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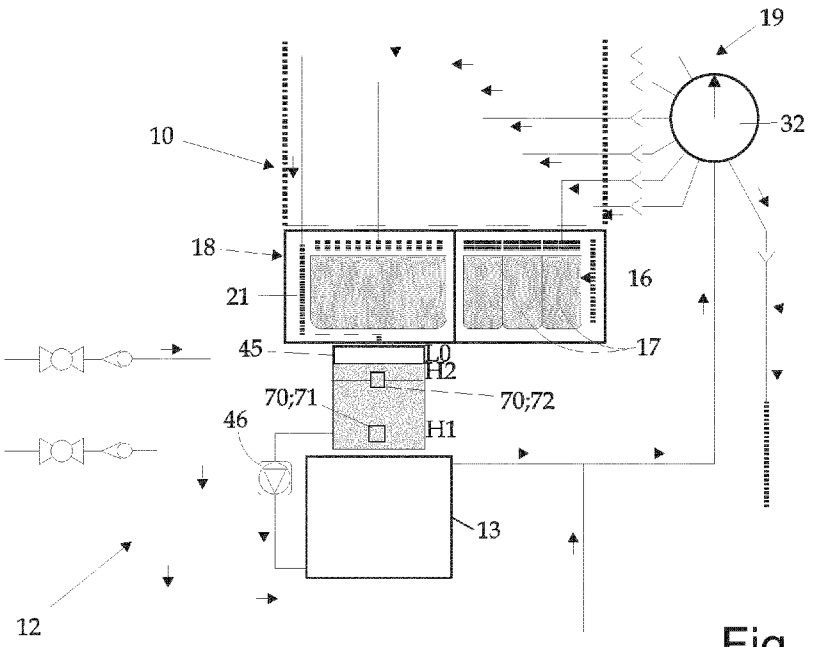

Fig. 4

(57) Abstract: A laundry washing machine (1) comprising an outer casing (2) and, inside the outer casing (2), a washing tub (3), a rotatable drum housed in axially rotatable manner inside the washing tub (3) and structured for housing the laundry to be washed, a detergent dispenser (10) which is structured for supplying detergent into the washing tub (3), a fresh-water supply circuit (12) which is structured for selectively channelling a flow of fresh water from the water mains towards the detergent dispenser (10) and/or the washing tub (3), an internal water softening device (13) filled with a water softening agent capable of reducing the hardness degree of the fresh water directed towards the detergent dispenser (10) or the washing tub (3), and a brine tank (45) comprising an internal space containing brine to be supplied, on command, to said water softening device (13); and an electric sensor assembly which is configured to determine a first pressure (PI) of the brine at a prefixed first height (HI) of the brine tank (45) when the actual level of the brine (LO) is equal to or

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exceeding a prefixed second height (H2) which is greater than said prefixed first height (HI), and determine the salinity of brine based on both the first pressure (PI) and the height difference between the prefixed first height (HI) and the prefixed second height (H2).

LAUNDRY WASHING MACHINE COMPRISING A WATER SOFTENING DEVICE

The present invention relates to a laundry washing machine provided with an electro-optical apparatus configured to determine the concentration of the salt in a brine contained in a brine container.

More in particular, the present invention relates to a home laundry washing machine, to which the following description refers purely by way of example without this implying any loss of generality.

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

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

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

The water softening device is generally internally provided with a given amount of ion-exchange resins which are capable of retaining the calcium and

magnesium ions (Ca++ and Mg++) dissolved in the water flowing through the same water softening device, so as to reduce the hardness degree of the tap water directed towards the detergent dispenser and the washing tub.

Since the water softening capabilities of the ion-exchange resins are used to quickly drop away after a limited number of washing cycles, the laundry washing machines are generally provided with an internal reservoir of salt (NaCl) to be used for selectively producing some brine (i.e. salt water) which is periodically channeled into the water softening device to regenerate the ion-exchange resins located therein. Salt water, in fact, is able to remove from the ion-exchange resins the calcium and magnesium ions previously combined/fixed to said resins.

However, the result of the regeneration of the ion-exchange resins depends on the salinity concentration of the brine supplied into the water softening device. In detail, when the salinity concentration of the brine is under a predetermined threshold, the regeneration process carried out with brine can be prejudiced.

Therefore, salinity concentration of the brine needs to be determined time by time in order to assure an effective regeneration of the ion-exchange resins of the water softening device.

It is further well known that some washing machine are equipped with water hardness sensors, through which the regeneration process of the ion-exchange resins of the water softening device is activated when the water hardness is lower than a prefixed threshold. In detail, in use, the process of regeneration of the resins is activated by an electronic system according to the resistivity of the water determinate by the hardness sensors.

Such system has the drawbacks to activate the regeneration process of the ion-exchange resins based on the resin status which in turn is indirectly detected based on the hardness of the water; as a result the regeneration process may be activated also in those instances where the salt concentration is insufficient to efficiently complete the regeneration of the of the ion-exchange resins of the water softening. Moreover, although a low voltage is applied to the sensors, there will always be a danger, because these sensors are in direct contact with water.

The aims of the present invention is that of solving the above drawbacks and provide in particular a washing machine provided with a salinity sensor device which is designed to accurately determine the salinity concentration of the brine tank in order to assure an effective regeneration of the ion-exchange resins of the water softening.

In compliance with the above aims, according to the present invention there is provided a household washing machine comprising: a washing member structured for housing products to be washed, a water softening device filled with ion-exchange resins designed to reduce the hardness degree of water to be supplied to said washing member, a brine tank containing brine to be supplied to said water softening device for regenerating said ion-exchange resins, said household washing machine being characterized by comprising: electric sensor assembly which is provided with pressure sensing means configured to measure the pressure of the brine stored into said brine tank at least at a prefixed height; and electronic control means configured to determine the salinity of the brine stored in said brine tank based on said measured pressure.

Preferably, said electronic control means are configured to determine, by means of said pressure sensing means, a first pressure of the brine at a prefixed first height of the brine tank, when the actual level of the brine is equal or greater than a prefixed second height which is greater than said prefixed first height, and determine the salinity of said brine based on said first pressure and the height difference between said prefixed first height and said prefixed second height.

Preferably said brine tank comprises an overflow hydraulic system configured to cause the maximum level of the brine contained in said brine tank not to exceed said prefixed second height.

Preferably, the electric sensor assembly comprises: a first pressure sensor which is associated with said brine tank and is configured to provide a first electric signal which is indicative of said first pressure of the brine at a prefixed first height, and a second pressure sensor which is associated with said brine tank and is configured to provide a second electric signal indicating a second pressure of the

brine at a prefixed second height of said brine tank being greater than said first height, said electronic control means being configured to determine the salinity of the brine, based on said first pressure, said second pressure and said height difference.

Preferably said electronic control means are configured to determine the salinity of the brine by the following equation:

$$\varrho = \frac{P1 - P2}{g(H2 - H1)}$$

wherein: H1 is the prefixed first height; H2 is the prefixed second height; g is gravitational acceleration; P1 is the pressures of the brine determined at the first height H1; P2 is the pressures of the brine determined at the second height H2.

Preferably said electronic control means are further configured to determine the actual level of the brine stored into the brine tank by the following equation:

$$L0 = \frac{P2}{\varrho * g} + H2 = \frac{P1}{\varrho * g} + H1$$

wherein: L0 is the actual level of the brine; H1 is the prefixed first height; H2 is the prefixed second height; g is gravitational acceleration, P1 is the pressures of the brine determined at the first height H1; P2 is the pressures of the brine determined at the second height H2.

Preferably, said electric sensor assembly further comprises level sensing means configured to measure the level of the brine stored in said brine tank, said electronic control means being further configured to determine the salinity of the brine stored in said brine tank based on said measured pressure/s and/or said measured level.

Preferably, said electric sensor assembly comprises: a first pressure sensor, which is associated with said brine tank and is configured to provide a first electric signal which is indicative of said first pressure of the brine at a prefixed first height, and a float detecting device, which is configured to detect when the actual level of the brine is equal to at least one prefixed second height greater than said first height,

said electronic control means being configured to determine the salinity of the brine based on said first pressure and the height difference between said first height and said second height, when said detector detects that said actual level of the brine is equal to said second height.

Preferably, said float detecting device comprises a floating body, which is designed to float inside said brine tank on the basis of the actual level of the brine inside brine tank, and at least a detector which is configured to detect when the actual level of the brine is equal to said prefixed second height based on the position of the floating body.

Preferably said electric sensor assembly comprises a plurality of detectors which are vertically associated with the brine tank one above of the other at respective heights to detect the vertical position of said floating body inside said brine tank, said electronic control means being configured to determine the actual level of the brine in said brine tank based on the position of said floating body detected by said detectors.

Preferably, said electric sensor assembly comprises: a first pressure sensor which is associated with said brine tank and is configured to provide a first electric signal which is indicative of said first pressure of the brine at a prefixed first height, and optoelectronic detecting means, which are associated with said brine tank and are configured to: emit a radiation beam across said brine, receive the radiation beam after crossing said brine, and detect when the actual level of the brine is equal to said prefixed second height based the received radiation beam, electronic control means configured to determine the salinity of the brine based on said first pressure and said height difference, when said optoelectronic detecting means detect that said actual level of the brine is equal to said second height.

Preferably, said optoelectronic detecting means comprise an emitting device and a receiving device which are associated with the brine tank in order that the beam projected by the emitting device hits the receiving device based on the actual level of brine compared with said prefixed second height.

Preferably, said optoelectronic detecting means comprise a plurality of

emitting devices and a plurality of receiving devices which are associated with the brine tank at respective prefixed heights in order that the beam projected by the emitting devices hits respective receiving devices based on the actual level of brine compared with said respective prefixed heights.

Preferably, said electronic control means are configured to determine the salinity of the brine by performing the following equation:

$$\varrho = \frac{P1}{g(H2 - H1)}$$

wherein: H1 is the prefixed first height; H2 is the prefixed second height corresponding to the second level; g is gravitational acceleration, P1 is the pressures of the brine determined at the first height.

Preferably, the household washing machine comprises a main electronic central control unit which is configured to: receive the determined salinity from said electric sensor assembly, and alert to the user a lack of salt and/or that refilling of salt is requested based on said received salinity.

Preferably, the household washing machine further comprises a main electronic central control unit which is configured to: receive the salinity from said electric sensor assembly, and determine, on the basis of said determined salinity, whether the brine contained into brine tank has a salinity degree sufficient for successfully performing the regeneration process of the ion-exchange resins.

Preferably, the household washing machine further comprises a main electronic central control unit which is configured to: receive the determined salinity from said electric sensor assembly and control the time of the regeneration process based on the determined salinity.

Preferably, the household washing machine further comprises a salt compartment containing salt grains to be used in the regeneration process of water softening device, and a main electronic central control unit which is configured to receive the determined salinity from the sensor assembly and determine, on the basis of the determined salinity, when the amount of salt grains stored into said

compartment is depleting.

Preferably, the household washing machine further comprises a salt compartment containing salt grains to be used in the regeneration process of water softening device, and a main electronic central control unit which is configured to receive the determined salinity from the sensor assembly and determine, on the basis of the determined salinity, when the salt grains in the said compartment form a compact block of salt difficult to be dissolved by the fresh water poured into the said compartment, and accordingly decide to stop or skip the regeneration process of said water softening device.

Preferably, said salt compartment is structured for being manually fillable with a given quantity of salt grains and is fluidically communicates with said brine tank.

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

- Figure 1 is a perspective view of a laundry washing machine realized in accordance with the teachings of the present invention, with parts removed for clarity;

- Figures 2 is a side view of the Figure 1 laundry washing machine, with parts removed for clarity;

- Figure 3 is a perspective view of the detergent dispensing assembly of the Figure 1 laundry washing machine, with parts removed for clarity;

- Figure 4 is a schematic view of part of the hydraulic circuit of the Figure 1 laundry washing machine;

- Figure 5 is a schematic cross-section of part of the detergent dispensing assembly of the Figure 1 laundry washing machine, with parts removed for clarity;

- Figure 6 is a schematic partial longitudinal-section of a brine tank provided with the sensor assembly made according to a first embodiment of the present invention;

- Figure 7 is a schematic partial longitudinal-section of a brine tank provided with the sensor assembly made according to a second embodiment of the present

invention;

- Figure 8 is a schematic partial longitudinal-section of a brine tank provided with the sensor assembly made according to a third embodiment of the present invention;

- Figure 9 is a schematic partial longitudinal-section of a brine tank provided with the sensor assembly made according to a fourth embodiment of the present invention;

- Figure 10 is a schematic partial longitudinal-section of a brine tank provided with the sensor assembly made according to a fifth embodiment of the present invention;

- Figure 11 is a schematic vertical-section of a dishwashing machine realized in accordance with the teachings of the present invention, with parts in large scale and parts removed for clarity according to a sixth embodiment of the present invention;

- Figure 12 is a schematic vertical-section of a dishwashing machine realized in accordance with the teachings of the present invention, with parts in large scale and parts removed for clarity according to a seventh embodiment of the present invention;

- Figure 13 is a schematic vertical-section of a dishwashing machine realized in accordance with the teachings of the present invention, with parts in large scale and parts removed for clarity according to a eight embodiment of the present invention;

- Figure 14 is a schematic vertical-section of a dishwashing machine realized in accordance with the teachings of the present invention, with parts in large scale and parts removed for clarity according to a ninth embodiment of the present invention; whereas

- Figure 15 is a schematic vertical-section of a dishwashing machine realized in accordance with the teachings of the present invention, with parts in large scale and parts removed for clarity according to a tenth embodiment of the present invention;

- Figure 16 is a schematic cross-section of part of the detergent dispensing assembly of the Figure 1 laundry washing machine, with parts removed for clarity according to an eleventh embodiment of the present invention;

- Figure 17 is a schematic partial longitudinal-section of a brine tank provided with the sensor assembly made according to an eleventh embodiment of the present invention;

- Figure 18 is a schematic vertical-section of a dishwashing machine realized in accordance with the teachings of the present invention, with parts in large scale and parts removed for clarity according to a twelfth embodiment of the present invention.

With reference to Figures 1, 2 and 3, reference number 1 indicates as a whole a laundry washing machine 1 which preferably basically comprises: a preferably substantially parallelepiped-shaped, outer boxlike casing 2 structured for resting on the floor; a washing member which is arranged inside the casing 2 and is designed for housing laundry to be washed. The washing member is provided with preferably substantially horizontally-oriented, approximately cylindrical washing tub 3 with the mouth directly facing a laundry loading/unloading pass-through opening realized in the front wall 4 of the outer casing 2; and a substantially cylindrical, cup-shaped rotatable drum (not shown) which is structured for housing the laundry to be washed, and is fitted in axially rotatable manner inside the washing tub 3 with the concavity facing the front opening or mouth of washing tub 3, so as to be able to freely rotate about its longitudinal axis inside the washing tub 3.

The laundry washing machine 1 further comprises a porthole door 5 which is hinged to the front wall 4 of casing 2 so as to be movable to and from a closing position in which the door 5 closes the laundry loading/unloading opening on front wall 4 for watertight sealing the washing tub 4; and an electrically-powered motor assembly 6 which is structured for driving into rotation the rotatable drum (not shown) about its longitudinal axis inside the washing tub 3.

In the example shown, in particular, the rotatable drum (not shown) of laundry washing machine 1 is preferably arranged inside the washing tub 3 with the

drum rotation axis locally substantially coaxial to the longitudinal axis of washing tub 3, i.e. oriented substantially horizontally, and with the circular front opening or mouth of the drum directly aligned and faced to the circular front opening or mouth of washing tub 3, so as to receive the laundry to be washed through the laundry loading/unloading opening realized on front wall 4.

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

More in detail, the water softening device 13 basically consists in a closed container which has a water inlet and a water outlet fluidically connected to the fresh-water supply circuit 12 and/or the detergent dispenser 10 so as to be crossed by the tap water directed towards the washing tub 3, and which is furthermore filled with a given amount of ion-exchange resins capable of retaining the calcium and magnesium ions (Ca++ and Mg++) dissolved in the water flowing through the same container, so as to reduce the hardness degree of the tap water directed towards the washing tub 3.

In the examples shown, in particular, the water softening device 13 is preferably located inside the boxlike casing 2 adjoined to the detergent dispenser 10,

and is preferably fluidically connected directly to detergent dispenser 10 so as to be crossed by the fresh water flowing towards the washing tub 3 via the same detergent dispenser 10.

With reference to Figure 1, in addition to the above, the laundry washing machine 1 preferably moreover comprises an appliance control panel 14 which is preferably located on front wall 4 of casing 2, above the laundry loading/ unloading opening and preferably also immediately beneath the upper worktop or top wall 11 of casing 2, and is structured to allow the user to manually select the desired washing cycle among a number of available washing cycles.

With reference to Figures 1-4, detergent dispenser 10 in turn basically comprises: a detergent drawer 16 which is provided with one or more substantially basin-shaped, detergent compartments 17 (three detergent compartments 17 in the example shown) each structured for being manually fillable with a given amount of detergent, softener or other washing agent, and which is fitted/inserted in manually extractable manner into a corresponding preferably substantially basin-shaped, drawer housing 18 which, in turn, is located/recessed inside the casing 2 above washing tub 3, and whose entrance is preferably located on front wall 4 of casing 2, above the laundry loading/unloading opening realized on the same front wall 4; and preferably a drawer flush circuit 19 which is connected to the fresh-water supply circuit 12, and is structured for selectively channelling/pouring, when the detergent drawer 16 is completely fitted/inserted into drawer housing 18, the fresh water of the water mains into any one of the detergent compartments 17 of detergent drawer 16 so as to selectively flush the detergent, softener or other washing agent out of the same detergent compartment 17 and down onto the bottom of drawer housing 18.

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

In addition to the above, with reference to Figure 4, detergent drawer 16 is preferably furthermore provided with a substantially basin-shaped, regeneration-agent compartment 21 which is located beside the one or more detergent compartments 17, and is structured for being manually fillable with a given quantity of salt grains (NaCl) or other regeneration agent suitable to be used in the regeneration process of the ion-exchange resins of the water softening device 13.

The drawer flush circuit 19, in turn, is preferably additionally structured for selectively channelling, when detergent drawer 16 is placed in the retracted position, the fresh water of the water mains also into the regeneration-agent compartment 21, so as to dissolve some of the salt grains contained into the same regeneration-agent compartment 21 and form brine (i.e. salt water).

More in details, the regeneration-agent compartment 21 is preferably arranged, on detergent drawer 16, beside the one or more detergent compartments 17, so that both detergent compartment/s 17 and regeneration-agent compartment 21 are allowed to almost contemporaneously come out from the front wall 4 of casing 2 when detergent drawer 16 moves from the retracted position to the extracted position.

Preferably, the regeneration-agent compartment 21 is moreover dimensioned to accommodate/contain an amount of consumable salt (NaCl) or other regeneration agent sufficient for performing a plurality of regeneration processes of the ion-exchange resins of the water softening device 11. According to an exemplary embodiment the detergent drawer 16 preferably has, on the bottom of regeneration-agent compartment 21, a large pass-through draining opening which is suitably shaped/dimensioned to allow the brine (i.e. the salt water) formed inside the regeneration-agent compartment 21 to freely fall on the bottom of drawer housing 18.

More in detail, with reference to Figures 3 and 5, in the example shown detergent drawer 16 preferably comprises: a drawer main body 23 which is preferably made in a one piece construction, and is fitted/inserted in axially sliding manner into the drawer housing 18; and a manually-sizable front panel 24 which is

arranged/located on a front side of the drawer main body 23, so as to close the entrance of drawer housing 18 when detergent drawer 16 is placed in the retracted position.

With reference to Figure 3 and 5, the drawer flush circuit 19, in turn, is preferably directly connected to the fresh-water supply circuit 12 for receiving the fresh water of the water mains, and is suitably structured for selectively pouring/channeling, when the detergent drawer 16 is completely fitted/inserted into drawer housing 18, the fresh water arriving from the water mains into any one of detergent compartments 17 of detergent drawer 16, or into the regeneration-agent compartment 21 of detergent drawer 16.

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

The drawer flush circuit 19 is preferably structured to selectively channel, when detergent drawer 16 is placed in the retracted position, the fresh water of the water mains towards the water inlet of a lid assembly 26 which, in turn, is structured to distribute the fresh water arriving from drawer flush circuit 19 into the regeneration-agent compartment 21, so as to dissolve some of the salt grains (NaCl) contained into the regeneration-agent compartment 21 and form the brine that falls on the bottom of drawer housing 18 via opening.

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

The plate-like element 27 preferably has a hollow structure and is preferably provided with a water inlet which is suitably structured to watertight couple, when detergent drawer 16 is placed in the retracted position, with the drawer flush circuit 19 thus to allow the fresh water to enter into the plate-like element 27; and with one or more water-outlets 30 which are arranged on the lower face of plate-like element 27, preferably all around the central pass-through opening closed by trapdoor 28. Each water-outlet 30 allows the fresh water entered into the plate-like element 27 to slowly come out of plate-like element 27 and freely fall into the regeneration-agent compartment 21.

More in detail, with reference to Figures 3- 5, the drawer flush circuit 19 of detergent dispenser 10 preferably comprises an electrically-operated, water distributor 32 which is fluidically connected to the fresh-water supply circuit 12 and/or to the internal water softening device 13 for receiving a flow of unsoftened or softened fresh water, and is suitably structured to selectively channel the unsoftened fresh water arriving from fresh-water supply circuit 12 or the softened fresh water arriving from water softening device 13, towards any one of the water-delivery portions of a plate-like water conveyor 31.

The electrically-operated, water distributor 32, in turn, preferably consists in a discrete, electrically-operated, flow-diverter module which is firmly attached to the outside of plate-like water conveyor 31, at a coupling socket preferably realized on one of the two major faces of the same plate-like water conveyor 31.

The electrically-operated flow-diverter module 32 preferably has a water inlet which directly communicates with the water softening device 13 for directly receiving softened fresh water, and preferably also with the fresh-water supply circuit 12 for also directly receiving unsoftened fresh water; and a number of water outlets which are located, preferably one side by side the other, at the interface portion of flow-diverter module 32 suited to couple with coupling socket of plate-like water conveyor 31.

Preferably the electrically-operated, flow-diverter module 32 furthermore internally accommodates a rotatable flow diverter (not shown) which is capable of

channeling, according to its angular position, the water entering into flow-diverter module 32 via the water inlet towards any one of the water outlets of the same flow-diverter module 32.

With reference to Figures 3 and 5, the plate-like water conveyor 31, on the other hand, is provided with a number of water inlets which are separately fluidically communicate each with a respective water-delivery portion of the water conveyor 31 via a corresponding internal water channel extending inside the body of the same water conveyor 31.

The electrically-operated, flow-diverter module 32 is therefore structured to selectively channel, on command, the water entering into the flow-diverter module 32 via its water inlet towards any one of the water inlets of the plate-like water conveyor 31.

With reference to Figure 3, the basin-shaped bottom portion 42 vertically aligned to regeneration-agent compartment 21, is structured for receiving the brine (i.e. the salt water) trickling/falling down from the regeneration-agent compartment 21 via the pass-through opening, and directly fluidically communicates with the inside of a small brine tank 45 which is dimensioned to catch and contain a given amount of brine preferably greater than 100 ml (millilitres), and is arranged underneath the same basin-shaped bottom portion 42 so as to allow the brine to quickly fall/flow by gravity directly into the brine tank 45 and to accumulate therein.

Preferably, said brine tank 45 furthermore fluidically communicates with the inside of the water softening device 13 via a small, electrically-powered pump assembly 46 which is capable of selectively pumping the brine (i.e. the salt water) accumulated into the brine tank 45, from brine tank 45 to water softening device 13, and preferably also to watertight isolate the brine tank 45 from the water softening device 13 when deactivated.

The laundry washing machine 1 therefore comprises: a regeneration-agent reservoir, i.e. the regeneration-agent compartment 21 of detergent drawer 16, which is located/recessed inside the casing 2 and is structured for being manually fillable with a given amount of consumable salt (NaCl) or other regeneration agent; a brine

tank, i.e. brine tank 45, which is dimensioned to contain a given amount of brine preferably greater than 100 ml (millilitres) and fluidically communicates with said regeneration-agent reservoir for receiving and accumulating the brine (i.e. the salt water) coming out from said regeneration-agent reservoir; and preferably also a small, electrically-powered pump assembly 46 having the suction connected to the brine tank 45 and the delivery connected to the water softening device 13, thus to be able to selectively pump the brine (i.e. the salt water) from the brine tank 45 to the water softening device 13.

In the example shown, in particular, brine tank 45 is preferably dimensioned to contain a maximum amount of brine preferably overapproximating the whole amount of brine to be pumped into the internal water softening device 13 for performing the regeneration process of the ion-exchange resins located inside the same water softening device 13.

More in detail, assuming for example that the overall amount of brine to be pumped into the water softening device 13 for performing the whole regeneration process of the ion-exchange resins is preferably equal to 500 cm^3 (cubic centimeters), brine tank 45 is preferably dimensioned to contain a maximum amount of brine preferably equal to 520 cm^3 (cubic centimeters).

With reference to Figure 3, in the example shown, in particular, the water softening device 13 preferably comprises a substantially plate-like, discrete modular cartridge 47 which is provided with a water inlet and a water outlet, and is filled with a given amount of ion-exchange resins capable of retaining the calcium and magnesium ions (Ca++ and Mg++) dissolved in the water flowing through the same modular cartridge 47.

This modular cartridge 47 is preferably furthermore rigidly attached to a sidewall of drawer housing 18 preferably by means of one or more anchoring screws and/or one or more releasable mechanical couplings, so as to cantilevered extend downwards beyond the bottom of drawer housing 18 and next to brine tank 45, preferably while remaining locally substantially parallel and tangent to a vertical sidewall of the outer casing 2.

Preferably the water inlet and a water outlet of modular cartridge 47 are additionally fluidically connected to the plate-like water conveyor 31 preferably via appropriate hydraulic connectors, so that the modular cartridge 47 is selectively crossable by the unsoftened fresh water arriving from fresh-water supply circuit 12 and directed towards any one of the detergent compartments 17 or optionally towards the regeneration-agent compartment 21 of detergent drawer 16.

Brine tank 45, in turn, is preferably discrete from drawer housing 18, and is firmly attached directly to the bottom of drawer housing 18, preferably locally substantially vertically aligned to the basin-shaped bottom portion 42 and preferably by means of one or more anchoring screws and/or one or more releasable mechanical couplings. Preferably brine tank 45 is moreover adjacent to modular cartridge 47 and is preferably rigidly attached also to the same modular cartridge 47, preferably by means of one or more anchoring screws and/or one or more releasable mechanical couplings.

With reference to Figure 3 and 4, pump assembly 46, in turn, is preferably interposed between brine tank 45 and water softening device 13 so as to remain unmovably trapped between brine tank 45 and modular cartridge 47 when they are rigidly attached to one another.

According to an exemplary embodiment the pump assembly 46 may preferably basically comprise an electrically-powered membrane pump or other electrically-powered volumetric pump, which has the suction of the pump fluidically connected to brine tank 45 preferably via a first duckbill valve, so as to be able to suck the brine from the inside of brine tank 45, and the delivery of the pump fluidically connected to the modular cartridge 47 of water softening device 13 preferably via a second duckbill valve, so as to be able to feed the brine into the water softening device 13.

With reference to Figures 3-10, the laundry washing machine 1 furthermore comprises an electric sensor assembly, which is configured to determine/calculate the salinity of the brine (i.e. the salt water) stored in the brine tank 45.

Preferably, the electric sensor assembly 70 is configured to determine a

pressure value of the brine at least at a prefixed first height of the inner space of the brine tank 45, determine a height difference between the prefixed height and the height of the actual level of the brine in the brine tank 45, preferably although not necessary, when the actual level of the brine reaches a second prefixed height in the brine tank 45, and determine the salinity of the brine based on the determined pressure and the height difference.

With reference to a first embodiment illustrated in the Figures 5 and 6, the electric sensor assembly 70 comprises two pressure sensing devices which are associated with the brine tank 45 at different heights, one to the other, from the bottom 45a of the brine tank 45, and are configured to measure the pressures of the brine inside of the brine tank 45 at said respective heights, and an electronic control device 73, which is configured to determine the salinity of the brine based on said determined pressures and the difference between the heights used to measure such brine pressures.

With reference to the exemplary first embodiment illustrated in Figures 5 and 6, the electric sensor assembly 70 comprises a first pressure sensing device 71 which is stably placed in the brine tank 45 at a prefixed first height H1 from the bottom 45a of the brine tank 45, and is configured to determine/measure a first pressure value P1 of the brine at said prefixed first height H1 in order to provide an electrical signal which is indicative of the determined first pressure value P1.

The electric sensor assembly 70 further comprises a second pressure sensing device 72, which is stably placed in the brine tank 45 at a prefixed second height H2 from the bottom 45a, greater than the first height H1, and is configured to determine/measure a second pressure value P2 of the brine at the prefixed second height H2 in order to provide an electrical signal which is indicative of the determined second pressure value P2.

Preferably, the first pressure sensing device 71 may be associated with, coupled to, a vertical side wall of the brine tank 45, close to the bottom 45a, whereas the second pressure sensing device 72 may be preferably associated with, coupled to, a vertical side wall of the brine tank 45 above the first sensing device

71 in a intermediate or upper position of the brine tank 45.

It is point out that hereinafter with the term "level" it will be understood the level of the brine (L0, L1, ...LN) measured at a certain height Hi (i variable from 0 to N; H0, H1, ...HN) of the inner space of brine tank from the bottom 45a of brine tank 45. It is evident that the level Li of the brine corresponds to a respective height Hi of the brine tank 45 measured from the bottom 45a.

With regards to the electronic control device 73, in the first embodiment illustrated in Figure 6, it is configured to: receive the electric signals from the first pressure sensing device 71 and the second pressure sensing device 72, determine the first P1 and second pressure values P2 based on the received electric signals, and determine/calculate the salinity of the brine based on the first P1 and second pressure values P2 and the height difference ΔH between the first height H1 and the second height H2.

Preferably, the electronic control device 73 calculates the salinity of the brine by the following equation a):

$$\varrho = \frac{P1 - P2}{g(H2 - H1)}$$

wherein:

ϱ is the salinity of the brine;

H1 is the prefixed first height;

H2 is the prefixed second height;

g is gravitational acceleration (9.81m/s^2);

P1 is the pressure value of the brine determined at the first height H1;

P2 is the pressure value of the brine determined at the second height H2.

Preferably, the electronic control device 73 may be further configured to calculate the actual level L0 of the brine into the brine tank 45 based on: the determined salinity ϱ, the first P1 or the second pressure values P2, and the first H1 or the second height H2. For example, the electronic control device 73 may be further configured to calculate the actual height or level L0 of the brine in the brine

tank 45 by the following equation b):

$$L0 = \frac{P2}{\varrho * g} + H2 = \frac{P1}{\varrho * g} + H1$$

It should be pointed out that the present invention is not limited to the embodiment described above wherein the brine salinity is determined according with two pressure values provided by two sensing devices placed at different heights H1 and H2 one to the other. Indeed according to the embodiment illustrated in Figures 16 and 17, the brine salinity may be conveniently determined according to a single pressure value provided by a single sensing device, i.e. the first pressure sensing device 71. According to this embodiment, the washing machine 1 may be provided with an overflow hydraulic system 800, which is configured to cause the level L0 of the brine contained in the brine tank 45 not to exceed the prefixed second height H2. In other words, the overflow hydraulic system 800 is structured to cause the brine to be automatically spilled from the brine tank 45 when the level of the brine reaches an overflow condition, i. e. L0=H2.

According to the exemplary embodiment illustrated in Figures 16 and 17, the brine tank 45 may comprise an outlet which is located at the second height H2 and is hydraulically connected with an overflow pipe or siphon which in turn may be preferably connected to a drain system of the washing machine 1 (illustrated in Figure 2).

In this case, the electronic control device 73 may be configure to: temporarily maintain the brine in the tank 45 in the overflow condition (L0=H2) for example by controlling the main fresh-water supply circuit 12, receive from the first pressure sensing device 71 an electric signal indicative of the first pressure value P1, and determine the salinity of the brine based on the first pressure P1 and the height difference ΔH between the first height H1 and the second height H2 corresponding to the overflow height, in which the level L0 of the brine is equal to the prefixed second height H2.

Preferably, the electronic control device 73 may be configured to determine

the salinity of the brine stored in the brine tank 45 by the following equation :

$$\varrho = \frac{P1}{g(H2 - H1)}$$

wherein H2 is the overflow height.

Preferably, the electronic control device 73 may be further configured to detect/determine when the salinity of the brine stored into brine tank 45 exceeds a predetermined minimum salinity value, and preferably determine when the level of the brine stored inside brine tank 45 is equal to, or higher than, a predetermined threshold level value.

Preferably said predetermined minimum salinity value may be equal to, or higher than, the minimum salinity value required to successfully perform the regeneration process of the ion-exchange resins contained into the water softening device 13. The threshold level value, in turn, preferably corresponds to a level wherein the brine tank 45 is completely filled up with fresh water or brine, i.e. to an amount of brine inside brine tank 45 sufficient to successfully perform the regeneration process of the ion-exchange resins contained into the water softening device 13.

More in detail, assuming that brine tank 45 is preferably dimensioned to contain a maximum amount of brine preferably equal to 230 cm^3 (cubic centimeters), the threshold level value may be associated with a volume of 230 cm^3 (cubic centimeters) of fresh water or brine into brine tank 45.

In the example shown, in particular, the electric sensor assembly 70 is preferably configured to determine, at same time, if the salinity degree of the brine stored into brine tank 45 exceeds said minimum salinity value, and whether the level of the fresh water or brine (i.e. salt water) stored inside brine tank 45 is equal to or higher than said predetermined threshold level value.

Preferably, the electric sensor assembly 70 is configured to determine, at same time, whether the salinity degree of the brine stored into brine tank 45 exceeds the minimum salinity value required to successfully perform the regeneration process

of the ion-exchange resins contained into the water softening device 13, and whether the actual level of the fresh water or brine stored inside the brine tank 45 is equal to or higher than said threshold level value, thus to successfully perform, in case of the brine, the regeneration process of the ion-exchange resins contained into the water softening device 13.

With reference to Figure 6, the electronic control device 73 may be further configured to provide the calculated/determined salinity and preferably the actual level L0 to a main electronic central control unit 74 of the washing machine 1 which, in turn, determines on the basis of the salinity, whether the brine to be pumped into the water softening device 13 has a sufficient salinity degree to successfully perform the regeneration process of the ion-exchange resins contained into the water softening device 13, and furthermore to precise control of the amount of brine to be pumped from the brine tank 45 into the water softening device 13. The combination of electric signals relating to salinity and actual level L0 provided by the electronic control device 73 in fact, causes the main electronic central control unit 74 of laundry washing machine 1 to compare the determined salinity with a prefixed salinity threshold, compare the determined brine level with a prefixed level threshold and determine according to the comparison results, whether the brine contained into brine tank 45 may be used and/or is sufficient for successfully performing the regeneration process of the ion-exchange resins.

In addition to the above, preferably, the main electronic central control unit 74 of the laundry washing machine 1 may be configured to control/determine the time of the regeneration process based on the determined salinity. In detail, the greater of the salinity, the lower of the time of the regeneration is, and vice versa.

For example, if the determined salinity is high, i.e. greater than a prefixed salinity threshold associated with a nominal regeneration time, the main electronic central control unit 74 may decrease the nominal regeneration time of a corresponding prefixed time, whereas in the opposite case, if the determined salinity is low, i.e. lower than a said prefixed salinity threshold associated with the nominal regeneration time, the main electronic central control unit 74 may increase the

nominal regeneration time of a corresponding prefixed time. It should be pointed out that such prefixed time may be determined, for example, based on the difference between the determined salinity and said prefixed salinity threshold.

In addition to the above, the main electronic central control unit 74 of the laundry washing machine 1 may be configured to determine, on the basis of the determined regeneration time, the instant/phase of the washing program/cycle in which the regeneration process has to be performed. For example, the main electronic central control unit 74 may compare the determined regeneration time of the regeneration process with the duration of the washing phases of the selected washing program and determine the washing phase to be used to perform the regeneration process on the basis of the results of comparison.

In addition to the above, the main electronic central control unit 74 of the laundry washing machine 1 may be configured to detect based on the determined salinity, when the amount of salt grains (NaCl) stored into regeneration-agent compartment 21 is depleting, and stop or skip the regeneration process of the ion-exchange resins based on the result of such detection. Indeed, a low salinity degree of the brine contained in brine tank 45, means that either the amount of salt grains (NaCl) stored into regeneration-agent compartment 21 is depleting.

Moreover, the main electronic central control unit 74 of the laundry washing machine 1 may be configured to determine on the basis of determined salinity/level, when the salt grains in the regeneration-agent compartment 21 form a big and compact block of salt difficult to be dissolved by the fresh water poured into the regeneration-agent compartment 21, and accordingly stop or skip the regeneration process of the ion-exchange resins. Indeed, a low salinity degree of the brine contained in brine tank 45, may also mean that fresh water poured into the regeneration-agent compartment 21 is unable to successfully dissolve a sufficient amount of salt grains in the regeneration-agent compartment 21.

In addition to the above, the main electronic central control unit 74 of the laundry washing machine 1 is configured to alert the user that refilling of salt grains (NaCl) into regeneration-agent compartment 21 is requested based on the determined

salinity. Furthermore the main electronic control unit 74, may activate a warning light (not illustrated) located on control panel 14 and/or other kind warning devices, such as for example a buzzer, when the main electronic central control unit 74 determines, either for the first time or after a given number of consecutive times, a low salinity degree conditions.

The Figure 7 illustrates an electric sensor assembly 80 made according to a second embodiment of the present invention, wherein component parts will be indicated, where possible, with the same reference numbers which identify corresponding parts of the electric sensor assembly 70 made according to the first embodiment illustrated in Figure 6.

This advantageous second embodiment differs from the first embodiment because the second pressure sensing device 72 in the brine tank 45 is replaced with a float detecting device 81 which is configured to detect when the actual level of the brine stored in the brine tank 45 reaches a prefixed level threshold corresponding to the prefixed second height H2.

With reference to the exemplary second embodiment illustrated in Figure 7, the float detecting device 81 comprises a floating body 82 which has a nominal density, lower than that of the fresh water, i.e. lower than approximately 1000 kg/m^3, so as to float in presence of any kind of water. i.e. both fresh water and brine, and is housed inside the brine tank 45 with the capability to freely move upwards and downwards between a lowered position and a raised position on the basis of the actual level of fresh water or brine inside brine tank 45. The float detecting device 81 further comprises a detector 83 which is configured to detect when the floating body 82 reaches said raised position inside brine tank 45. Preferably although not necessarily, detector 83 may be further configured to detect when the floating body 82 reaches said lower position inside brine tank 45.

In the second embodiment, the raised position of the floating body 82 corresponds to a level of fresh water or brine inside brine tank 45 which is equal to or exceeding a prefixed level threshold value. In the exemplary embodiment illustrated in Figure 7, the prefixed level threshold value is set so as to be equal the second

height H2 of the brine tank 45. Preferably although not necessary, the prefixed level threshold value may be preferably set so as to be equal to the threshold level value. The lowered position of the floating body 82, in turn, preferably corresponds to roughly no fresh water or brine inside brine tank 45. In the example shown in Figure 7, in particular, floating body 82 may be structured to be housed inside a vertical guide chamber 85 which, in the illustrated example, may be placed, in turn, within the brine tank 45. The floating body 82 may be designed to freely swing up and down inside said vertical guide chamber 85. Moreover, the vertical guide chamber 85 is hydraulically communicating with the rest of the internal space of the brine tank 45 in order to receive the brine from the latter (so as to perform communicating vessels). It should be pointed out that the use of the vertical guide chamber 85 to vertically guide the floating body 82 inside of the brine tank 45 is referred to, here, purely by way of example in connection with the second embodiment of the present invention, but however it may be different. For example, floating body 82 may be rigidly attached to the distal end of a guide arm which is pivotally jointed to a sidewall of brine tank 45 so as to be able to freely swing up and down inside brine tank 45 while remaining on a vertical reference plan.

With regards to the detector 83, it may be a switch device located on top wall of brine tank 45 which is configured to switch when the floating body 82 substantially abuts against lo switch. The detector 83 may be, for example, an electro-switch device or a magnetic-switch device or an optoelectronic switch device or similar devices.

With reference to the second embodiment example illustrated in Figure 7, the electronic control device 73 may be configured to receive from the first pressure sensing device 71 an electric signal indicative of the first pressure value P1 and receive form the detector 83 of the float detecting device 81 an electric signal which contains information indicating whether the actual level L0 of the brine stored in the brine tank 45 is equal to a prefixed level threshold. Indeed the electronic control device 73 may be configured to receive from the detector 83 the electric signal when the level of the brine stored in the brine tank 45 is equal to the prefixed second height

H2. When the level of the brine is equal to the prefixed second height H2, the electronic control device 73 determines the salinity of the brine based on the first pressure P1 and the height difference ΔH between the first height H1 and the second height H2 corresponding to the prefixed level threshold. Indeed, the electronic control device 73 may be configured to determine the salinity of the brine stored in the brine tank 45 by the following equation c):

$$\varrho = \frac{P1}{g(H2 - H1)}$$

wherein H2 is the prefixed second height corresponding to the prefixed level threshold.

Indeed, when the level of brine inside of the brine tank 45 reaches the second height H2, the floating body 82 causes the detector 83 to switch the electrical signal (i.e. from OFF to ON) that in turn activate the electronic control device 73 to calculate the salinity of the brine. In the second embodiment, the salinity is therefore determined according to equation c) when the float detecting device 81 detects that the brine inside of the brine tank 45 has reached the second height H2.

After having determined the salinity of the brine, the electronic control device 73 may further monitor/determine, time by time, the actual level L0 of brine stored in the brine tank 45, for example, during the step of pumping of the brine from the brine tank 45 to the water softening device 13. Since, during the pumping, the salinity of the brine in the brine tank 45 remains substantially constant, the electronic control device 73 may determine the actual level L0 of the brine by the following equation d)

$$L0(t) = \frac{P1(t)}{\varrho * g} + H1$$

Wherein P1 (t) is the first pressure measured by the first pressure sensing device 721 at the instant t, and L0(t) is the actual level of the brine determined at the same instant t.

Figure 8 illustrates an electric sensor assembly 90 made according to a third

embodiment of the present invention, wherein component parts will be indicated, where possible, with the same reference numbers which identify corresponding parts of the electric sensor assembly 80 of the second embodiment illustrated in Figure 7.

This advantageous third embodiment differs from the second embodiment because it comprises a number of detectors 83 which are vertically placed, one above of the other, preferably on the brine tank 45 at respective heights Hi. Preferably, the detectors 83 ma be vertically placed on a sidewall of the brine tank 45 in adjacent position, one to the other, in order to provide, in substantially continue manner, instant by instant, the actual level L0 of the brine inside the brine tank 45.

Due to the possibility of determining, time by time, the actual level L0 of the brine, and consequently the respective height Hi, the electronic control device 73 is conveniently configured to constantly determine and monitor the salinity of the brine.

Therefore, differently from the second embodiment wherein the salinity is determined only when the actual level L0 of the brine reaches the single prefixed threshold level value corresponding to the second height H2, the third embodiment allows the electronic control device 73 to calculate the salinity when the level of the brine changes from a minimum level value to a maximum level value HN. Indeed the electronic control device 73 may be configured to determine the salinity by the following equation e):

$$\varsigma(t) = \frac{P1(t)}{g(L0(t) - H1)}$$

wherein L0(t) is the actual level of brine determined at the instant t, and P1(t) is the first brine pressure determined at the instant t.

Figure 9 illustrates an electric sensor assembly 100 made according to a fourth embodiment of the present invention, wherein component parts will be indicated, where possible, with the same reference numbers which identify corresponding parts of the electric sensor assembly 70 illustrated in Figure 6.

This advantageous fourth embodiment differs from the first embodiment

because the second pressure sensing device 72 in the brine tank 45 is replaced with an optical detecting apparatus 101 which is associated with the brine tank 45 and is configured to: emit a radiation beam towards the brine, receive the beam reflected or refracted by the brine, and determine, when the level of brine reaches the prefixed second height H2 on the basis of the received beam. Indeed the electric sensor assembly 100 is configured to photoelectrically detecting when the brine level reaches the prefixed second height H2.

With reference to the exemplary fourth embodiment illustrated in Figure 9, the optical detecting apparatus 101 comprises an emitting device 102 and a receiving device 103 which may be associated with the brine tank 45 in order that in a first brine level condition, i.e. when the level of brine is lower than the prefixed second height H2, the beam projected by the emitting device 102 hits the receiving device 103, and vice versa in a second brine level condition, i.e. when the level of brine is equal to, or exceeding the, prefixed second height H2, the beam emitted by the emitting device 102 is refracted by the brine or the water in order to no hit the receiving device 103. In Figure 9, the radiation beam 104 which hits the receiving device 103 in the first level condition is indicate with a solid line, whereas the dotted line indicates the radiation beam 105 in the second level condition wherein the brine refracts/deflect the radiation beam. Indeed, when, in the first condition, the level of brine is under than the prefixed second height H2, the refraction index of the air does not cause the emitted beam to be deviated, and the receiving device 103 receives the radiation beam so that the receiving device 103 is actuated, indicating that the brine level is under the prefixed second height H2. In the second condition, the level of brine reaches the prefixed second height H2, the refraction index of the brine being different to that of the air, causes the refracted beam to be deviated, and the receiving device 103 receives no radiation beam or a much less amount of radiation beam so that the receiving device 103 is not actuated, indicating that the brine level is equal to prefixed second height H2

It should be pointed out that the positions of the emitting 102 and receiving devices 103 in the brine tank 45 are referred to, here, purely by way of example in

connection with the fourth embodiment of the present invention, and may be different. For example the receiving device 103 may be placed in the brine tank 45 in order that in the first brine level condition, the beam emitted by the emitting device 102 do not hit the receiving device 103, and vice versa in the second brine level condition, i.e. the beam emitted by the emitting device 102 is refracted by the brine or the water in order to hit the receiving device 103.

Likewise the second embodiment, the electronic control device 73 in the fourth embodiment is configure to: receive from the first pressure sensing device 71 an electric signal indicative of the first pressure value P1, receive form the optical sensing device 101 an electric signal containing the information (OFF/ON) indicating whether the level of the brine stored in the brine tank 45 is equal to the prefixed second height H2, and determine the salinity of the brine based on the first pressure P1 and the height difference ΔH between the first height H1 and the second height H2, when the level of the brine is equal to the prefixed second height H2.

Preferably, the electronic control device 73 is configured to determine the salinity of the brine stored in the brine tank 45 by the following equation f):

$$ϱ = \frac{P1}{g(H2 - H1)}$$

Likewise to second embodiment, the electronic control device 73 may further monitor/determine, time by time, the actual level L0 of brine stored in the brine tank 45 for example during the step of pumping of the brine from the brine tank 45 to the water softening device 13. Since, during the pumping, the salinity of the brine in the brine tank 45 remains substantially constant, the electronic control device 73 may determine the actual level L0 of the brine by the following equation g)

$$L0(t) = \frac{P1(t)}{ϱ * g} + H1$$

Wherein P1 (t) is the first pressure measured by the first pressure sensing

device at the instant t, and L0(t) is the actual level of the brine determined at the same instant t.

Figure 10 illustrates an electric sensor assembly 110 made according to a fifth embodiment of the present invention, wherein component parts will be indicated, where possible, with the same reference numbers which identify corresponding parts of the electric sensor assembly 100 of the fourth embodiment illustrated in Figure 9.

This advantageous fifth embodiment differs from the fourth embodiment because it comprises a number of optical detecting apparatus 101 which are vertically placed one above of the other preferably on the brine tank 45 at respective heights Hi. Preferably, the emitting 102 and receiving devices 103 of the optical detecting apparatus 101 ma be vertically placed on the respective opposite sidewalls of the brine tank 45 in adjacent position one to the other in order to determine, in substantially continue manner, instant by instant, the actual level L0 of the brine inside the brine tank 45.

Due to the possibility of determining, time by time, the actual level L0 of the brine, and consequently the respective height Hi, the electronic control device 73 is conveniently able to constantly determine the salinity of the brine.

Therefore, differently from the fourth embodiment wherein the salinity is determined only when the actual level L0 of the brine reaches the prefixed second height H2, the fifth embodiment allows the electronic control device 73 to calculate the salinity when the actual level of the brine changes from a minimum level value to a maximum level value Hn. Indeed the electronic control device 73 may be configured to determine the salinity by the following equation h):

$$\varrho(t) = \frac{P1(t)}{g(L0(t) - H1)}$$

wherein L0(t) is the actual level of brine determined at the instant t, and P1(t) is the first brine pressure determined at the instant t.

It has thus been shown that the present invention allows all the set objects to be achieved.

While the present invention has been described with reference to the particular embodiments shown in the Figures, it should be noted that the present invention is not limited to the specific embodiments illustrated and described herein; on the contrary, further variants of the embodiments described herein fall within the scope of the present invention, which is defined in the claims.

In detail, although the sensor assembly above disclosed has proved to be particularly advantageous when applied to the brine tank of a laundry washing machine, it can be conveniently applied to a brine tank of a dishwashing machine too.

In this regard, Figure 11 illustrates schematically a program-controlled household dishwashing machine 200 provided with an electric sensor assembly 270 made according to a sixth embodiment of the present invention.

In detail, the household dishwashing machine 200 comprises a box-shaped, preferably, though not necessarily, parallelepiped-shaped outer casing 201 having an opening at a front side; a door 202 openably installed on the front side of the outer casing 201; and washing member installed inside the outer casing 201 for washing dishes. The washing member comprises a washing chamber 203 installed inside the outer casing 201 for washing dishes; one or more shelf or dish-rack baskets 204 which are housed inside the wash chamber 203 and designed to accommodate dishes to be washed during a washing cycle. Dish-rack baskets 204 rests on known runners (not shown) by which to pull the baskets out drawer-fashion through access opening to wash chamber 203.

Household dishwashing machine 200 further comprises one or more nozzles 205 (only one illustrated) rotatably installed in respective sides (upper and bottom) of the wash chamber 203 for spraying washing water through spraying holes; a sump 206 formed on a lower side of the washing chamber 203 for collecting washing water; a washing pump 207 for pumping washing water through the nozzle 205; and a main control unit 208 for controlling the operation of the dishwashing machine 200. At a lower side of the washing chamber 203, the dishwashing machine 200 may preferably comprise: a heater (not shown) for heating washing water supplied to the

inside of the sump 206; and a water supplying system 209 which supplies wash water to the spray arms of nozzles 205 via the pump 207 during the dish-washing cycles. Water supplying system 209 in dishwashing machines 200 comprises water lines/pipes and valve-controlled water connections which are known and therefore will be not illustrated/disclosed in detail.

Dishwashing machine 200 further comprises a water softening device 210 comprising a water softening agent capable of reducing the hardness degree of a fresh water designed to be supplied to the washing chamber 203 during a washing cycle; and a brine tank 211 containing brine to be supplied to the water softening device 210 for regenerating said water softening agent. Preferably, the water softening device 210 may comprise a closed container located along one or more lines/pipes of the water supplying system 209 so as to be crossed by the tap water to be softened, and which is furthermore filled with a given amount of ion-exchange resins capable of retaining the calcium and magnesium ions (Ca++ and Mg++) dissolved in the water flowing through the same container, so as to reduce the hardness degree of the received tap water.

With regards to the brine tank 211, it fluidically communicates with the water softening device 210 in order to supply, preferably, although not necessarily, on command, the brine to the latter so as to regenerate the ion-exchange resins.

The sensor assembly 270 is associated with the brine tank 211 to determine/measure the salinity and/or the level of the brine contained in the brine tank 211.

Preferably, the sensor assembly 270 is configured to: determine a pressure value of the brine at least at a prefixed first height of the inner space of the brine tank 211, determine a height difference between the prefixed height and the height of the actual level of the brine in the brine tank 211, preferably although not necessary, when the actual level of the brine reaches a second prefixed height in the brine tank 211, and determine the salinity of the brine based on the determined pressure and the height difference. Preferably, the electric sensor assembly 270 comprises two pressure sensing devices which are associated with the brine tank 211 at different

heights, one to the other, from the bottom inner surface 211a of the brine tank 211, and are configured to measure the pressures of the brine inside of the brine tank 211 at said respective heights, and an electronic control device 273, which is configured to determine the salinity of the brine based on said determined pressures, and the difference between the heights used to measure such brine pressures.

With reference to the exemplary dishwashing machine embodiment illustrated in Figure 11, the electric sensor assembly 270 comprises a first pressure sensing device 271 which is stably placed in the brine tank 211 at a prefixed first height H1 from the bottom surface 211a, and is configured to determine/measure a first pressure value P1 of the brine at said prefixed first height H1 in order to provide an electrical signal which is indicative of the determined first pressure value P1 and a second pressure sensing device 272, which is stably placed in the brine tank 211 at a prefixed second height H2 from the bottom surface 211a, greater than the first height H1, and is configured to determine/measure a second pressure value P2 of the brine at the prefixed second height H2 in order to provide an electrical signal which is indicative of the determined second pressure value P2.

Preferably, the first pressure sensing device 271 may be associated with, coupled to, a vertical side wall of the brine tank 211, close to the bottom 211a, whereas the second pressure sensing device 271 may be preferably associated with, coupled to, a vertical side wall of the brine tank 211 above the first sensing device 271 in a intermediate position of the brine tank 211.

With regards to the electronic control device 273, it is configured to: receive the electric signals from the first 271 and the second pressure sensing devices 272, determine the first P1 and second pressure values P2 based on the received electric signals, and determine/calculate the salinity of the brine stored in the brine tank 211 of the dishwashing machine 200 based on the first P1 and second pressure values P2 and the height difference ΔH between the first H1 and the second height H2.

Preferably, the electronic control device 273 calculates the salinity of the brine by using the above disclosed equation a) :

$$\varrho = \frac{P1 - P2}{g(H2 - H1)}$$

Preferably, the electronic control device 273 may be further configured to calculate the actual level L0 of the brine contained in the brine tank 211 of the dishwashing machine 200 based on the following parameters: the determined salinity ϱ, the first P1 or the second pressure values P2, and the first H1 or respectively the second height H2. Preferably, the electronic control device 273 may be further configured to calculate the actual height or level L0 of the brine contained into the brine tank 211 of the dishwashing machine 200 by the above disclosed equation b):

$$L0 = \frac{P2}{\varrho * g} + H2 = \frac{P1}{\varrho * g} + H1$$

It is understood that the present invention is not limited to the embodiment described above wherein the brine salinity in the brine tank 211 of the dishwashing machine 200 is determined according to two pressure values provided by two sensing devices placed at different heights H1 and H2. Indeed, according to the embodiment illustrated in Figure 18, the brine salinity in the brine tank 211 may be conveniently determined according to a single pressure value provided by a single sensing device, i.e. the first pressure sensing device 271. According to this embodiment, the dishwashing machine 200 may be provided with an overflow hydraulic system 800, which is configured to cause the level L0 of the brine contained in the brine tank 211 not to exceed the prefixed second height H2. In other words, the overflow hydraulic system 800 is structured to cause the brine to be automatically spilled out from the brine tank 211 when the level of the brine reaches an overflow condition, i. e. L0=H2.

According to the exemplary embodiment illustrated in Figure 18, the brine tank 211 may comprise an outlet which is located at the second height H2 and is hydraulically connected with an overflow pipe or siphon which in turn may be preferably connected to a drain system of the dishwashing machine 200 (not illustrated).

In this case, the electronic control device 273 may be configure to: temporarily maintain the brine in the tank 211 in the overflow condition (L0=H2), receive from the first pressure sensing device 271 an electric signal indicative of the first pressure value P1, and determine the salinity of the brine based on the first pressure P1 and the height difference ΔH between the first height H1 and the second height H2 corresponding to the brine overflow height, in which the level L0 of the brine is equal to the prefixed second height H2.

Preferably, the electronic control device 273 may be configured to determine the salinity of the brine stored in the brine tank 45 by the following equation :

$$\varrho = \frac{P1}{g(H2 - H1)}$$

wherein H2 is the overflow height.

Preferably, the electronic control device 273 may be further configured to detect/determine when the salinity of the brine contained in the brine tank 211 of the dishwashing machine 200 exceeds a predetermined minimum salinity value, and preferably determine when the level of the water or brine stored inside contained in the brine tank 211 is equal to or higher than a predetermined threshold level value. Preferably said predetermined minimum salinity value may be equal to, or higher than, the minimum salinity value required to successfully perform the regeneration process of the ion-exchange resins contained into the water softening device 210. The threshold level value, in turn, preferably corresponds to a level wherein the brine tank 211 is completely filled up with fresh water or brine, i.e. to an amount of brine inside brine tank 211 sufficient to successfully perform the regeneration process of the ion-exchange resins contained into the water softening device 210.

In the example shown, in particular, the electric sensor assembly 270 may be preferably configured to determine, at same time, if the salinity degree of the brine stored into brine tank 211 of the dishwashing machine 200 exceeds said minimum salinity value, and whether the level of the fresh water or brine (i.e. salt water) stored inside brine tank 211 is equal to or higher than said predetermined threshold level

value. Preferably, the electric sensor assembly 270 may be configured to determine, at same time, whether the salinity degree of the brine stored into brine tank 211 exceeds the minimum salinity value required to successfully perform the regeneration process of the ion-exchange resins contained into the water softening device 210, and whether the actual level of the fresh water or brine stored inside the brine tank 211 is equal to or higher than said threshold level value, thus to successfully perform, in case of the brine, the regeneration process of the ion-exchange resins contained into the water softening device 210.

With reference to Figure 11, the electronic control device 273 may be further configured to provide the determined salinity and preferably the actual level L0 to the main control unit 208 of the dishwashing machine 200 which, in turn, determines on the basis of the salinity, whether the brine to be pumped into the water softening device 210 has a sufficient salinity degree to successfully perform the regeneration process of the ion-exchange resins contained into the water softening device 210, and furthermore to precise control of the amount of brine to be pumped from the brine tank 211 into the water softening device 210. The combination of electric signals relating to salinity and actual level L0 provided by the electronic control device 273 in fact, causes the main control unit 208 of dishwashing machine 200 to compare the determined salinity with a prefixed salinity threshold, compare the determined brine level with a prefixed level threshold and determine according to the comparison results, whether the brine contained into brine tank 211 may be used and/or is sufficient for successfully performing the regeneration process of the ion-exchange resins.

Figure 12 illustrates a dish washing machine 200 made according to a seventh embodiment of the present invention, wherein component parts will be indicated, where possible, with the same reference numbers which identify corresponding parts of the dish washing machine 200 made according to the sixth embodiment illustrated in Figure 11. This advantageous embodiment differs from the sixth embodiment because the second pressure sensing device 272 in the brine tank 211 of the dishwashing machine 200 is replaced with a float detecting device 281 which is

configured to detect when the actual level of the brine stored in the brine tank 211 reaches a prefixed level threshold corresponding to the prefixed second height.

With reference to the exemplary embodiment illustrated in Figure 12, the electric sensor assembly 280 is provided with the float detecting device 281 comprising in turn a floating body 282, which has a nominal density lower than that of the fresh water (i.e. lower than approximately 1000 kg/m^3), so as to float in presence of any kind of water (i.e. both fresh water and brine), and is housed inside the brine tank 211 with the capability to freely move upwards and downwards between a lowered position and a raised position on the basis of the actual level of fresh water or brine inside brine tank 211. The float detecting device 281 further comprises a detector 283 which is configured to detect when the floating body 282 reaches said raised position inside brine tank 211. Preferably, although not necessarily, the detector 283 may be further configured to detect when the floating body 282 reaches said lower position inside brine tank 211. Preferably, the raised position of the floating body 282 corresponds to a level of fresh water or brine inside brine tank 211 which is equal to or exceeding a prefixed level threshold value. In the exemplary embodiment illustrated in Figure 12, the prefixed level threshold value is set so as to be equal the second height of the brine tank 211. Preferably although not necessary, the prefixed level threshold value may be preferably set so as to be equal to the threshold level value. With regard to the lowered position of the floating body 282, in turn, it preferably corresponds to roughly no fresh water or brine inside brine tank 211.

In the example shown in Figure 12, in particular, floating body 282 may be structured to be housed inside a vertical guide chamber 285 which, in the illustrated example, is placed within the brine tank 211. The floating body 282 may be designed to freely swing up and down inside said vertical guide chamber 285. Moreover, the vertical guide chamber 285 may be hydraulically communicating with the rest of the internal space of the brine tank 211 in order to receive the brine from the latter (so as to perform communicating vessels).

With reference to the example illustrated in Figure 12, the electronic control

device 273 may be configured to receive from the first pressure sensing device 271 an electric signal indicative of the first pressure value P1, and receive form the detector 283 of the float detecting device 281 an electric signal which contains information indicating whether the actual level of the brine stored in the brine tank 211 is equal to the prefixed level threshold. Indeed the electronic control device 273 may be configured to receive from the detector 283 the electric signal when the level of the brine stored in the brine tank 211 is equal to the prefixed second height. Moreover, when the level of the brine stored in the brine tank 211 is equal to the prefixed second height, the electronic control device 273 may determine the salinity of the brine, based on the first pressure P1 and the height difference between the first height and the second height corresponding to the prefixed level threshold. Indeed, the electronic control device 273 may be configured to determine the salinity of the brine stored in the brine tank 211 of the dishwashing machine 200 by the above disclosed equation c):

$$ϱ = \frac{P1}{g(H2 - H1)}$$

When the level of brine inside of the brine tank 211 reaches the second height, the floating body 282 causes the electronic detecting device 283 to switch the electrical signal (i.e. from OFF to ON) that, in turn, activate the electronic control device 273 to calculate the salinity of the brine. The salinity is therefore determined according to equation c) when the float detecting device 281 detects that the brine inside of the brine tank 211 has reached the second height. After having determined the salinity of the brine, the electronic control device 273 may further monitor/determine, time by time, the actual level of brine stored in the brine tank 211 for example during the step of pumping of the brine from the brine tank 211 to the water softening device 210. Since, during the pumping, the salinity of the brine in the brine tank 211 remains substantially constant, the electronic control device 273 may determine the actual level of the brine by the above disclosed equation d)

$$L0(t) = \frac{P1(t)}{\varrho * g} + H1$$

Figure 13 illustrates a dish washing machine 200 made according to a eighth embodiment of the present invention, wherein component parts will be indicated, where possible, with the same reference numbers which identify corresponding parts of the dish washing machine 200 made according to the seventh embodiment illustrated in Figure 12. This embodiment differs from the seventh embodiment because the electric sensor assembly 290 comprises a number of detectors 283 which are vertically placed one above of the other preferably on the brine tank 211 at respective heights. Preferably, detectors 283 may be vertically placed on a sidewall of the brine tank 211 in adjacent positions one to the other in order to provide, in substantially continue manner, instant by instant, the actual level of the brine inside the brine tank 211. Due to the possibility of determining time by time the actual level of the brine, and consequently the respective height, the electronic control device 273 is conveniently configured to constantly determine the salinity of the brine. Therefore, differently from the sixth embodiment wherein the salinity is determined only when the actual level of the brine reaches the single prefixed threshold level value corresponding to the second height, the seventh embodiment allows the electronic control device 273 to calculate the salinity when the level of the brine changes from a minimum level value to a maximum level value. Indeed, the electronic control device 273 may be configured to determine the salinity of the brine stored into the brine tank of the dishwashing machine 200 by the above disclosed equation e):

$$\varrho(t) = \frac{P1(t)}{g(L0(t) - H1)}$$

Figure 14 illustrates a dish washing machine 200 made according to a ninth embodiment of the present invention, wherein component parts will be indicated, where possible, with the same reference numbers which identify corresponding parts of the dishwashing machine 200 made according to the sixth embodiment illustrated

in Figure 11. This embodiment differs from the sixth embodiment because the second pressure sensing device 272 in the brine tank 211 is replaced with an optical detecting apparatus 301 which is associated with the brine tank 211 and is configured to: emit a radiation beam towards the brine, receive the beam reflected or refracted by the brine, and determine, when the level of brine reaches the prefixed second height, on the basis of the received beam. Indeed the electric sensor assembly 300 is configured to photo-electrically detecting when the brine level reaches the prefixed second height. With reference to the exemplary embodiment illustrated in Figure 14, the electric sensor assembly 300 is provided with the optical detecting apparatus 301 comprising, in turn, an emitting device 302 and a receiving device 303 which may be associated with the brine tank 211 in order that in a first brine level condition, i.e. when the level of brine is lower than the prefixed second height, the beam projected by the emitting device 302 hits the receiving device 303, and vice versa in a second brine level condition, i.e. when the level of brine is equal to or exceeding the prefixed second height, the beam emitted by the emitting device 302 is refracted by the brine or the water in order to no hit the receiving device 303. In Figure 14, the radiation beam 304 which hits the receiving device 303 in the first level condition is indicate with a solid line, whereas the dotted line indicates the radiation beam 305 in the second level condition wherein the brine refracts/deflect the radiation beam. Indeed, when in the first condition, the level of brine is under than the prefixed second height, the refraction index of the air does not cause the emitted beam to be deviated, and the receiving device 303 receives the radiation beam so that the receiving device 303 is actuated, indicating that the brine level is under the prefixed second height. In the second condition, the level of brine reaches the prefixed second height, the refraction index of the brine being different to that of the air, causes the refracted beam to be deviated, and the receiving device 303 receives no radiation beam or a much less amount of radiation beam so that the receiving device 303 is not actuated, indicating that the brine level is equal to prefixed second height. It should be pointed out that the positions of the emitting 302 and receiving devices 303 in the brine tank 211 are referred to, here, purely by way of example in

connection with the ninth embodiment of the present invention, and may be different. For example the receiving device 303 may be placed in the brine tank 211 in order that in the first brine level condition, the beam emitted by the emitting device 302 does not hit the receiving device 303, and vice versa in the second brine level condition, i.e. the beam emitted by the emitting device 302 is refracted by the brine or the water in order to hit the receiving device 303. Likewise the second embodiment, the electronic control device 273 in the ninth embodiment is configure to: receive from the first pressure sensing device 271 an electric signal indicative of the first pressure value, receive form the optical sensing device 291 an electric signal containing the information (OFF/ON) indicating whether the level of the brine stored in the brine tank 211 is equal to the prefixed second height, and determine, when the level of the brine is equal to the prefixed second height, the salinity of the brine based on the first pressure P1 and the height difference between the first height and the second height. Preferably, the electronic control device 273 is configured to determine the salinity of the brine stored in the brine tank 211 by the above disclosed equation f):

$$ϱ = \frac{P1}{g(H2 - H1)}$$

The electronic control device 273 may further monitor/determine, time by time, the actual level of brine stored in the brine tank 211, for example during the step of pumping of the brine from the brine tank 211 to the water softening device 210. Since, during the pumping, the salinity of the brine in the brine tank 211 remains substantially constant, the electronic control device 273 may determine the actual level of the brine by the above disclosed equation g)

$$L0(t) = \frac{P1(t)}{ϱ * g} + H1$$

Figure 15 illustrates a dish washing machine 200 made according to a tenth embodiment of the present invention, wherein component parts will be indicated,

where possible, with the same reference numbers which identify corresponding parts of the dish washing machine 200 made according to the third embodiment illustrated in Figure 10. This embodiment differs from the ninth embodiment because it comprises a number of optical detecting apparatus 301 which are vertically placed one above of the other preferably on the brine tank 211 at respective heights. Preferably, the optical detecting apparatus 301 of the electric sensor assembly 400 is provided with emitting 302 and receiving devices 303 vertically placed on the respective opposite sidewalls of the brine tank 211 in adjacent position one to the other in order to determine, in substantially continue manner, instant by instant, the actual level of the brine inside the brine tank 211. Due to the possibility of determining, time by time, the actual level of the brine, and consequently the respective height, the electronic control device 273 is conveniently able to constantly determine the salinity of the brine. Therefore, differently from the ninth embodiment wherein the salinity is determined only when the actual level of the brine reaches the prefixed second height, the tenth embodiment allows the electronic control device 273 to calculate the salinity when the actual level of the brine changes from a minimum level value to a maximum level value. Indeed the electronic control device 273 may be configured to determine the salinity by the above disclosed equation h):

$$\varsigma(t) = \frac{P1(t)}{g(L0(t) - H1)}$$

CLAIMS

1. A household washing machine (1)(200) comprising:
   - a washing member structured for housing products to be washed,
   - a water softening device (13)(210) filled with ion-exchange resins designed to reduce the hardness degree of water to be supplied to said washing member,
   - a brine tank (45)(211) containing brine to be supplied to said water softening device (13)(210) for regenerating said ion-exchange resins,

   said household washing machine (1)(200) being characterized by comprising:
   - electric sensor assembly (70)(80)(90)(100)(110)(270)(280)(290)(300)(400) which is provided with pressure sensing means (71)(72)(271)(272) configured to measure the pressure of the brine stored into said brine tank (45)(211) at least at a prefixed height (H1);
   - electronic control means (73)(273), which are configured to determine the salinity of the brine stored in said brine tank (45)(211) based on said measured pressure.

2. A household washing machine according to claim 1, wherein said electronic control means (73)(273) are configured to:
   - determine, by means of said pressure sensing means (71)(72)(271)(272), a first pressure (P1) of the brine at a prefixed first height (H1) of the brine tank (45)(210), when the actual level of the brine (L0) is equal or greater than a prefixed second height (H2) which is greater than said prefixed first height (H1), and
   - determine the salinity of said brine based on said first pressure (P1) and the height difference (ΔH) between said prefixed first height (H1) and said prefixed second height (H2).

3. A household washing machine according to claim 2, comprising an overflow hydraulic system (800) configured to spill out the brine from said brine tank (45)(211) when the level of the brine (L0) in said brine tank (45)(211) reaches said prefixed second height (H2).

4. A household washing machine according to claim 1, wherein said electric sensor assembly (70)(270) comprises:
- a first pressure sensor (71) which is associated with said brine tank (45) (211) and is configured to provide a first electric signal which is indicative of said first pressure (P1) of the brine at a prefixed first height (H1), and
- a second pressure sensor (72) which is associated with said brine tank (45) (211) and is configured to provide a second electric signal indicating a second pressure (P2) of the brine at a prefixed second height (H2) of said brine tank (45) being greater than said first height (H1),
- said electronic control means (73) being configured to determine the salinity of the brine, based on said first pressure (P1), said second pressure (P2) and said height difference (ΔH).

5. A household washing machine according to claim 4, wherein said electronic control means (73)(273) are configured to determine the salinity of the brine by the following equation:

$$\varrho = \frac{P1 - P2}{g(H2 - H1)}$$

wherein: H1 is the prefixed first height; H2 is the prefixed second height; g is gravitational acceleration (9.81m/s^2); P1 is the pressures of the brine determined at the first height H1; P2 is the pressures of the brine determined at the second height H2.

6. A household washing machine according to claim 5, wherein said electronic control means (73)(273) are further configured to determine the actual level (L0) of the brine stored into the brine tank (45) by the following equation:

$$L0 = \frac{P2}{\varrho * g} + H2 = \frac{P1}{\varrho * g} + H1$$

wherein: L0 is the actual level of the brine; H1 is the prefixed first height; H2 is the prefixed second height; g is gravitational acceleration (9.81m/s^2), P1 is the pressures of the brine determined at the first height H1; P2 is the pressures of the brine determined at the second height H2.

7. A household washing machine according to claim 1, wherein said wherein said electric sensor assembly further comprises level sensing means (81)(101)(281)(301) configured to measure the level of the brine stored in said brine tank (45)(211),

- said electronic control means (73)(273), being further configured to determine the salinity of the brine stored in said brine tank (45)(211) based on said measured pressure/s and/or said measured level.

8. A household washing machine according to claim 7, wherein said electric sensor assembly (80)(280) comprises:

- a first pressure sensor (71)(271), which is associated with said brine tank (45)(211) and is configured to provide a first electric signal which is indicative of said first pressure (P1) of the brine at a prefixed first height (H1), and
- a float detecting device (81)(90)(281)(290), which is configured to detect when the actual level (L0) of the brine is equal to at least one prefixed second height (H2) greater than said first height (H1),
- said electronic control means (73)(273) being configured to determine the salinity of the brine based on said first pressure (P1) and the height difference (ΔH) between said first height (H1) and said second height (H2), when said detector (83) detects that said actual level (L0) of the brine is equal to said second height (H2).

9. A household washing machine according to claim 8, wherein said float detecting device (81)(90)(281)(290) comprises a floating body (82)(282), which is designed to float inside said brine tank (45)(211) on the basis of the actual

level (L0) of the brine inside brine tank (45)(211), and at least a detector (83)(283) which is configured to detect when the actual level (L0) of the brine is equal to said prefixed second height (H2) based on the position of the floating body (82)(282).

10. A household washing machine according to claim 8, wherein said electric sensor assembly (90)(290) comprises a plurality of detectors (83)(283) which are vertically associated with the brine tank (45)(211) one above of the other at respective heights (Hi) to detect the vertical position of said floating body (82)(282) inside said brine tank (45)(211); said electronic control means (73)(273) being configured to determine the actual level (L0) of the brine in said brine tank (45)(211) based on the position of said floating body detected by said detectors (83)(283).

11. A household washing machine according to claim 7, wherein said electric sensor assembly (100)(300) comprises:

- a first pressure sensor (71)(271) which is associated with said brine tank (45)(211) and is configured to provide a first electric signal which is indicative of said first pressure (P1) of the brine at a prefixed first height (H1), and
- optoelectronic detecting means (101)(301), which are associated with said brine tank (45)(211) and are configured to: emit a radiation beam across said brine, receive the radiation beam after crossing said brine, and detect when the actual level (L0) of the brine is equal to said prefixed second height (H2) based the received radiation beam,
- electronic control means (73)(273) configured to determine the salinity of the brine based on said first pressure (P1) and said height difference (ΔH), when said optoelectronic detecting means (101)(301) detect that said actual level (L0) of the brine is equal to said second height (H2).

12. A household washing machine according to claim 11, wherein said

optoelectronic detecting means (101)(301) comprise an emitting device (102)(302) and a receiving device (103)(303) which are associated with the brine tank (45)(211) in order that the beam projected by the emitting device (102)(302) hits the receiving device (103)(303) based on the actual level (L0) of brine compared with said prefixed second height (H2).

13. A household washing machine according to claim 11, wherein said optoelectronic detecting means (101) comprise a plurality of emitting devices (102)(302) and a plurality of receiving devices (103)(303) which are associated with the brine tank (45)(211) at respective prefixed heights (Hi) in order that the beam projected by the emitting devices (102)(302) hits respective receiving devices (103)(303) based on the actual level (L0) of brine compared with said respective prefixed heights (Hi).

14. A household washing machine according to claims 2 or 8 or 11, wherein said electronic control means (73)(273) are configured to determine the salinity of the brine by performing the following equation:

$$\varrho = \frac{P1}{g(H2 - H1)}$$

wherein: H1 is the prefixed first height; H2 is the prefixed second height corresponding to the second level; g is gravitational acceleration (9.81m/s^2), P1 is the pressures of the brine determined at the first height.

15. A household washing machine to anyone of the claims from 1 to 14, comprising a main electronic central control unit (74)(208) which is configured to: receive the determined salinity from said electric sensor assembly (70)(80)(90)(100)(110), and alert to the user a lack of salt and/or that refilling of salt is requested based on said received salinity.

16. A household washing machine according to any of the previous claims from 1 to 14, comprising a main electronic central control unit (74)(208) which is configured to: receive the salinity from said electric sensor assembly (70)(80)(90)(100)(110)(270)(280)(290)(300)(400), and determine, on the basis of said determined salinity, whether the brine contained into brine tank (45)(211) has a salinity degree sufficient for successfully performing the regeneration process of the ion-exchange resins.

17. A household washing machine according to any of the previous claims from 1 to 14, comprising a main electronic central control unit (74)(208) which is configured to: receive the determined salinity from said electric sensor assembly (70)(80)(90)(100)(110) and control the time of the regeneration process based on the determined salinity.

18. A household washing machine to anyone of the claims from 1 to 14, provided with a salt compartment (21) containing salt grains (NaCl) to be used in the regeneration process of water softening device (13)(210), and a main electronic central control unit (74)(208) which is configured to receive the determined salinity from the sensor assembly (70)(80)(90)(100)(110) and determine, on the basis of the determined salinity, when the amount of salt grains (NaCl) stored into said compartment (21) is depleting.

19. A household washing machine to anyone of the claims from 1 to 14, provided with a salt compartment (21) containing salt grains (NaCl) to be used in the regeneration process of water softening device (13)(210), and a main electronic central control unit (74)(208) which is configured to receive the determined salinity from the sensor assembly (70)(80)(90)(100)(110) and determine, on the basis of the determined salinity, when the salt grains in the said compartment (21) form a compact block of salt difficult to be dissolved by the fresh water

poured into the said compartment (21), and accordingly decide to stop or skip the regeneration process of said water softening device (13)(110).

20. A household washing machine to anyone of the claims 18 or 19, wherein said salt compartment (21) is structured for being manually fillable with a given quantity of salt grains (NaCl) and is fluidically communicates with said brine tank (45).

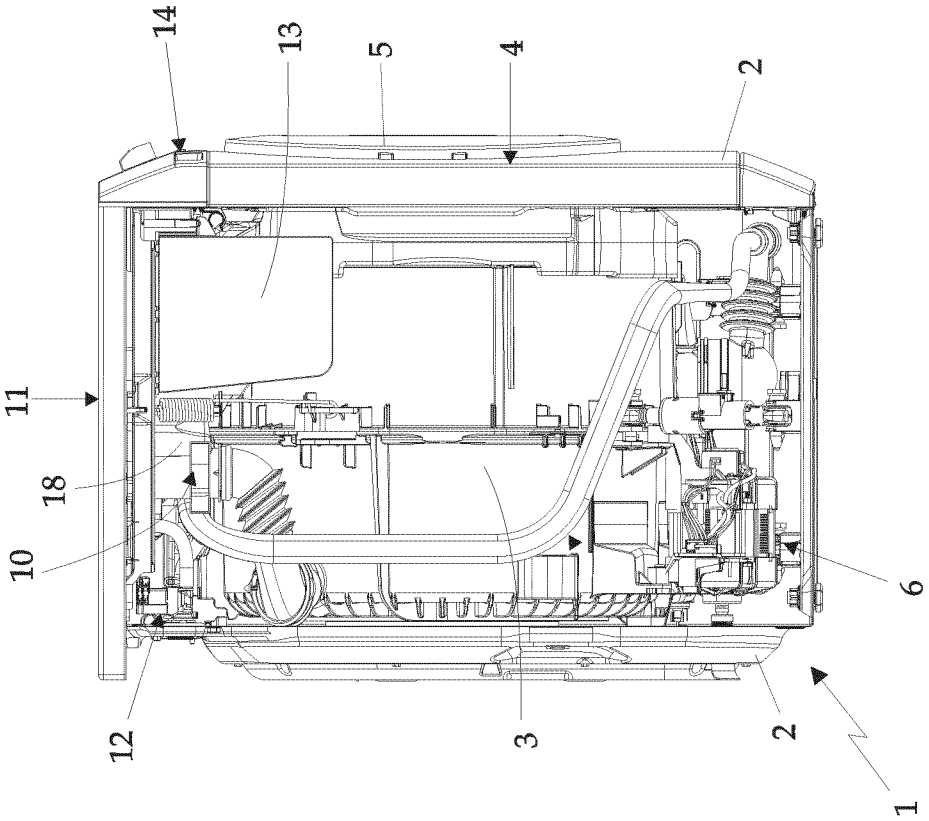


Fig. 2

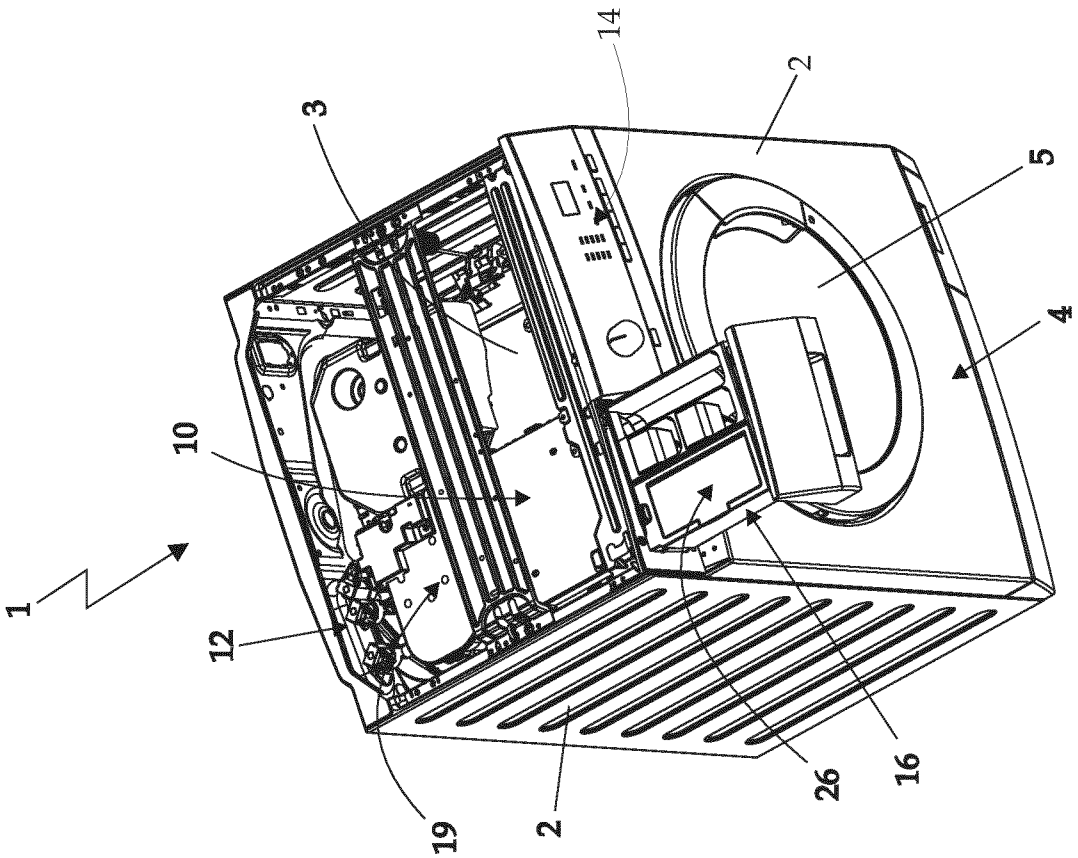


Fig. 1

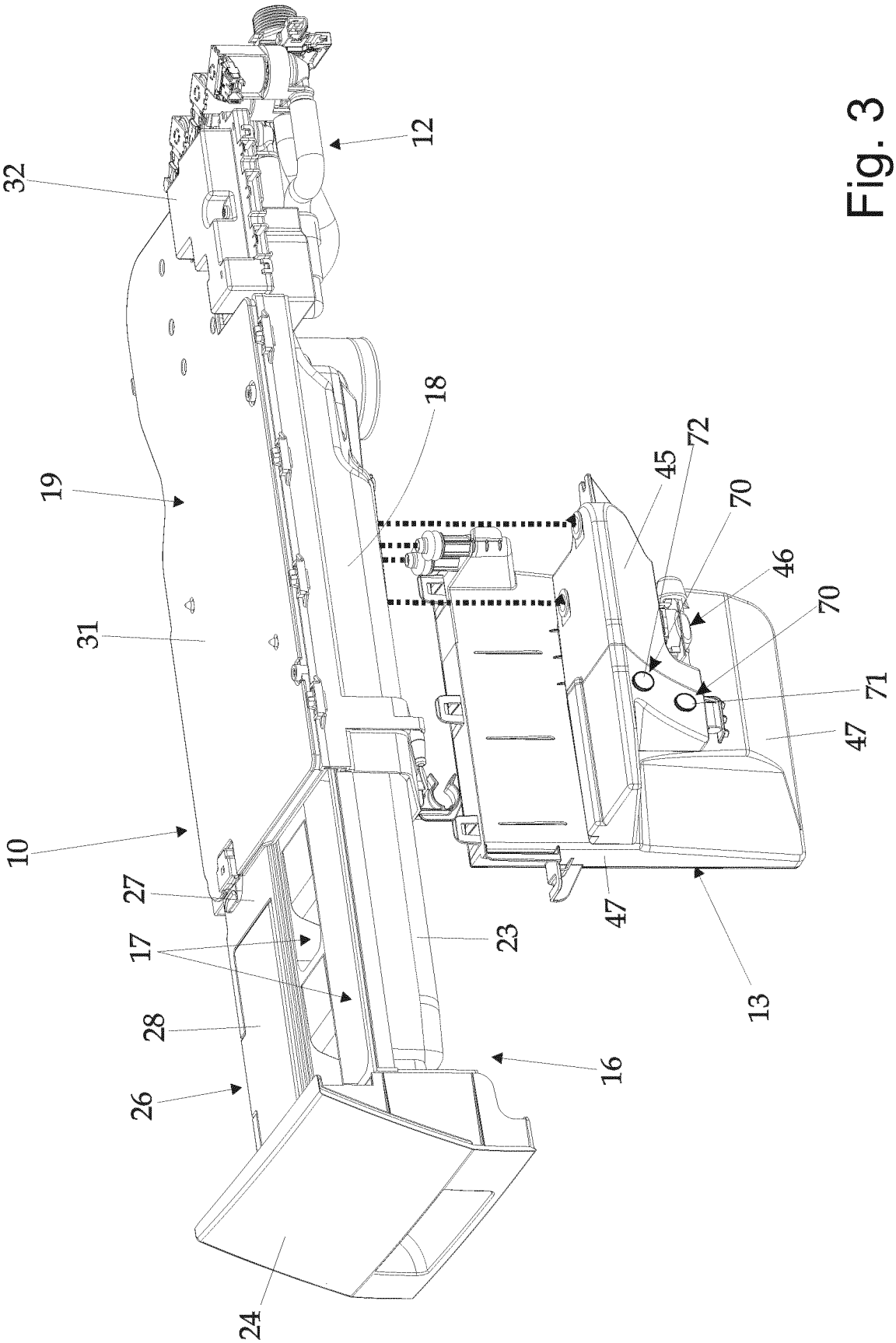


Fig. 3

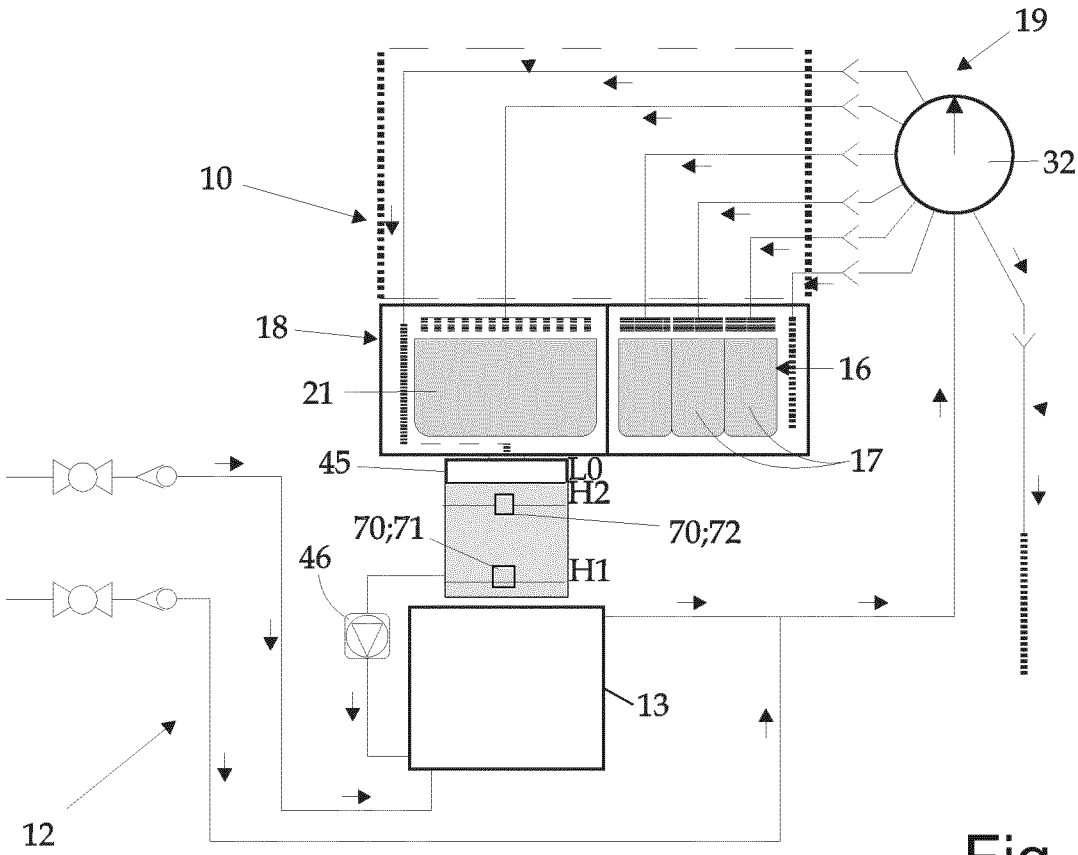
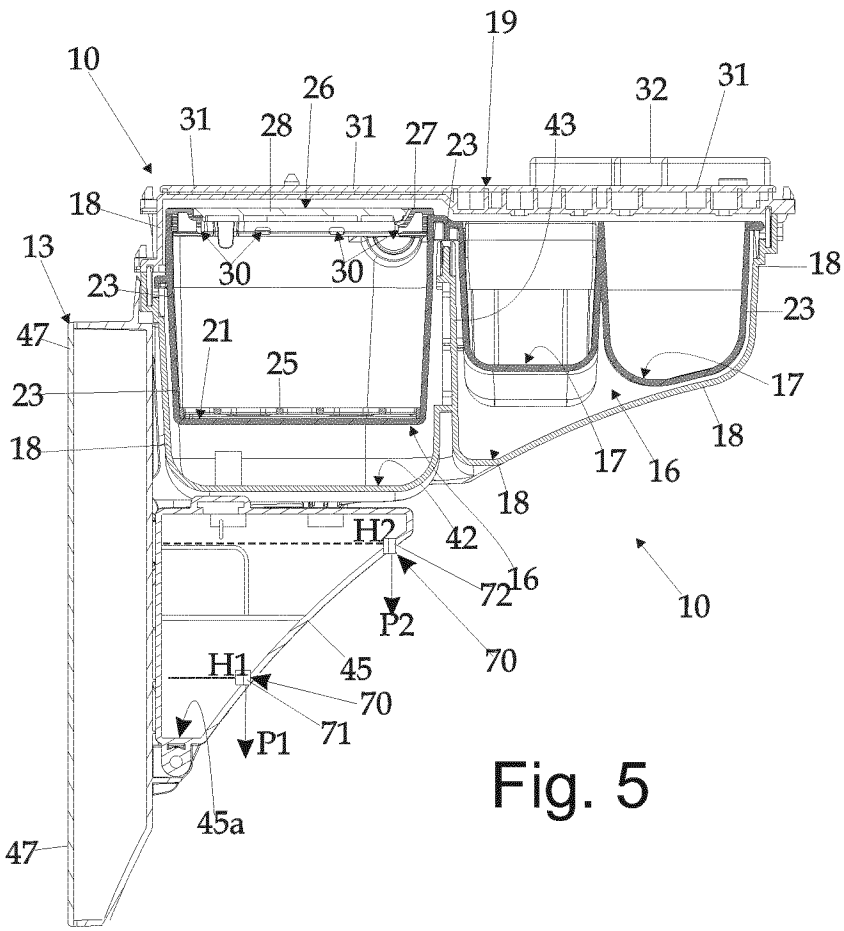

19
32
10
18
16
21
17
45
L0
H2
70;71
70;72
46
H1
13
12

Fig. 4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27
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43
32
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18
13
30
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18
23
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21
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23
17
18
17
16
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H1
45
70
71
P1
45a
47

Fig. 5

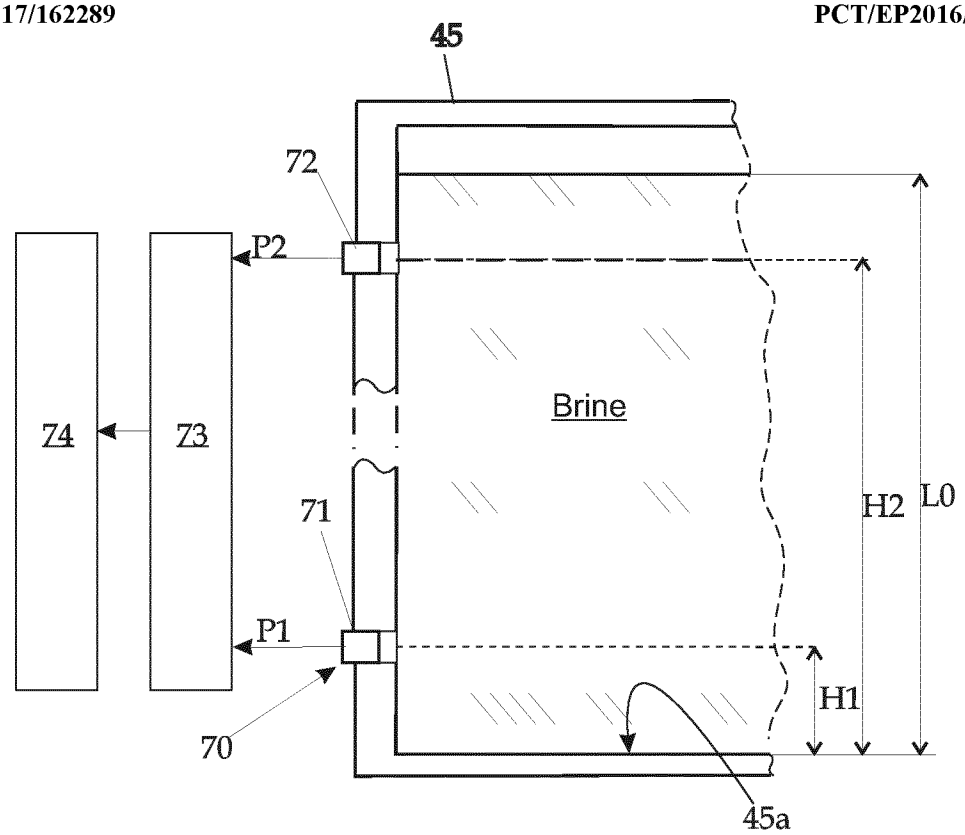
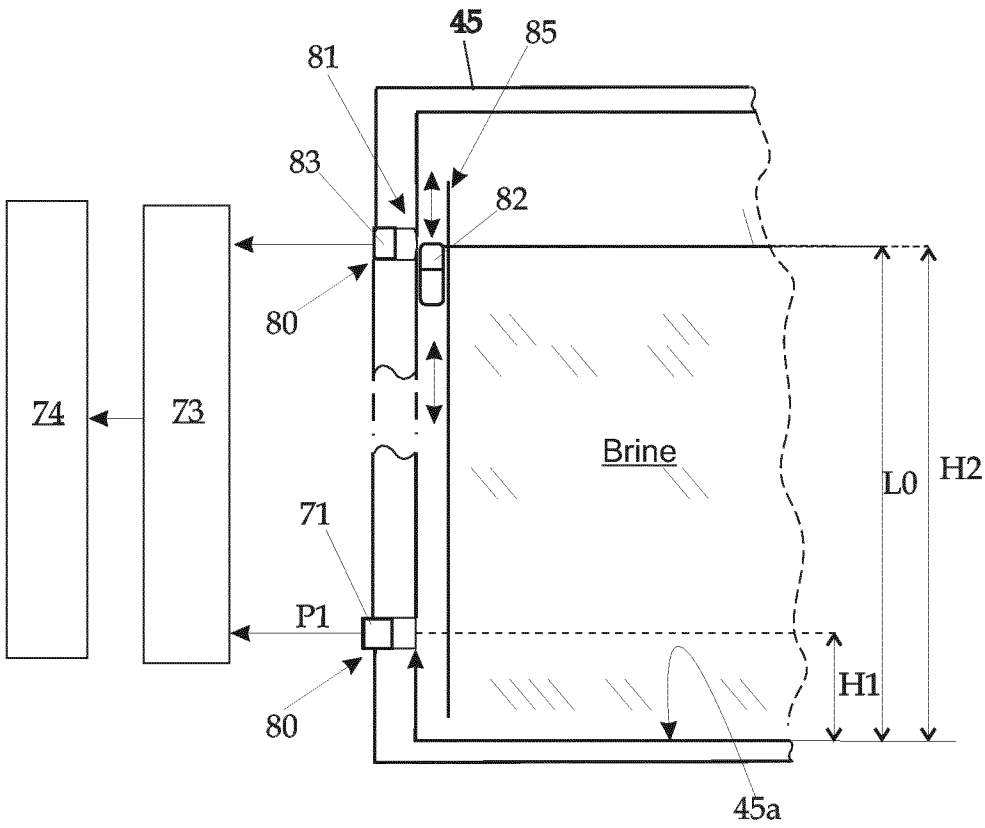

45
72
P2
Z4
Z3
Brine
71
H2
L0
P1
H1
70
45a

Fig. 6


45
85
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83
82
80
Z4
Z3
Brine
L0
H2
71
P1
H1
80
45a

Fig. 7

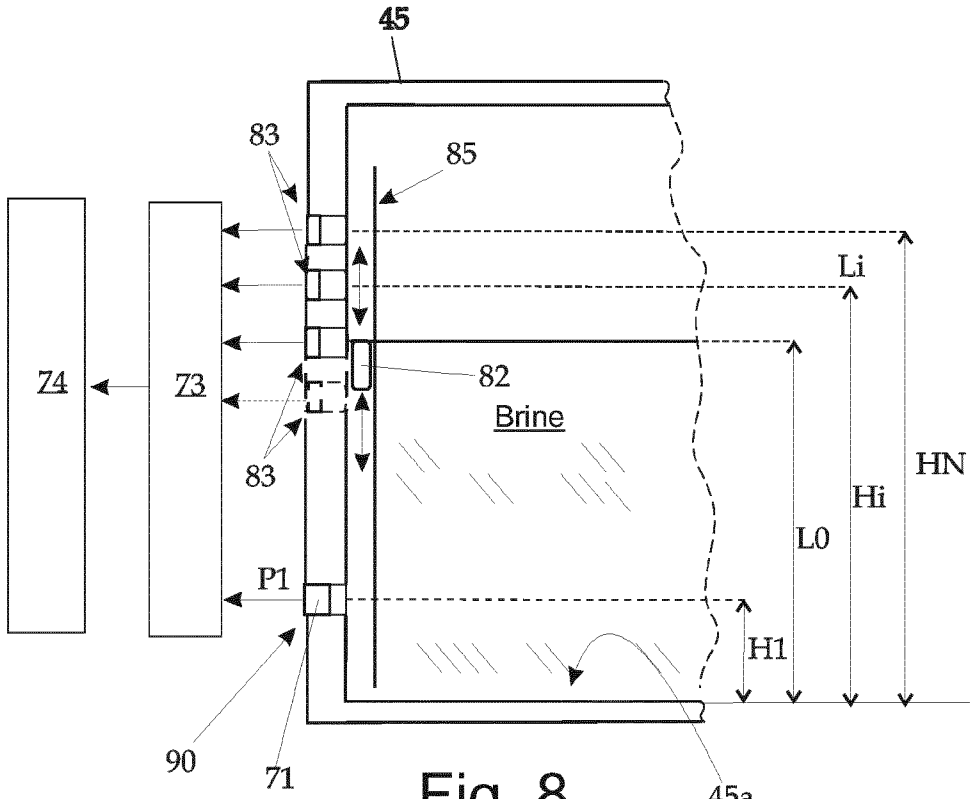
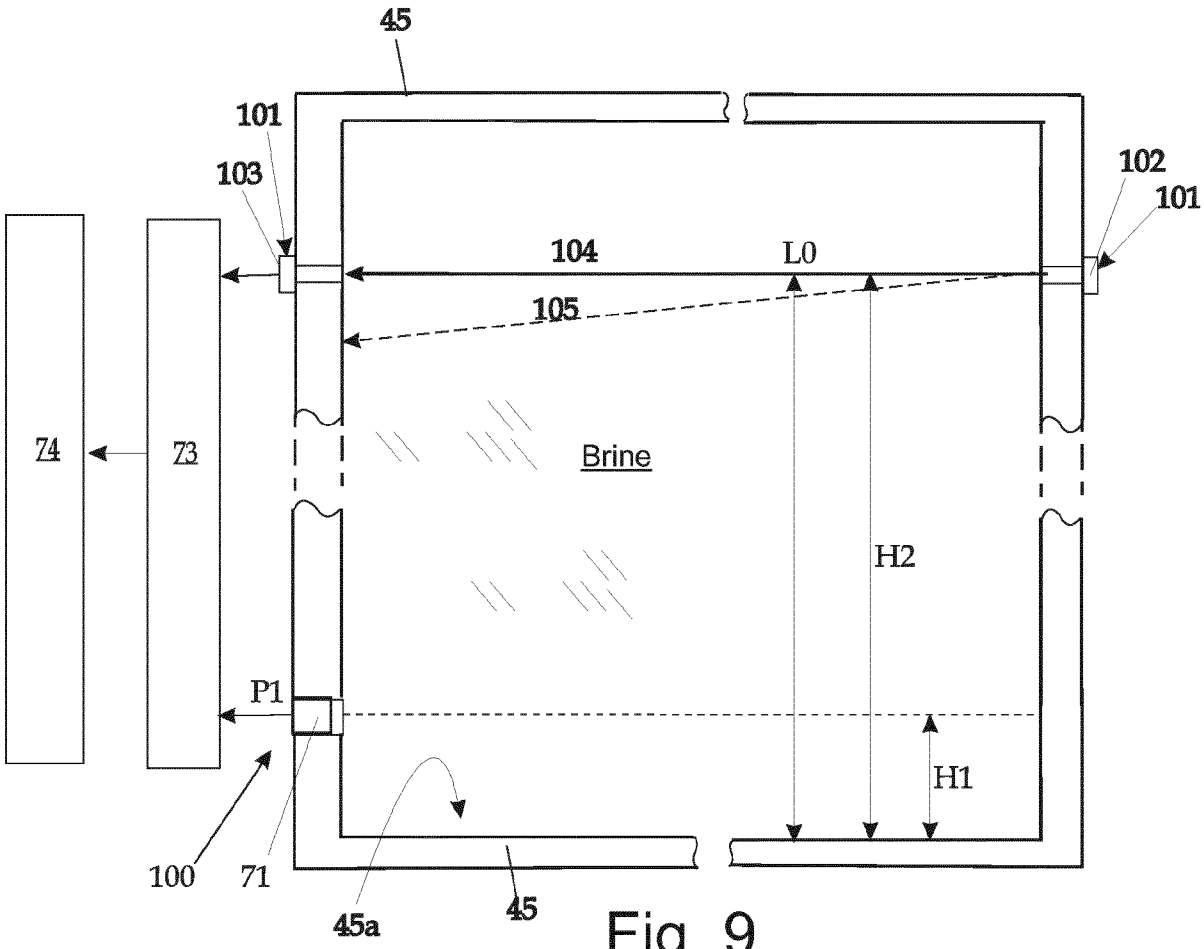

45
83
85
Li
Z4
Z3
82
Brine
83
HN
Hi
L0
P1
H1
90
71
45a

Fig. 8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Z3
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Fig. 9

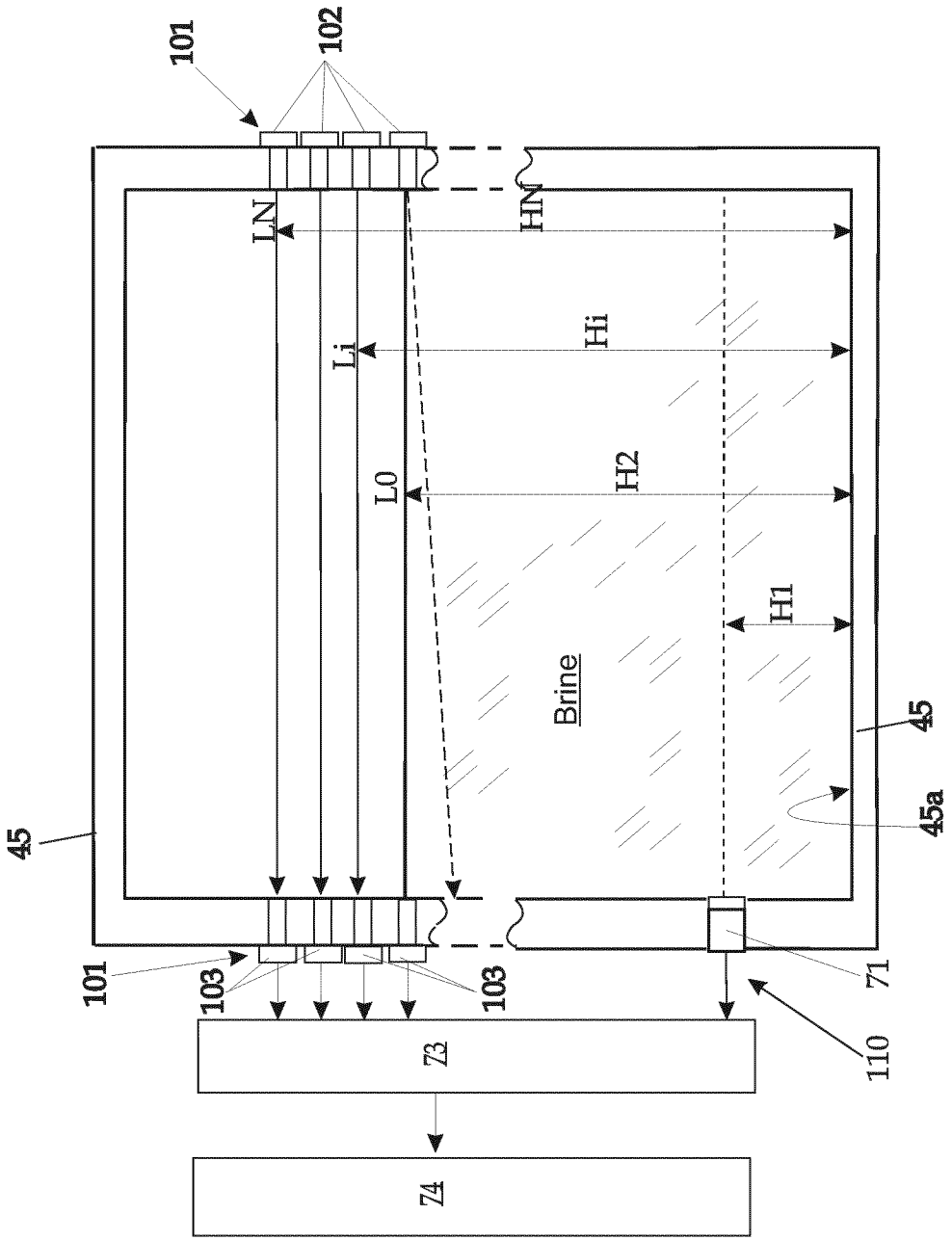
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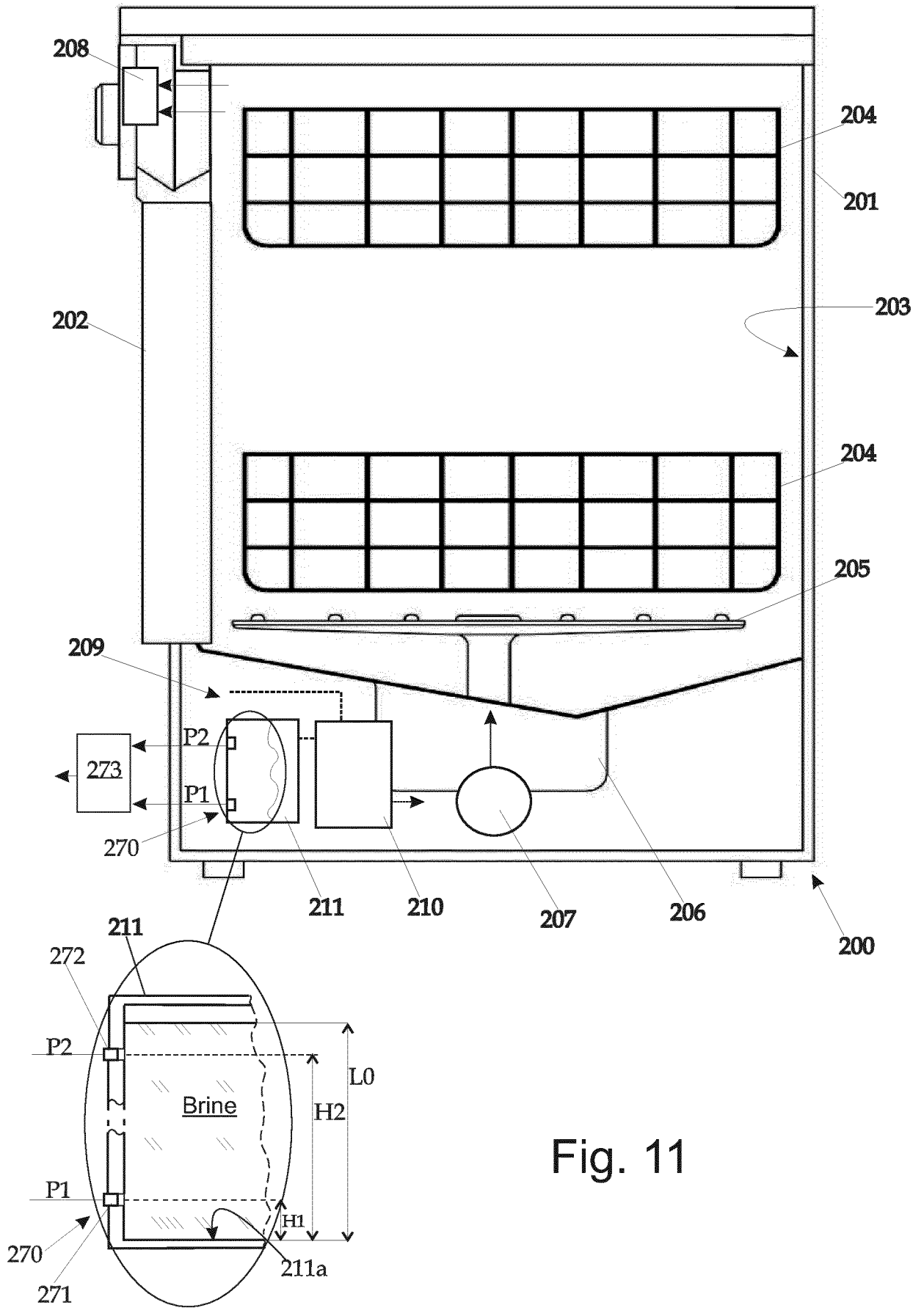
Fig. 10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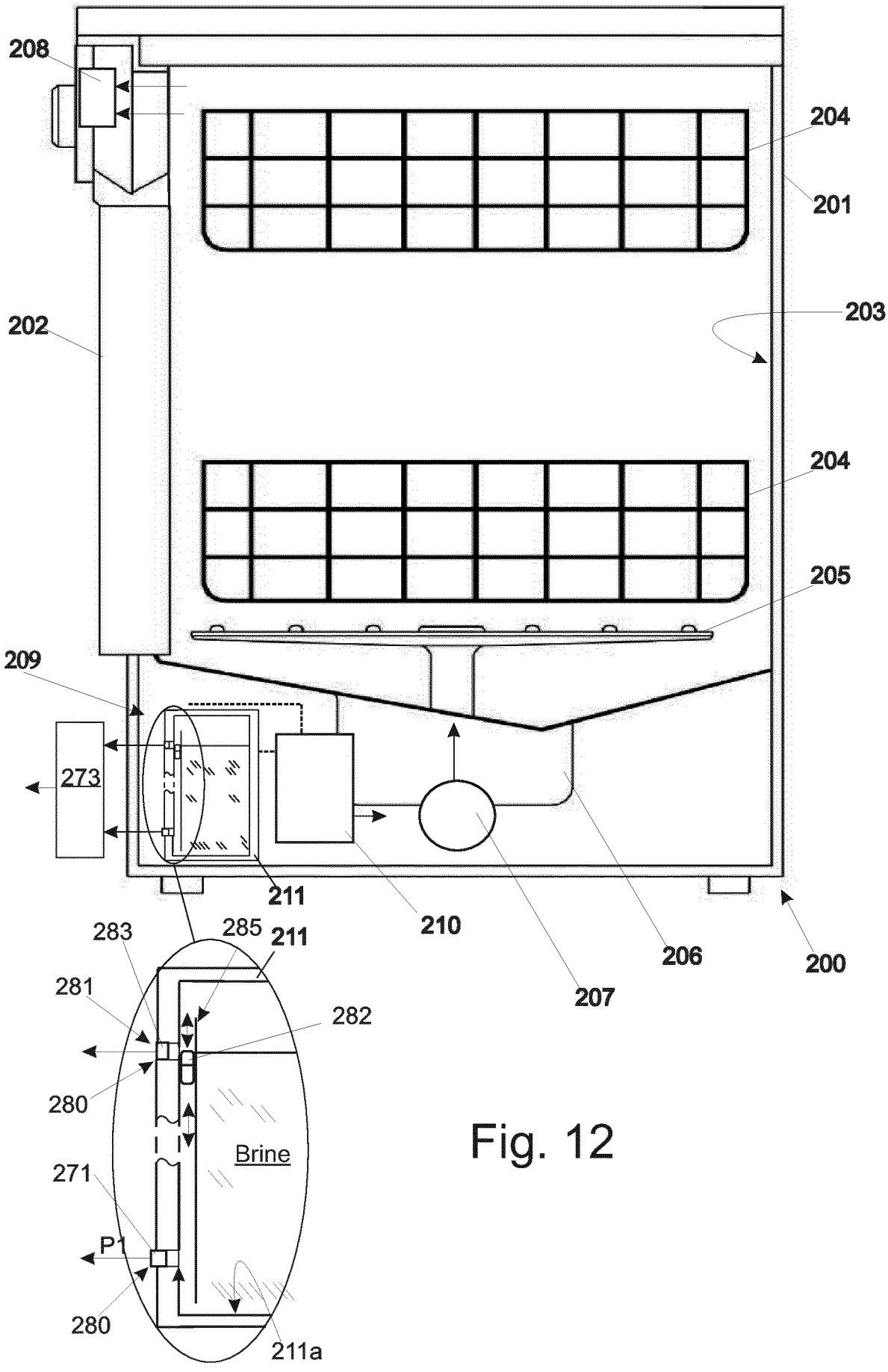
Brine
P1
H1
270
271
211a

Fig. 11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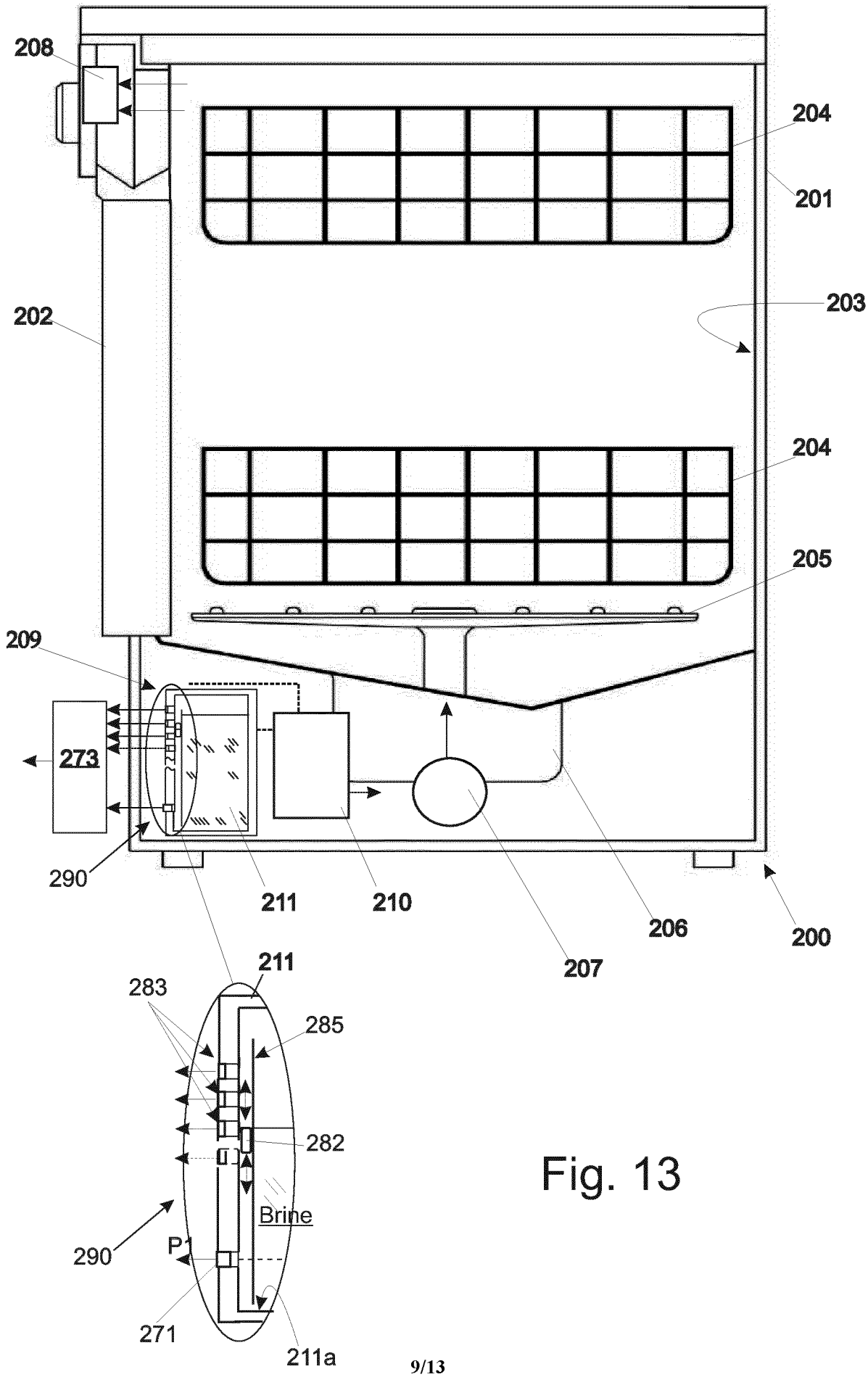
P1
280
211a

Fig. 12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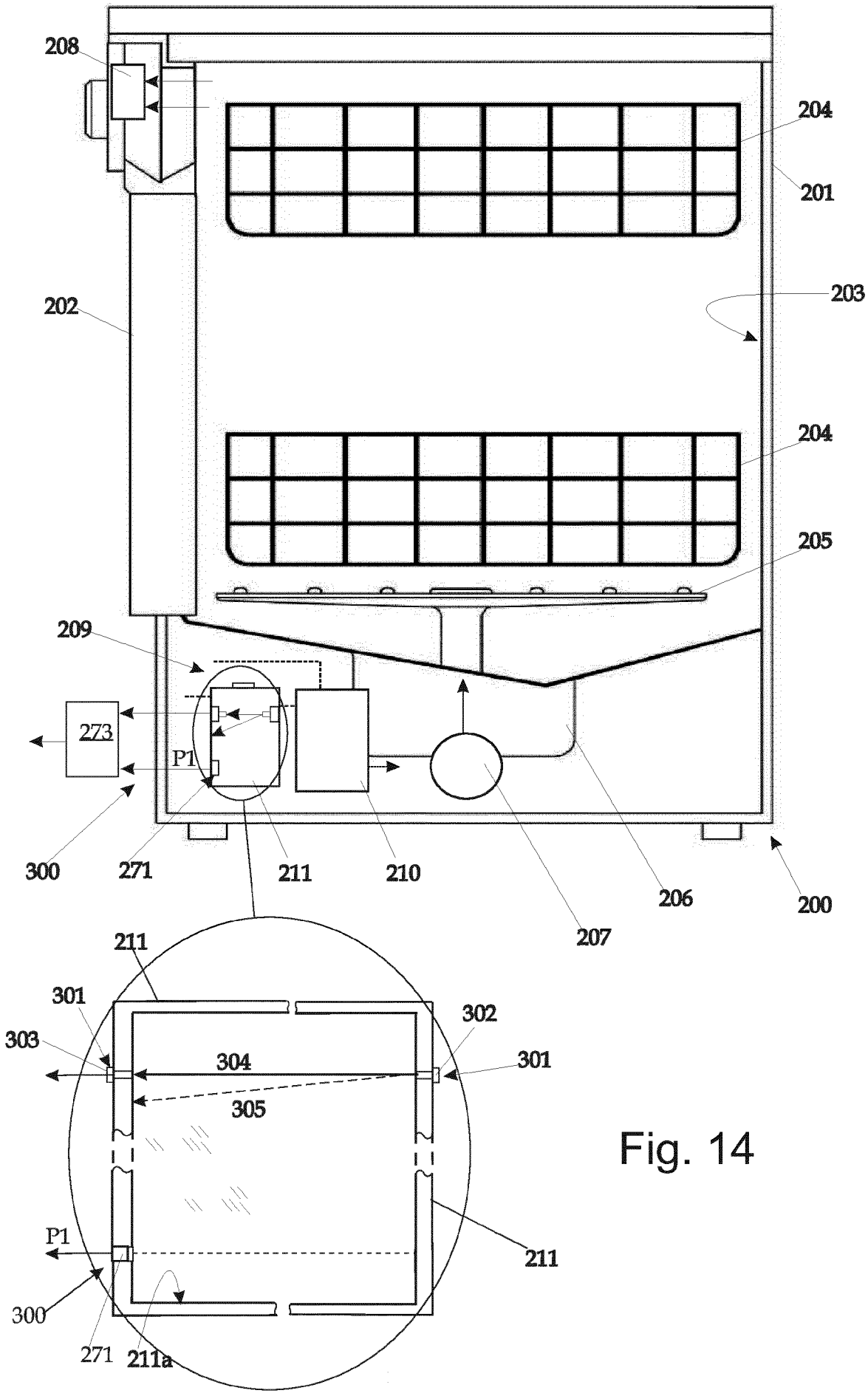
282
Brine
290
P1
271
211a

Fig. 13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301
305
P1
211
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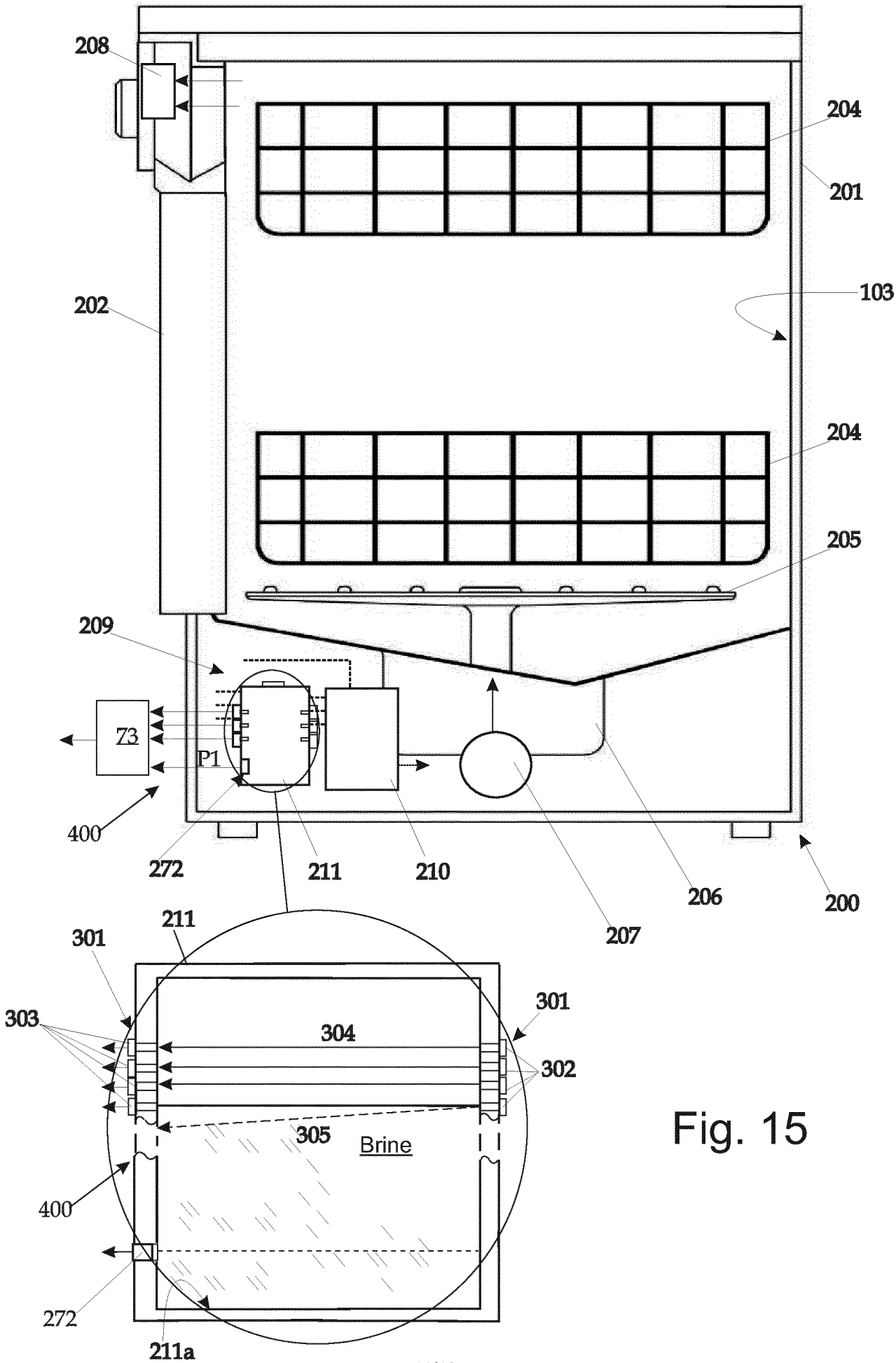
271
211a

Fig. 14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302
305
Brine
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272
211a

Fig. 15

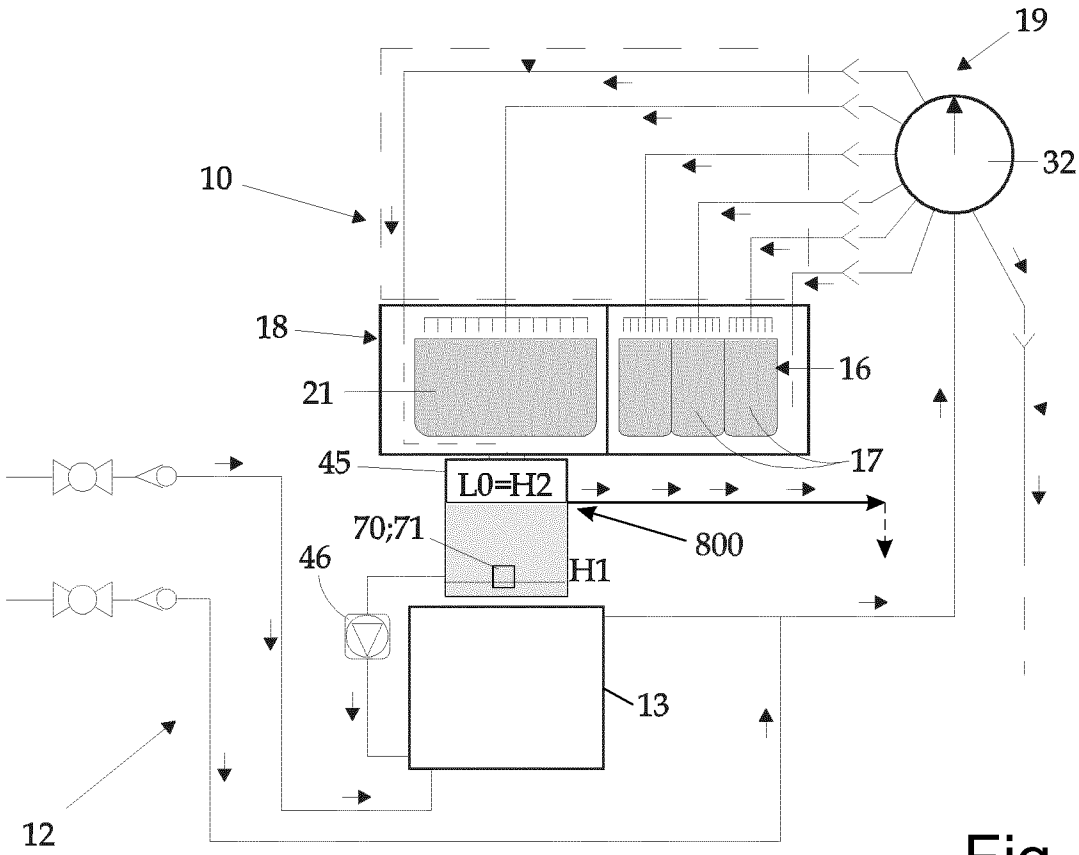
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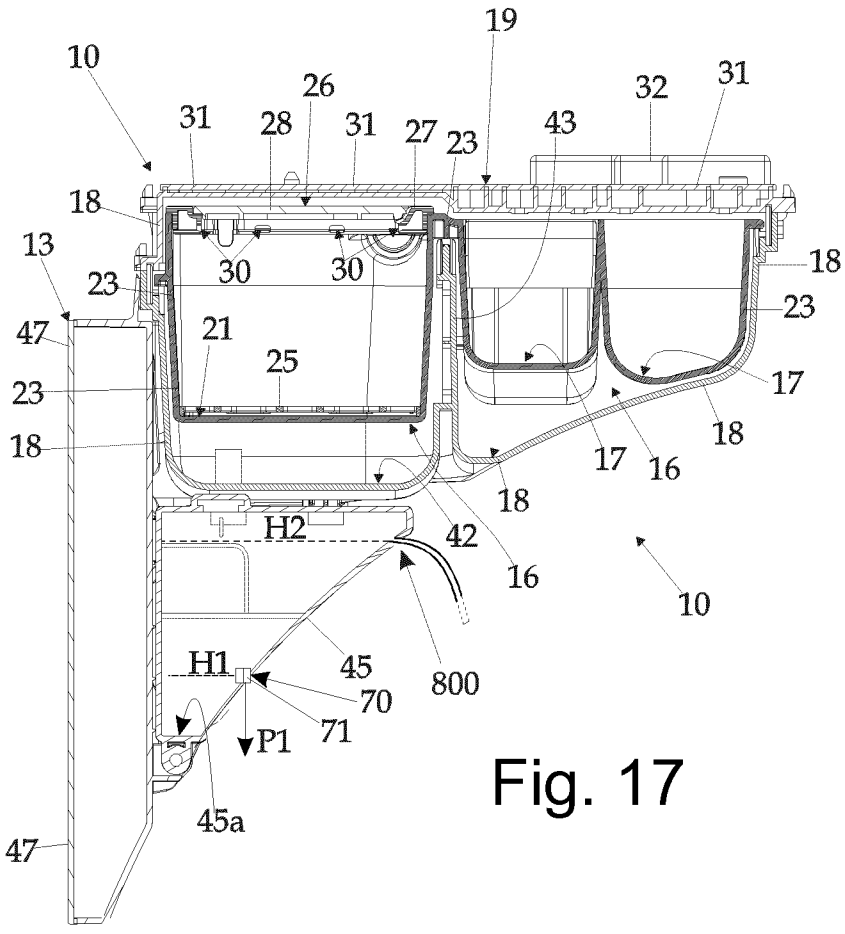
Fig. 16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H2
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H1
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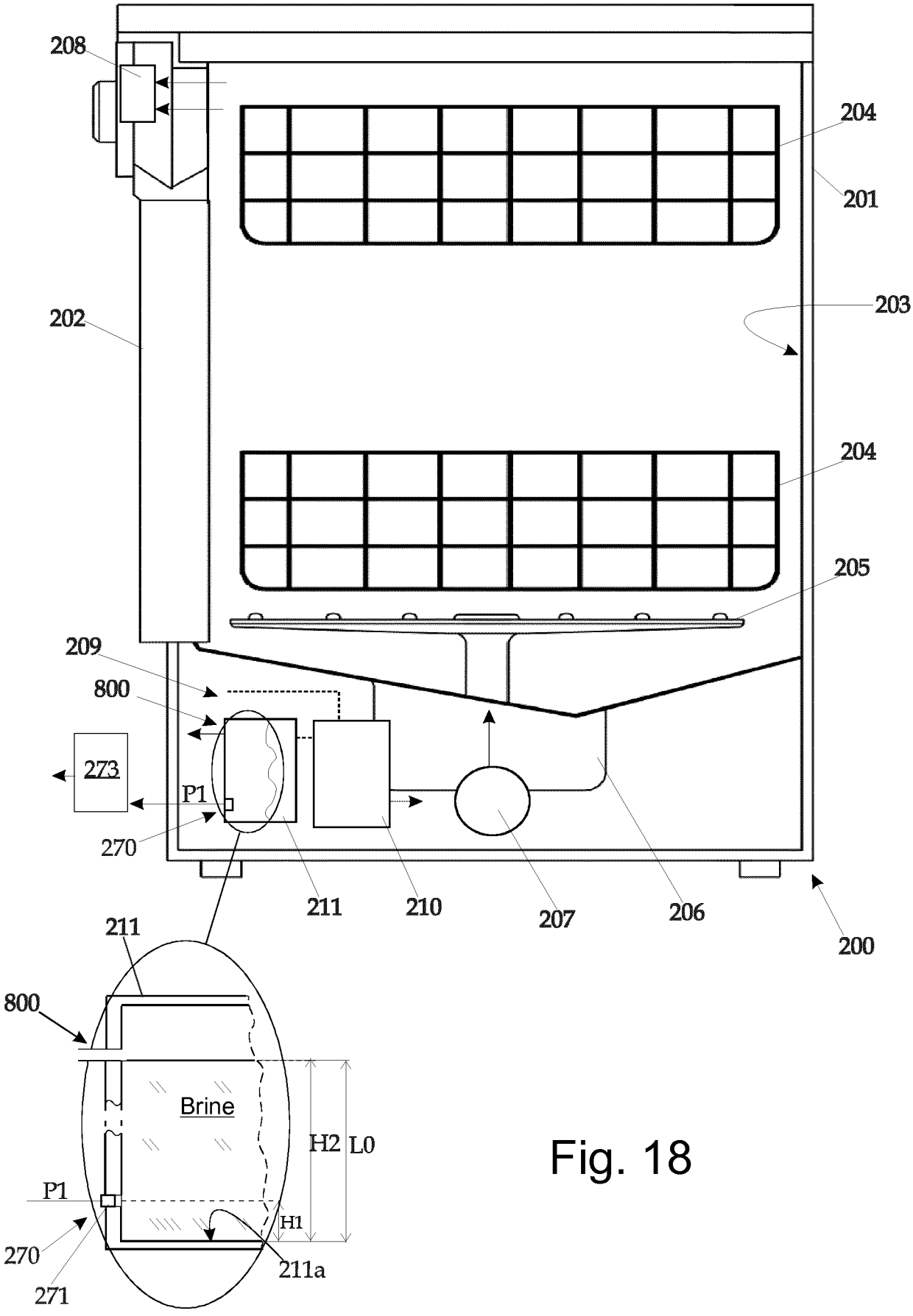
P1
45a
47

Fig. 17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P1
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800
Brine
H2
L0
P1
H1
270
271
211a

Fig. 18

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/056549

A. CLASSIFICATION OF SUBJECT MATTER
INV. D06F39/00 D06F33/02
ADD. A47L15/42 D06F39/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D06F A47L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 24 03 624 A1 (AWECO APP & GERAETEBAU KG) 14 August 1975 (1975-08-14) the whole document	1,2,7, 14-20
X	DE 24 22 092 A1 (AWECO APP & GERAETEBAU KG) 27 November 1975 (1975-11-27) the whole document	1,2,7, 14-20
X	JP H07 270212 A (MIURA KOGYO KK) 20 October 1995 (1995-10-20)	1-7, 14-20
Y	the whole document	8-13
Y	DE 102 04 002 A1 (AWECO APPLIANCE SYS GMBH & CO [DE]) 14 August 2003 (2003-08-14) the whole document	8-13

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
20 May 2016	01/06/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Prosig, Christina

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/056549

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP H07 270214 A (MIURA KOGYO KK) 20 October 1995 (1995-10-20) the whole document	1-3,7, 14-20
X	JP 2003 004618 A (MIURA KOGYO KK) 8 January 2003 (2003-01-08) the whole document	1-3,7, 14-20
A	US 2002/195403 A1 (TAKEDA HIROYUKI [JP] ET AL) 26 December 2002 (2002-12-26) abstract paragraphs [0036] - [0038]; figures	1-20
A	GB 1 480 698 A (LICENTIA GMBH) 20 July 1977 (1977-07-20) the whole document	1-20
A	WO 2014/121820 A1 (ELECTROLUX APPLIANCES AB [SE]) 14 August 2014 (2014-08-14) the whole document	1,7, 15-20

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2016/056549

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 2403624 A1	14-08-1975	NONE	
DE 2422092 A1	27-11-1975	NONE	
JP H07270212 A	20-10-1995	JP 2900789 B2	02-06-1999
		JP H07270212 A	20-10-1995
DE 10204002 A1	14-08-2003	NONE	
JP H07270214 A	20-10-1995	JP 2885063 B2	19-04-1999
		JP H07270214 A	20-10-1995
JP 2003004618 A	08-01-2003	JP 3918465 B2	23-05-2007
		JP 2003004618 A	08-01-2003
US 2002195403 A1	26-12-2002	CA 2391064 A1	26-12-2002
		CN 1405095 A	26-03-2003
		JP 4507270 B2	21-07-2010
		JP 2003001251 A	07-01-2003
		KR 20030004055 A	14-01-2003
		US 2002195403 A1	26-12-2002
GB 1480698 A	20-07-1977	FR 2289907 A1	28-05-1976
		GB 1480698 A	20-07-1977
		IT 1043693 B	29-02-1980
WO 2014121820 A1	14-08-2014	EP 2959049 A1	30-12-2015
		US 2016010266 A1	14-01-2016
		WO 2014121820 A1	14-08-2014