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(54) WASHING MACHINE, AND CONTROL APPARATUS, CONTROL METHOD AND CONTROL SYSTEM THEREFOR

(57) A control apparatus of a washing machine. The washing machine may comprise an outer cylinder. The control apparatus may comprise a plurality of water level detection apparatuses. The plurality of water level detection apparatuses may comprise: a first water level detection apparatus and a second water level detection apparatus. The first water level detection apparatus may be configured to detect a set water level in the outer cylinder. The second water level detection apparatus may be configured to detect any water level in the outer cylinder.

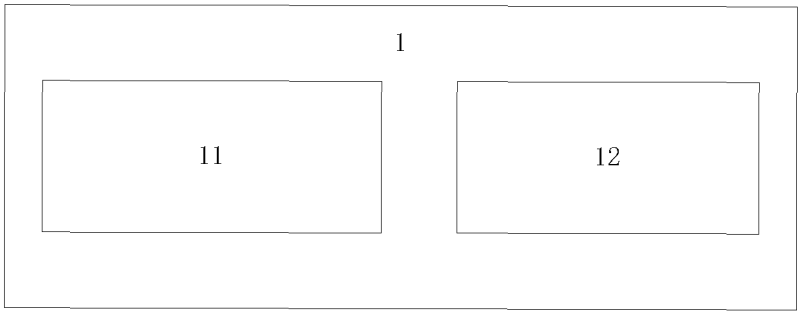

FIG. 1

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Description

FIELD

[0001] Embodiments of the present disclosure relate to, but are not limited to, the field of electrical equipment, and in particular, but not limited to, a washing machine, and a control apparatus, control method and control system therefor.

BACKGROUND

[0002] In some washing machines, it is required to reliably determine a height of a water level at a bottom of a tub in order to achieve a steam washing function with steam at the bottom of the tub. If the determination is incorrect, on the one hand, an excessively low water level may lead to dry burning of a heating pipe, causing a safety accident; and on the other hand, an excessively high water level may wet clothes, affecting user experience.

SUMMARY

[0003] The following is the summary of subject matters detailed in the present disclosure. This summary is not intended to limit the scope of claims.

[0004] A control apparatus for a washing machine is provided. The washing machine may include an outer tub. The control apparatus includes a plurality of water level detection devices. The plurality of water level detection devices includes a first water level detection device and a second water level detection device. The first water level detection device is configured to detect a predetermined water level in the outer tub, and the second water level detection device is configured to detect a water level in the outer tub.

[0005] A washing machine is provided. The washing machine may include: a processor, an inner tub, an outer tub, and the above control apparatus. The inner tub is located within the outer tub, and the processor is electrically connected to the control apparatus.

[0006] A control method for a washing machine is provided. The method may be applied to the above washing machine. The method may include: detecting the predetermined water level in the outer tub of the washing machine by the first water level detection device of the washing machine; and detecting a water level in the outer tub by the second water level detection device of the washing machine.

[0007] A control system for a washing machine is provided. The washing machine includes an outer tub. The control system includes a plurality of water level detection devices, a processor, a heating device, and a water inlet valve. The plurality of water level detection devices includes a first water level detection device and a second water level detection device. The first water level detection device is configured to detect a predetermined water level in the outer tub, and the second water level detection device is configured to detect a water level in the outer tub. The processor is configured to control the heating device and the water inlet valve based on detection signals of the plurality of water level detection devices.

[0008] Other aspects will be apparent after reading and understanding the drawings and detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The accompanying drawings are used to provide further understanding of technical solutions herein and form part of the specification, and are used in conjunction with embodiments of the present disclosure to explain the technical solutions herein and do not constitute limitation to the technical solutions herein.

FIG. 1 is a composition block diagram of a water intake control apparatus for a washing machine according to an embodiment of the present disclosure.

FIG. 2 is a schematic structural view of a washing machine according to an embodiment of the present disclosure.

FIG. 2a is a schematic structural view of a part A in FIG. 2.

FIG. 3 is a composition block diagram of a washing machine according to an embodiment of the present disclosure.

FIG. 4 is a first flowchart of a water intake control method of a washing machine according to an embodiment of the present disclosure.

FIG. 5 is a second flowchart of a water intake control method of a washing machine according to an embodiment of the present disclosure.

FIG. 6 is a composition block diagram of a water intake control apparatus for a washing machine according to an embodiment of the present disclosure.

[0010] Description of reference numbers:

Reference number	Term	Reference number	Term
1	Control apparatus	2	Washing machine
11	First water level detection device	12	Second water level detection device
22	Inner tub	21	Outer tub
H1	First high water level	H2	First low water level
h1	Second high water level	h2	Second low water level
23	Heating device	25	Processor
24	Water inlet valve	3	Control system

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0011] Embodiments of the present disclosure will be described below in conjunction with the accompanying drawings. It should be noted that the embodiments and features in the embodiments in the present disclosure may be combined with each other in any combination without conflict.

[0012] Embodiments of the present disclosure provide a control apparatus 1 for a washing machine. As illustrated in FIG. 1, FIG. 2 and FIG. 2a, a washing machine 2 may include an outer tub 21, and the control apparatus 1 may include a plurality of water level detection devices. The plurality of water level detection devices may include a first water level detection device 11 and a second water level detection device 12. The first water level detection device 11 is configured to detect a predetermined water level in the outer tub 21, and the second water level detection device 12 is configured to detect a water level in the outer tub 21.

[0013] When a steam washing function is performed in the washing machine, it is inevitable to heat supplied water to generate steam. If there is fault or even error in determining the water level, on the one hand, it may causes excessively low water level, which may result in dry burning of a heating pipe to bring safety accidents, and lead to damage to an inner assembly of the washing machine and affect a service life of the washing machine. On the other hand, the wrong determination may cause excessively high water level, and the water flow inevitably enters the inner tub of the washing machine and wet the clothes, and therefore the clothes are piled up due to an increased weight of the clothes after water absorption. Thus, a contact area between the clothes and the steam is small. In addition, since the clothes have absorbed too much water, little or no steam is absorbed. As a result, a steam washing effect is seriously affected, and user experience is also influenced. Therefore, it is required to reliably determine a height of a water level in the outer tub during this process.

[0014] In exemplary embodiments of the present disclosure, in order to accurately detect a water level in the outer tub 21, a plurality of water level detection devices with different detection principles may be provided at the outer tub. For example, two water level detection devices are provided, i.e., the first water level detection device 11 and the second water level detection device 12 are provided.

[0015] In exemplary embodiments of the present disclosure, the detecting the predetermined water level refers to determining whether an actual water level reaches a fixed water level, and the detecting a water level refers to detecting the actual water level in real time.

[0016] In exemplary embodiments of the present disclosure, a plurality of predetermined water levels is provided. For example, two predetermined water levels are provided in an embodiment of the present disclosure, and are defined as a first high water level H1 and a first low water level H2.

[0017] In exemplary embodiments of the present disclosure, the second water level detection device has two thresholds. That is, a second high water level h1 and a second low water level h2 are provided, and $H1 \geq h1$ and $H2 \leq h2$ may be satisfied.

[0018] In exemplary embodiments of the present disclosure, only the second water level detection device is required to perform water level detection. A detection process may include: supplying water, and performing heating when the actual water level is greater than h2; stopping the water supply when the actual water level reaches h1; and stopping the heating and supplying water when the water level is lower than h2.

[0019] In the exemplary embodiment of the present disclosure, since $H1 \geq h1$ and $H2 \leq h2$, the actual water level normally does not reach H1 and H2.

[0020] In the exemplary embodiment of the present disclosure, in response to inaccurate detection or detection failure of the second water level detection device 12, the water supply may be stopped when the actual water level reaches H1, and the heating may be stopped when the actual water level reaches H2. Therefore, the first water level detection device 11 has a guarantee function, and ensures that clothes cannot get wet or dry burning cannot occur, in response to the misjudgment or the detection failure of the second water level detection device 12.

[0021] In exemplary embodiments of the present disclosure, the washing machine may further include an inner tub 22 located within the outer tub 21, and the control apparatus 1 may further include a heating device 23. The heating device 23 may be disposed between a bottom of the inner tub 22 and a bottom of the outer tub 21.

[0022] In exemplary embodiments of the present disclosure, the heating device 23 may be configured to heat water supplied to the outer tub 21 to generate steam. The heating device 23 may be located between the inner tub 22 and the outer tub 21, for example, may be disposed between the bottom of the inner tub 22 and the bottom of the outer tub 21. The inner tub 22 may have at least one first through hole, and the at least one first through hole may be configured to provide steam generated between the inner tub 22 and the outer tub 21 with a passage access to the inner tub 22. The outer tub 21 may be connected to a water inlet interface to supply water into the outer tub 21 through the water inlet interface.

[0023] In exemplary embodiments of the present disclosure, the first water level detection device 11 includes a first water level detection portion, and the first water level detection portion of the first water level detection device 11 is disposed between the bottom of the inner tub 22 and the bottom of the outer tub 21.

[0024] In exemplary embodiments of the present disclosure, the second water level detection device 12 includes a second water level detection portion, the second water level detection portion of the second water level detection device 12 is disposed at an outlet of a drain pipe of the washing machine, and the drain pipe may be in communication with the outer tub 21.

[0025] In exemplary embodiments of the present disclosure, the first water level detection portion is located at a position higher than a position where the second water level detection portion is located.

[0026] The first water level detection portion may be located at a position higher than a position where the heating device is located.

[0027] In exemplary embodiments of the present disclosure, the first low water level H2 may be higher than a predetermined position of the heating device 23.

[0028] In exemplary embodiments of the present disclosure, the first water level detection portion may be located at a predetermined height of the water level in the outer tub 21, and therefore only the water level at the predetermined height (such as, the first high water level H1 and the first low water level H2) may be detected. The second water level detection portion may be disposed at the outlet of the drain pipe, and may detect the water level in the outer tub 21. For example, in order to prevent the water level from being too high after water supplying, the first water level detection portion configured to limit a maximum height of the water level may be disposed below the bottom of the inner tub 22 to detect the first high water level H1.

[0029] In exemplary embodiments of the present disclosure, when the heating device 23 is disposed between the bottom of the inner tub 22 and the bottom of the outer tub 21, a dry burning prevention water level may be provided above the heating device 23 and between the bottom of the inner tub 22 and the bottom of the outer tub 21, in order to prevent dry burning of the heating device 23 caused by starting the heating device 23 when a small amount of water is supplied. For example, the first low water level H2 is provided, and may be detected by the first water level detection portion.

[0030] In exemplary embodiments of the present disclosure, when the first high water level H1 is a predetermined safe water level, which can be used to prevent the detection fault of the second water level detection device or the failure of the second water level detection device from occurring and thus avoiding continuous supplying of the water from a water inlet valve, thereby preventing the water in the outer tub 21 from entering the inner tub 22 to wet the clothes and from influencing a steam effect.

[0031] In exemplary embodiments of the present disclosure, the safe water level is provided. In this way, in response to the first water level detection device 11 detecting that the water level has been higher than the safe water level, any one or more of the following measures may be selected: the water inlet valve is closed and a safety alarm is sent to remind a user (for example, sound, light and a combination thereof may be used, but are not limited thereto); or the washing machine may be directly turned off to avoid further damage to the washing machine due to the detection failure caused by a fault of the washing machine.

[0032] In exemplary embodiments of the present disclosure, when the first low water level H2 is set to be a safe water level, the first low water level H2 may be used to prevent potential safety hazard caused by taking no corresponding protection measure when a water level in the outer tub 21 has been lowered below the safe water level through continuous heating of the heating device 23 due to the detection fault of the second water level detection device or the failure of the second water level detection device.

[0033] In exemplary embodiments of the present disclosure, the safe water level is configured to, in response to the first water level detection device 11 detecting that the water level has been lower than or equal to the safe water level, select one or more of the following measures: the heating device 23 is turned off, water is supplied into the outer tub 21, and a safety alarm is sent to remind a user, for example, any sound, light and a combination thereof may be used, but are not limited thereto; or the washing machine may be directly turned off to avoid damage to the washing machine.

[0034] In the exemplary embodiment of the present disclosure, there are no restrictions on model selection, specific

disposing positions, specific quantities and the like of the first water level detection device 11 and the second water level detection device 12, and different selections may be made based on different requirements.

[0035] In exemplary embodiments of the present disclosure, the first water level detection device 11 may be a water level switch, and the second water level detection device 12 may be a Micro-Electro-Mechanical System, MEMS, water level sensor.

[0036] In the exemplary embodiment of the present disclosure, the water level switch is disposed at the first high water level H1 and the first low water level H2, and thus the water level switch can be controllable to be opened and closed in time when the water level of the outer tub 21 reaches the predetermined water level. Therefore, a valve body (such as, the water inlet valve) and the heating device in the washing machine are correspondingly controlled.

[0037] In exemplary embodiments of the present disclosure, the water level in the outer tub 21 may be intelligently detected by the MEMS water level sensor.

[0038] In exemplary embodiments of the present disclosure, the combination of the MEMS water level sensor and the water level switch is configured to synthetically determine the water level in the outer tub 21, which ensures safe and effective operation of the washing machine in a steam washing process.

[0039] In exemplary embodiments of the present disclosure, a specific value of each of the first high water level H1, the first low water level H2, the second high water level h1 and the second low water level h2 is also not limited, and it is possible to employ different configurations based on different washing machine models, different inner tub sizes, different outer tub sizes, different internal spaces, and the like.

[0040] In exemplary embodiments of the present disclosure, a height calculation benchmark (i.e., a water level of 0) of each of the first high water level H1, the first low water level H2, the second high water level h1 and the second low water level h2 may be a horizontal plane arbitrarily configured between the bottom of the outer tub 21 and the bottom of the inner tub 22.

[0041] In exemplary embodiments of the present disclosure, the height calculation benchmark of each of the first high water level H1, the first low water level H2, the second high water level h1 and the second low water level h2 may also be the bottom of the inner tub 22, that is, the height of the water level is calculated from the bottom of the inner tub 22.

[0042] In exemplary embodiments of the present disclosure, a height of the predetermined water level, i.e., a vertical distance between the predetermined water level and the bottom of the outer tub 21, may be set to be d/2-3d/ 4, where d may be a vertical distance between the bottom of the inner tub 22 and the bottom of the outer tub 21.

[0043] In exemplary embodiments of the present disclosure, there is a distance between the heating device 23 and the bottom of the inner tub 22. The water inlet valve at the water inlet pipeline is controlled to be opened to supply water to a certain height into the outer tub 21, and the water in the outer tub 21 is heated by the heating device 23 of the washing machine to generate the steam at the bottom of the tub. Therefore, the steam washing function is realized.

[0044] In exemplary embodiments of the present disclosure, the first high water level H1, the first low water level H2, the second high water level h1 and the second low water level h2 may all be higher than the position where the heating device 23 is located in order to avoid dry burning. When a height of each of H1, H2, h1 and h2 is set to satisfy d/2-3d/4, the heating device 23 may be disposed at a position between d/3-d/2, that is, a vertical distance between the heating device 23 and the bottom of the outer tub 21 is d/3-d/2.

[0045] In exemplary embodiments of the present disclosure, the heating device may be a heating pipe, a heating plate, and the like. A specific implementation form, a setting position, a setting quantity, model selection, heating power and the like of the heating device are not limited herein, and may be customized based on specific requirements.

[0046] In exemplary embodiments of the present disclosure, an embodiment of the plurality of water level detection devices is described below.

[0047] In exemplary embodiments of the present disclosure, the water level switch may be disposed between the heating device 23 and the bottom of the inner tub 22, and the MEMS water level sensor is connected to the bottom of the outer tub 21. The water level switch and the MEMS water level sensor are combined to determine the water level, and the water inlet valve and/or the heating device is controlled to be turned on or turned off based on the determined water level to implement the steam washing function smoothly.

[0048] In exemplary embodiments of the present application, for example, the height of the water level in the outer tub 21 is detected by the MEMS water level sensor during normal water supply. The heating device 23 may be controlled to start heating to generate steam, in response to the MEMS water level sensor detecting that the water level in the outer tub 21 reaches the second low water level h2.

[0049] In exemplary embodiments of the present disclosure, the height of the water level in the outer tub 21 is continuously detected by the MEMS water level sensor. The water inlet valve may be controlled to be closed to stop the water supply, in response to the MEMS water level sensor detecting that the water level in the outer tub 21 reaches the second high water level h2. Therefore, the water is prevented from entering the inner tub to wet the clothes due to too high water level.

[0050] In exemplary embodiments of the present disclosure, in order to avoid failure of the MEMS water level sensor, the water level in the outer tub 21 is detected by the water level switch at the same time during the normal water supply

process. In response to the water level switch detecting that the water level in the outer tub 21 is higher than or equal to the first high water level H1, the water inlet valve is controlled to be closed to stop the water supply in order to avoid water flow entering the inner tub 22 through a plurality of first through holes formed at the inner tub 22 to wet the clothes due to continuous supply of the water. In this case, the heating device may be continuously controlled to keep in the operating state, and therefore the heating device continuously heats the water to continuously generate the steam.

[0051] In exemplary embodiments of the present disclosure, in response to the water level switch detecting that the water level in the outer tub 21 is higher than or equal to the first high water level H1, no matter whether the height of the water level detected by the MEMS water level sensor reaches the predetermined threshold, the water inlet valve is controlled to be closed to stop the water supply, and the heating device is controlled to keep in the operating state to continuously heat the water.

[0052] In exemplary embodiments of the present disclosure, in response to the water level switch detecting that the water level at the bottom of the outer tub 21 is lower than or equal to the first low water level H2, no matter whether the height of the water level detected by the MEMS water level sensor reaches the predetermined threshold, the heating device is directly controlled to immediately stop the heating, for example, the water level switch cuts off a heating main circuit of the heating device, to avoid dry burning. In this case, the water inlet valve can be controlled to be in an open state to continue to supply the water into the outer tub 21, to allow the water level to be higher than the safe water level (i.e., the first low water level H2).

[0053] Embodiments of the present disclosure further provide a washing machine 2. As illustrated in FIG. 3, the washing machine 2 may include a processor 25, an inner tub 22, an outer tub 21, and the above control apparatus 1.

[0054] In exemplary embodiments of the present disclosure, the control apparatus 1 may include a heating device 23, a water inlet valve 24, and a plurality of water level detection devices. The plurality of water level detection devices may include a first water level detection device 11 and a second water level detection device 12.

[0055] The first water level detection device 11 may be configured to detect a predetermined water level in the outer tub 21.

[0056] The second water level detection device 12 may be configured to detect a water level in the outer tub 21.

[0057] The heating device 23 may be disposed between the bottom of the inner tub 22 and the bottom of the outer tub 21, and may be configured to heat water in the outer tub 21.

[0058] The water inlet valve 24 may be configured to be opened to supply water into the outer tub 21, in response to the second water level detection device 12 detecting that the water level is lower than the second low water level h2.

[0059] The water inlet valve 24 may be configured to supply the water into the outer tub 21 by opening the water inlet valve 24, and to stop the supply of the water into the outer tub 21 by closing the water inlet valve 24.

[0060] The processor 25 may be configured to control the heating device 23 and the water inlet valve 24 based on detection signals of the above at least one water level detection device.

[0061] In exemplary embodiments of the present disclosure, the predetermined water level may include a first high water level H1 and a first low water level H2.

[0062] The second water level detection device may correspond to at least two water level thresholds including a second high water level h1 and a second low water level h2. That is, the second water level detection device may detect a water level between the second high water level h1 and the second low water level h2, where $H1 > H2$, $h1 > h2$, $H1 \geq h1$, and $H2 \leq h2$.

[0063] In exemplary embodiments of the present disclosure, the heating device 23 may be configured to perform heating to generate steam, in response to the second water level detection device 12 detecting that the current water level reaches the second low water level h2.

[0064] The water inlet valve 24 may be configured to be closed to stop the water supply, in response to the second water level detection device 12 detecting that the current water level reaches the second high water level h1.

[0065] The heating device 23 may further be configured to stop the heating, in response to the first water level detection device 11 detecting that the current water level is lower than the first low water level H2.

[0066] The water inlet valve 24 may be further configured to be closed to stop the water supply, in response to the first water level detection device 11 detecting that the current water level reaches the first high water level H1.

[0067] In exemplary embodiments of the present disclosure, the processor 25 controls the heating device 23 and the water inlet valve 24 based on the detection signals of the at least one water level detection device. This control of the processor 25 may include: controlling, subsequent to a predetermined steam washing program being started, the water inlet valve 24 to be opened to supply water into the outer tub 21; controlling the heating device 23 to perform the heating to generate the steam, in response to the second water level detection device 12 detecting that the current water level reaches the second low water level h2; controlling the water inlet valve 24 to be closed to stop the water supply, in response to the second water level detection device 12 detecting that the current water level reaches the second high water level h1; and controlling the water inlet valve to be opened again to supply water again, in response to the second water level detection device 12 detecting that the current water level is lower than the second low water level h2.

[0068] In exemplary embodiments of the present disclosure, the controlling the heating device 23 and the water inlet

valve 24 by the processor 25 based on the detection signals of the at least one water level detection device may include: controlling the heating device 23 to stop the heating, in response to the first water level detection device 11 detecting that the current water level is lower than the first low water level H2; and controlling the water inlet valve 24 to be closed to stop the water supply, in response to the first water level detection device 11 detecting that the current water level reaches the first high water level H1.

[0069] In exemplary embodiments of the present disclosure, any embodiment in the above control apparatus is applicable to the embodiments of the washing machine, and details thereof are not repeated herein.

[0070] Embodiments of the present disclosure further provide a control system 3 for a washing machine. As illustrated in FIG. 6, the control system 3 may include a plurality of water level detection devices, a processor 25, a heating device 23, and a water inlet valve 24. The plurality of water level detection devices, the heating device 23 and the water inlet valve 24 are electrically connected to the processor 25.

[0071] The plurality of water level detection devices may include a first water level detection device 11 and a second water level detection device 12. The first water level detection device 11 is configured to detect a predetermined water level in an outer tub 21 of the washing machine, and the second water level detection device 12 is configured to detect a water level in the outer tub 21.

[0072] The processor 25 is configured to control the heating device 23 and the water inlet valve 24 based on detection signals of the plurality of water level detection devices.

[0073] In exemplary embodiments of the present disclosure, the predetermined water level includes a first high water level H1 and a first low water level H2.

[0074] The processor 25 is further configured to: control the heating device 23 to perform heating to generate steam, in response to the second water level detection device 12 detecting that a current water level reaches the second low water level h2; control the water inlet valve 24 to be opened to supply water, in response to the second water level detection device 12 detecting that the current water level is lower than the second low water level h2; control the water inlet valve 24 to be closed to stop the water supply, in response to the second water level detection device 12 detecting that the current water level reaches the second high water level h1; control, regardless of a detection result of the second water level detection device 12, the heating device to stop the heating, in response to the first water level detection device 11 detecting that the current water level is lower than the first low water level H2; and control, regardless of the detection result of the second water level detection device 12, the water inlet valve 24 to be closed to stop the water supply, in response to the first water level detection device detecting that the current water level reaches the first high water level H1, where $H1 > H2$, $h1 > h2$, $H1 \geq h1$, and $H2 \leq h2$.

[0075] Embodiments of the present disclosure further provide a control method of a washing machine. The control method may be applied in any one of the washing machines as described above. The control method may be implemented by the above-mentioned processor 25. As illustrated in FIG. 4, the control method may include operations at blocks S101 and S102.

[0076] At block S101, the predetermined water level in the outer tub of the washing machine is detected by the first water level detection device 11 of the washing machine.

[0077] At block S102, a water level in the outer tub 21 is detected by the second water level detection device 12 of the washing machine.

[0078] In exemplary embodiments of the present disclosure, in order to prevent an excessively high water level or an excessively low water level in the outer tub 21 that affects the washing effect and washing safety in the steam washing process, a plurality of and/or a plurality types of water level detection devices may be used to detect a water level in the outer tub.

[0079] In exemplary embodiments of the present disclosure, the washing machine may further include a heating device and a water inlet valve. The heating device may be configured to perform heating of water supplied into the outer tub to generate steam in the steam washing process. The water inlet valve may be disposed at a water inlet pipe of the washing machine that may be connected to the outer tub 21. The supply of the water into the outer tub and stopping the water supply can be controlled by opening and closing the water inlet valve.

[0080] In exemplary embodiments of the present disclosure, a solution embodiment of performing water level detection by a plurality of water level detection devices provided when a steam washing function is executed are provided below. As illustrated in FIG. 5, the control method may further include operations at blocks S201 to S204.

[0081] At block S201, the water inlet valve may be controlled to be opened to supply water into the outer tub 21 subsequent to a predetermined steam washing program being started.

[0082] At block S202, the heating device 23 may be controlled to perform the heating to generate the steam when the current water level reaches the second low water level h2.

[0083] At block S203, the water inlet valve may be controlled to be closed to stop the water supply when the current water level reaches the second high water level h1.

[0084] At block S204, the water inlet valve is controlled to be opened to supply water again when the current water level is lower than the second low water level h2 due to the water being consumed.

[0085] In exemplary embodiments of the present disclosure, before performing steam washing, it is required to firstly supply water into the outer tub 21 to prepare for steam generation. The heating device 23 may be disposed between the outer tub 21 and the bottom of the inner tub 22. During supplying of water into the outer tub 21, when the water level in the outer tub 21 reaches the second low water level h2, it is indicated that the water level in the outer tub 21 has exceeded a predetermined height of the heating device. In this case, the heating device 23 may be turned on to perform heating to generate steam, as there is definitely no dry heating when the heating device 23 is turned on at this moment.

[0086] In exemplary embodiments of the present disclosure, during continuous heating of the heating device 23, the water inlet valve 24 is controlled to be continuously opened to continuously supply water into the outer tub 21. When the water level in the outer tub 21 continues to increase with the continuous water supply, if the preset second water level detection device 12 detects that the current water level reaches the second high water level h1, it is indicated that sufficient water is supplied into the outer tub 21. In this case, if the water continues to be supplied into the outer tub 21, the water may flow to the inner tub 22 and thus wet the clothes. Therefore, in this case, the water inlet valve may be controlled to be closed to stop the supply of the water into the outer tub 21.

[0087] In exemplary embodiments of the present disclosure, since the outer tub 21 has sufficient water therein, the heating device is controlled to be heated continuously, and a heating power of the heating device may be adjusted based on requirements, to control an amount and/or a speed of the generated steam.

[0088] In exemplary embodiments of the present disclosure, a heating mode for the heating device 23 may be automatically defined based on requirements without being specified in detail. For example, the heating device 23 may continuously perform heating with a predetermined heating power, may perform the heating with a continuously changing heating power, may also perform intermittent heating (i.e., stopping a certain duration after heating for a certain duration), and may also perform the heating by combining the above-mentioned heating modes.

[0089] In exemplary embodiments of the present disclosure, the control method may further include: controlling, during the heating of the heating device 23, the water inlet valve to be opened again to supply water again when the current water level in the outer tub 21 is lower than the second low water level h2.

[0090] In exemplary embodiments of the present disclosure, during the continuous heating of the heating device, the water in the outer tub 21 is gradually converted into steam as a heating duration increases. In this case, if there is no continuous supply of the water, the water in the outer tub 21 inevitably decreases. When the water level in the outer tub decreases to the second low water level h2, it is indicated that if the current water level continues to decrease, the heating device may be exposed from the water surface and thus has a risk of dry burning. Therefore, during the heating of the heating device 23, the water inlet valve may be controlled to be opened again to supply water into the outer tub 21 again, in response to detecting that the water level is lower than or equal to the second low water level h2.

[0091] In exemplary embodiments of the present disclosure, during the re-supplying of the water into the outer tub 21, if the second water level detection device 12 detects that the water level has reached the second high water level h1 again, the water inlet valve is controlled to be closed again to stop the supply of the water into the outer tub 21.

[0092] In exemplary embodiments of the present disclosure, during the heating of the heating device 23, water is supplied again, in response to detecting that the water level is lower than or equal to the second low water level h2. The water supply may be stopped again, in response to detecting that the water level has reached the second high water level h1. This process may be continuously performed until the predetermined steam washing process ends. For example, a predetermined steam washing duration reaches. The water supply is immediately stopped, when the detection of the second water level detection device 12 fails and thus the first water level detection device 11 detects that the water level reaches the first high water level H1. Alternatively, the heating is stopped immediately, in response to the first water level detection device 11 detecting that the water level is lower than or equal to the first low water level H2.

[0093] In exemplary embodiments of the present disclosure, in the process of performing the steam washing, in order to avoid detection failure or water level misjudgment of the second water level detection device that causes the heating device is still in a heating state when the water level in the outer tub 21 is very low, and thus leads to dry burning and damage to an inner assembly of the washing machine, an additional detection may be performed by the first water level detection device 11. The heating device is controlled to stop operation in time, in response to the first water level detection device 11 detecting that the water level is equal to or lower than the first low water level H2.

[0094] In exemplary embodiments of the present disclosure, in the process of performing the steam washing, in order to avoid detection failure or water level misjudgment of the second water level detection device that causes the continuous supply of the water into the outer tub 21 when the water level in the outer tub 21 is very high, and thus wets the clothes and affects the steam effect, the additional detection of the first water level detection device 11 may also be perform. The water inlet valve is controlled to be closed in time to stop the water supply, in response to the first water level detection device 11 detecting that the water level is equal to or higher than the first high water level H1.

[0095] In exemplary embodiments of the present disclosure, after the washing machine runs the steam washing program, the inner tub may be controlled to rotate synchronously during the water supply prior to the steam generation. In this case, the rotation speed of the inner tub may be a first rotation speed r1.

[0096] In exemplary embodiments of the present disclosure, the first rotation speed r1 during the water supply may

be a larger value, and therefore even if the water falls onto an outer wall of the inner tub during the water supply, the water is thrown off due to the rotation of the inner tub at the high speed. Thus, water flow cannot smoothly enter the inner tub through the first through hole to prevent the internal clothes from being wetted.

[0097] Once the clothes get wet, the clothes become heavy and pile up. Therefore, no gap exists between the clothes. After steam is generated in a later period, even if a large amount of steam enters the inner tub, it is difficult for the wet clothes to absorb the steam due to the tightly overlapping between the clothes. In addition, once the clothes get wet, the clothes have absorbed a large amount of water, and even the clothes has been saturated with excessive water supplied into the inner tub, and therefore the clothes cannot absorb the steam. Moreover, since the clothes are wetted by a large amount of cold water, a temperature of the clothes is reduced, which is not favorable to wash oil stains on the clothes. In addition, after the steam is generated, the cold water absorbed by the clothes can also reduce a temperature of the steam or even enable a large amount of steam to condense into water, which greatly reduces the steam effect.

[0098] In exemplary embodiments of the present disclosure, the inner tub is simultaneously controlled to rotate at a high speed during the water supply, the water flow can be effectively prevented from entering the inner tub. Therefore, the clothes are prevented from getting wet by the water. Further, many problems possibly arise from the above-mentioned analysis are avoided. Therefore, the embodiments of the present disclosure solve a large problem in the steam washing by increasing the rotation speed of the inner tub during the water supply.

[0099] In exemplary embodiments of the present disclosure, the heating device starts heating, and the water level reaches the predetermined water level. After the water inlet valve is controlled to stop the water supply, the inner tub may still be controlled to rotate in this case. However, the rotation speed of the inner tub may be a lower rotation speed in this case, for example, a second rotation speed r2. The second rotation speed r2 is slower than the first rotation speed r1. In this case, since no water is supplied, there is no need to worry that the supplied water flow will enter the inner tub to wet the clothes in the inner tub. In this case, low-speed rotation is performed to enable the generated steam to pass through the first through hole into the inner tub, which avoids the steam from being blocked outside the inner tub due to too high rotation speed. In addition, the low-speed rotation of the inner tub enables the clothes in the inner tub to be gradually shaken out to allow for a larger contact area between the clothes and air in the inner tub. Therefore, the clothes can be in contact with the steam in a larger area. Thus, a wrinkle-removing effect is enhanced.

[0100] In exemplary embodiments of the present disclosure, the specific value of the second rotational speed r2 may be defined based on different types of washing machines, different capacities, different motor configurations, and different requirements, and the specific value of the second rotational speed r2 is not limited herein.

[0101] In exemplary embodiments of the present disclosure, in the process of generating steam, when the inner tub rotates at a lower speed, the inner tub may rotate clockwise and anticlockwise alternately. During the alternate rotation of the inner tub, the inner tub may rotate one or more revolutions clockwise, and then rotates one or more revolutions countercl ockwi se.

[0102] In exemplary embodiments of the present disclosure, the control method may further include: during the heating of the heating device, detecting whether the water level in the outer tub 21 has decreased to the second low water level h2 in real time, and continuously performing the heating to generate the steam, in response to detecting that the water level in the outer tub 21 has not decreased to the second low water level h2; and supplying water into the outer tub 21 again, and controlling the inner tub to rotate at a high speed again during the re-supply of the water, in response to detecting that the water level in the outer tub 21 decreases to the second low water level h2.

[0103] In exemplary embodiments of the present disclosure, when it is detected that the water level in the outer tub has decreased to the predetermined second low water level h2, it is indicated that the amount of water in the outer tub is relatively little. In this case, water can be supplied into the outer tub again in order to prevent dry burning. Moreover, the rotation speed of the inner tub is still increased during the re-supply of the water to allow the inner tub to rotate at a high speed during the water supply, and the speed of the inner tub can be reduced again after the water supply is completed.

[0104] It should be noted that all directional indications (such as, up, down, left, right, front, rear) in the embodiments of the present disclosure are only used to explain a relative positional relationship, movement, and the like among various components in a particular posture (as illustrated in the accompanying drawings). If this specific posture changes, the directional indications will correspondingly change as well.

[0105] In addition, terms, such as "first", "second", and the like, in the embodiments of the present disclosure are used for description, and are not intended to indicate or imply relative importance or significance. Thus, the feature defined with "first" and "second" may include at least one feature. In the description of the present disclosure, "a plurality of" means at least two, for example, two or three, unless specified otherwise.

[0106] In the present disclosure, unless specified or limited otherwise, terms "connected," "fixed", and the like, are understood broadly, such as fixed, detachable mountings, connections and couplings or integrated, and can be mechanical or electrical mountings, connections and couplings, and also can be direct and via media indirect mountings, connections, and couplings, and further can be inner mountings, connections and couplings of two components or interaction relations between two components, which can be understood by those skilled in the art according to the detail

embodiment of the present disclosure.

[0107] Those skilled in the art can understand that all or some steps in the method, the system, the functional modules/units in the devices as disclosed above can be implemented as software, firmware, hardware, and appropriate combinations thereof. In a hardware implementation, the division between the functional modules/units mentioned in the above description does not necessarily correspond to a division of physical components. For example, one physical component may have a plurality of functions, or one function or step may be cooperatively performed by several physical components. Some or all of the components may be implemented as software executed by a processor, such as a digital signal processor or a microprocessor, or as hardware, or as an integrated circuit, such as an application specific integrated circuit. Such software may be distributed on a computer readable medium, which may include a computer storage medium (or a non-transitory medium) and a communication medium (or a transitory medium). As is well-known to those skilled in the art, the term "computer storage medium" includes a volatile and nonvolatile and removable and non-removable medium implemented in any method or technology for storing information, such as, computer readable instructions, a data structure, a program module, or other data. The computer storage medium includes, but is not limited to, RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital versatile disks (DVD) or other optical disk storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium that can be used to store desired information and that can be accessed by a computer. Further, as is well-known to those skilled in the art, a communication medium typically embodies computer the readable instructions, the data structure, the program module, or the other data in a modulated data signal such as a carrier wave or other transmission mechanism, and may include any information delivery medium. Further, the specification may have presented methods and/or processes as a particular sequence of steps in describing representative embodiments. However, to the extent that the method or process does not depend on the specific order of steps described herein, the method or process should not be limited to the specific order of steps described. Other sequences of steps are possible as will be appreciated by those skilled in the art. Therefore, the particular order of steps set forth in the specification should not be construed as limitation to the claims. Furthermore, the claims directed to the methods and/or processes should not be limited to perform their steps in the order described herein, those skilled in the art can readily appreciate that such orders can vary and still fall within the spirit and scope of the embodiments of the present disclosure.

[0108] Although the embodiments disclosed herein are described above, the description is only for the convenience of understanding the embodiments, and is not intended to limit the present disclosure. Any modifications and changes may be made by those skilled in the art to which the present disclosure belongs in the form and details of the embodiments without departing from the spirit and scope disclosed herein, but the patent scope herein is still defined by the appended claims.

Claims

1. A control apparatus for a washing machine, the washing machine comprising an outer tub, the control apparatus comprising:

   a plurality of water level detection devices, the plurality of water level detection devices comprising a first water level detection device and a second water level detection device,
   wherein the first water level detection device is configured to detect a predetermined water level in the outer tub; and
   wherein the second water level detection device is configured to detect a water level in the outer tub.

2. The control apparatus according to claim 1, wherein the washing machine further comprises an inner tub located within the outer tub; and
   the control apparatus further comprises a heating device disposed between a bottom of the inner tub and a bottom of the outer tub.

3. The control apparatus according to claim 2, wherein the first water level detection device is provided with a first water level detection portion disposed between the bottom of the inner tub and the bottom of the outer tub; and
   the second water level detection device is provided with a second water level detection portion disposed at an outlet of a drain pipe.

4. The control apparatus according to claim 3, wherein the first water level detection portion is located at a position higher than a position where the heating device is located.

5. The control apparatus according to claim 2, wherein the predetermined water level comprises a first high water level

H1 and a first low water level H2; and
the second water level detection device corresponds to at least two water level thresholds comprising a second high water level h1 and a second low water level h2, where H1 >H2, h1 >h2, H1≥h1, and H2≤h2.

6. The control apparatus according to claim 5, wherein the first low water level H2 is higher than a position where the heating device is located.

7. The control apparatus according to claim 5, wherein the control apparatus further comprises a water inlet valve;

the heating device is configured to perform heating to generate steam, in response to the second water level detection device detecting that a current water level reaches the second low water level h2;
the water inlet valve is configured to be opened to supply water, in response to the second water level detection device detecting that the current water level is lower than the second low water level h2;
the water inlet valve is further configured to be closed to stop the water supply, in response to the second water level detection device detecting that the current water level reaches the second high water level h1;
the heating device is further configured to stop the heating, in response to the first water level detection device detecting that the current water level is lower than the first low water level H2; and
the water inlet valve is further configured to be closed to stop the water supply, in response to the first water level detection device detecting that the current water level reaches the first high water level H1.

8. The control apparatus according to any one of claims 1 to 7, wherein the first water level detection device is a water level switch; and
the second water level detection device is a Micro-Electro-Mechanical System, MEMS, water level sensor.

9. A washing machine, comprising:

a processor;
an inner tub;
an outer tub; and
the control apparatus according to any one of claims 1 to 8,
wherein the inner tub is located within the outer tub; and
wherein the processor is electrically connected to the control apparatus.

10. The washing machine according to claim 9, wherein the control apparatus is the control apparatus according to claim 7; and
the processor is configured to control the heating device and/or the water inlet valve based on detection signals of the plurality of water level detection devices.

11. The washing machine according to claim 10, wherein said controlling the heating device and the water inlet valve by the processor based on the detection signals of the plurality of water level detection devices comprises:

controlling, subsequent to a predetermined steam washing program being started, the water inlet valve to be opened to supply water into the outer tub; and
controlling the heating device to perform the heating to generate the steam, in response to the second water level detection device detecting that the current water level reaches the second low water level h2;
controlling the water inlet valve to be closed to stop the water supply, in response to the second water level detection device detecting that the current water level reaches the second high water level h1; and
controlling the water inlet valve to be opened to supply water, in response to the second water level detection device detecting that the current water level is lower than the second low water level h2.

12. The washing machine according to claim 10, wherein said controlling the heating device and the water inlet valve by the process based on the detection signals of the plurality of water level detection devices comprises:

controlling, regardless of a detection result of the second water level detection device, the heating device to stop the heating, in response to the first water level detection device detecting that the current water level is lower than the first low water level H2; and
controlling, regardless of the detection result of the second water level detection device, the water inlet valve to be closed to stop the water supply, in response to the first water level detection device detecting that the

current water level reaches the first high water level H1.

13. A control method of a washing machine, applied to the washing machine according to any one of claims 9 to 12, the control method comprising:

detecting the predetermined water level in the outer tub of the washing machine by the first water level detection device of the washing machine; and
detecting a water level in the outer tub by the second water level detection device of the washing machine.

14. The control method according to claim 13, further comprising:

controlling, subsequent to a predetermined steam washing program being started, the water inlet valve of the washing machine to be opened to supply water into the outer tub;
controlling a heating device of the washing machine to perform heating to generate steam, in response to the second water level detection detecting that a current water level reaches a predetermined second low water level h2;
controlling the water inlet valve to be closed to stop the water supply, in response to the second water level detection device detecting that the current water level reaches a predetermined second high water level h1; and
controlling the water inlet valve to be opened to supply water, in response to the second water level detection device detecting that the current water level is lower than the second low water level h2.

15. The control method according to claim 14, further comprising:
controlling, during the heating of the heating device, the water inlet valve to be opened to supply water again, when the current water level in the outer tub is lower than the second low water level h2.

16. The control method according to claim 14, further comprising:

controlling, regardless of a detection result of the second water level detection device, the heating device to stop the heating, in response to the first water level detection device detecting that the current water level is lower than a predetermined first low water level H2; and
controlling, regardless of the detection result of the second water level detection device, the water inlet valve to be closed to stop the water supply, in response to the first water level detection device detecting that the current water level reaches a predetermined first high water level H1.

17. A control system for a washing machine, the washing machine comprising an outer tub, the control system comprising:

a plurality of water level detection devices comprising a first water level detection device and a second water level detection device;
a processor;
a heating device; and
a water inlet valve,
wherein the first water level detection device is configured to detect a predetermined water level in the outer tub, the second water level detection device being configured to detect a water level in the outer tub; and
wherein the processor is configured to control the heating device and the water inlet valve based on detection signals of the plurality of water level detection devices.

18. The control system according to claim 17, wherein the predetermined water level comprises a first high water level H1 and a first low water level H2; and
the processor is further configured to:

control the heating device to perform heating to generate steam, in response to the second water level detection device detecting that a current water level reaches a second low water level h2;
control the water inlet valve to be opened to supply water, in response to the second water level detection device detecting that the current water level is lower than the second low water level h2;
control the water inlet valve to be closed to stop the water supply, in response to the second water level detection device detecting that the current water level reaches a second high water level h1;
control, regardless of a detection result of the second water level detection device, the heating device to stop the heating, in response to the first water level detection device detecting that the current water level is lower

than the first low water level H2; and

control, regardless of the detection result of the second water level detection device, the water inlet valve to be closed to stop the water supply, in response to the first water level detection device detecting that the current water level reaches the first high water level H1, where H1 >H2, h1 >h2, H1≥h1, and H2≤h2.

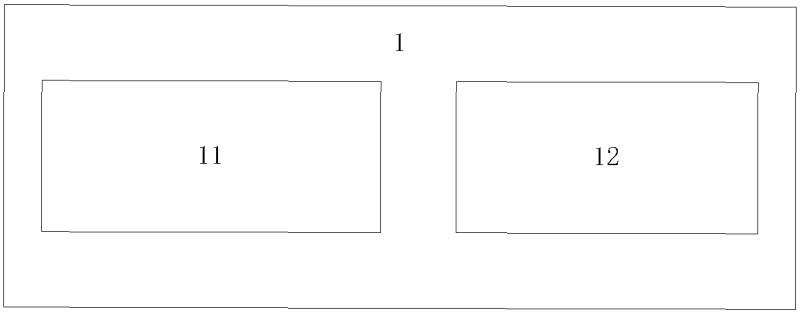

FIG. 1

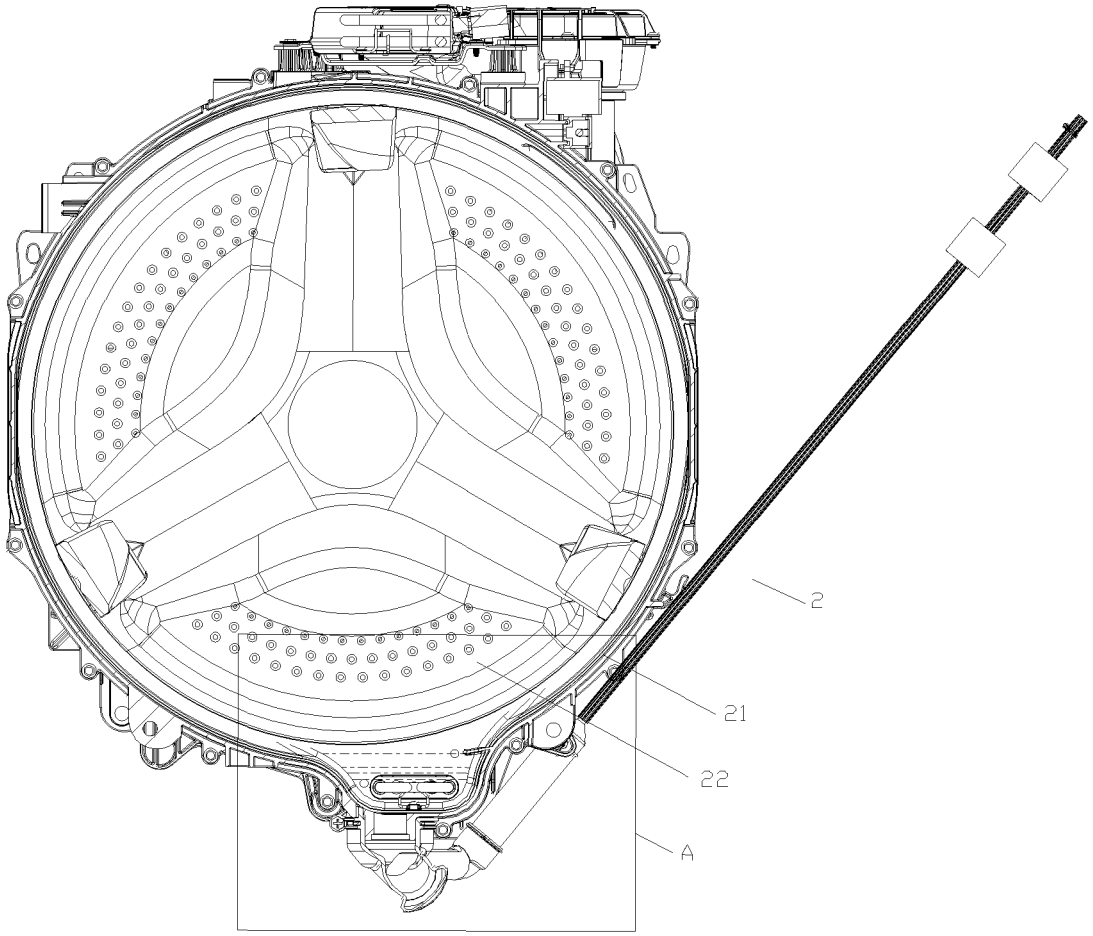

FIG. 2

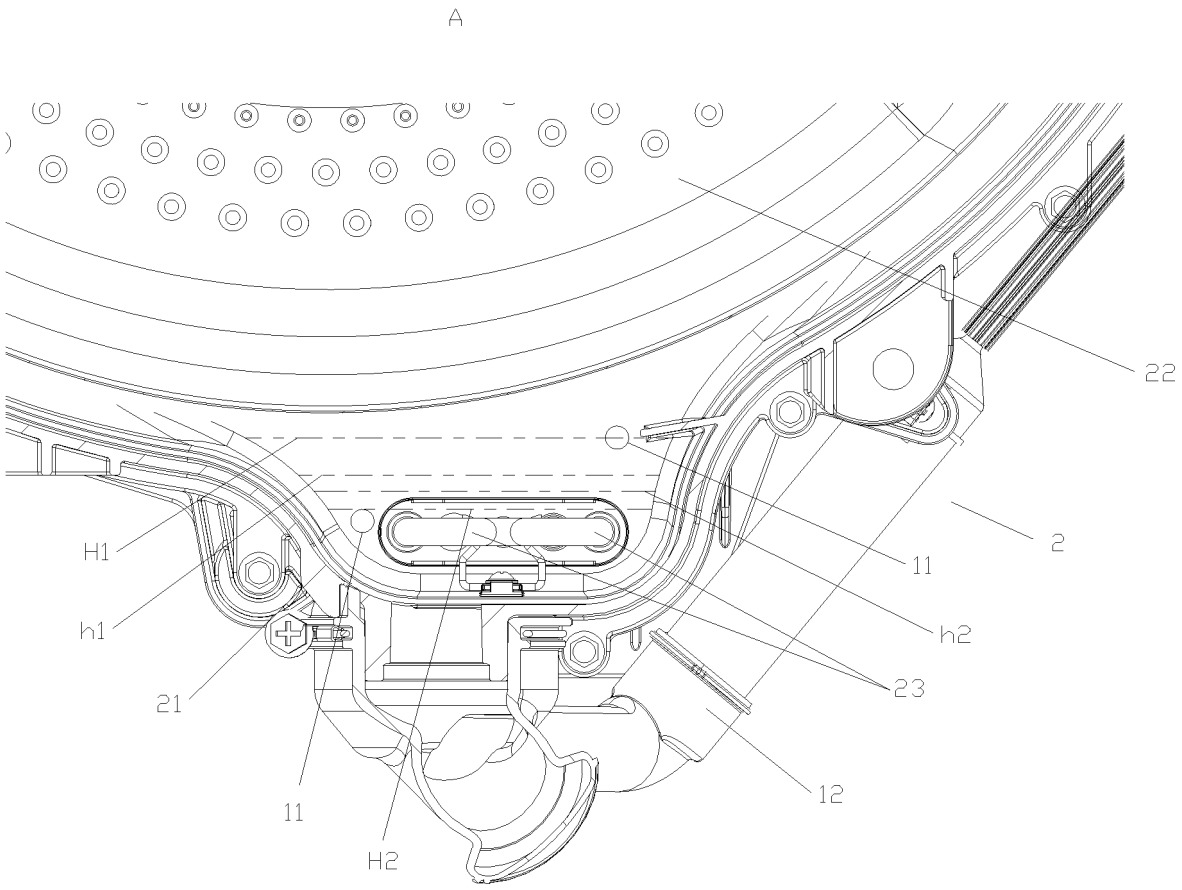

FIG. 2a

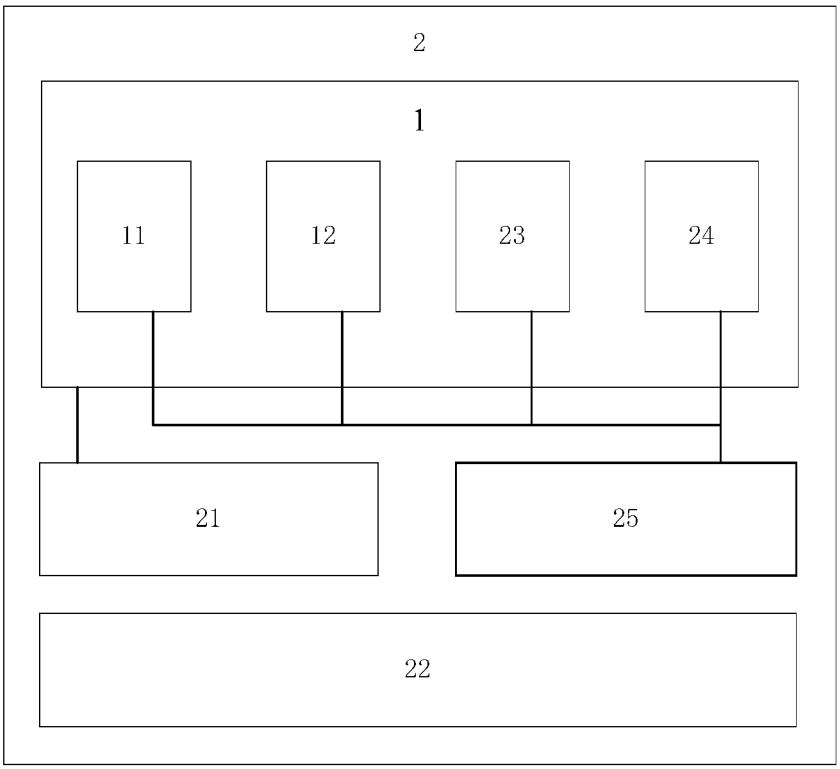
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FIG. 3

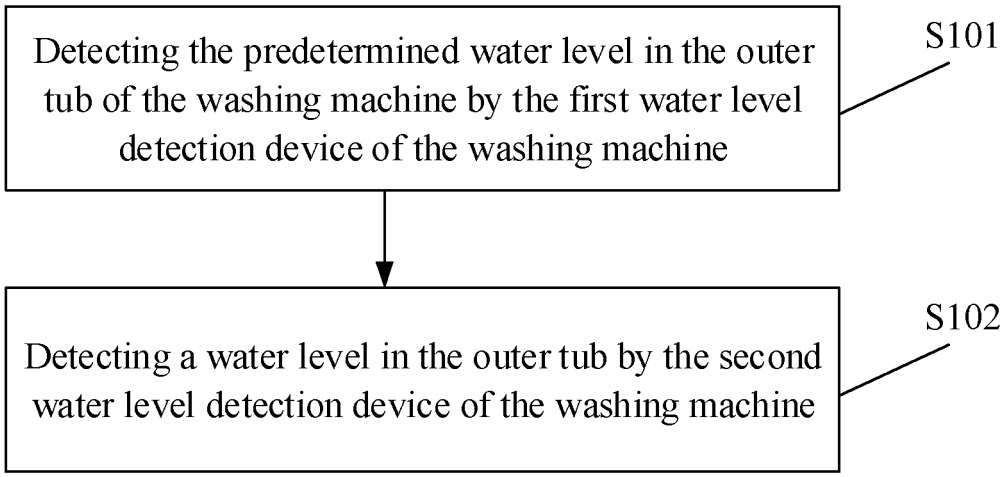
Detecting the predetermined water level in the outer tub of the washing machine by the first water level detection device of the washing machine
S101
Detecting a water level in the outer tub by the second water level detection device of the washing machine
S102

FIG. 4

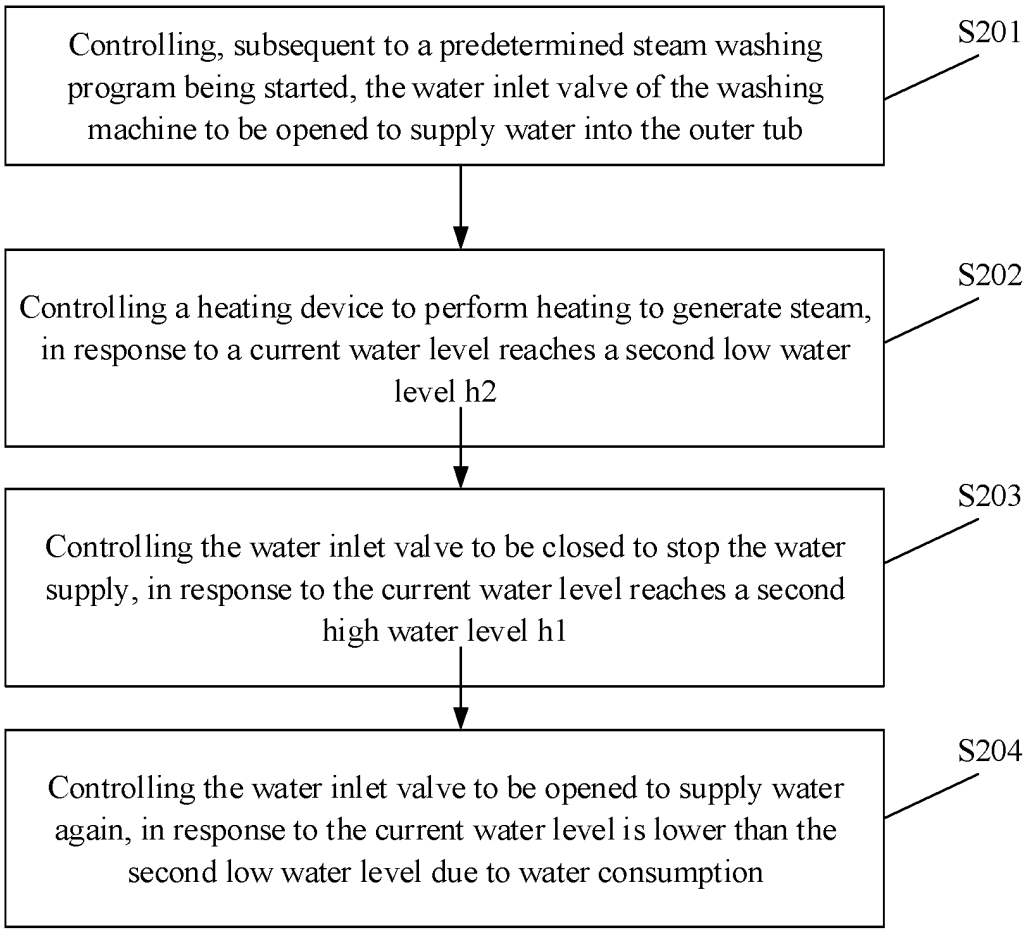
Controlling, subsequent to a predetermined steam washing program being started, the water inlet valve of the washing machine to be opened to supply water into the outer tub
S201
Controlling a heating device to perform heating to generate steam, in response to a current water level reaches a second low water level h2
S202
Controlling the water inlet valve to be closed to stop the water supply, in response to the current water level reaches a second high water level h1
S203
Controlling the water inlet valve to be opened to supply water again, in response to the current water level is lower than the second low water level due to water consumption
S204

FIG. 5

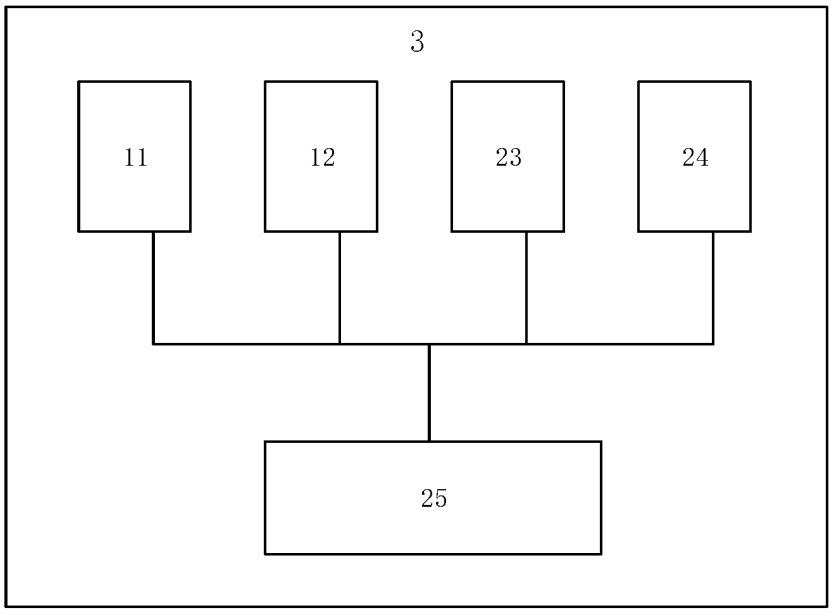
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FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/130915

A. CLASSIFICATION OF SUBJECT MATTER

D06F 34/14(2020.01)i; D06F 39/04(2006.01)i; D06F 39/08(2006.01)i

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; F26B

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)

WPI, EPODOC, CNPAT, CNKI: 小天鹅, 周震东, 水位, 液位, 检测, 监测, 实时, 实际, 蒸汽, 加热, 精度, 精确, 准确, 第二, 传感器, water+, level, detect+, sensor?, transducer?, second, steam+, vapor, wash+, heater

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 113186692 A (WUXI LITTLE SWAN ELECTRIC CO., LTD.) 30 July 2021 (2021-07-30) claims 1-17, and description, paragraphs 56-166	1-18
X	KR 20090063372 A (SAMSUNG ELECTRONICS CO., LTD.) 18 June 2009 (2009-06-18) description, paragraphs 17-58, and figures 1-4	1-6, 8-9, 13, 17
Y	KR 20090063372 A (SAMSUNG ELECTRONICS CO., LTD.) 18 June 2009 (2009-06-18) description, paragraphs 17-58, and figures 1-4	7, 10-12, 14-16, 18
Y	CN 1989288 A (LG ELECTRONICS INC.) 27 June 2007 (2007-06-27) description, specific embodiments, and figures 1-11	7, 10-12, 14-16, 18
A	CN 105951374 A (WUXI LITTLE SWAN CO., LTD.) 21 September 2016 (2016-09-21) entire document	1-18
A	CN 110965281 A (QINGDAO HAIER WASHING MACHINE CO., LTD.) 07 April 2020 (2020-04-07) entire document	1-18
A	US 5146693 A (INDUSTRIE ZANUSSI S.P.A.) 15 September 1992 (1992-09-15) entire document	1-18

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 January 2022	**10 February 2022**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN)** **No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088, China** Facsimile No. **(86-10)62019451**	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2021/130915

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	113186692	A	30 July 2021	None			
KR	20090063372	A	18 June 2009	KR	101138887	B1	14 May 2012
CN	1989288	A	27 June 2007	WO	2006129913	A1	07 December 2006
				US	RE47692	E	05 November 2019
				EP	1885935	A1	13 February 2008
				EP	1885935	A4	07 December 2016
				EP	1885935	B1	04 September 2019
				CN	1989288	B	26 May 2010
				US	2012266391	A1	25 October 2012
				US	8621695	B2	07 January 2014
				US	2008134445	A1	12 June 2008
				US	8181299	B2	22 May 2012
				US	2011126360	A1	02 June 2011
CN	105951374	A	21 September 2016	None			
CN	110965281	A	07 April 2020	None			
US	5146693	A	15 September 1992	IT	8934090	V0	01 December 1989
				IT	221382	Z2	16 March 1994

Form PCT/ISA/210 (patent family annex) (January 2015)