid **245** opposite to an inner face of the closure lid **245** so that, in operation (*i.e.*, when the closure lid **245** is fixed to the housing **H**) it faces the rear part of the lower housing shell **205₁**.

[0185] According to the exemplary embodiment, the receiving portion **250** is configured (for example, it is shaped and sized) to house the processing unit **195**. According to the exemplary embodiment, the receiving portion **250** is configured (for example, it is shaped and sized) to provide a retention action on the processing unit **195**.

[0186] According to the exemplary embodiment, the housing **H** comprises a cover **255** for covering the processing unit **195**. According to the exemplary embodiment, the cover **255** is configured (for example, it is shaped and sized) to be fixed to the closure lid **245**, for example by means of a snap engagement with an edge of (*i.e.*, which delimits) the receiving portion **250**.

[0187] With reference now to **Figure 3**, it shows a diagram of a method **300** for operating a water softening system according to the exemplary embodiment of the present disclosure.

[0188] According to the exemplary embodiment, the method **300** is performed by the control unit **CU**.

[0189] According to the exemplary embodiment, the method **300** is performed when a softening agent regeneration procedure is requested (for example, autonomously by the household appliance, such as at the end of each treatment cycle or after a predetermined or selectable number of treatment cycles, or by a user).

[0190] According to the exemplary embodiment, the method steps are implemented by a computer program product loadable into an internal memory of the control unit **CU**. According to the exemplary embodiment, the computer program product comprises software code means for configuring the control unit **CU** to perform the method steps when the computer program product is run.

[0191] By computer program product loadable into an internal memory of an apparatus (such as an internal memory of the control unit **CU**), it is herein meant that the computer program can be introduced into the internal memory of the relevant apparatus so as to achieve an apparatus programmed to be capable of, or adapted to, carrying out the corresponding method steps.

[0192] Without losing generality, the computer pro-

gram product implementing the method steps may comprise, or be included in, a firmware of the household appliance **100**, the firmware being for example stored in the internal memory of the control unit **CU**.

[0193] Broadly speaking, as better discussed in the following, the method **300** comprises activating the draining arrangement **155** to cause the brine to be drained from the salt container **150** when the salinity detection unit **180** detects that the salinity level of the brine is below a threshold salinity level.

[0194] According to the exemplary embodiment, the method **300** comprises checking a presence or absence of the salt container **150** within the household appliance **100** (decision node **305**). According to the exemplary embodiment, the presence or absence of the salt container **150** is checked by the control unit **CU** based on the presence detection signals from the presence detection unit **185** (for example, based on the presence detection signals from the presence detection unit **185** to the processing unit **195** and on the corresponding indication of the presence or absence of the salt container **150** from the processing unit **195** to the control unit **CU**).

[0195] Checking the presence or absence of the salt container **150** within the household appliance **100** is particularly (although not exclusively) advantageous when the method **300** is run long after (or relatively long after) end of the treatment cycle, due to the fact that the salt container **150** may have been extracted in the meanwhile, accidentally (for example, by a child) or voluntarily (for example, by the user for purposes of cleaning or autonomously salt refilling).

[0196] According to the exemplary embodiment, if the salt container **150** is not present within the household appliance **100** (exit branch **N** of decision node **305**), the method **300** ends (action node **310**). According to an embodiment, the method **300** ends (action node **310**) and no further actions are performed.

[0197] According to the exemplary embodiment, if the salt container **150** is present within the household appliance **100** (exit branch **Y** of decision node **305**), the method **300** comprises performing a water softening agent regeneration procedure (action node **315**). According to the exemplary embodiment, during the water softening agent regeneration procedure the salt container **150** is configured to receive the fresh water, generate a mixture of salt and fresh water to produce the brine, and channel the brine into the water softening agent container **145**.

[0198] According to the exemplary embodiment, the method **300** comprises checking the salinity level of the brine within the salt container **150** (decision node **320**). According to the exemplary embodiment, the salinity level of the brine within the salt container **150** is checked by the control unit **CU** based on the salinity detection signals from the salinity detection unit **180** (for example, based on the salinity detection signals from the salinity detection unit **180** to the processing unit **195** and on the corresponding indication of the salinity level from the processing unit **195** to the control unit **CU**).

[0199] According to the exemplary embodiment, if the salinity level is above a threshold salinity level (exit branch **N** of decision node **315**), the method **300** ends (action node **325**). According to the exemplary embodiment, the method **300** ends (action node **325**) and no further actions are performed.

[0200] According to the exemplary embodiment, if the salinity level is below the threshold salinity level (exit branch **Y** of decision node **320**), the method **300** comprises activating the draining arrangement **155** to cause the brine with the insufficient salinity level to be drained from the salt container **150** (action node **330**).

[0201] According to the exemplary embodiment, the method **300** comprises checking the brine level in the salt container **150** (decision node **335**). According to the exemplary embodiment, the brine level in the salt container **150** is checked by the control unit **CU** based on the brine level detection signals from the brine level detection unit **190** (for example, based on the brine level detection signals from the brine level detection unit **190** to the processing unit **195** and on the corresponding indication of the brine level from the processing unit **195** to the control unit **CU**).

[0202] According to the exemplary embodiment, if the brine level is below a threshold brine level (exit branch **Y** of decision node **335**), an empty or substantially empty condition of the salt container **150** is decreed, thereby confirming that draining of the brine from the salt container **150** was correctly performed.

[0203] According to the exemplary embodiment, the activation of the draining arrangement **155** to cause the brine to be drained from the salt container **150** (action node **330**) is performed until the empty or substantially empty condition of the salt container **150** is reached. This is conceptually represented in the figure by loop connection between exit branch **N** of decision node **335** and action node **330**.

[0204] According to the exemplary embodiment, if the empty or substantially empty condition of the salt container **150** has not been reached (exit branch **N** of decision node **335**), no actions are performed, and the draining arrangement **155** keeps on draining the brine from the salt container **150** (action node **330**).

[0205] According to the exemplary embodiment, if the empty or substantially empty condition of the salt container **150** has been reached (exit branch **Y** of decision node **335**), the method **300** comprises activating the warning means to provide the corresponding warning indications (action node **340**), for example to inform the user that the salt container **150** can be extracted from the household appliance **100** to be refilled with salt.

[0206] Without losing generality, activation of the warning means may follow or precede or be contextual with a deactivation of the draining arrangement **155**.

[0207] The household appliance **100** (and the corresponding method **300** implemented by it) allows automatically detecting the salinity level of the brine inside the salt container **150**, which relieves the user from the

burden and responsibility of determining the salt level within the salt container **150** by visual inspection and/or subjective estimation. This avoids that the user adds salt too frequently or not frequently enough. This also avoids the use of a large capacity salt container, which may result in a bulky household appliance that may be prohibitive in small living spaces. This also avoids the use of indicator sticks to determine the amount of salt within the salt container, which may result inaccurate due to salt bridges that may change an appearance of the salt volume.

[0208] The household appliance **100** (and the corresponding method **300** implemented by it) allows automatically draining the brine from the salt container **150** when the salinity level of the brine is below the threshold salinity level, so that the user is allowed to extract the salt container **150** only when it is empty or substantially empty. This avoids spill or overflow of brine when the salt container **150** is extracted, without provision of watertight closures, and without envisaging complex or relatively complex architectural solutions for emptying of the salt container **150** from brine before extraction.

[0209] Naturally, in order to satisfy local and specific requirements, a person skilled in the art may apply to the disclosure described above many logical and/or physical modifications and alterations. More specifically, although the disclosure 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 disclosure 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. Household appliance (**100**) comprising a water softening system (**WSS**) configured to receive fresh water having a first level of hardness and to provide softened water having a second level of hardness lower than the first level of hardness, wherein the water softening system comprises:

a water softening agent container (**145**) configured to store a water softening agent capable of reducing a hardness of the fresh water;
a salt container (**150**), removably accommodated within the household appliance and hydraulically connected to the water softening agent container when accommodated within the household appliance, the salt container being configured to receive the fresh water, generate

a mixture of salt and fresh water to produce a brine, and channel the brine into the water softening agent container to allow a regeneration of the water softening agent;

a salinity detection unit (**180**) for detecting a salinity level of the brine inside the salt container, a draining arrangement (**155**) hydraulically connected to the salt container, and configured to drain the brine from the salt container; and
a control unit (**CU**) configured to activate the draining arrangement (**155**) to cause the brine to be drained from the salt container (**150**) when the salinity detection unit detects (**180**) that the salinity level of the brine is below a threshold salinity level.

2. Household appliance (**100**) according to claim 1, wherein the water softening system (**WSS**) further comprises a presence detection unit (**185**) for detecting a presence or absence of the salt container (**150**) within the household appliance, and/or a brine level detection unit (**190**) for detecting a brine level in the salt container (**150**), the control unit (**CU**) being configured to activate the draining arrangement (**155**) to cause the brine to be drained from the salt container (**150**) further when the presence detection unit detects (**185**) the presence of the salt container (**150**) within the household appliance and/or when the brine level detection unit (**190**) detects that the brine level in the salt container (**150**) is above a threshold brine level.
3. Household appliance (**100**) according to claim 2, wherein the household appliance further comprises warning means (**120₃**) configured to communicate with the control unit (**CU**), wherein the control unit is configured to provide a signal indicative of an empty condition of the salt container (**150**) when, after activation of the draining arrangement (**155**), the brine level detection unit (**190**) detects that the brine level in the salt container (**150**) is below the threshold brine level and to activate the warning means (**120₃**) to inform a user that the salt container (**150**) can be extracted from the household appliance to be refilled with salt.
4. Household appliance (**100**) according to any preceding claims, wherein the water softening system (**WSS**) comprises a housing (**H**) for removably accommodating the salt container (**150**) therein, wherein the housing is hydraulically connected to the salt container (**150**) and to the draining arrangement (**155**).
5. Household appliance (**100**) according to claim 4, wherein the salinity detection unit (**180**) is arranged in the housing (**H**).

6. Household appliance (100) according to claim 4 or 5 when depending directly or indirectly on claim 2, wherein the presence detection unit (185) and/or the brine level detection unit (190) are arranged in the housing (H). 5
7. Household appliance (100) according to any of the preceding claims, further comprising a processing unit (195) for receiving salinity detection signals from the salinity detection unit (180), and for providing to the control unit (CU) an indication of the salinity level of the brine contained in the salt container (150). 10
8. Household appliance (100) according to claim 7 when depending directly or indirectly on claim 4, wherein the processing unit (195) is arranged in the housing (H). 15
9. Household appliance (100) according to claim 7 or 8 when depending on directly or indirectly on claim 2, wherein the processing unit (195) is configured to 20
- receive presence detection signals from the presence detection unit (185), and provide to the control unit (CU) an indication of the presence of the salt container (150) within the household appliance, and/or 25
- receive brine level detection signals from the brine level detection unit (190), and provide to the control unit (CU) an indication of the brine level in the salt container (150). 30
10. Household appliance (100) according to any of the preceding claims, wherein said draining arrangement (155) comprises a draining pump. 35
11. Household appliance (100) according to claim 10 when depending directly or indirectly on claim 4, wherein the housing (H) comprises a seat (220) for accommodating the draining pump therein. 40
12. Household appliance (100) according to any claim from 4 to 11 when depending directly or indirectly on claim 4, wherein the housing (H) comprises a first housing shell (205₁) and a second housing shell (205₂) connected to each other in a removable manner. 45
13. Method (300) of operating a household appliance (100) comprising a water softening agent container (145) configured to store a water softening agent capable of reducing a hardness of fresh water, and a salt container (150) configured to receive the fresh water, generate a mixture of salt and fresh water to produce a brine, and channel the brine into the water softening agent container to allow a regeneration of the water softening agent, the method comprising: 50
- detecting (320) a salinity level of the brine inside the salt container; 55
- when the salinity level of the brine is below a threshold salinity level, activating a draining arrangement (155) hydraulically connected to the salt container, to drain the brine (330, 335) from the salt container.
14. Method (300) according to claim 13, further comprising:
- detecting (305) a presence or absence of the salt container (150) within the household appliance, and/or
 - detecting (335) a brine level in the salt container (150), and
 - activating (330) the draining arrangement (155) to drain the brine from the salt container (150) when the presence detection unit detects (185) the presence of the salt container (150) within the household appliance and/or if the brine level detection unit (190) detects that the brine level in the salt container (150) is above a threshold brine level.
15. Method (300) according claim according to claim 14, further comprising: 55
- providing a signal indicative of an empty condition of the salt container (150) when, after activation of the draining arrangement (155), the brine level detection unit (190) detects that the brine level in the salt container (150) is below the threshold brine level (155).

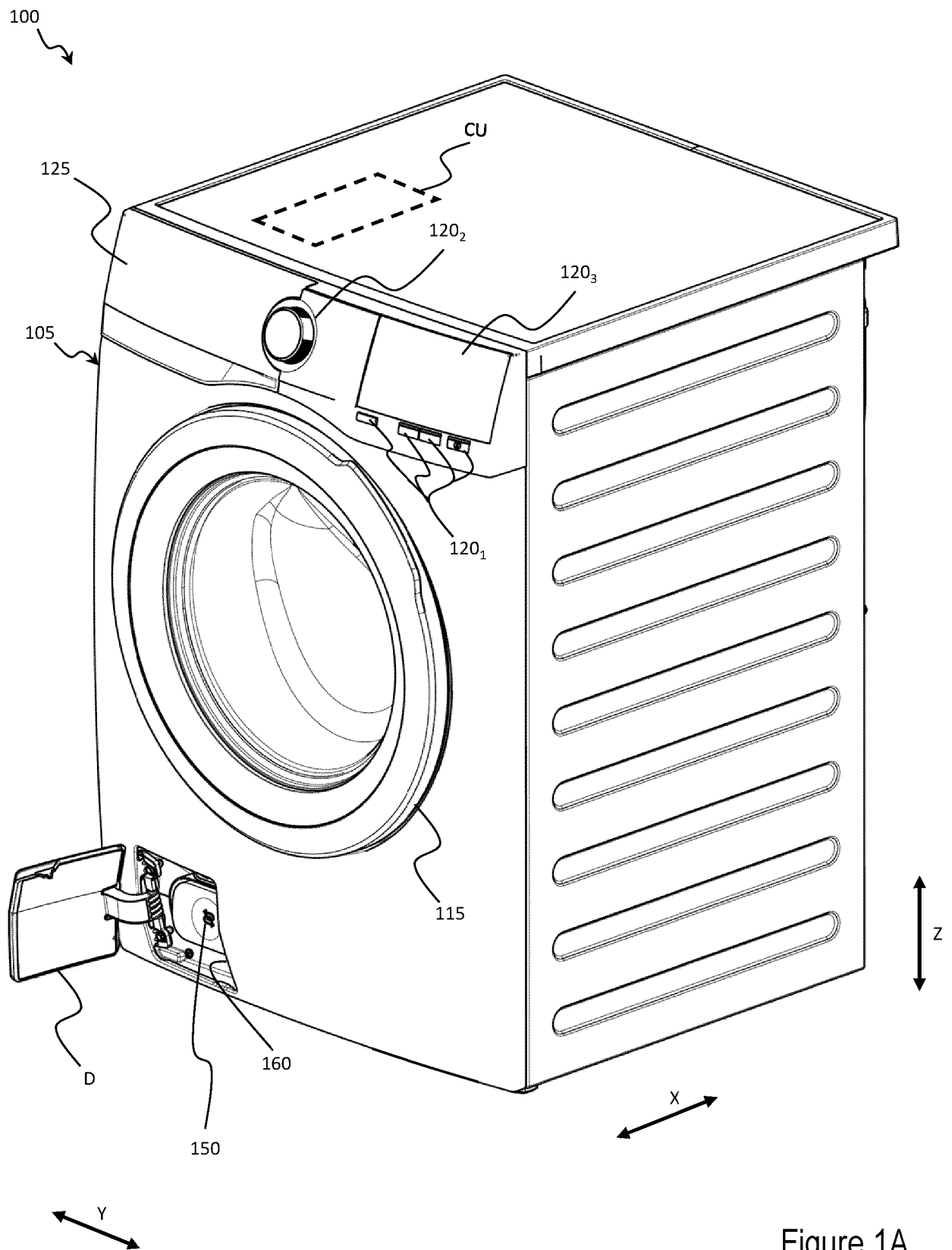


Figure 1A

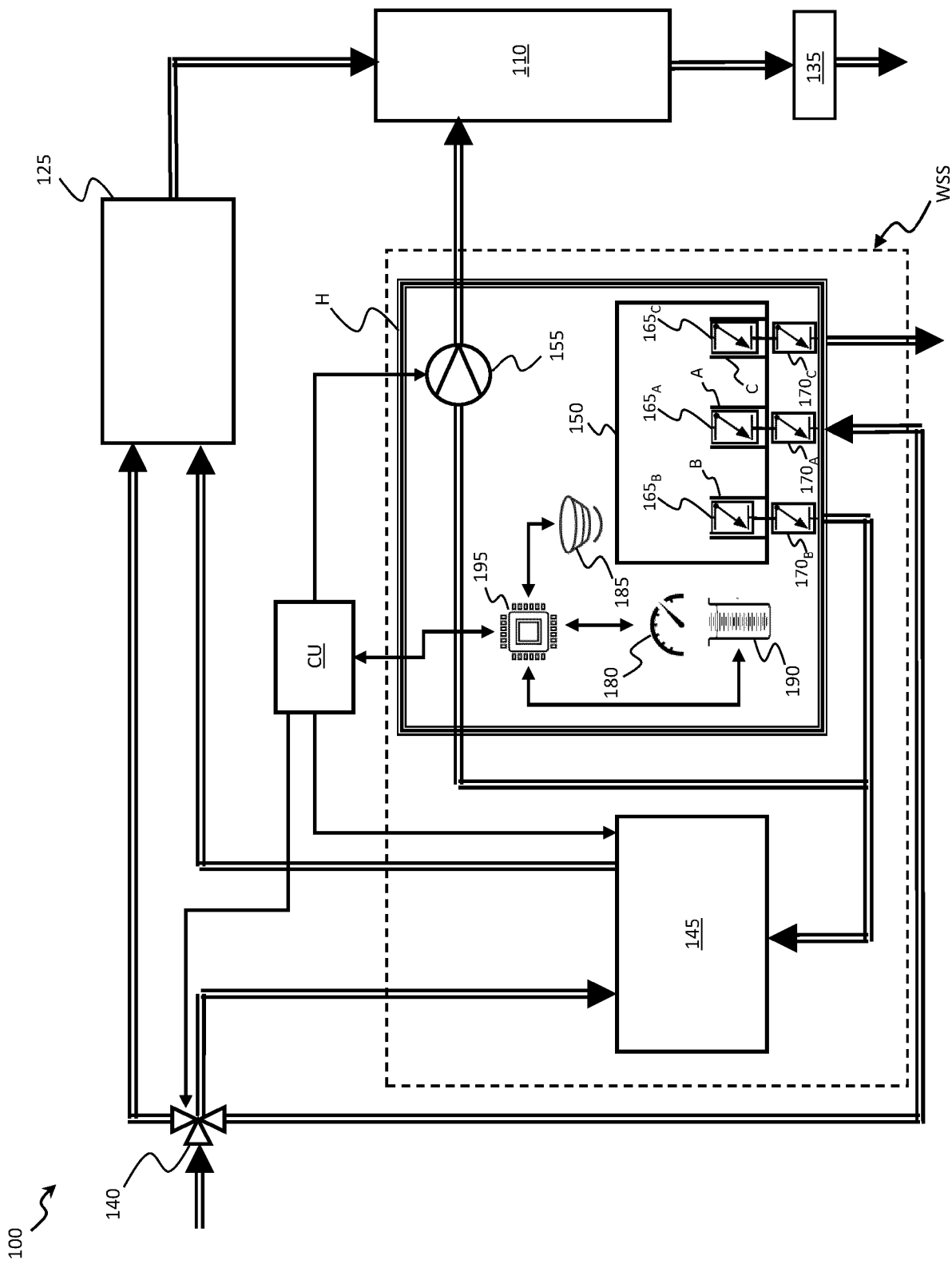
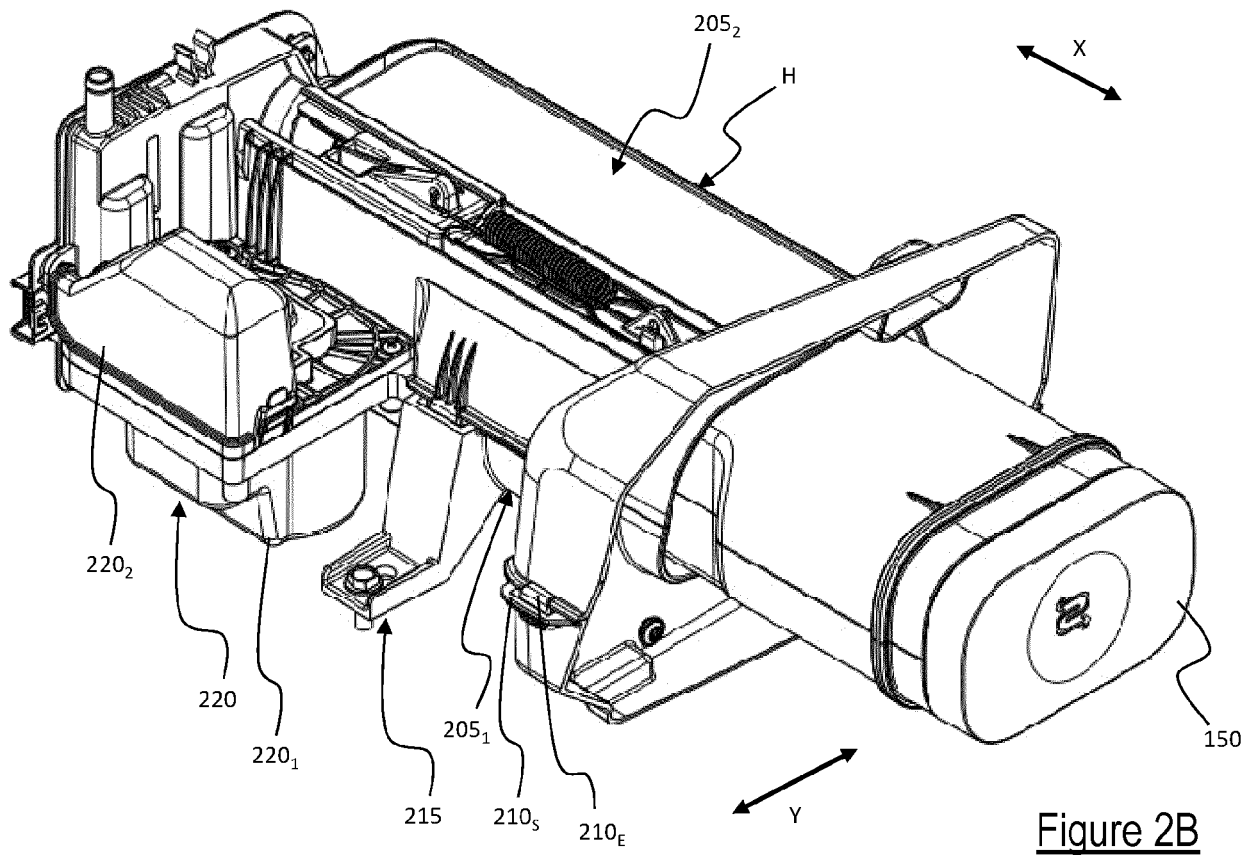
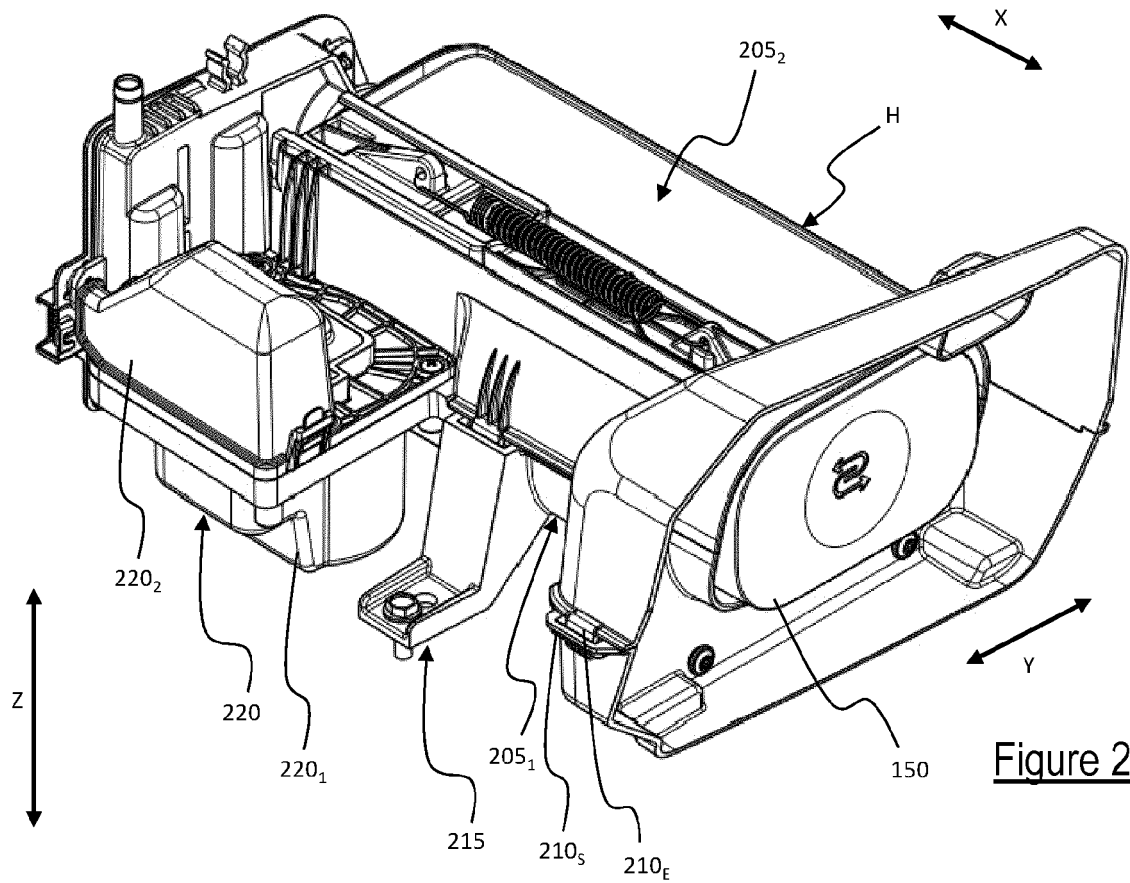


Figure 1B



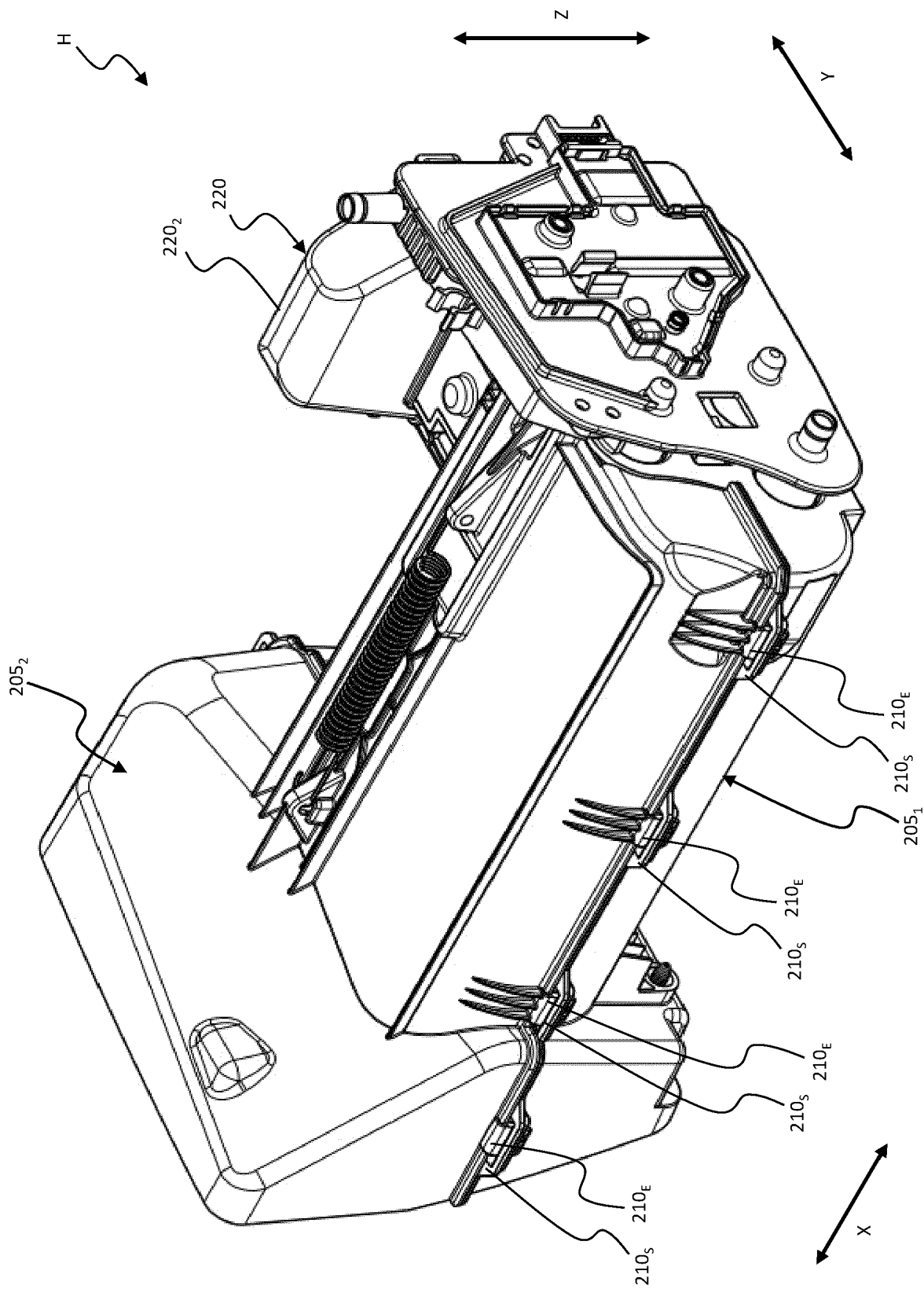


Figure 2C

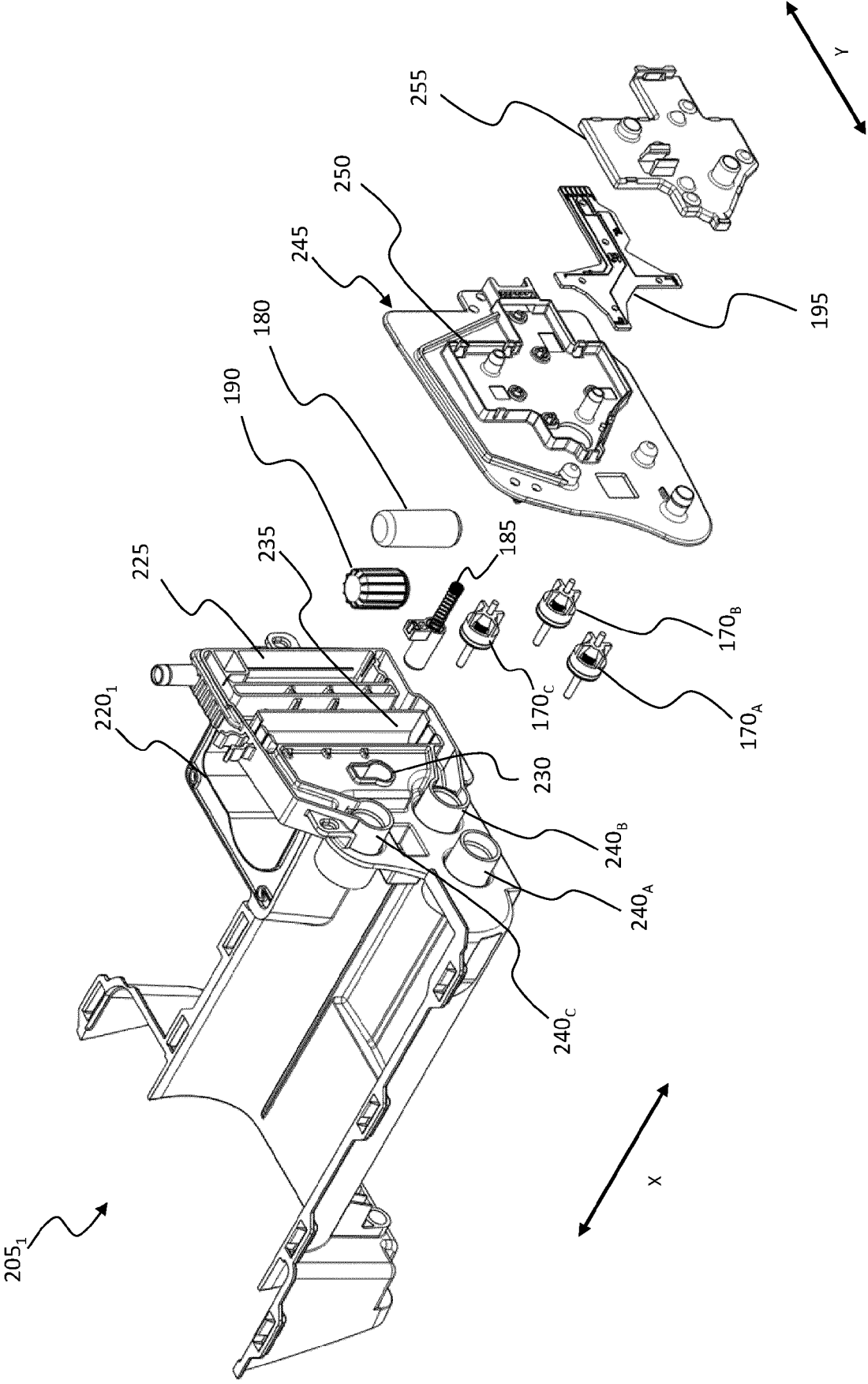


Figure 2D

300 ↘

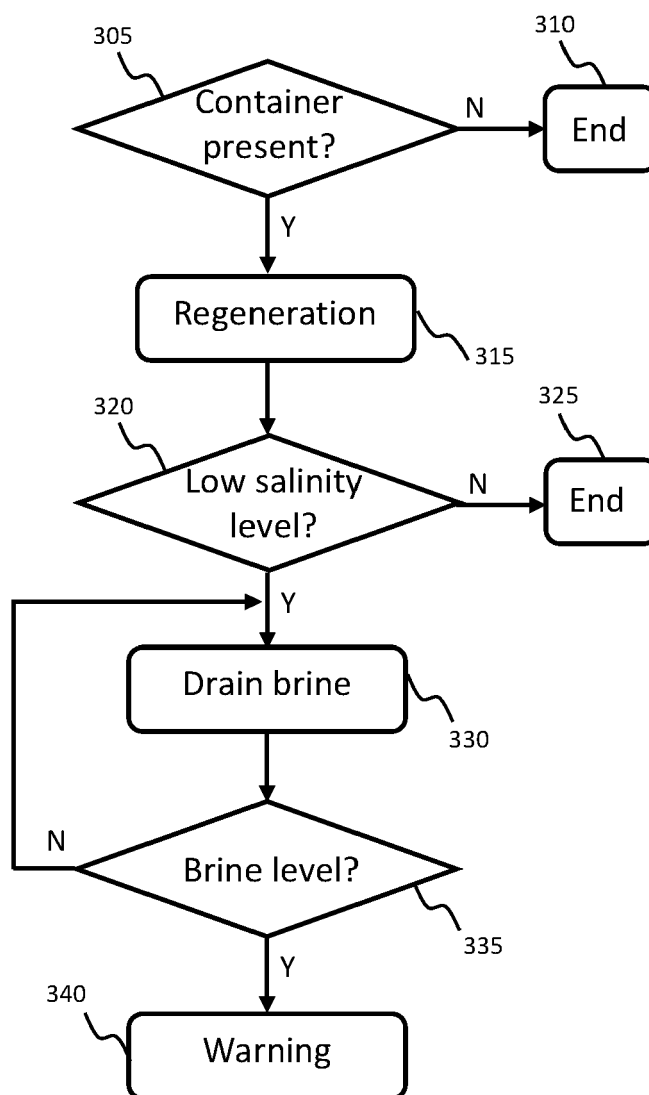


Figure 3



EUROPEAN SEARCH REPORT

Application Number

EP 22 21 3628

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A	EP 3 632 286 A1 (VESTEL BEYAZ ESYA SANAYI VE TICARET AS [TR]) 8 April 2020 (2020-04-08) * paragraph [0010] - paragraph [0013] * * paragraph [0022] - paragraph [0028] * * paragraph [0033] * * figures 1-30 * -----	1-15	INV. D06F33/57 D06F39/00 ADD. D06F103/00 D06F103/20 D06F105/08 D06F105/58
A	EP 2 954 112 B1 (ELECTROLUX APPLIANCES AB [SE]) 9 June 2021 (2021-06-09) * paragraph [0035] - paragraph [0048] * * paragraph [0075] - paragraph [0102] * * paragraph [0124] - paragraph [0137] * * paragraph [0154] - paragraph [0156] * * figures 1-7 * -----	1-15	
A	WO 2017/162289 A1 (ELECTROLUX APPLIANCES AB [SE]) 28 September 2017 (2017-09-28) * page 9, line 11 - line 22 * * page 10, line 6 - line 28 * * page 12, line 2 - page 13, line 14 * * page 15, line 13 - page 18, line 6 * * page 19, line 7 - page 21, line 9 * * page 22, line 6 - page 24, line 5 * * figures 1-10, 16, 17 * -----	1-15	TECHNICAL FIELDS SEARCHED (IPC) D06F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 23 May 2023	Examiner Sabatucci, Arianna
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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