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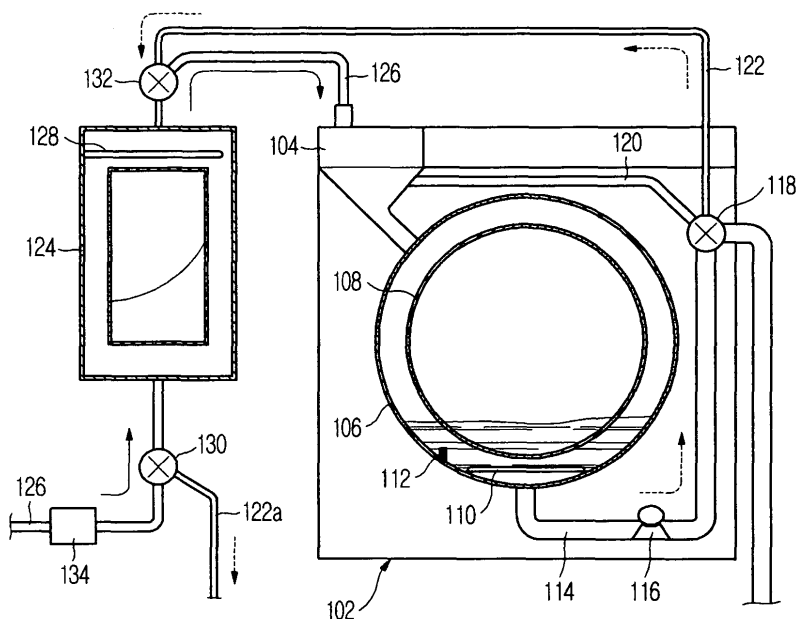
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(54) **Washing machine having water softener**

(57) A washing machine (102) having a water softener (124), which converts hard water to soft water using hot water instead of salt water, thereby having low production costs and high efficiency and providing convenience to users. The washing machine includes the water softener for softening water supplied to the washing ma-

chine using a hard water component absorbent material, and a heater (110) for heating the water supplied to the washing machine through the water softener, wherein the heated water is re-supplied to the water softener so as to regenerate the hard water component absorbent material of the water softener.

Fig.1



Description**BACKGROUND OF THE INVENTION**

1. Field of the Invention

[0001] The present invention relates to a washing machine. More particularly, to a washing machine having a water softener to convert hard water into soft water.

2. Description of the Related Art

[0002] Generally, a conventional water softener is used to soften hard water. Since the softening capacity of a hard water component absorbent material in the water softener is not permanent, the hard water component absorbent material must be regenerated after the hard water component absorbent is used for a designated time. The conventional water softener includes a salt water supply device (or a salt supply device) as a regenerating device. That is, in order to regenerate the hard water component absorbent material, the salt water supply device generates salt water and supplies the salt water to the inside of the water softener, thereby allowing the hard water component absorbent material in the water softener to be regenerated. As a method for regenerating most ion exchange resins, salt water is used. In this method, a Na^+ component of salt is absorbed into an ion exchange resin, and, when hard water passes through the ion exchange resin, Ca^{2+} and Mg^{2+} components of the hard water are exchanged with the Na^+ component.

[0003] After the softening capacity of the ion exchange resin serving as the hard water component absorbent of the water softener is used up, salt water (NaCl) is injected into the hard water component absorbent material in the direction of the flow of the softened water or its reverse direction so that the Na^+ component of the salt water is absorbed again into the ion exchange resin, thereby regenerating the ion exchange resin. During the above regenerating process, Na^+ ions, Cl^- ions, Ca^{2+} ions, and Mg^{2+} ions are discharged. The above conventional salt water injection methods include a manual salt water injection method, a semiautomatic salt water injection method, and an automatic salt water injection method. All of these methods have problems, such as waste of resources, water contamination, and complication in regenerating the ion exchange resin.

[0004] In terms of the water contamination, water containing Na^+ ions discharged from the water softener is harmful to the growth of plants, and to patients on a restricted diet.

[0005] In terms of the waste of resources, the salt water injection methods incur costs of salt for producing salt water, costs of materials of a device for storing the salt water, and costs for treating the regenerated water obtained after regenerating of the ion exchange resin.

[0006] Since the water softener using the manual salt water injection method must be periodically managed every several weeks or three months, the manual salt water injection method causes inconvenience. Further, the use of the semiautomatic or automatic salt water injection method deteriorates the capability of the water softener due to a malfunction of its control device, and increases the production costs of the water softener due to its sensing costs.

SUMMARY OF THE INVENTION

[0007] Accordingly, it is an aspect of the present invention to provide a washing machine having a water softener, which converts hard water to soft water using hot water instead of salt water, thereby having low production costs and high efficiency, and providing convenience to users.

[0008] Additional aspects and/or advantages of the invention will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the invention.

[0009] The foregoing and/or other aspects of the present invention are achieved by providing a washing machine including a water softener to soften water supplied to the washing machine using a hard water component absorbent material, and a heater to heat the water supplied to the washing machine through the water softener, wherein the heated water is re-supplied to the water softener so as to regenerate the hard water component absorbent material in the water softener.

[0010] A washing or rinsing operation may be performed by receiving only cold water supplied from the outside.

[0011] The washing machine further includes a tub to store the supplied water, wherein the heater heats the water stored in the tub so that the heated water is used to regenerate the hard water component absorbent material.

[0012] The washing machine further includes a sensor to detect an amount of the water stored in the tub, wherein it is determined whether the amount of the water necessary to regenerate the hard water component absorbent material is stored in the tub using the detected results of the sensor.

[0013] The washing machine further includes a drain pipe to discharge the water in the tub to the outside, and a flow control valve to supply the water discharged through the drain pipe to one of the water softener or the outside of the

washing machine, wherein the heated water discharged from the tub is supplied to the water softener by controlling the flow control valve when the hard water component absorbent material is regenerated.

[0014] The washing machine further includes a bypass pipe installed between the drain pipe and the tub to re-supply the water discharged through the drain pipe to the tub, wherein the re-supply of the water through the bypass pipe is controlled by the flow control valve, and a part of the water discharged from the tub is bypassed to the inside of the tub so that the amount of the water supplied to the water softener is adjusted.

[0015] It is another aspect of the present invention to provide a washing machine including a water softener to soften water supplied to the washing machine using a hard water component absorbent material, wherein hot water supplied from the outside of the washing machine to the washing machine is supplied to the water softener when the hard water component absorbent material of the water softener is regenerated.

[0016] The washing machine further includes a sensor to detect an amount of the water supplied to the water softener, wherein it is determined whether the amount of the water necessary to regenerate the hard water component absorbent material is supplied to the water softener using the detected results of the sensor.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] These and/or other aspects and advantages of the invention will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings in which:

FIG. 1 is a schematic view illustrating a washing machine having a water softener, which receives only cold water supplied from the outside and uses hot water obtained by heating the cold water, in accordance with a first embodiment of the present invention; and

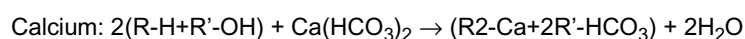
FIG. 2 is a schematic view illustrating a washing machine having a water softener, which receives and uses both cold water and hot water supplied from the outside, in accordance with a second embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] Reference will now be made in detail to the embodiments of the present invention, an example of which is illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout. The embodiments are described below to explain the present invention by referring to the figures.

[0019] Hereinafter, the principles of the softening of hard water and the regenerating of a hard water component absorbent material will be described in detail.

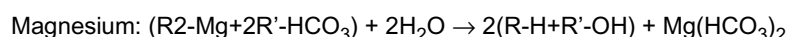
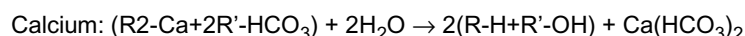
[0020] First, the principle of the softening of hard water using water at a low temperature (cold water) will be described using the below Equations.



[0021] In the above Equations, R, R₂, R', and 2R' are porous materials, made of organic substances, resins, or natural substances, for absorbing hard components, H⁺ is an hydrogen ion, OH⁻ is an hydroxide ion, Ca is calcium, Ma is magnesium, and HCO₃ is carbonic acid.

[0022] That is, at a low temperature, Ca(HCO₃)₂ or Mg(HCO₃)₂, which is a hard water component to be eliminated, is absorbed into a hard water component absorbent material, i.e., 2(R-H+R'-OH), thereby being eliminated. Then, two water molecules are produced.

[0023] Hereinafter, the principle of the regenerating of the hard water component absorbent material using water at a high temperature (hot water) will be described using the below Equations.



[0024] That is, in the regenerating process, two water molecules (2H₂O) at the high temperature are divided into H⁺ and OH⁻. Then, H⁺ and OH⁻ are absorbed again into the hard water component absorbent material, and Ca(HCO₃)₂ or Mg(HCO₃)₂, which was absorbed into the hard water component absorbent material, are detached from the hard water component absorbent material. Thereby, the hard water component absorbent material is returned to a state for softening hard water.

[0025] Hereinafter, embodiments of the present invention will be described with reference to FIGS. 1 and 2. FIG. 1 is

a schematic view illustrating a washing machine having a water softener, which receives only cold water supplied from the outside and uses hot water obtained by heating the cold water, in accordance with a first embodiment of the present invention.

[0026] As shown in FIG. 1, the washing machine 102 in accordance with the first embodiment of the present invention comprises a detergent solving device 104 to dissolve a detergent in water, a tub 106 to contain washing water (or rinsing water) supplied through the detergent solving device 104, and a drum 108 rotatably installed in the tub 106. When the drum 108 is rotated under the condition that the tub 106 is fixed, laundry in the drum 108 is lifted and dropped, thereby being washed.

[0027] A heater 110 to heat the washing water (or the rinsing water) and a sensor unit 112 to detect a quality of the washing water (or the rinsing water), such as the amount, the temperature, the hardness, the electric conductivity, the pH value, etc., are installed between the tub 106 and the drum 108 (particularly, in the lower portion of the inside of the tub 106). The heater 110 may be installed at any position for heating the water supplied to the washing machine 102. The heater 110 to heat the washing water (or the rinsing water) is used to regenerate a water softener 124, which will be described later.

[0028] A drain pump 116 to discharge remaining water to the outside of the washing machine 102 after the washing operation (or the rinsing operation) is completed is installed in a drain pipe 114. A flow control valve 118 to control a flow of the water to be discharged is installed in the drain pipe 114 at a middle position (i.e., a position pass the drain pump 116 from the tub 106). The flow control valve 118 is selectively opened and closed so that the water discharged from the tub 106 is supplied again to the detergent solving device 104 through a bypass pipe 120 or is supplied to the water softener 124 through a regenerated water supply pipe 122. The bypass pipe 120 bypasses a part of the water supplied through the regenerated water supply pipe 122, and thus controls the amount of the water supplied to the water softener 124. That is, the flow control valve 118 is controlled so that, when the amount of the water supplied to the water softener 124 through the regenerated water supply pipe 122 is excessively larger than a necessary amount of the water for regenerating the water softener 124, a part of the water discharged from the washing machine 102 is supplied again to the inside of the tub 106 through the detergent solving device 104.

[0029] The water softener 124, which softens the water supplied to the washing machine 102, is installed in a cold water supply pipe 126 to supply cold water to the washing machine 102. A bypass pipe (not shown) to supply the cold water directly to the detergent solving device 104 without passing through the water softener 124 may be additionally installed. A prefilter 134 for filtering out foreign substances contained in the cold water is installed in the cold water supply pipe 126, thereby assisting the hard water-softening function of the water softener 124. The water supplied through the cold water supply pipe 126 is softened by the water softener 124 before the water reaches the detergent solving device 104 of the washing machine 102. The above-described regenerated water supply pipe 122 as well as the cold water supply pipe 126 is connected to the water softener 124. The regenerated water supply pipe 122 causes hot water, obtained by heating and discharged from the washing water 102, to be supplied to the water softener 124, thereby allowing a hard water component absorbent material of the water softener 124 to be regenerated using the hot water. The hot water used to regenerate the hard water component absorbent material of the water softener 124 is discharged to the outside of the water softener 124 through a regenerated water discharge pipe 122a.

[0030] A sensor unit 128 to detect the quality of the water supplied to the water softener 124, such as the amount, the temperature, the hardness, the electric conductivity, the pH value, etc., is installed in the water softener 124. Two flow control valves 130 and 132 are respectively installed at both ends of the water softener 124. The flow control valve 130 is selectively opened and closed so that one of the supply of the cold water to the water softener 124 and the discharge of the hot water from the water softener 124 is carried out, and the flow control valve 132 is selectively opened and closed so that one of the supply of the softened cold water from the water softener 124 to the washing machine 102 and the supply of the hot water from the washing machine 102 to the water softener 124 is carried out. When the flow control valve 130 is in a state in which the cold water is supplied to the water softener 124, the flow control valve 132 is in a state in which the cold water is supplied from the water softener 124 to the washing machine 102 to be supplied to the detergent solving device 104. Alternatively, when the flow control valve 132 is in a state in which the hot water discharged from the washing machine 102 is supplied to the water softener 124, the flow control valve 130 is in a state in which the hot water supplied to the water softener 124 is discharged to the outside through the regenerated water discharge pipe 122a.

[0031] In FIG. 1, the supply route of the cold water for washing (or rinsing) laundry is represented by the solid arrow, and the supply route of the hot water used to regenerate the hard water component absorbent material is represented by the dotted arrow. That is, the cold water supplied through the cold water supply pipe 126 is softened by the water softener 124, and is then supplied to the washing machine 102, thereby being used in the washing operation (or rinsing operation). In the case that it is necessary to regenerate the water softener 124, the water supplied to the washing machine 102 is heated, and is then supplied again to the water softener 124, thereby regenerating the hard water component absorbent material in the water softener 124.

[0032] FIG. 2 is a schematic view illustrating a washing machine having a water softener, which receives and uses

cold water and hot water supplied from the outside, in accordance with a second embodiment of the present invention. Some parts shown in FIG. 2, which are substantially the same as those shown in FIG. 1, are denoted by the same reference numerals even though they are depicted in different drawings.

[0033] In FIG. 2, the washing machine 102 in accordance with the second embodiment of the present invention comprises the detergent solving device 104 to dissolve a detergent in water, the tub 106 to contain washing water (or rinsing water) supplied through the detergent solving device 104, and the drum 108 rotatably installed in the tub 106. When the drum 108 is rotated under the condition that the tub 106 is fixed, laundry in the drum 108 is lifted and dropped, thereby being washed.

[0034] The heater 110 to heat the washing water (or the rinsing water) and the sensor unit 112 to detect the quality of the washing water (or the rinsing water), such as the amount, the temperature, the hardness, the electric conductivity, the pH value, are installed between the tub 106 and the drum 108 (particularly, in the lower portion of the inside of the tub 106). The heater 110 may be installed at any position to heat the water supplied to the washing machine 102. The heater 110 to heat the washing water (or the rinsing water) is used to regenerate the water softener 124.

[0035] The drain pump 116 to discharge remaining water to the outside of the washing machine 102 after the washing operation (or the rinsing operation) is completed is installed in the drain pipe 114.

[0036] The water softener 124, which softens the water supplied to the washing machine 102, is installed in the cold water supply pipe 126 to supply cold water to the washing machine 102. A bypass pipe (not shown) to supply the cold water directly to the detergent solving device 104 without passing through the water softener 124 may be additionally installed. The prefilter 134 to filter out foreign substances contained in the cold water is installed in the cold water supply pipe 126, thereby assisting the hard water-softening function of the water softener 124. The water supplied through the cold water supply pipe 126 is softened by the water softener 124 before the water reaches the detergent solving device 104.

[0037] A hot water supply pipe 202 as well as the cold water supply pipe 126 is connected with the detergent solving device 104 of the washing machine 102. The hot water supply pipe 202 supplies hot water, which is generated from a separate hot water generating device (not shown), to the inside of the tub 106 through the detergent solving device 10. A prefilter 206 to filter out foreign substances contained in the hot water is installed in the hot water supply pipe 202, thereby assisting the hard water-softening function of the water softener 124. A regenerated water supply pipe 208 is installed between the hot water supply pipe 202 and the water softener 124, thereby allowing a part or all of the hot water supplied through the hot water supply pipe 202 to be supplied to the water softener 124.

[0038] The supply of the hot water to the water softener 124 and the detergent solving device 104, and the amount of the supplied hot water are controlled by opening and closing a directional control device 204. When the hot water supplied through the hot water supply pipe 202 is supplied to the water softener 124 through the regenerated water supply pipe 208, the hard water component absorbent material of the water softener 124 is regenerated using the hot water, and the hot water used to regenerate the hard water component absorbent material of the water softener 124 is discharged to the outside of the water softener 124 through a regenerated water discharge pipe 208a.

[0039] The sensor unit 128 to detect the quality of the water supplied to the water softener 124, such as the amount, the temperature, the hardness, the electric conductivity, the pH value, etc., is installed in the water softener 124. Two flow control valves 130 and 132 are respectively installed at both ends of the water softener 124. The flow control valve 130 is selectively opened and closed so that one of the supply of the cold water to the water softener 124 and the discharge of the hot water from the water softener 124 is carried out, and the flow control valve 132 is selectively opened and closed so that one of the supply of the softened cold water from the water softener 124 to the washing machine 102 and the supply of the hot water to the water softener 124 is carried out. When the flow control valve 130 is in a state in which the cold water is supplied to the water softener 124, the flow control valve 132 is in a state in which the cold water is supplied from the water softener 124 to the washing machine 102 to be supplied to the detergent solving device 104. Alternatively, when the flow control valve 132 is in a state in which the hot water is supplied to the water softener 124, the flow control valve 130 is in a state in which the hot water supplied to the water softener 124 is discharged to the outside through the regenerated water discharge pipe 208a.

[0040] In FIG. 2, the supply route of the cold water for washing (or rinsing) laundry is represented by the solid arrow, and the supply route of the hot water used to regenerate the hard water component absorbent material is represented by the dotted arrow. That is, the cold water supplied through the cold water supply pipe 126 is softened by the water softener 124, and is then supplied to the washing machine 102, thereby being used in the washing operation (or rinsing operation). When it is necessary to regenerate the water softener 124, the hot water supplied from the outside of the washing machine 102 is supplied to the water softener 124, thereby regenerating the hard water component absorbent material in the water softener 124.

[0041] As apparent from the above description, the present invention provides a washing machine having a water softener, which converts hard water into soft water using hot water instead of salt water. Accordingly, the washing machine of the present invention does not require a separate salt water (or salt) supply device, thus having a simple structure and reducing production costs. Further, the washing machine of the present invention is easily maintained and repaired at a low cost, thus having a higher competitiveness than a conventional washing machine comprising a water

softener using salt water, in terms of cost, capability, and a user's favorite.

[0042] Although a few embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made in these embodiments without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.

Claims

1. A washing machine comprising:

a water softener to soften water supplied to the washing machine using a hard water component absorbent material; and
a heater to heat the water supplied to the washing machine through the water softener, wherein the heated water is re-supplied to the water softener so as to regenerate the hard water component absorbent material in the water softener.

2. The washing machine as set forth in claim 1, wherein a washing or a rinsing operation is performed by receiving only cold water supplied from an outside.

3. The washing machine of claim 2, further comprising a cold water supply pipe wherein the water softener is installed at a portion of the cold water supply pipe to supply the cold water to the washing machine.

4. The washing machine of claim 3, further comprising a prefilter is installed in the cold water supply pipe to filter out foreign substances contained in the cold water.

5. The washing machine of claim 4, further comprising a first and a second flow control valve, the first and the second flow control valves are installed at respective ends of the water softener, wherein the first flow control valve selectively opens and closes such that one of a supply of the cold water to the water softener or a discharge of hot water from the water softener to an outside is conducted, and the second flow control valves selectively opens and closes such that one of the supply of softened cold water from the water softener to the washing machine or the supply of the hot water from washing machine to the water softener is conducted.

6. The washing machine of claim 5, wherein when the first flow control valve is in a state in which the cold water is supplied to the water softener, the second control valve is in a state in which the cold water is supplied from the water softener to the washing machine, and when the second flow control valve is in a state in which the hot water discharged from the washing machine is supplied to the water softener, the first flow control valve is in a state in which the hot water supplied to the water softener is discharged to the outside.

7. The washing machine as set forth in claim 1, further comprising a tub to store the supplied water, wherein the heater heats the water stored in the tub so that the heated water is used to regenerate the hard water component absorbent material.

8. The washing machine as set forth in claim 7, further comprising a first sensor unit to detect an amount of the water stored in the tub, wherein it is determined whether the amount of the water necessary to regenerate the hard water component absorbent material is stored in the tub using the detected results of the first sensor unit.

9. The washing machine as set forth in claim 7, further comprising:

a drain pipe to discharge the water in the tub to the outside; and a flow control valve to supply the water discharged through the drain pipe to one of the water softener or the outside of the washing machine, wherein the heated water discharged from the tub is supplied to the water softener by controlling the flow control valve when the hard water component absorbent material is regenerated.

10. The washing machine as set forth in claim 9, further comprising a bypass pipe installed between the drain pipe and the tub to re-supply the water discharged through the drain pipe to the tub, wherein the re-supply of the water through the bypass pipe is controlled by the flow control valve, and a part of the water discharged from the tub is bypassed to the inside of the tub so that the amount of the water supplied to the water softener is adjusted.

11. The washing machine of claim 1, further comprising a second sensor unit to detect a quality of the water supplied to the water softener, such as an amount, a temperature, a hardness, an electric conductivity, an a pH value of the water, wherein the second sensor unit is located inside of the water softener.

5 12. A washing machine comprising a water softener to soften water supplied to the washing machine using a hard water component absorbent material,
wherein hot water supplied from an outside of the washing machine to the washing machine is supplied to the water softener when the hard water component absorbent material of the water softener is regenerated.

10 13. The washing machine as set forth in claim 12, further comprising a sensor to detect the amount of the water supplied to the water softener, wherein it is determined whether an amount of the water necessary to regenerate the hard water component absorbent material is supplied to the water softener using the detected results of the sensor.

15 14. The washing machine of claim 12, further comprising:

a hot water supply pipe to supply the hot water to the washing machine; and
a prefilter to filter out foreign substances contained in the hot water, is installed in the hot water supply pipe.

20 15. The washing machine of claim 14, further comprising a regenerated water supply pipe installed between the hot water supply pipe and the water softener to thereby allow a part or all of the hot water supplied through the hot water supply pipe to be supplied to the water softener.

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Fig.1

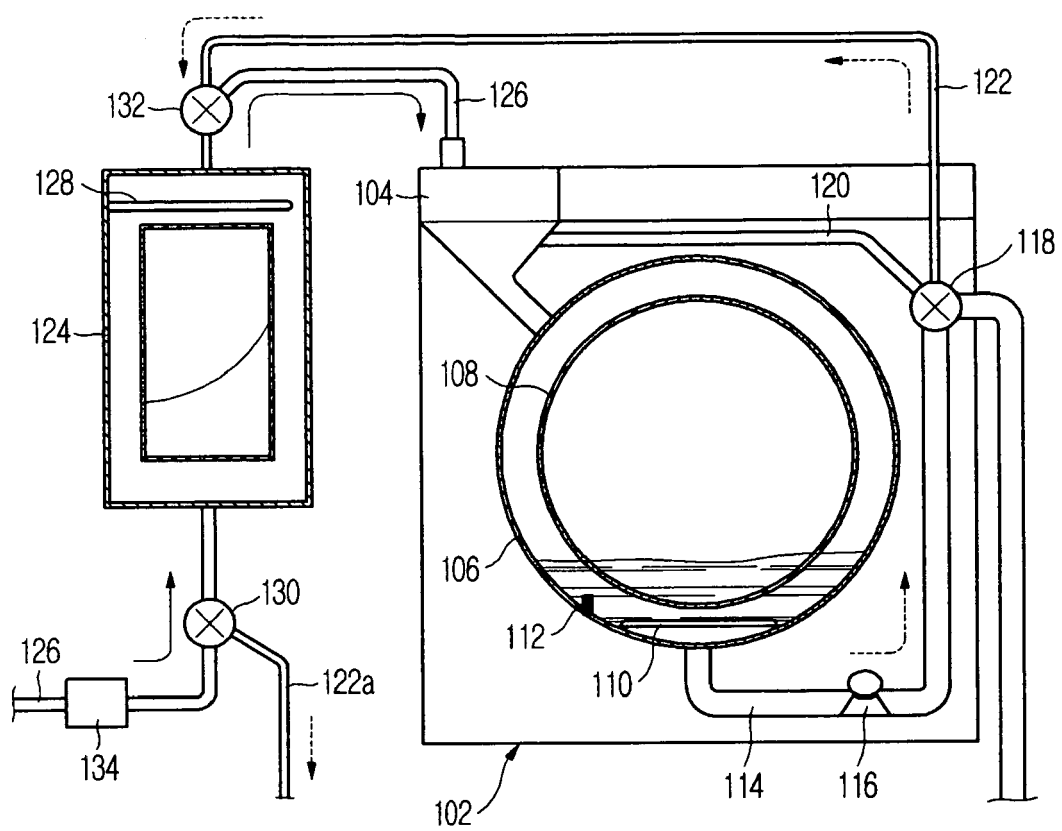


Fig.2

