

DESCRIPTION

WASHING MACHINE

5 TECHNICAL FIELD

The present invention relates to a washing machine equipped with an automatic liquid agent injection device constituting a liquid supply device.

BACKGROUND ART

10 PTL 1 discloses a washing machine that automatically injects a liquid agent such as detergent liquid or softener liquid.

The above washing machine includes a housing, a receiving cylinder elastically anti-vibration supported in the housing, a drum rotatably supported in the receiving cylinder, an automatic liquid agent injection device configured to automatically inject a liquid agent inside a tank into the drum, and a liquid agent remaining amount detector configured to detect a remaining amount of liquid agent in the tank. The liquid agent remaining amount detector includes a float portion pivotally provided at an upper portion of the tank and floating on a liquid surface, a magnet disposed in the float portion, and a magnetic force sensor configured to detect magnetic force of the magnet. PTL 1 discloses a configuration that detects the remaining amount of liquid agent in the tank based on an output voltage from the magnetic force sensor.

According to the conventional configuration, however, as the remaining amount of liquid agent in the tank increases, a distance between the magnet and the magnetic force sensor increases. This may lead to a failure to detect any magnetic force from the magnet by using the magnetic force sensor. As a result, the remaining amount of liquid agent cannot be accurately detected.

Citation List

Patent Literature

PTL 1: Chinese Patent Application Publication No. 105463787

5 SUMMARY OF THE DISCLOSURE

The present disclosure provides a washing machine that can accurately determine sufficiency or insufficiency of a remaining amount of liquid agent in a wide range.

A washing machine according to an aspect of the present disclosure
10 includes a housing, a water tub supported in the housing, a tank containing a liquid agent, a liquid supply device configured to automatically supply the liquid agent inside the tank to the water tub, a remaining amount detector configured to detect a remaining amount of liquid agent in the tank, and a controller configured to control a washing operation of the washing machine.
15 The remaining amount detector includes a float portion floating on a surface of the liquid agent in the tank, a plurality of to-be-detected portions provided on the float portion, and a detector configured to detect the to-be-detected portions. The plurality of to-be-detected portions are disposed apart from each other at positions along a moving direction of the float portion in accordance with
20 changes in level of the liquid agent, and the to-be-detected portion at a lowest position of the plurality of to-be-detected portions is provided at a position higher than the detector while the tank is filled with the liquid agent.

According to an embodiment, there is provided a washing machine comprising:

- 25 a water tub supported in the housing;
- a tank having an opening in an upper portion and containing a liquid agent;

a tank lid provided on an upper portion of the tank and configured to open and close the opening;

a liquid supply device configured to automatically supply the liquid agent inside the tank to the water tub;

5 a to-be-detected portion floating on a surface of the liquid agent in the tank;

a detector configured to detect the to-be-detected portion;

a storage unit configured to store a detection value from the detector; and

a controller configured to control a washing operation,

10 wherein the controller further includes a trouble determination unit, and

the trouble determination unit calculates a difference between a detection value from the detector after the liquid agent is discharged from the tank and detection value from the detector after the liquid agent has been previously discharged, the detection value being stored in the storage unit, and determines
15 that the liquid agent is fixed in the tank if a value of the calculated difference is less than a predetermined value.

According to an embodiment, there is provided a washing machine comprising: a housing;

a water tub supported in the housing;

20 a tank having an opening in an upper portion and containing a liquid agent;

a tank lid provided on an upper portion of the tank and configured to open and close the opening;

25 a liquid supply device configured to automatically supply the liquid agent inside the tank to the water tub;

a to-be-detected portion floating on a surface of the liquid agent in the tank;

a detector configured to detect the to-be-detected portion;

30 a liquid agent injection amount calculator configured to calculate an injection amount of liquid agent into the water tub;

a storage unit configured to store a detection value from the detector; and

a controller configured to control a washing operation,
wherein the controller further includes a trouble determination unit, and
the trouble determination unit calculates a difference between a detection
value from the detector when an accumulated liquid agent discharge amount from
5 the tank exceeds a predetermined value and a detection value from the detector
when a previous accumulated liquid agent discharge amount exceeds a
predetermined value, the detection value being stored in the storage unit, and
determines that the liquid agent is fixed in the tank if a value of the calculated
difference is less than a predetermined value.

10 This configuration allows the detector to detect magnetic force from the to-
be-detected portions in a wide moving range of the float portion when the to-be-
detected portions of the float portion pass through the detector. This makes it
possible to improve detection accuracy as well as expanding a detection range for
the remaining amount of liquid agent.

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BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is an external perspective view of a washing machine according to an exemplary embodiment of the present invention.

FIG. 2 is a longitudinal sectional view of the washing machine
5 according to the same exemplary embodiment.

FIG. 3 is an exploded perspective view of a main part of the washing machine according to the same exemplary embodiment.

FIG. 4 is a plan view of an automatic liquid agent injection device of the washing machine according to the same exemplary embodiment.

10 FIG. 5 is a right side view of the automatic liquid agent injection device of the washing machine according to the same exemplary embodiment.

FIG. 6 is a left side view of the automatic liquid agent injection device of the washing machine according to the same exemplary embodiment.

15 FIG. 7 is a left-side sectional view of the automatic liquid agent injection device of the washing machine according to the same exemplary embodiment.

FIG. 8 is a front-side sectional view of the automatic liquid agent injection device of the washing machine according to the same exemplary embodiment.

20 FIG. 9 is an exploded perspective view of a main part of the automatic liquid agent injection device of the washing machine according to the same exemplary embodiment.

25 FIG. 10A is a schematic view of a three-way valve unit when tap water is supplied to the washing machine according to the same exemplary embodiment.

FIG. 10B is a schematic view of the three-way valve unit when detergent liquid is supplied to a water tub of the washing machine according to

the same exemplary embodiment.

FIG. 10C is a schematic view of the three-way valve unit when softener liquid is supplied to the water tub in the washing machine according to the same exemplary embodiment;

5 FIG. 11 is a sectional view of a pump unit of the washing machine according to the same exemplary embodiment.

FIG. 12 is a bottom view of each of a detergent tank and a softener tank.

10 FIG. 13 is a sectional view of a tank storage case in which the detergent tank and the softener tank are mounted.

FIG. 14 is an enlarged view of portion E1 in FIG. 13.

FIG. 15 is a rear sectional view of the tank storage case in which the detergent tank and the softener tank are mounted.

FIG. 16 is a sectional view taken along line 16-16 in FIG. 15.

15 FIG. 17 is a top view of each of the detergent tank and a detergent tank lid of the washing machine according to the same exemplary embodiment.

FIG. 18A is a sectional view taken along line 18A-18A in a state in which a float portion is not attached to a lower surface of the detergent tank lid in FIG. 17.

20 FIG. 18B is a sectional view taken along line 18B-18B in a state in which the float portion is attached to the lower surface of the detergent tank lid in FIG. 17.

FIG. 19 is a sectional view taken along line 19-19 in a state in which a filter member in FIG. 17 is not attached.

25 FIG. 20 is a sectional view of the detergent tank, showing lines of sight when users of the washing machine according to the same exemplary embodiment who have different heights see into the detergent tank from an

opening.

FIG. 21 is an enlarged sectional view of a main part of the detergent tank and a detergent side three-way valve of the washing machine according to the same exemplary embodiment.

5 FIG. 22 is a perspective view of a filter material of the washing machine according to the same exemplary embodiment.

FIG. 23A is a sectional view taken along line 23A-23A in FIG. 22.

FIG. 23B is an enlarged view of portion E2 in FIG. 22.

10 FIG. 24 is a block diagram showing a configuration of the main part of the washing machine according to the same exemplary embodiment.

FIG. 25 is a top view of an automatic liquid agent injection device of the washing machine according to the same exemplary embodiment.

FIG. 26 is a sectional view taken along line 26-26 in FIG. 25.

15 FIG. 27 is an exploded perspective view of the detergent tank, detergent tank lid, and float portion of the washing machine according to the same exemplary embodiment.

FIG. 28 is a lower exploded perspective view of the detergent tank lid and float portion of the washing machine according to the same exemplary embodiment.

20 FIG. 29 is a perspective view of the detergent tank of the washing machine according to the same exemplary embodiment.

FIG. 30 is a graph showing a relationship between magnetic flux density received by a linear Hall element and an output voltage from the linear Hall element.

25 FIG. 31 is a schematic view of a lower surface of the detergent tank lid to which the float portion of the washing machine according to the same exemplary embodiment is attached.

FIG. 32 is a schematic side sectional view showing a positional relationship between the float portion and the linear Hall element of the washing machine according to the same exemplary embodiment.

FIG. 33 is a schematic side sectional view showing a positional relationship between the float portion and the linear Hall element when a level of detergent liquid becomes lower than that in FIG. 32.

FIG. 34 is a schematic side sectional view showing a positional relationship between the float portion and the linear Hall element when a level of detergent liquid becomes lower than that in FIG. 33.

FIG. 35 is a schematic side sectional view showing a positional relationship between the float portion and the linear Hall element when a level of detergent liquid becomes lower than that in FIG. 34.

FIG. 36 is a graph showing a relationship between a remaining amount of detergent in the detergent tank and an output voltage of the linear Hall element of the washing machine according to the same exemplary embodiment.

FIG. 37 is a flowchart for insufficient remaining amount determination concerning a detergent and detergent tank defect determination in the washing machine according to the same exemplary embodiment.

FIG. 38 is a timing chart showing states of a detergent-side coil, softener-side coil, drive motor, first water supply valve, and drain pump in a "maintenance mode" of the washing machine according to the same exemplary embodiment.

DESCRIPTION OF EMBODIMENTS

Hereinafter, exemplary embodiments will be described in detail with reference to the accompanying drawings. However, more detailed descriptions than necessary may be omitted. For example, detailed descriptions of already

well-known matters and repeated description of substantially the same structure may be omitted. This is to avoid an unnecessarily redundant description below and to facilitate understanding by those skilled in the art.

(First exemplary embodiment)

5 A washing machine according to a first exemplary embodiment will be described below item by item with reference to FIGS. 1 to 38.

[1-1. Configuration]

[1-1-1. Configuration of washing machine]

10 A configuration of the washing machine according to this exemplary embodiment will be described first with reference to FIGS. 1 and 2.

FIG. 1 is an external perspective view of the washing machine according to this exemplary embodiment. FIG. 2 is a longitudinal sectional view of the washing machine.

As shown in FIGS. 1 and 2, the washing machine according to the
15 exemplary embodiment includes housing 101 and bottomed cylindrical water tub 105 provided inside housing 101. Housing 101 constitutes an exterior of washing machine 100. Water tub 105 is supported by a plurality of suspensions (not shown) and damper 163 so as to be elastically vibration-proofed. Drum 106 constituting a bottomed cylindrical washing tub is
20 rotatably disposed in water tub 105. Drum 106 includes a plurality of baffles 106a on an inner wall surface of drum 106. Baffles 106a perform an agitating operation with respect to clothes, for example, hooking and lifting the clothes and then dropping the clothes when drum 106 rotates at a low speed. Drum 106 also has a plurality of small through holes (not shown) formed in a
25 circumferential surface of drum 106. Water tub 105 includes a tub rotating motor (not shown) disposed on a bottom portion of water tub 105. The tub rotating motor rotates and drives drum 106.

Housing 101 includes clothes load and unload port 103 which is formed in a front surface of housing 101 and through which clothes are loaded and unloaded. Lid body 102 is provided on the front surface of housing 101. Lid body 102 openably covers clothes load and unload port 103. Opening lid body 102 allows a user to load clothes into drum 106 through clothes load and unload port 103.

Housing 101 includes automatic liquid agent injection device 109 constituting a liquid supply device. Automatic liquid agent injection device 109 is provided above water tub 105. A configuration of automatic liquid agent injection device 109 will be described in detail in [1-1-2. Configuration of automatic liquid agent injection device].

As shown in FIG. 1, housing 101 has openable lid body 114a on housing 101. Opening lid body 114a enables to attach and detach detergent tank 117 and softener tank 126 in and from opening 114b.

Lid body 102 has operation display unit 104 disposed on an upper portion of lid body 102. Operation display unit 104 includes an operation unit that performs a driving operation and a display unit that displays a driving state.

Housing 101 further includes a controller (not shown). The controller controls the tub rotating motor and the like and executes a series of steps such as washing, rinsing, and dewatering while sequentially controlling the steps. The controller includes a cloth amount determination unit (not shown) and a liquid agent load amount calculator (not shown). The cloth amount determination unit detects a torque current value when, for example, the tub rotating motor rotates at a predetermined rotation speed. Based on this detection, the cloth amount determination unit determines a cloth amount by, for example, classifying laundry up to 10 kg into about 10 classes. The

controller decides an amount of water used for washing based on a determination result obtained by the cloth amount determination unit. The liquid agent load amount calculator calculates a detergent load amount and a softener load amount from the cloth amount detected by the cloth amount
5 determination unit.

Washing machine 100 includes a storage unit (not shown). The storage unit is constituted by, for example, an electrically erasable and programmable read only memory (EEPROM). The storage unit includes a detergent type storage unit (not shown) that stores information concerning a detergent type,
10 and stores various types of setting information concerning a washing operation.

The washing machine according to this exemplary embodiment is constituted in the above manner.

[1-1-2. Configuration of automatic liquid agent injection device 109 (liquid supply device)]

15 The configuration of automatic liquid agent injection device 109 will be described next with reference to FIGS. 3 to 27.

FIG. 3 is an exploded perspective view of a main part of the washing machine according to the same exemplary embodiment. FIG. 4 is a plan view of an automatic liquid agent injection device of the same washing machine.
20 FIG. 5 is a right side view of the same automatic liquid agent injection device. FIG. 6 is a left side view of the same automatic liquid agent injection device. FIG. 7 is a left-side sectional view of the same automatic liquid agent injection. FIG. 8 is a front-side sectional view of the same automatic liquid agent injection device. FIG. 9 is an exploded perspective view of a main part of the
25 same automatic liquid agent injection device. FIG. 10A is a schematic view of a three-way valve unit when tap water is supplied to the same washing machine. FIG. 10B is a schematic view of the three-way valve unit when

detergent liquid is supplied to a water tub of the same washing machine. FIG. 10C is a schematic view of the three-way valve unit when softener liquid is supplied to the water tub in the same washing machine. FIG. 11 is a sectional view of a pump unit of the same washing machine. FIG. 12 is a bottom view of each of a detergent tank and a softener tank. FIG. 13 is a sectional view of a tank storage case in which the detergent tank and the softener tank are mounted. FIG. 14 is an enlarged view of portion E1 in FIG. 13. FIG. 15 is a rear sectional view of the tank storage case in which the detergent tank and the softener tank are mounted. FIG. 16 is a sectional view taken along line 16-16 in FIG. 15. FIG. 17 is a top view of each of the detergent tank and a detergent tank lid of the same washing machine. FIG. 18A is a sectional view taken along line 18A-18A in a state in which a float portion is not attached to a lower surface of the detergent tank lid in FIG. 17. FIG. 18B is a sectional view taken along line 18B-18B in a state in which the float portion is attached to the lower surface of the detergent tank lid in FIG. 17. FIG. 19 is a sectional view taken along line 19-19 in a state in which a filter member in FIG. 17 is not attached. FIG. 20 is a sectional view of the detergent tank, showing lines of sight when users of the same washing machine who have different heights see into the detergent tank from an opening. FIG. 21 is an enlarged sectional view of a main part of the detergent tank and a detergent side three-way valve of the same washing machine. FIG. 22 is a perspective view of a filter of the same washing machine. FIG. 23A is a sectional view taken along line 23A-23A in FIG. 22. FIG. 23B is an enlarged view of portion E2 in FIG. 22. FIG. 24 is a block diagram showing a configuration of the main part of the same washing machine. FIG. 25 is a top view of an automatic liquid agent injection device of the same washing machine. FIG. 26 is a sectional view taken along line 26-26 in FIG. 25. FIG. 27 is an exploded perspective view of the detergent tank,

detergent tank lid, and float portion of the same washing machine.

As described above, automatic liquid agent injection device 109 (see FIG. 2) is provided above water tub 105 of housing 101. Automatic liquid agent injection device 109 includes, for example, water supply device 110, pump unit 111, three-way valve unit 113 constituting a switching section, and tank storage case 114 in which detergent tank 117 and softener tank 126 are mounted and which constitutes a tank storage portion, each of which will be described in detail below. Note that detergent tank 117 and softener tank 126 will be simply referred to as the "tank" when no discrimination is made between them. In addition, detergent liquid and softener liquid will be simply referred to as an "agent" or "liquid" when no discrimination is made between them.

(Water supply device 110)

Water supply device 110 is provided at an upper portion of housing 101 and includes water supply channel 110c, first water supply valve 110a, and second water supply valve 110b. Note that first water supply valve 110a and second water supply valve 110b will be simply referred to as the "water supply valve" when no discrimination is made between them.

Water supply channel 110c has one end communicating with a faucet of a tap water pipe or the like through a water supply hose (not shown). Controlling opening and closing of first water supply valve 110a and second water supply valve 110b will select a water channel through which tap water flows. A water channel for tap water will be described in (Configuration of water injection case 116 and configuration of water channel) described later.

(Three-way valve unit 113)

Three-way valve unit 113 constitutes a unit that selectively discharges liquid agents in detergent tank 117 and softener tank 126, which are mounted

in tank storage case 114, to piston pump unit 112 (see FIG. 11). Note that the three-way valve unit is an example of the switching section.

As shown in FIG. 9, three-way valve unit 113 includes detergent-side three-way valve 113a, softener-side three-way valve 113b, detergent-side coil 113d, and softener-side coil 113i.

As shown in FIG. 10A, three-way valve unit 113 is provided with water channel 124 for causing the detergent liquid or the softener liquid to flow to pump unit 111. Three-way valve unit 113 controls a flow of water in water channel 124. Water channel 124 communicates with detergent-side cylindrical portion 111b communicating with detergent tank 117 and softener-side cylindrical portion 111f communicating with softener tank 126 on a front of water channel 124. In addition, water channel 124 communicates with second water channel 182 (water channel) and suction water channel 112h of piston pump unit 112.

As shown in FIG. 24, detergent-side three-way valve 113a selectively switches a flow of tap water flowing to second water channel 182 and a flow of detergent liquid flowing from detergent tank 117. This supplies either the tap water or the detergent liquid to softener-side three-way valve 113b.

A specific operation of detergent-side three-way valve 113a will be described with reference to FIGS. 10A to 10C.

Detergent-side three-way valve 113a includes, for example, detergent-side cylinder 113l, detergent-side plunger 113e, detergent-side valve body 113f, and detergent-side spring 113c. Detergent-side plunger 113e is provided in detergent-side cylinder 113l and reciprocally operates back and forth. Detergent-side valve body 113f is provided on a front end portion of detergent-side plunger 113e. Detergent-side spring 113c is disposed such that one end is located on a rear wall of detergent-side cylinder 113l and the other end is

located on a rear end portion of detergent-side plunger 113e. Detergent-side cylinder 113l has opening portion a in a front end portion of detergent-side cylinder 113l. Detergent-side coil 113d is disposed around detergent-side cylinder 113l so as to cover detergent-side plunger 113e.

5 As shown in FIGS. 10A and 10C, while detergent-side coil 113d is not energized, detergent-side plunger 113e receives forward biasing force from detergent-side spring 113c. Biased detergent-side valve body 113f closes opening portion b formed in a rear end portion of detergent-side cylindrical portion 111b. This causes detergent-side valve body 113f to block a flow of
10 detergent liquid from detergent tank 117. At this time, opening portion a of detergent-side cylinder 113l is opened. This causes tap water flowing from second water channel 182 into water channel 124 in a direction indicated by arrow X1 to pass through opening portion a of detergent-side cylinder 113l (arrow X2) and flow into softener-side three-way valve 113b (arrow X3).

15 As shown in FIG. 10B, when detergent-side coil 113d is energized, detergent-side coil 113d generates a magnetic field. Accordingly, upon receiving electromagnetic force from the magnetic field, detergent-side plunger 113e moves backward against the biasing force of detergent-side spring 113c. This opens opening portion b of detergent-side cylindrical portion 111b. As a
20 result, detergent liquid from detergent tank 117 flows to softener-side three-way valve 113b through opening portion b as indicated by arrow X5 and arrow X6. At this time, detergent-side valve body 113f closes opening portion a of detergent-side cylinder 113l. Accordingly, detergent-side valve body 113f blocks the flow of tap water flowing through second water channel 182.

25 As described above, detergent-side three-way valve 113a operates to switch the flow of tap water from second water channel 182 and the flow of detergent liquid from detergent tank 117. This makes it possible to selectively

supply either the tap water or the detergent liquid to softener-side three-way valve 113b.

In addition, like detergent-side three-way valve 113a, softener-side three-way valve 113b selectively switches a flow of liquid flowing from detergent-side three-way valve 113a and a flow of softener liquid flowing from softener tank 126. This configuration makes it possible to supply either the tap water or the softener to suction water channel 112h of piston pump unit 112.

More specifically, like detergent-side three-way valve 113a, softener-side three-way valve 113b includes softener-side cylinder 113m, softener-side plunger 113j, softener-side valve body 113k, and softener-side spring 113h. Softener-side plunger 113j is provided in softener-side cylinder 113m and reciprocally moves back and forth. Softener-side valve body 113k is provided on a front end portion of softener-side plunger 113j. Softener-side spring 113h is disposed such that one end is located on a rear wall of softener-side cylinder 113m and the other end is located on a rear end portion of softener-side plunger 113j. Softener-side cylinder 113m is configured to cause liquid from detergent-side three-way valve 113a to flow into softener-side cylinder 113m. Softener-side cylinder 113m has opening portion c in a front end portion of softener-side cylinder 113m. Softener-side coil 113i is provided around softener-side cylinder 113m so as to cover softener-side plunger 113j.

As shown in FIGS. 10A and 10B, while softener-side coil 113i is not energized, softener-side plunger 113j receives forward biasing force from softener-side spring 113h. Biased softener-side valve body 113k closes opening portion d formed in a rear end portion of softener-side cylindrical portion 111f. This causes softener-side valve body 113k, which closes opening portion d of softener-side cylindrical portion 111f, to block the flow of softener liquid from

softener tank 126. At this time, opening portion c of softener-side plunger 113j is opened. This causes the detergent liquid or the tap water supplied from detergent-side three-way valve 113a to softener-side three-way valve 113b to flow from opening portion c to suction water channel 112h of piston pump unit 112 as indicated by arrow X4 or arrow X7.

As shown in FIG. 10C, when softener-side coil 113i is energized, softener-side coil 113i generates a magnetic field. Accordingly, upon receiving electromagnetic force from the magnetic field, softener-side plunger 113j moves backward against the biasing force of softener-side spring 113h. This opens opening portion d of softener-side cylindrical portion 111f. As a result, the softener liquid from softener tank 126 flows from opening portion d to suction water channel 112h of piston pump unit 112 as indicated by arrow X8 and arrow X9. At this time, softener-side valve body 113k closes opening portion c of softener-side plunger 113j. Accordingly, softener-side valve body 113k blocks the flow of liquid from detergent-side three-way valve 113a.

As described above, softener-side three-way valve 113b operates to switch the flow of liquid from detergent-side three-way valve 113a and the flow of softener liquid from softener tank 126. This makes it possible to selectively supply either the liquid or the softener liquid to suction water channel 112h.

That is, according to the above configuration, as shown in FIG. 10A, when both detergent-side coil 113d and softener-side coil 113i are set in a non-energized state, tap water in second water channel 182 is supplied to piston pump unit 112 through three-way valve unit 113. As shown in FIG. 10B, when detergent-side coil 113d is energized and softener-side coil 113i is set in a non-energized state, the detergent liquid in detergent tank 117 is supplied to piston pump unit 112 through three-way valve unit 113. As shown in FIG. 10C, when detergent-side coil 113d is set in a non-energized state and softener-side coil

113i is set in an energized state, the softener liquid in softener tank 126 is supplied to piston pump unit 112 through three-way valve unit 113.

(Pump unit 111)

As shown in FIG. 9, pump unit 111 constitutes a unit for sucking the
5 detergent liquid in detergent tank 117 or the softener liquid in softener tank 126 and discharging the detergent liquid or the softener liquid to water tub 105.

Pump unit 111 includes outer frame 111a and piston pump unit 112 provided inside outer frame 111a.

10 Outer frame 111a is formed from a resin such as polypropylene and surrounds piston pump unit 112 to protect piston pump unit 112. As shown in FIG. 6, outer frame 111a is disposed between water supply device 110 and tank storage case 114.

As shown in FIGS. 9, 10A to 10C, and 21, outer frame 111a includes
15 detergent-side cylindrical portion 111b formed below an outer wall front surface so as to extend forward and backward. As shown in FIG. 21, a front end portion of detergent-side cylindrical portion 111b is inserted into cylindrical portion 123 formed on a lower rear wall of detergent tank 117. A front outer circumferential surface of detergent-side cylindrical portion 111b
20 has a plurality of packings 111c provided apart from each other. As shown in FIGS. 9 and 21, protruding rib 111e is formed in front of detergent-side cylindrical portion 111b so as to extend forward. A rear end portion of detergent-side cylindrical portion 111b is connected to water channel 124, as shown in FIG. 10A. Water channel 124 communicates with suction water
25 channel 112h of pump unit 111.

As shown in FIG. 9, outer frame 111a includes softener-side cylindrical portion 111f formed below the outer wall front surface so as to extend forward

and backward. Softener-side cylindrical portion 111f extending forward than outer frame 111a is inserted into a cylindrical portion (not shown) formed on a lower rear wall of softener tank 126. As shown in, for example, FIG. 10A, a rear end portion of softener-side cylindrical portion 111f is connected to water channel 124 so as to communicate with water channel 124.

As shown in FIGS. 9 and 11, piston pump unit 112 includes cylinder 112d, suction water channel 112h through which the liquid agent flows into cylinder 112d, discharge water channel 112g through which the liquid agent is discharged from cylinder 112d, and drive motor 112f. Drive motor 112f is provided in cylinder 112d and drives piston 112e that can reciprocally operate up and down.

That is, cylinder 112d is formed into a hollow substantially cylindrical shape (including a cylindrical shape). Piston 112e that can reciprocally operate up and down is disposed inside cylinder 112d. Piston 112e is coupled to drive motor 112f via link 112a and cam 112b. With the above configuration, rotation of drive motor 112f is transmitted to piston 112e via link 112a and cam 112b, and piston 112e reciprocally operates up and down.

Cylinder 112d is attached such that suction water channel 112h and discharge water channel 112g communicate with a lower portion of cylinder 112d. Suction water channel 112h and discharge water channel 112g are disposed below piston 112e. With this configuration, the liquid agent discharged by piston 112e can be discharged with great force.

As shown in FIG. 10A, suction water channel 112h constitutes a water channel that communicates with discharge port e of water channel 124 and sucks liquid discharged from softener-side three-way valve 113b into storage portion 112c in cylinder 112d.

As shown in FIG. 11, suction water channel 112h includes suction-side

check valve 164 provided inside suction water channel 112h. Suction-side check valve 164 has convex portion 164a formed at a lower portion of suction-side check valve 164. In addition, suction water channel 112h is provided with spring 164b that biases suction-side check valve 164 downward. Convex portion 164a is biased by spring 164b to come into contact with a shoulder of inner wall surface 112i of suction water channel 112h. This causes suction-side check valve 164 to move upward. However, suction-side check valve 164 does not move below cylinder 112d beyond a contact position with inner wall surface 112i of suction water channel 112h.

On the other hand, discharge water channel 112g constitutes a water channel that discharges liquid in cylinder 112d. As shown in FIG. 5, discharge water channel 112g is connected to branch water channel 129a of coupling hose 129.

Discharge water channel 112g includes discharge-side check valve 165 provided inside discharge water channel 112g. Discharge-side check valve 165 has convex portion 165a formed at an upper portion of discharge-side check valve 165. Discharge water channel 112g is provided with spring 165b that biases discharge-side check valve 165 upward. Convex portion 165a is biased by spring 165b to come into contact with a shoulder of inner wall surface 112j of discharge water channel 112g. This causes discharge-side check valve 165 to move downward. However, discharge-side check valve 165 does not move above cylinder 112d beyond a contact position with inner wall surface 112j of discharge water channel 112g.

In the above configuration, when piston 112e moves upward, negative pressure is generated in storage portion 112c of cylinder 112d, and hence upward force is exerted on suction-side check valve 164. At this time, if the upward force is larger than resultant force of gravitational force (own weight)

of suction-side check valve 164 and elastic force of spring 164b, suction-side check valve 164 moves upward. This forms a gap between convex portion 164a of suction-side check valve 164 and inner wall surface 112i of suction water channel 112h. As a result, liquid flowing through three-way valve unit 113
5 flows into suction water channel 112h and cylinder 112d through the gap.

On the other hand, when piston 112e moves downward, positive pressure is generated in storage portion 112c of cylinder 112d, and hence downward force is exerted on discharge-side check valve 165. At this time, if resultant force of gravitational force (own weight) of discharge-side check valve
10 165 and the downward force exerted on discharge-side check valve 165 is larger than elastic force of spring 165b that biases discharge-side check valve 165 upward, discharge-side check valve 165 moves downward. This forms a gap between convex portion 165a of discharge-side check valve 165 and inner wall surface 112j of discharge water channel 112g. As a result, liquid in
15 storage portion 112c of cylinder 112d flows into discharge water channel 112g through the gap and is discharged to branch water channel 129a.

As shown in FIG. 5, discharge water channel 112g is connected to branch water channel 129a of coupling hose 129 so as to communicate with branch water channel 129a. Coupling hose 129 is a hose that causes drain
20 port 114c of tank storage case 114 to communicate with water tub 105. Accordingly, when piston 112e moves downward, a liquid agent in storage portion 112c of cylinder 112d is discharged into water tub 105 through branch water channel 129a of coupling hose 129 communicating with discharge water channel 112g.

25 As described above, piston 112e of piston pump unit 112 repeats an up-down operation. With this operation, as shown in FIG. 24, the detergent liquid in detergent tank 117 or the softener liquid in softener tank 126 is sucked into

pump unit 111 and discharged into water tub 105.

Note that suction water channel 112h, discharge water channel 112g, and branch water channel 129a described above are disposed in an almost vertical direction (including a vertical direction) so as to cause a liquid agent and the like to freely fall.

(Tank storage case 114 (tank storage portion))

As shown in FIG. 3, tank storage case 114 constitutes a vessel having a storage portion having an opening in an upper surface. Detergent tank 117 and softener tank 126 are detachably mounted on a back side of the storage portion of tank storage case 114. Detergent case 115 is detachably mounted on a front side of the storage portion of tank storage case 114.

As shown in FIG. 21, tank storage case 114 has insertion hole 114d formed in a lower rear wall of tank storage case 114. Detergent-side cylindrical portion 111b of pump unit 111 is inserted into insertion hole 114d.

As shown in FIGS. 3 and 5, tank storage case 114 includes linear Hall elements 136 disposed on left and right side walls of tank storage case 114 and constituting a detector. Linear Hall element 136 is formed from, for example, an analog type element. Note that linear Hall element 136 is an example of a magnetic force sensor.

A side wall lower portion of tank storage case 114 is provided with lower water injection port 114g (water injection port). Lower water injection port 114g communicates with bypass water channel 184 (to be described later).

As shown in FIG. 5, tank storage case 114 has drain port 114c formed in a bottom portion of tank storage case 114. Drain port 114c is connected to one end of coupling hose 129. The other end of coupling hose 129 is swingably connected to water tub 105. Branch water channel 129a is connected to coupling hose 129 so as to branch from a midway portion of coupling hose 129

in a vertical direction. As described above, branch water channel 129a communicates with discharge water channel 112g of pump unit 111.

(Detergent tank 117 and softener tank 126)

As shown in FIG. 27, detergent tank 117 and softener tank 126
5 constitute a vessel having upper surface opening portion 118 in an upper portion. Note that detergent tank 117 and softener tank 126 will be simply referred to as the "tank" when no discrimination is made between them.

An upper peripheral edge of detergent tank 117 is provided with packing 117f. Detergent tank lid 119 constituting a tank lid is attached to an
10 upper portion of detergent tank 117 through packing 117f so as to openably cover upper surface opening portion 118. When detergent tank lid 119 is attached to an upper portion of detergent tank 117, packing 117f is crushed to water-tightly fix detergent tank 117. Even when, for example, detergent tank 117 is tilted sideways, this configuration can prevent the detergent liquid
15 inside detergent tank 117 from leaking out of detergent tank 117. Note that the packing may be provided alongside detergent tank lid 119 instead of detergent tank 117. This configuration can obtain the same effect.

As shown FIG. 27, detergent tank lid 119 has opening portion 139 formed in a front portion of detergent tank lid 119. In addition, detergent tank
20 lid 119 includes small window 119b openably covering opening portion 139 and constituting a liquid agent replenishment lid. Note that small window 119b is formed from a member having optical transparency, such as polypropylene.

As shown in FIG. 21, detergent tank 117 includes cylindrical portion 123 formed below rear wall 117a so as to extend inward (forward). Cylindrical
25 portion 123 includes check valve 123b disposed in an inner circumferential surface of cylindrical portion 123. Check valve 123b is biased backward by, for example, a spring (not shown). Check valve 123b biased in a natural state

presses an inner circumferential wall of cylindrical portion 123. Accordingly, no gap is formed between check valve 123b and the inner circumferential wall of cylindrical portion 123. This prevents the detergent liquid in detergent tank 117 from leaking out of cylindrical portion 123.

5 With the above configuration, when detergent tank 117 is mounted in tank storage case 114, detergent-side cylindrical portion 111b (corresponding to a second cylindrical portion) of automatic liquid agent injection device 109 is inserted into cylindrical portion 123 (corresponding to a first cylindrical portion). At this time, protruding rib 111e of detergent-side cylindrical portion
10 111b pushes check valve 123b forward. This forms a gap between check valve 123b and an inner wall of cylindrical portion 123. As a result, as indicated by arrows I in FIG. 21, the detergent liquid in detergent tank 117 can be discharged from cylindrical portion 123 into three-way valve unit 113.

On the other hand, when detergent tank 117 is pulled out from tank
15 storage case 114, check valve 123b is biased backward by the spring. This eliminates a gap between check valve 123b and an inner circumference of cylindrical portion 123. This prevents the detergent liquid from leaking out of detergent tank 117.

When detergent tank 117 is mounted in tank storage case 114, packing
20 111c water-tightly holds cylindrical portion 123 and detergent-side cylindrical portion 111b. When detergent tank 117 is mounted, this configuration prevents the detergent liquid from leaking out from cylindrical portion 123 of detergent tank 117 into tank storage case 114. As a result, a desired amount of detergent liquid can be discharged to drum 106 through three-way valve unit
25 113.

As shown in FIG. 27, detergent tank 117 includes grip 117g formed on a front outer wall surface of detergent tank 117. Grip 117g is provided at a

distance from a wall surface of detergent tank 117. This allows a user to grip
grip 117g. Gripping grip 117g and pulling detergent tank 117 toward the user
allows the user to pull out detergent tank 117 from tank storage case 114. In
this case, the user may grip grip 117g by, for example, inserting his or her
5 fingers into a gap between grip 117g and detergent tank 117 from above or
from below. Alternatively, for example, the user may grip grip 117g by
inserting his or her thumb into the gap between grip 117g and detergent tank
117 from above and also inserting remaining two or three fingers into the gap
from below.

10 Note that when the user grips grip 117g from below and pulls out
detergent tank 117, the user needs to insert his or her wrist into a narrow
space of a storage portion of detergent case 115. Accordingly, the wrist fits
tightly. For this reason, the user inserts his or her finger into the gap between
grip 117g and detergent tank 117 from above. This makes it possible to easily
15 pull out detergent tank 117 without making a posture of the wrist become
tight.

In addition, as shown in FIG. 12, detergent tank 117 has concave
portion 117k formed in a rear outer bottom surface of detergent tank 117 so as
to be depressed upward. Concave portion 117k includes receiving portion 117h
20 formed on a peripheral edge portion so as to extend backward. Receiving
portion 117h is constituted by extending portion 117i extending backward and
projection 117j formed on a rear end portion of extending portion 117i.

As shown in FIGS. 13 to 15, tank storage case 114 includes two guide
ribs 114h on bottom surface 120. While detergent tank 117 is mounted, guide
25 ribs 114h are formed at positions sandwiching receiving portion 117h of
detergent tank 117. When detergent tank 117 is mounted in tank storage case
114, detergent tank 117 is pushed backward while being inserted into the

storage portion of tank storage case 114. At this time, as shown in FIGS. 13 to 16, projection 117j of receiving portion 117h is placed between guide ribs 114h. This fits receiving portion 117h to guide ribs 114h, thereby fixing detergent tank 117 to tank storage case 114.

5 Note that when detergent tank 117 is not completely mounted in tank storage case 114, the detergent liquid may leak out from cylindrical portion 123 and/or detergent-side cylindrical portion 111b. This may lead to a failure to supply a desired amount of detergent liquid to water tub 105, and hence may affect washing performance.

10 Accordingly, the washing machine according to this exemplary embodiment is configured to fit receiving portion 117h of detergent tank 117 between two guide ribs 114h of tank storage case 114. This makes it possible to certainly mount detergent tank 117 into tank storage case 114. When the user mounts detergent tank 117 into tank storage case 114, projection 117j
15 passes between guide ribs 114h. For this reason, the user needs to forcibly push detergent tank 117 backward. At this time, when a distal end of projection 117j passes between guide ribs 114h, resistance felt when the user pushes detergent tank 117 decreases. This makes the user feel a sense of clicking when mounting detergent tank 117 in tank storage case 114. This
20 allows the user to recognize that receiving portion 117h is certainly inserted between guide ribs 114h. Accordingly, it is possible to more certainly prevent the detergent liquid from leaking out from cylindrical portion 123 or detergent-side cylindrical portion 111b. As a result, a desired amount of detergent liquid can be supplied to water tub 105. In addition, guide ribs 114h also have a
25 function for positioning detergent tank 117 at the time of insertion.

 This exemplary embodiment has exemplified the configuration for fixing detergent tank 117 and tank storage case 114 with receiving portion

117h and guide ribs 114h. However, this is not exhaustive. For example, detergent tank 117 may be attached to tank storage case 114 by snap fitting by pushing detergent tank 117 backward. More specifically, a ring-shaped stop member to be fitted to receiving portion 117h may be formed on tank storage
5 case 114 to enable the snap fitting.

As shown in FIG. 18A, detergent tank 117 has first longitudinal rib 138a, second longitudinal rib 138b, and third longitudinal rib 138c which are formed spaced apart from each other on an inner wall surface so as to extend upward from a bottom surface. Note that first longitudinal rib 138a, second
10 longitudinal rib 138b, and third longitudinal rib 138c will be simply referred to as the "longitudinal rib" when no discrimination is made between them.

Second longitudinal rib 138b is located behind first longitudinal rib 138a and formed shorter than first longitudinal rib 138a. Third longitudinal rib 138c is located behind second longitudinal rib 138b and formed shorter
15 than second longitudinal rib 138b. This allows the user to grasp an approximate remaining amount of detergent liquid inside detergent tank 117 by checking lengths between a surface of detergent liquid inside detergent tank 117 and upper end portions of first longitudinal rib 138a, second longitudinal rib 138b, and third longitudinal rib 138c. That is, the user can
20 easily grasp an approximate remaining amount of detergent liquid depending on how many of the three longitudinal ribs the user can see. When, for example, first longitudinal rib 138a, second longitudinal rib 138b, and third longitudinal rib 138c are all hidden in the detergent liquid and cannot be seen, the user can determine that the remaining amount of detergent liquid in
25 detergent tank 117 is large. On the other hand, when first longitudinal rib 138a and second longitudinal rib 138b are seen while only third longitudinal rib 138c is hidden in the detergent liquid and cannot be seen, the user can

determine that the remaining amount of detergent liquid has become small. In addition, when first longitudinal rib 138a, second longitudinal rib 138b, and third longitudinal rib 138c are all seen, the user can determine that the detergent liquid is becoming insufficient.

5 As shown in FIG. 18B, detergent tank 117 accommodates float portion 130a disposed on a lower surface of detergent tank lid 119. As shown in FIG. 19, float portion 130a is disposed with gaps from first longitudinal rib 138a, second longitudinal rib 138b, and third longitudinal rib 138c in a lateral direction. Float portion 130a is configured so as not to pivot forward beyond
10 third longitudinal rib 138c. This can prevent float portion 130a from hiding first longitudinal rib 138a, second longitudinal rib 138b, and third longitudinal rib 138c when the user opens small window 119b of detergent tank lid 119 and sees into opening portion 139.

 That is, as shown in FIG. 20, lengths of first longitudinal rib 138a,
15 second longitudinal rib 138b, and third longitudinal rib 138c are set in accordance with a line of sight of the user located in front of the washing machine when the user sees into detergent tank 117 through small window 119b. More specifically, first longitudinal rib 138a, second longitudinal rib 138b, and third longitudinal rib 138c are formed such that the lengths
20 decrease stepwise from a front side to a back side. This allows the user to easily visually check the upper end portions of first longitudinal rib 138a, second longitudinal rib 138b, and third longitudinal rib 138c through small window 119b when the user sees into opening portion 139 from a front side. As shown in FIG. 20, it is possible to grasp the remaining amount of detergent
25 liquid with both line of sight B (chain line) of a short person and line of sight A (dotted line) of a tall person by easily visually recognizing the upper end portions of first longitudinal rib 138a, second longitudinal rib 138b, and third

longitudinal rib 138c.

Note that softener tank 126 has the same configuration as that of detergent tank 117, and hence a description of the configuration will be omitted. The respective constituent elements of softener tank 126 correspond
5 to grip 126g, receiving portion 126h, extending portion 126i, projection 126j, concave portion 126k, softener cylindrical portion 127 (corresponding to a second cylindrical portion), guide ribs 114i (see FIG. 15) of tank storage case 114, and a cylindrical portion (not shown) (corresponding to a first cylindrical portion), as shown in FIG. 12. Like detergent tank 117, softener tank 126 also
10 includes a softener tank lid (not shown) constituting a tank lid and a small window (not shown) provided in the softener tank lid and constituting a liquid agent replenishment lid.

(Filter 122)

As shown in FIGS. 18B and 27, filter 122 is detachably provided in
15 detergent tank 117 so as to be obliquely inclined in consideration of a state described below. Filter 122 is formed from a resin such as polypropylene. Filter 122 has through holes (not shown) formed in a lattice pattern so as to extend through obverse and reverse surfaces of filter 122. Filter 122 filters the detergent liquid in detergent tank 117. This makes it possible to prevent a
20 fixed substance and the like of the detergent liquid from being clogged in cylindrical portion 123 or detergent-side cylindrical portion 111b.

That is, in general, the detergent liquid has high viscosity. For this reason, if filter 122 is horizontally disposed inside detergent tank 117, the detergent liquid may not pass through the through holes of filter 122 and may
25 remain and be fixed on a surface of filter 122. If the detergent liquid remains and is fixed on the surface of the filter 122, an appropriate amount of detergent liquid may not be discharged from detergent tank 117. In addition,

if the through holes of filter 122 are clogged with the detergent liquid, an air pool is generated in a space below filter 122 inside detergent tank 117. This may cause idling of drive motor 112f of pump unit 111 to result in failure to discharge a desired amount of detergent liquid.

5 Accordingly, in this exemplary embodiment, filter 122 is obliquely installed in detergent tank 117.

As shown in FIGS. 22 and 23B, filter 122 is constituted by a plurality of longitudinal rib portions 122e and a plurality of transverse rib portions 122f in a lattice pattern. Longitudinal rib portions 122e are formed to extend in a
10 direction oblique to a horizontal plane while filter 122 is attached to detergent tank 117. Transverse rib portions 122f are arranged on back surfaces of longitudinal rib portions 122e so as to intersect with longitudinal rib portions 122e. With the above configuration, the detergent liquid adhering to the surface of filter 122 flows toward bottom surface 120 (see FIG. 18B) of
15 detergent tank 117 along a direction of longitudinal rib portions 122e. This can prevent the detergent liquid from remaining and being fixed on the surface of filter 122. In addition, the detergent liquid passing through the through holes of filter 122 flows obliquely downward along side surfaces of transverse rib portions 122f and drops from distal end portions of transverse rib portions
20 122f. This can prevent the detergent liquid adhering to filter 122 from clogging the through holes of filter 122.

As shown in FIGS. 18A, 18B, and 23A, lower end 122d of filter 122 is bent while filter 122 is attached in detergent tank 117. Filter 122 also includes engagement pawl 122g on a back surface of filter 122. Engagement pawl 122g
25 includes extending rib 122b and convex portion 122c. Extending rib 122b is formed to extend in a back surface direction of filter 122. Convex portion 122c is formed on a distal end portion of extending rib 122b in a convex shape

backward.

On the other hand, as shown in FIG. 18A, detergent tank 117 includes hook portion 121 on bottom surface 120. Hook portion 121 is engaged with lower end 122d of filter 122. Detergent tank 117 includes protruding portion 117b formed on rear wall 117a so as to protrude to an inside of detergent tank 117. Protruding portion 117b is engaged with convex portion 122c of engagement pawl 122g of filter 122. With the above configuration, filter 122 is engaged and fixed in detergent tank 117 so as to be obliquely inclined.

A method of attaching and detaching filter 122 in and from detergent tank 117 will be described below.

First of all, filter 122 is mounted in detergent tank 117 by the following method.

More specifically, lower end 122d of filter 122 is engaged with hook portion 121 of detergent tank 117. In this engaged state, filter 122 is pushed backward in detergent tank 117, with lower end 122d being a fulcrum point, as shown in FIG. 18A. This engages engagement pawl 122g of filter 122 with protruding portion 117b of detergent tank 117. As a result, filter 122 is obliquely fixed and held in detergent tank 117.

On the other hand, filter 122 can be detached from detergent tank 117 by the following method.

More specifically, filter 122 is pushed backward in FIG. 18A and deformed. This disengages engagement pawl 122g from protruding portion 117b. As a result, filter 122 can be easily pulled out from detergent tank 117.

In addition, as shown in FIG. 22, filter 122 includes downward extending rib 122a. On the other hand, as shown in FIG. 21, detergent tank 117 includes downward recessed portion 117c formed on the bottom surface at a position near cylindrical portion 123. Downward recessed portion 117c is

provided to enable to discharge the detergent liquid even if the remaining amount of detergent liquid is small. Downward extending rib 122a is mounted in downward recessed portion 117c to prevent foreign substances such as a fixed liquid agent substance from intruding into downward recessed portion 117c.

(Detergent case 115)

As shown in FIG. 4, detergent case 115 is detachably mounted closer to a front side than detergent tank 117 and softener tank 126 in tank storage case 114 are.

As shown in FIG. 7, detergent case 115 is disposed in contact with detergent tank 117 and softener tank 126. Accordingly, when detergent case 115 is attached to tank storage case 114, detergent case 115 pushes detergent tank 117 and softener tank 126 backward. When detergent tank 117 is pushed backward, detergent-side cylindrical portion 111b is inserted into cylindrical portion 123 provided on outer frame 111a of pump unit 111. This makes it possible to certainly prevent the detergent liquid and the like from leaking out from detergent tank 117.

Likewise, softener tank 126 is also certainly mounted in tank storage case 114 by being pushed backward by detergent case 115. This makes it possible to certainly prevent the softener liquid from leaking out from softener tank 126.

As shown in FIG. 4, detergent case 115 constitutes a vessel whose upper surface is opened and includes partition wall 115a. Partition wall 115a partitions the storage portion of detergent case 115 into detergent storage portion 115b and softener storage portion 115c. This allows the user to manually inject powder detergent and softener into detergent storage portion 115b and softener storage portion 115c, respectively.

Detergent case 115 has a discharge port (not shown) formed in a bottom surface of detergent case 115. A liquid agent flowing from the discharge port is supplied to water tub 105 through tank storage case 114 and coupling hose 129.

5 Note that when washing away powder detergent injected into detergent storage portion 115b, the controller opens first water supply valve 110a shown in FIG. 24. This causes tap water supplied from a faucet to flow into first water channel 181 and a water injection channel, as indicated by arrow A1 in FIG. 24. The tap water is then injected from first upper water
10 injection port 116b into detergent storage portion 115b of detergent case 115.

On the other hand, softener storage portion 115c further includes a conventional known siphon mechanism. When causing the softener liquid injected into softener storage portion 115c to flow, the controller opens second water supply valve 110b shown in FIG. 24. This causes tap water to flow
15 through third water channel 183, as indicated by arrow A3 in FIG. 24. The tap water is then injected from second upper water injection port 116c into softener storage portion 115c of detergent case 115. Injecting water into softener storage portion 115c will raise a water level. A siphon effect provided by the siphon mechanism causes the softener liquid injected into softener
20 storage portion 115c to completely flow into water tub 105 without remaining in softener storage portion 115c.

(Configuration of water injection case 116 and configuration of water channels)

As shown in FIGS. 3 and 4, tank storage case 114 includes water injection case 116 through which tap water flows and disposed at an upper
25 portion of tank storage case 114. Water injection case 116 has pawl portions 116a, which are engaged with engagement portions 114m of tank storage case 114. This fixes water injection case 116 to tank storage case 114.

As shown in FIG. 24, water injection case 116 communicates with a water injection channel communicating with first water supply valve 110a and a water injection channel communicating with second water supply valve 110b. In addition, water injection case 116 has first upper water injection port 116b and second upper water injection port 116c formed on a front side. First upper water injection port 116b and second upper water injection port 116c communicate with the water injection channel. Water injection case 116 further includes third upper water injection port 116d (corresponding to a second water injection port) formed on a back side.

As shown in FIG. 24, first water channel 181 constitutes a water channel through which water flowing from first water supply valve 110a flows through water injection case 116 and is injected from first upper water injection port 116b into detergent storage portion 115b of detergent case 115. That is, when the controller opens first water supply valve 110a, tap water flows through first water channel 181 and is injected from first upper water injection port 116b into detergent storage portion 115b. In addition, first water channel 181 branches second water channel 182 on an upstream side of water injection case 116.

Second water channel 182 constitutes a water channel through which water flows into branch water channel 129a of coupling hose 129 through three-way valve unit 113 and pump unit 111. Second water channel 182 branches such that bypass water channel 184 extends vertically downward on an upstream side of three-way valve unit 113. Bypass water channel 184 communicates with lower water injection port 114g (water injection port) of tank storage case 114.

In general, an opening and closing portion of detergent-side three-way valve 113a sometimes cannot be completely closed due to clogging with foreign

substances or a temporal change. In this case, the detergent liquid in detergent tank 117 may flow back in second water channel 182. With the water channel configuration according to this exemplary embodiment, the liquid agent flowing back in second water channel 182 flows to bypass water channel 184. This makes it possible to certainly prevent the liquid agent from flowing back to a water supply faucet.

As shown in FIG. 24, third water channel 183 constitutes a water channel in which tap water flowing from second water supply valve 110b flows through water injection case 116 and is injected from second upper water injection port 116c into softener storage portion 115c of detergent case 115.

That is, when the controller opens second water supply valve 110b, tap water flows through third water channel 183. The tap water is then injected from second upper water injection port 116c into softener storage portion 115c of detergent case 115.

As shown in FIG. 24, third water channel 183 branches to branch water channel 185 at third branch point 183a. Branch water channel 185 communicates with third upper water injection port 116d. This causes part of tap water flowing through third water channel 183 to flow through branch water channel 185. The tap water is then injected from third upper water injection port 116d toward inclined surface 114j in a direction indicated by arrow D in FIG. 8. The injected water flows on inclined surface 114j to cylindrical portion 123 and detergent-side cylindrical portion 111b.

Each water channel is formed in the above manner.

(Back-flow prevention device 170)

FIG. 26 is a sectional view of back-flow prevention device 170 of automatic liquid agent injection device 109 of washing machine 100 according to the same exemplary embodiment.

As shown in FIG. 24, back-flow prevention device 170 is provided on an upstream side of first branch point 181a of first water channel 181. When detergent liquid in detergent tank 117 or softener liquid in softener tank 126 flows back through second water channel 182 due to a power outage, water
5 outage, or the like, back-flow prevention device 170 prevents a liquid agent from flowing back to the water supply faucet. Back-flow prevention device 170 is constituted by, for example, outer frame 111a, aspirator 172, and upper lid 177.

As shown in FIG. 9, upper lid 177 is disposed to cover an upper portion
10 of outer frame 111a. In this case, as shown in FIG. 26, water flow channel 171 is formed from a space surrounded by the upper portion of outer frame 111a and upper lid 177. Water flow channel 171 causes water flowing from water supply channel 110c and passing through first water supply valve 110a to flow from back to front.

Aspirator 172 is disposed in water flow channel 171, as shown in FIGS.
15 9 and 26. Aspirator 172 is welded and fixed to a lower surface of upper lid 177. Aspirator 172 is configured so as to have a substantially rectangular cross-section (including a rectangular cross-section) and increase in inner diameter toward front and back.

Inflow water channel 173, negative pressure generator 174, outflow
20 water channel 175, and the like are formed in water flow channel 171. Inflow water channel 173 is formed on an upstream side of aspirator 172. Negative pressure generator 174 is constituted by a water channel formed in aspirator 172 and having a small inner diameter. Outflow water channel 175 is formed
25 on a downstream side of aspirator 172 so as to have a larger inner diameter than the inner diameter of negative pressure generator 174. More specifically, height dimension L1 of inflow water channel 173 is, for example, 12.12 mm,

height dimension L2 of negative pressure generator 174 is, for example, 1.9 mm, and height dimension L5 of outflow water channel 175 is, for example, 15 mm. Negative pressure generator 174 is formed to have an inner diameter smaller than inner diameters of inflow water channel 173 and outflow water channel 175. The above configuration increases a flow rate of water flowing through water flow channel 171 at negative pressure generator 174 having the small water channel diameter due to a Venturi effect.

Aspirator 172 has air inlet 174a formed in negative pressure generator 174. Diameter L3 of air inlet 174a is, for example, 2.5 mm. Upper lid 177 has protruding portion 177a formed so as to surround air inlet 174a and internally have cavity 177d.

Protruding portion 177a internally has a through hole and is connected to connecting portion 177b, as shown in FIG. 25. Connecting portion 177b has opening 177c in an end portion. Opening 177c is connected to one end of atmosphere introduction hose 176 shown in FIGS. 3 to 5. The other end of atmosphere introduction hose 176 is connected to and communicates with an upper portion of tank storage case 114 through connecting port 176a. With this configuration, tank storage case 114 is opened to atmosphere. The above configuration makes negative pressure generator 174 communicate with tank storage case 114 through air inlet 174a of aspirator 172. This also causes negative pressure generator 174 to be opened to atmosphere.

As shown in FIG. 26, aspirator 172 is configured such that a height of inner circumferential upper portion 172b of a water channel on a downstream side of air inlet 174a is higher than a height of inner circumferential upper portion 172a of a water channel on an upstream side of air inlet 174a. This forms step m between the water channel on the downstream side of air inlet 174a and the water channel on the upstream side of air inlet 174a. In this

exemplary embodiment, step m has a height dimension of, for example, 0.9 mm.

An upper peripheral edge of air inlet 174a of negative pressure generator 174 is formed into chamfered portion 174b. Chamfered portion 174b is formed so as to decrease in diameter from protruding portion 177a to negative pressure generator 174.

[1-1-3. Configuration of bathwater pump]

Bathwater pump 140 is disposed behind tank storage case 114, as shown in FIG. 3. Bathwater pump 140 sucks bathwater in a bathtub through a bathwater hose (not shown) and supplies the bathwater to water tub 105.

As shown in FIG. 24, first water channel 181 branches at second branch point 181b in water injection case 116 and communicates with one end of auxiliary hose 141 (auxiliary water channel) through a water injection case hole (not shown) in a rear wall of water injection case 116. On the other hand, the other end of auxiliary hose 141 communicates with a suction port (not shown) of bathwater pump 140.

As shown in FIG. 3, a discharge port (not shown) of bathwater pump 140 communicates with one end of discharge hose 142 (discharge water channel). The other end of discharge hose 142 communicates with hole 114k formed in a rear wall of tank storage case 114 and constituting a first water injection port.

With this configuration, in a washing step, water flowing through first water channel 181 flows from second branch point 181b to auxiliary hose 141 and becomes auxiliary water for bathwater pump 140. When bathwater pump 140 is filled with the auxiliary water, the bathwater is sucked through bathwater pump 140. The bathwater flows from hole 114k into tank storage case 114 through discharge hose 142, as indicated by arrow A in FIG. 3. The

inflowing bathwater flows on inclined surface 114j behind tank storage case 114 in directions indicated by arrow B in FIG. 3 and arrow E in FIG. 8.

That is, disposing bathwater pump 140 at a position where the water injection case hole faces hole 114k can shorten lengths of auxiliary hose 141 and discharge hose 142. This can reduce a concern of water leakage due to breakage of auxiliary hose 141 and discharge hose 142 and achieve a reduction in cost.

[1-1-4. Configuration of remaining amount detector]

A configuration of a remaining amount detector of washing machine 100 according to this exemplary embodiment will be described below with reference to FIGS. 28 to 30.

FIG. 28 is an exploded perspective view of detergent tank lid 119 and float portion 130a of washing machine 100 according to this exemplary embodiment when viewed from below. FIG. 29 is a perspective view of detergent tank 117 of washing machine 100 when viewed from above. FIG. 30 shows a relationship between magnetic flux density received by linear Hall element 136 and an output voltage from linear Hall element 136.

Automatic liquid agent injection device 109 includes, for example, first remaining amount detector 130 and a second remaining amount detector (not shown). First remaining amount detector 130 detects an amount of detergent in detergent tank 117. The second remaining amount detector detects an amount of softener in softener tank 126. Note that first remaining amount detector 130 and the second remaining amount detector will be simply referred to as the "remaining amount detector" when no discrimination is made between them.

First remaining amount detector 130 is constituted by float portion 130a, linear Hall element 136, and the like described below. The second

remaining amount detector has the same configuration as that of first remaining amount detector 130, and a description of the configuration will be omitted.

(Float portion 130a)

5 As shown in FIG. 28, detergent tank lid 119 includes first bearing portion 119c and second bearing portion 119e formed parallel at separate positions on the lower surface of detergent tank lid 119. First hole 119d and second hole 119f are respectively formed in first bearing portion 119c and second bearing portion 119e.

10 Float portion 130a includes link 133, pivot shaft 131 provided on an upper end of link 133, and magnet box 135 provided on a lower end of link 133. Pivot shaft 131 includes first pivot shaft 131a and second pivot shaft 131b. First pivot shaft 131a is pivotally inserted in first hole 119d. Second pivot shaft 131b is pivotally inserted in second hole 119f. With this configuration,
15 pivot shaft 131 of float portion 130a is pivotally disposed on the lower surface of detergent tank lid 119.

 At this time, second hole 119f is formed to have a larger diameter than first hole 119d. First pivot shaft 131a is formed to have a diameter matching a diameter of first hole 119d. Likewise, second pivot shaft 131b is formed to
20 have a diameter matching a diameter of second hole 119f. This makes it possible to prevent first pivot shaft 131a from being erroneously inserted into second hole 119f or to prevent second pivot shaft 131b from being erroneously inserted into first hole 119d.

 First bearing portion 119c is formed at a height position higher than a
25 height position, in the vertical direction, at which second bearing portion 119e is formed.

 Link 133 of float portion 130a has stopper rib 132 formed near second

pivot shaft 131b. If first pivot shaft 131a is erroneously inserted into second hole 119f or second pivot shaft 131b is erroneously inserted into first hole 119d, stopper rib 132 comes into contact with first bearing portion 119c. This disables float portion 130a to pivot. This allows the user to easily grasp erroneous mounting of float portion 130a.

As shown in FIG. 27, magnet box 135 has a hollow interior and constitutes a sealed hollow vessel together with cover 135a. Magnet box 135 internally has first magnet 134a and second magnet 134b. Note that first magnet 134a and second magnet 134b will be simply referred to as the "portion to be detected" or "magnet" when no discrimination is made between them. In addition, the magnet is an example of a "magnetic force generator" or "magnetic body".

First magnet 134a and second magnet 134b are hermetically encapsulated by magnet box 135 and cover 135a. This prevents the detergent liquid from infiltrating magnet 134. Magnet box 135 has holding rib 135c (see FIG. 27) that is formed inside magnet box 135 to hold first magnet 134a and second magnet 134b.

Note that magnet box 135 internally has a hollow structure and hence receives buoyant force in the detergent liquid. This makes float portion 130a float on a liquid level of the detergent liquid in detergent tank 117 under normal conditions. This causes pivot shaft 131 of float portion 130a to pivot in the vertical direction in accordance with a change in level of the detergent liquid.

As shown in FIG. 28, magnet box 135 has receiving portion 135b formed in, for example, a U-shape on a lower portion of magnet box 135. On the other hand, detergent tank 117 includes magnet stopper 137 formed on an inner bottom surface of detergent tank 117. Magnet stopper 137 is formed to

have a U-shaped round portion so as to make abutment portion 137a abutting against receiving portion 135b fit in receiving portion 135b. Magnet stopper 137 comes into contact with receiving portion 135b when the remaining amount of detergent in detergent tank 117 becomes an amount of detergent liquid that is determined as insufficient.

That is, when the level of detergent liquid in detergent tank 117 decreases, float portion 130a pivots downward, and receiving portion 135b comes into contact with magnet stopper 137. This prevents float portion 130a from pivoting downward beyond magnet stopper 137. That is, even when the liquid level of detergent liquid in detergent tank 117 further lowers from a predetermined amount of detergent liquid that is determined as insufficient, magnet box 135 does not further pivot downward. Accordingly, an output voltage from linear Hall element 136 does not change, and linear Hall element 136 outputs a voltage near $(1/2) V_{dd}$ that is a set output voltage value (to be described later).

U-shaped receiving portion 135b comes into surface contact with magnet stopper 137 having a shape similar to receiving portion 135b. Coming into contact with magnet stopper 137 will suppress backlash of receiving portion 135b in longitudinal and lateral directions and stably support float portion 130a. Even if a position of float portion 130a is shifted in the lateral direction, U-shaped receiving portion 135b serves as a guide for magnet stopper 137. This makes it possible to more certainly guide magnet box 135 to a desired position.

(Linear Hall element 136)

As shown in FIG. 5, linear Hall elements 136 constituting detectors are respectively provided on lower portion sides of outer surfaces of left and right side walls of tank storage case 114. Each linear Hall element 136 outputs a

voltage corresponding to a detected magnetic flux density. Note that linear Hall element 136 is an example of a magnetic force sensor.

In general, linear Hall element 136 has a characteristic shown in FIG. 30. With reference to FIG. 30, an abscissa represents magnetic flux density detected by linear Hall element 136, and an ordinate represents an output voltage value from linear Hall element 136.

Upon detecting magnetic flux density near 0 (zero) Wb/m², linear Hall element 136 outputs a voltage of (1/2) V_{dd} (V) corresponding to half of maximum voltage value V_{dd} (V). Note that a state in which magnetic force is near 0 (zero) Wb/m² indicates a state in which the magnetic body is separated from linear Hall element 136 by a distance at which linear Hall element 136 cannot detect magnetic force of the magnetic body.

When a magnetic body having north magnetic polarity approaches linear Hall element 136 in the above state, linear Hall element 136 detects strong north magnetic force. Accordingly, an output voltage from linear Hall element 136 becomes higher than (1/2) V_{dd}. That is, as the detected north magnetic force increases, the output voltage increases toward a direction indicated by arrow O in FIG. 30.

In contrast, when a magnetic body having south magnetic polarity approaches linear Hall element 136, linear Hall element 136 detects strong south magnetic force. Accordingly, the output voltage from linear Hall element 136 becomes lower than (1/2) V_{dd}. That is, as the detected south magnetic force increases, the output voltage decreases toward a direction indicated by arrow N in FIG. 30.

As described above, linear Hall element 136 is provided on a lower portion side of a side wall outer surface of tank storage case 114. Accordingly, when the level of detergent liquid in detergent tank 117 decreases, a distance

between linear Hall element 136 and magnet box 135 decreases. This changes the output voltage from linear Hall element 136, and hence it is possible to detect a change in the level of detergent liquid in detergent tank 117.

Note that if linear Hall element 136 is disposed on an outer bottom surface side of detergent tank 117, the detergent remains on an inner bottom surface of detergent tank 117, and hence linear Hall element 136 cannot detect a reduction in detergent liquid in detergent tank 117. For this reason, this exemplary embodiment has linear Hall element 136 provided on an outer side of a side wall of tank storage case 114. This can prevent the above detection error because the detergent flows down along an inner surface of the side wall.

[1-2. Operation and function]

An operation and function of washing machine 100 having the above configuration will be described below.

[1-2-1. Washing Operation]

A washing operation of washing machine 100 according to this exemplary embodiment will be described first.

In general, the washing operation of washing machine 100 includes a washing step, a rinsing step, a spin-drying step, and a drying step. In the washing step, clothes are soaked with washing water, and drum 106 is rotated to clean the clothes. In the rinsing step, the clothes soaked with detergent liquid is rinsed to remove the detergent liquid. In the spin-drying step, the wet clothes are dehydrated. In the drying step, warm air is supplied to drum 106 to dry the clothes in drum 106.

First of all, before starting the washing operation of washing machine 100, the user injects the detergent liquid into detergent tank 117 and injects softener liquid into softener tank 126.

More specifically, when replenishing the detergent liquid into

detergent tank 117, the user opens lid body 114a and removes detergent tank 117 from tank storage case 114. The user then opens detergent tank lid 119, injects the detergent liquid into detergent tank 117, and returns detergent tank 117 into tank storage case 114. Note that the user may directly inject the
5 detergent liquid into detergent tank 117 without removing detergent tank 117 from tank storage case 114.

Likewise, when replenishing the softener liquid into softener tank 126, the user opens lid body 114a and removes softener tank 126 from tank storage case 114. The user opens softener tank lid 128, injects the softener liquid into
10 softener tank 126, and returns softener tank 126 into tank storage case 114. Note that the user may directly inject the softener liquid into softener tank 126 without removing softener tank 126 from tank storage case 114.

In this case, lid body 114a, detergent tank lid 119, and softener tank lid 128 of washing machine 100 according to this exemplary embodiment are
15 configured to be opened and closed while vertically pivoting by using, for example, a hinge mechanism. Accordingly, when closing detergent tank lid 119 and softener tank lid 128 in an open state, the user can close detergent tank lid 119 and softener tank lid 128 in the same manner by closing lid body 114a.

When starting the washing operation, the user opens lid body 102 and
20 loads clothes into drum 106 through clothes load and unload port 103.

The user then turns on a power switch by operating operation display unit 104 and sets various types of washing courses and washing conditions such as washing, rinsing, and spin-drying. At this time, the user can set washing courses, such as "only washing", "only rinsing", and "only spin-drying".

25 An operation in "washing course" will be described below.

In "washing course", the controller controls to sequentially execute a cloth amount determination step, water supply step, washing step, rinsing

step, and spin-drying step.

First of all, in the cloth amount determination step, the controller causes the cloth amount determination unit to measure a torque current value when repeatedly rotating the tub rotating motor in forward and reverse
5 directions at a predetermined rotation speed. The cloth amount determination unit detects a cloth amount in drum 106 from the measured torque current value.

The controller then drives pump unit 111 to automatically inject an amount of detergent liquid which is calculated by the liquid agent load amount
10 calculator from detergent tank 117 into drum 106.

The controller then executes the water supply step of opening first water supply valve 110a and supplying an amount of tap water which corresponds to the detected cloth amount into drum 106.

Upon completion of the water supply step, the controller drives the tub
15 rotating motor to rotate drum 106 clockwise and counterclockwise. With this operation, the controller executes the washing step of agitating laundry in drum 106.

Upon completion of the washing step, the controller executes the spin-drying step, and then executes the rinsing step.

20 Note that in the rinsing step, the controller opens first water supply valve 110a and supplies a predetermined amount of tap water into water tub 105. Subsequently, the controller drives pump unit 111 to automatically supply an amount of softener liquid which is calculated by the liquid agent load amount calculator from softener tank 126 into water tub 105.

25 Upon supplying the detergent liquid or the softener liquid, the controller washes away detergent and softener liquid remaining in detergent tank 117, softener tank 126, and the water channel by supplying tap water to

the water channel. This prevents the detergent liquid and the softener liquid in detergent tank 117, softener tank 126, and the water channel from being fixed.

Upon completion of the rinsing step, the controller executes the spin-drying step. This completes a series of operations in the washing course.

[1-2-2. Water supply method and liquid agent supply method using automatic liquid agent injection device]

A water supply method and a liquid agent supply method with respect to water tub 105 will be described in detail below.

First of all, in the washing step, tap water is supplied to water tub 105.

As shown in FIG. 24, when supplying tap water, the controller opens first water supply valve 110a and closes second water supply valve 110b. In addition, the controller deenergizes detergent-side coil 113d, softener-side coil 113i, and drive motor 112f. With this operation, tap water supplied from a faucet of a tap water pipe and the like flows through first water channel 181 shown in FIG. 24 and is supplied to water tub 105 through tank storage case 114, coupling hose 129, and the like.

Upon completion of water supply, the controller supplies the detergent liquid from detergent tank 117 into water tub 105. In this case, as shown in FIG. 10B, the controller energizes detergent-side coil 113d and drive motor 112f and deenergizes softener-side coil 113i. This causes detergent tank 117 to communicate with suction water channel 112h of pump unit 111. At this time, check valve 123b in cylindrical portion 123 of detergent tank 117 moves backward. This causes the detergent liquid in detergent tank 117 to flow from cylindrical portion 123 into suction water channel 112h of pump unit 111 through detergent-side cylindrical portion 111b, detergent-side three-way valve 113a, and softener-side three-way valve 113b.

As shown in FIG. 11, the controller then drives drive motor 112f of piston pump unit 112 to vertically reciprocate piston 112e in cylinder 112d. This alternately generates negative pressure and positive pressure in cylinder 112d.

5 At this time, when piston 112e moves upward, the negative pressure is generated in cylinder 112d. This moves suction-side check valve 164 upward to cause the detergent liquid to flow into storage portion 112c in cylinder 112d through a gap between suction-side check valve 164 and suction water channel 112h. When piston 112e moves downward, the positive pressure is generated
10 in cylinder 112d. This moves discharge-side check valve 165 downward. Accordingly, the detergent liquid in storage portion 112c in the cylinder is discharged directly below to branch water channel 129a through a gap between discharge-side check valve 165 and inner wall surface 112j of discharge water channel 112g, as indicated by arrow C in FIG. 7. The
15 discharged detergent liquid flows through branch water channel 129a of coupling hose 129, which is disposed in the vertical direction, so as to be supplied to water tub 105.

As described above, piston 112e repeatedly moves up and down for a predetermined period of time to supply a predetermined amount of detergent
20 liquid to water tub 105. At this time, second water channel 182 communicates with water tub 105. While lid body 102 is open, an inside of water tub 105 is open to atmosphere under normal conditions. For this reason, in a water channel through which the liquid agent flows from piston pump unit 112 to water tub 105, the liquid agent may be dried, fixed, and deposited.

25 Accordingly, in washing machine 100 according to this exemplary embodiment, discharge water channel 112g of piston pump unit 112 is connected to branch water channel 129a of coupling hose 129. This causes the

detergent liquid to be discharged while freely falling vertically toward water tub 105 without flowing through a water injection channel of water injection case 116 in tank storage case 114 (see arrow C in FIG. 7). This shortens a length of discharge water channel 112g and prevents a water channel from being complicated. It is therefore possible to effectively prevent, for example, fixation of the detergent liquid in the water channel.

Upon completion of injection of the detergent liquid, as shown in FIG. 10A, the controller deenergizes detergent-side coil 113d and softener-side coil 113i. At the same time, the controller opens first water supply valve 110a for a predetermined period of time (for example, 10 sec). This causes water flowing from first water channel 181 to second water channel 182 to flow into three-way valve unit 113 and pump unit 111. As a result, the inflowing water can wash away the detergent liquid remaining in three-way valve unit 113, pump unit 111, and coupling hose 129.

In general, at the start of water supply, force of flowing tap water is weak. This may fail to sufficiently move suction-side check valve 164 and discharge-side check valve 165 of piston pump unit 112 to block a flow of supplied water. Accordingly, this exemplary embodiment may be configured to drive motor 112f for a predetermined period of time (for example, 20 sec) after starting to open first water supply valve 110a. The above configuration makes piston 112e of piston pump unit 112 vertically reciprocate to alternately generate the positive pressure and the negative pressure in storage portion 112c in the cylinder. This makes it possible to sufficiently move suction-side check valve 164 and discharge-side check valve 165 and cause tap water to flow into pump unit 111 with great force. As a result, the detergent liquid remaining in three-way valve unit 113, pump unit 111, coupling hose 129, and the like can be washed away more certainly.

As shown in FIG. 5, in washing machine 100 according to this exemplary embodiment, discharge water channel 112g of pump unit 111 communicates with water tub 105 through coupling hose 129 without passing through tank storage case 114. This can prevent the liquid agent from remaining and being fixed in a water channel from pump unit 111 to water tub 105.

On the other hand, as shown in FIG. 10C, when supplying the softener liquid from softener tank 126, the controller energizes softener-side coil 113i and drive motor 112f and deenergizes detergent-side coil 113d. Note that a softener liquid supply method is the same as the detergent liquid supply method, and hence a description of the method will be omitted.

In the above configuration, when foreign substances are caught in an opening and closing portion of detergent-side three-way valve 113a, a gap may be formed in the opening and closing portion of detergent-side three-way valve 113a. At this time, if, for example, power outage or water outage occurs while first water supply valve 110a is open, the detergent liquid in detergent tank 117 may flow from the gap in the opening and closing portion of detergent-side three-way valve 113a and flow back in second water channel 182 toward the water supply faucet.

As shown in FIG. 24, second water channel 182 of washing machine 100 according to this exemplary embodiment is provided with bypass water channel 184 branching downward. In addition, lower water injection port 114g that is a water outlet of bypass water channel 184 is disposed below detergent tank 117. The detergent liquid flowing back from detergent tank 117 through detergent-side three-way valve 113a therefore flows through bypass water channel 184 indicated by arrow A4 in FIG. 24. The detergent liquid then flows to water tub 105 through tank storage case 114 and coupling hose 129. This

prevents the detergent liquid from flowing back to the water supply faucet. This can prevent the detergent liquid from causing failures in the water supply faucet.

5 In this case, tap water flowing through bypass water channel 184 flows into tank storage case 114. Accordingly, at the time of water supply, the tap water can be used to wash away the detergent liquid fixed to tank storage case 114.

Note that it is also possible to prevent softener in softener tank 126 from flowing back in the same manner as the detergent liquid, and hence a description will be omitted.

[1-2-3. Method of supplying manually injected detergent and softener into water tub]

15 A method of supplying powder detergent and softener into water tub 105 when the user sets a manual detergent injection mode will be described below.

First of all, as shown in FIG. 24, when supplying the powder detergent, which is manually injected by the user into detergent case 115, to water tub 105, the controller opens first water supply valve 110a and closes second water supply valve 110b. At this time, as indicated by arrow A1 in FIG. 24, tap water supplied from the faucet flows through first water channel 181 and is injected from first upper water injection port 116b to detergent storage portion 115b of detergent case 115. This causes the powder detergent in detergent storage portion 115b to flow from drain port 114c to coupling hose 129, together with the injected tap water, and be supplied into water tub 105.

25 As indicated by arrow A2 in FIG. 24, the tap water supplied from the faucet to first water channel 181 is supplied to second water channel 182 at first branch point 181a. As indicated by arrow A4 in FIG. 24, the tap water

flowing through second water channel 182 flows into bypass water channel 184 and is supplied from lower water injection port 114g to an inner bottom surface of tank storage case 114. This causes water injected from an upper side and water injected from a lower side to be supplied to tank storage case 114. As a
5 result, the powder detergent injected into detergent storage portion 115b is washed away to coupling hose 129 without remaining in tank storage case 114.

On the other hand, when supplying the softener, which is manually injected by the user into softener storage portion 115c of detergent case 115, to water tub 105, the controller controls to close first water supply valve 110a and,
10 at the same time, controls to open second water supply valve 110b. This causes the tap water supplied from the faucet to flow through third water channel 183 and to be injected from second upper water injection port 116c to softener storage portion 115c of detergent case 115, as indicated by arrow A3 in FIG. 24. This raises the level of water in softener storage portion 115c. The
15 siphon effect provided by the siphon mechanism causes the softener liquid to outflow to tank storage case 114 without remaining in softener storage portion 115c. The softener liquid outflowing to tank storage case 114 flows from drain port 114c to coupling hose 129 and is supplied into water tub 105.

[1-2-4. Function of back-flow prevention device 170]

20 A function of back-flow prevention device 170 will be described below with reference to FIG. 26.

Negative pressure generator 174 of back-flow prevention device 170 shown in FIG. 26 is formed so as to have a smaller inner diameter than inflow water channel 173 and outflow water channel 175. This increases a flow rate
25 of tap water passing through negative pressure generator 174. Accordingly, a so-called Venturi effect generates negative pressure in negative pressure generator 174 as compared with inflow water channel 173 and outflow water

channel 175.

In this case, atmospheric pressure is set to P_0 (N/m²), and water pressure of tap water flowing in inflow water channel 173 is set to $P + P_0$ (N/m²). In this case, when dynamic pressure of tap water flowing in negative pressure generator 174 becomes more than or equal to P (N/m²), static pressure in negative pressure generator 174 becomes less than or equal to P_0 (N/m²). In this exemplary embodiment, tank storage case 114 is open to atmosphere. For this reason, a pressure on a side closer to atmosphere introduction hose 176 (see FIG. 4) than air inlet 174a is P_0 (N/m²).

Fluid flows from a high-pressure side to a low-pressure side under normal conditions. In this case, in this exemplary embodiment, a diameter of a water channel in aspirator 172 is designed to make the static pressure in negative pressure generator 174 become less than or equal to atmospheric pressure P_0 (N/m²). This causes tap water flowing to water flow channel 171 to flow to outflow water channel 175 without outflowing from air inlet 174a to protruding portion 177a of upper lid 177. On the other hand, air is introduced into negative pressure generator 174 through air inlet 174a open to atmosphere. Accordingly, tap water outflowing from aspirator 172 to outflow water channel 175 becomes a gas-liquid mixture.

When negative pressure is generated in the water supply channel due to power outage or water outage, the detergent liquid in detergent tank 117 and the softener liquid in softener tank 126 may flow back to a water supply faucet side. In this case, in this exemplary embodiment, air is introduced from air inlet 174a into negative pressure generator 174 through atmosphere introduction hose 176 open to atmosphere. This blocks a flow of tap water between inflow water channel 173 and outflow water channel 175. Accordingly, tap water in water flow channel 171 is separated into water flowing from air

inlet 174a to inflow water channel 173 and water flowing from air inlet 174a to outflow water channel 175. This makes it possible to prevent the detergent liquid in detergent tank 117 on a downstream side of outflow water channel 175 and the softener liquid in softener tank 126 from flowing back to the tap water faucet (water supply faucet).

In this exemplary embodiment, negative pressure generator 174 is provided with step m such that a water channel on a downstream side of air inlet 174a is larger in inner diameter than a water channel on an upstream side of air inlet 174a. With this configuration, tap water flowing through water flow channel 171 is discharged from a water channel (inner circumferential upper portion 172a) on an upstream side of air inlet 174a to a water channel (inner circumferential upper portion 172b) on a downstream side of air inlet 174a. At the same time, air is sucked from air inlet 174a. This can suppress outflow of tap water from air inlet 174a of negative pressure generator 174 into cavity 177d of protruding portion 177a.

In this exemplary embodiment, air inlet 174a has chamfered portion 174b formed on a peripheral edge of air inlet 174a so as to decrease in diameter toward negative pressure generator 174. With this configuration, at the time of passing water, even when water is splashed from air inlet 174a to atmosphere introduction hose 176, water droplets drop on chamfered portion 174b and flow toward negative pressure generator 174. This can prevent air inlet 174a from being clogged with water droplets.

In this exemplary embodiment, aspirator 172 is constituted by one component. This makes it possible to form back-flow prevention device 170 with a simple structure. It is therefore possible to prevent deterioration in performance due to assembly variation of back-flow prevention device 170. This configuration is free from time-dependent changes among components

unlike back-flow prevention device 170 constituted by a plurality of components. This makes it possible to greatly reduce a risk of failure during long-term use of back-flow prevention device 170.

[1-2-5. Maintenance of coupling portions between detergent tank and
5 automatic liquid agent injection device]

When executing washing in a manual washing mode upon manually injecting powder detergent into detergent storage portion 115b and softener into softener storage portion 115c, the user supplies detergent and softener into water tub 105 through drain port 114c of tank storage case 114. In this
10 case, the detergent and softener may remain in tank storage case 114 even after completion of washing. The remaining detergent and softener may adhere and be fixed to cylindrical portion 123 and detergent-side cylindrical portion 111b as coupling portions between detergent tank 117 and automatic liquid agent injection device 109. The adhering and fixed substances may peel
15 off when detergent tank 117 is pulled out from tank storage case 114 and enter a detergent supply water channel of automatic liquid agent injection device 109, resulting in narrowing the channel. This may cause a pressure loss in a water channel. In addition, fixed substances of a liquid agent and the like may adhere to packing 111c between cylindrical portion 123 and detergent-side
20 cylindrical portion 111b to result in failure in water tightness of the coupling portion.

For the above reasons and the like, washing performance and rinsing performance may deteriorate due to a failure to discharge a necessary amount of detergent liquid from detergent tank 117.

25 This makes it necessary to periodically maintain detergent tank 117 and automatic liquid agent injection device 109.

In this exemplary embodiment, however, as shown in FIG. 3, water

injection case 116 is provided in an upper portion of tank storage case 114. This makes it difficult to maintain cylindrical portion 123 and detergent-side cylindrical portion 111b disposed near a rear wall of tank storage case 114, thus imposing a heavy burden on the user.

5 In washing machine 100 according to this exemplary embodiment, as shown in FIGS. 3 and 24, at the time of supplying water in the washing step, water flowing through first water channel 181 is caused to flow into auxiliary hose 141 at second branch point 181b. The inflowing water flows through bathwater pump 140 and discharge hose 142 and is injected into tank storage
10 case 114 through hole 114k behind tank storage case 114, as indicated by arrow A in FIG. 3. The injected water flows along inclined surface 114j of a back side surface of tank storage case 114, as indicated by arrow B in FIG. 3 and arrow E in FIG. 8. The water flowing along inclined surface 114j flows toward cylindrical portion 123 and detergent-side cylindrical portion 111b as
15 coupling portions between tank storage case 114 and automatic liquid agent injection device 109.

With the above configuration, water injected from hole 114k washes away contamination from the coupling portions between detergent tank 117 and automatic liquid agent injection device 109 every time water is supplied.
20 This makes it unnecessary for the user to perform periodic maintenance, for example, removing contamination from the coupling portions.

The injected water washes away contamination adhering to packing 111c. This maintains water tightness of the coupling portions between cylindrical portion 123 and detergent-side cylindrical portion 111b. This
25 makes it possible to prevent the detergent liquid from leaking from detergent tank 117 and discharge a necessary amount of detergent liquid to water tub 105. In addition, it is possible to prevent residues from entering detergent-side

cylindrical portion 111b. As a result, it is possible to prevent a pressure loss in the water channel and stably discharge a necessary amount of detergent liquid to water tub 105.

Water injected from hole 114k is supplied from drain port 114c to water tub 105 through coupling hose 129. This makes it possible to maintain portions around cylindrical portion 123 and detergent-side cylindrical portion 111b by using water used in the washing step. This makes it unnecessary to use a dedicated water supply valve for washing away contamination from tank storage case 114 and hoses and the like constituting water channels, and hence makes it possible to suppress an increase in cost.

As shown in FIG. 24, at the time of supplying water in the rinsing step, water flowing through third water channel 183 flows into branch water channel 185 at third branch point 183a. The inflowing water flows from third upper water injection port 116d to a back side of tank storage case 114, as indicated by arrow D in FIG. 8. The inflowing water flows toward cylindrical portion 123 and detergent-side cylindrical portion 111b as the coupling portions between tank storage case 114 and automatic liquid agent injection device 109 while flowing along inclined surface 114j of the back side surface of tank storage case 114. This can wash portions around cylindrical portion 123 and detergent-side cylindrical portion 111b. That is, it is possible to obtain the same effects as those at the time of supplying water in the washing step.

In the washing step, when the user selects a "bathwater course" of supplying bathwater to water tub 105, the controller actuates bathwater pump 140 upon completion of automatic detergent injection. This causes part of water supplied from first water supply valve 110a to first water channel 181 to flow into bathwater pump 140 from auxiliary hose 141 at second branch point 181b. A hose (not show) having one end communicating with bathwater pump

140 and the other end put in the bath tub (not shown) is filled with tap water flowing into bathwater pump 140. In this state, when bathwater pump 140 is driven, bathwater in the bath tub is sucked into bathwater pump 140 through the hose. The sucked bathwater flows into tank storage case 114 from hole 5 114k behind tank storage case 114 through discharge hose 142, as indicated by arrow A in FIG. 3. The bathwater flowing into tank storage case 114 flows along inclined surface 114j and flows toward cylindrical portion 123 and detergent-side cylindrical portion 111b as the coupling portions between detergent tank 117 and automatic liquid agent injection device 109. This can 10 wash away residues of detergent liquid adhering to portions around cylindrical portion 123 and detergent-side cylindrical portion 111b.

Note that this exemplary embodiment may be configured to include a "tank storage case maintenance course" of cleaning portions around a rear wall of tank storage case 114 and detergent-side cylindrical portion 111b while 15 detergent tank 117 is removed from tank storage case 114.

More specifically, when the user selects the "tank storage case maintenance course", the controller opens first water supply valve 110a for a predetermined period of time. This causes tap water to flow through first water channel 181 and flow through auxiliary hose 141, bathwater pump 140, 20 and discharge hose 142 at second branch point 181b, and flow into tank storage case 114 through hole 114k. The water flowing into tank storage case 114 flows along inclined surface 114j in a direction indicated by arrow B and washes portions around a rear side of tank storage case 114 and detergent-side cylindrical portion 111b.

25 The tap water injected into tank storage case 114 through hole 114k flows along inclined surface 114j, as indicated by arrow F1 in FIG. 15. This makes it possible to clean guide ribs 114h and receiving portion 117h which fix

detergent tank 117 and tank storage case 114. Likewise, it is possible to clean guide ribs 114i and receiving portion 126h which fix softener tank 126 and tank storage case 114. Preventing a liquid agent from being fixed between guide ribs 114h and receiving portion 117h can facilitate pulling out detergent
5 tank 117 from tank storage case 114 and prevent a fitting failure between guide ribs 114h and receiving portion 117h due to fixation. This makes it possible to prevent the detergent liquid from leaking from cylindrical portion 123 and detergent-side cylindrical portion 111b.

[1-2-6. Method of determining insufficiency of remaining amount in detergent
10 tank]

A method of determining insufficiency of a remaining amount of detergent in detergent tank 117 will be described below with reference to FIGS. 32 to 36. Note that insufficient remaining softener amount determination in softener tank 126 is performed in the same manner as described below, and
15 hence a description will be omitted.

First of all, the controller stores in advance, in the storage unit, a threshold voltage (for example, 2.1 V) for insufficient remaining detergent amount determination, which is indicated by line TH in FIG. 36.

When the detergent liquid is discharged from detergent tank 117, a
20 level of liquid in detergent tank 117 lowers, and float portion 130a pivots downward. This changes a distance between magnet 134 and linear Hall element 136, and hence changes an output voltage from linear Hall element 136. If the output voltage from linear Hall element 136 becomes less than the threshold voltage stored in the storage unit, the controller determines that the
25 remaining amount of detergent is insufficient, and displays corresponding information on operation display unit 104.

Note that in this exemplary embodiment, two magnets 134 including

first magnet 134a and second magnet 134b are disposed at positions along a pivoting direction of float portion 130a in magnet box 135. First magnet 134a has its north pole facing linear Hall element 136, and second magnet 134b has its south pole facing linear Hall element 136. Accordingly, linear Hall element
5 136 detects magnetic force from first magnet 134a and magnetic force from second magnet 134b, which are different in polarity.

An output voltage from linear Hall element 136 which corresponds to each level of softener liquid in detergent tank 117 will be described below with reference to FIGS. 32 to 36.

10 FIGS. 32 to 35 are schematic views each showing a positional relationship between magnet 134 and linear Hall element 136 at each detergent level in detergent tank 117.

FIG. 36 is a graph showing a relationship between the remaining amount of detergent in detergent tank 117 and the output voltage from linear
15 Hall element 136 in washing machine 100 according to the same exemplary embodiment.

As shown in FIG. 32, while detergent tank 117 is filled with the detergent liquid, linear Hall element 136 receives north magnetic force from first magnet 134a. This causes linear Hall element 136 to output a voltage
20 like that indicated by a1 in FIG. 36.

When the detergent liquid is further discharged from detergent tank 117 in a state shown in FIG. 32, a liquid level of detergent tank 117 further lowers. This raises the output voltage from linear Hall element 136.

When first magnet 134a pivots to a height position of linear Hall
25 element 136 with the detergent liquid being discharged as shown in FIG. 33, the output voltage from linear Hall element 136 becomes a maximum voltage as indicated by a2 in FIG. 36.

When the detergent liquid is further discharged from detergent tank 117 in the state shown in FIG. 33, float portion 130a further pivots. At this time, a distance between linear Hall element 136 and first magnet 134a increases, and a distance between linear Hall element 136 and second magnet 134b decreases. This reduces the output voltage from linear Hall element 136.

When float portion 130a pivots to a position shown in FIG. 34, the output voltage from linear Hall element 136 becomes a voltage indicated by a3 in FIG. 36. When the detergent liquid is further discharged from detergent tank 117 in this state, the output voltage from linear Hall element 136 further decreases.

As shown in FIG. 35, when a height position of second magnet 134b of float portion 130a pivots to a position to face linear Hall element 136, the output voltage from linear Hall element 136 becomes a voltage indicated by a4 in FIG. 36.

As described above, as the detergent liquid is discharged, first of all, first magnet 134a approaches linear Hall element 136 (an interval between a1 and a2 in FIG. 36). Subsequently, as first magnet 134a moves away from linear Hall element 136, second magnet 134b approaches linear Hall element 136 (an interval between a2 and a3 in FIG. 36). Second magnet 134b then approaches linear Hall element 136 (an interval between a3 and a4 in FIG. 36).

That is, when float portion 130a pivots from a position in FIG. 33 to a position in FIG. 35 (an interval between a2 and a4 in FIG. 36), a distance between linear Hall element 136 and first magnet 134a increases, and a distance between linear Hall element 136 and second magnet 134b decreases. With this operation, in the magnetic flux density received by linear Hall element 136, a north-pole component decreases, and a south-pole component increases. In the interval between a2 and a4 in FIG. 36, a change in magnetic

force received by linear Hall element 136 is larger than that in a configuration having one magnet disposed in magnet box 135. That is, an amount of change in output voltage from linear Hall element 136 increases with a change in amount of detergent liquid discharged. This makes it possible to improve
5 insufficiency determination accuracy with respect to a remaining amount of detergent based on the output voltage from linear Hall element 136 as compared with a case in which one magnet is disposed in magnet box 135.

In this exemplary embodiment, as shown in FIG. 28, partition rib 119a is formed on the lower surface of detergent tank lid 119 so as to surround pivot
10 shaft 131 of float portion 130a. At this time, as shown in FIG. 32, when detergent tank 117 is filled with the detergent liquid, air pool 200 is formed inside a region surrounded by partition rib 119a. This prevents the detergent liquid from flowing into the region surrounded by partition rib 119a. It is therefore possible to prevent detergent liquid from adhering to pivot shaft 131
15 of float portion 130a. In addition, when detergent tank lid 119 is inclined in a state in which detergent tank lid 119 is removed from detergent tank 117, a liquid agent adheres to the lower surface of detergent tank lid 119. In this case as well, partition rib 119a blocks a flow of the adhering liquid agent to pivot shaft 131 of float portion 130a. This can prevent fixation of the detergent
20 liquid from hindering smooth pivoting of pivot shaft 131. As a result, it is possible to suppress deterioration in measurement accuracy with respect to the remaining amount of detergent.

In this exemplary embodiment, as shown in FIG. 29, magnet stopper 137 is disposed to come into contact with receiving portion 135b of magnet box
25 135 when the remaining amount of detergent on an inner bottom surface of detergent tank 117 is determined as insufficient. This prevents float portion 130a from further pivoting downward even when a liquid agent is further

discharged while the remaining amount of detergent is insufficient. Accordingly, while the remaining amount of detergent is insufficient, the output voltage from linear Hall element 136 does not change. As a consequence, it is possible to prevent erroneous detection that the remaining
5 amount of detergent is insufficient because of a variation in output voltage due to a further pivoting operation.

This exemplary embodiment has exemplified the configuration in which linear Hall element 136 is disposed to receive north magnetic polarity from first magnet 134a and receive south magnetic polarity from second
10 magnet 134b. However, this is not exhaustive. For example, linear Hall element 136 may be configured to receive south magnetic polarity from first magnet 134a and receive north magnetic polarity from second magnet 134b. In this case, a waveform of an output voltage received by linear Hall element 136 is inverted vertically with respect to a waveform in FIG. 36.

15 Three or more magnets may be provided in magnet box 135 at positions along the pivoting direction of float portion 130a. In this case, the respective magnets may be provided to alternately give different magnetic polarities to linear Hall element 136. This configuration can also provide the same functions and effects as those of the above exemplary embodiment.

20 In this exemplary embodiment, at the time of manufacture of a washing machine, a voltage of linear Hall element 136 with detergent tank 117 being filled with the detergent liquid and an output voltage from linear Hall element 136 with detergent tank 117 not being filled with the detergent liquid are measured while automatic liquid agent injection device 109 is attached,
25 and the measured voltages are stored in the storage unit in advance. Note that a state in which detergent tank 117 is filled with the detergent liquid corresponds to interval M1 in FIG. 36. In addition, a state in which detergent

tank 117 is not filled with the detergent liquid corresponds to interval M2 in FIG. 36. This makes it possible to reduce errors in determination of remaining detergent amount insufficiency due to manufacture variations in remaining amount detection for each washing machine or variations in installation of linear Hall element 136.

Note that remaining detergent amount insufficiency may be determined based on an output voltage from linear Hall element 136 when magnet box 135 comes into contact with magnet stopper 137. This makes it possible to compare an output voltage from linear Hall element 136 at the time of contact of magnet box 135 with an output voltage value in interval M2 which is stored in the storage unit while magnet stopper 137 is brought into contact with magnet box 135 in advance at the time of shipment. Accordingly, it is possible to reduce variation errors in remaining detergent amount determination for each washing machine.

[1-2-7. Method of detecting fault in detergent tank]

A method of detecting a fault in detergent tank 117 will be described below with reference to FIG. 36. Note that a method of detecting a fault in softener tank 126 is the same, and hence a description will be omitted.

For example, when automatic liquid agent injection device 109 is not used for a long period of time, the detergent liquid may be fixed in detergent tank 117. At this time, the fixed detergent liquid is clogged in cylindrical portion 123 as a discharge port in detergent tank 117 or detergent-side cylindrical portion 111b of automatic liquid agent injection device 109. Accordingly, a desired amount of detergent liquid may not be discharged from detergent tank 117. Assume that the detergent liquid is fixed on pivot shaft 131 of float portion 130a. In this case, float portion 130a does not pivot even when the detergent liquid is discharged from detergent tank 117. This reduces

detection accuracy of a remaining detergent amount detected upon pivoting of float portion 130a.

Accordingly, the controller according to this exemplary embodiment includes a trouble determination unit (not shown) for determining occurrence
5 of the above trouble due to fixation of the detergent liquid in detergent tank 117.

A method of determining a trouble in detergent tank 117 by using the trouble determination unit will be described below.

In general, when the detergent liquid is discharged from detergent
10 tank 117, a level of liquid in detergent tank 117 lowers, and float portion 130a pivots downward. This changes a distance between magnet 134 and linear Hall element 136 and changes the output voltage from linear Hall element 136.

Assume, however, that the detergent liquid and the like are fixed to pivot shaft 131 of float portion 130a or are clogged in cylindrical portion 123
15 and the like. In this case, the output voltage from linear Hall element 136 does not sufficiently change even when the detergent liquid is discharged from detergent tank 117.

Accordingly, first of all, the controller detects the output voltage from linear Hall element 136 when an accumulated amount of detergent discharged
20 from detergent tank 117 becomes larger than a predetermined value (for example, 30 ml). The controller then calculates a difference value between the detected voltage and the output voltage from linear Hall element 136 when the accumulated amount of detergent discharged from detergent tank 117 becomes larger than the predetermined value. At this time, if the difference value is
25 less than a predetermined value (for example, 0.1 V), the controller determines that float portion 130a has not pivoted despite discharging the detergent liquid from detergent tank 117. This determines that the above trouble has occurred

in detergent tank 117.

The controller then displays information indicating occurrence of the trouble on operation display unit 104 to notify the user of corresponding information. This makes it possible to detect occurrence of a trouble in
5 detergent tank 117 in an early stage. As a consequence, it is possible to make the user quickly recognize a failure to discharge a desired amount of detergent liquid or insufficiency of the remaining amount of detergent liquid, and prompt the user to deal with the trouble.

In this exemplary embodiment, as shown in FIG. 32, when detergent
10 tank 117 is filled with the detergent liquid, distances between first and second magnets 134a and 134b and linear Hall element 136 increase. At this time, magnetic field lines from first magnet 134a and second magnet 134b do not reach linear Hall element 136. For this reason, even if the remaining amount of detergent liquid decreases from 600 ml to 400 ml, the output voltage from
15 linear Hall element 136 sometimes becomes a constant value as indicated in interval M1 in FIG. 36. That is, even if float portion 130a pivots downward when, for example, about 150 ml of detergent liquid, from the remaining amount of detergent liquid, 600 ml, is discharged from detergent tank 117, the output voltage from linear Hall element 136 does not change. That is, in
20 interval M1 in FIG. 36, even when the above trouble, such as fixation or clogging, has not occurred in detergent tank 117, the trouble determination unit may erroneously detect occurrence of a trouble.

Accordingly, the controller according to this exemplary embodiment controls the trouble determination unit so as not to perform trouble
25 determination when the output voltage from linear Hall element 136 falls within a predetermined range while detergent tank 117 is filled with the detergent liquid. Note that the predetermined range described above is, for

example, about 2.7 V to about 2.9 V.

In the above manner, a failure (trouble) in detergent tank 117 or the like is detected.

The determination method and the detection method described in [1-2-
5 6. Method of determining insufficiency of remaining amount in detergent tank]
and [1-2-7. Method of detecting fault in detergent tank] will be described below
in detail with reference to FIG. 37.

FIG. 37 is a flowchart showing a method of detecting insufficiency of
the remaining amount of detergent in detergent tank 117 and a method of
10 detecting a fault in the detergent tank 117.

Note that washing machine 100 according to this exemplary
embodiment includes a detergent discharge amount storage unit (not shown)
that accumulates and stores calculation values obtained by a liquid agent
remaining amount calculator and first and second storage units (not shown)
15 that store output voltages from linear Hall element 136.

First of all, as shown in FIG. 37, the controller determines whether the
detergent liquid has been discharged from detergent tank 117. If no detergent
liquid has been discharged (No in step S0), the controller repeats a
determining operation at predetermined intervals until the detergent liquid is
20 discharged.

If the detergent liquid has been discharged (Yes in step S0), the
controller determines whether the output voltage from linear Hall element 136
is less than 2.1 V (step S1). If the output voltage is less than 2.1 V (Yes in step
S1), the controller determines that the remaining amount of detergent in
25 detergent tank 117 is insufficient, and displays a detergent remaining amount
insufficiency message on operation display unit 104 (step S2). Upon
recognizing the detergent remaining amount insufficiency message on

operation display unit 104, the user takes out detergent tank 117 from the storage portion of tank storage case 114 and replenishes detergent tank 117 with the detergent liquid. This raises the level of detergent liquid in detergent tank 117 and causes float portion 130a to pivot upward. In this state, the user
5 mounts detergent tank 117 in the storage portion of tank storage case 114 again. The controller then detects the output voltage from linear Hall element 136 again. At this time, if the detected output voltage is higher than 2.1 V (line TH in FIG. 36) as the threshold voltage, the controller determines that detergent tank 117 is replenished with the detergent liquid. The controller
10 then cancels the detergent remaining amount insufficiency message on operation display unit 104.

In contrast, if the output voltage from linear Hall element 136 is more than or equal to 2.1 V (No in step S1), the controller adds the calculation value obtained by the liquid agent remaining amount calculator to value X stored in
15 the detergent discharge amount storage unit (step S3). The controller then determines whether value X in the detergent discharge amount storage unit upon addition of the calculation value is larger than 30 ml (step S4). If value X in the detergent discharge amount storage unit is less than or equal to 30 ml (No in step S4), because a predetermined amount detergent liquid has not
20 been discharged, the controller terminates the processing without performing failure detection determination.

If value X in the detergent discharge amount storage unit is larger than 30 ml (Yes in step S4), the controller causes the trouble determination unit to execute a subsequent procedure, for example, a procedure for trouble
25 determination with respect to detergent tank 117.

More specifically, first of all, the controller reduces 30 ml from value X in the detergent discharge amount storage unit (step S5). The controller then

stores value Y of the output voltage from linear Hall element 136 in the first storage unit (step S6).

Subsequently, the controller determines whether value Y stored in the first storage unit falls within a range of 2.7 V to 2.9 V (step S7). If stored value Y falls within the range of 2.7 V to 2.9 V (Yes in step S7), the controller determines that detergent tank 117 is filled with the detergent liquid. The controller then stores value Y stored in the first storage unit in the second storage unit without performing trouble determination with respect to detergent tank 117 (step S10).

In contrast, if value Y stored in the first storage unit falls outside the range of 2.7 V to 2.9 V (No in step S7), the controller causes the trouble determination unit to determine whether an absolute value of a difference between value Y stored in the first storage unit and value (Y - 1) stored in the second storage unit is less than 0.1 V (step S8). If the absolute value of the difference is less than 0.1 V (Yes in step S8), the trouble determination unit of the controller determines that a liquid agent is fixed in detergent tank 117. The controller then displays information indicating occurrence of a trouble in detergent tank 117 on operation display unit 104 (step S9). That is, if the absolute value of the difference is less than 0.1 V, float portion 130a has not sufficiently pivoted despite discharging the detergent liquid from detergent tank 117. The trouble determination unit determines that a liquid agent has been fixed on detergent tank 117. Subsequently, the controller stores value Y, stored in the first storage unit, in the second storage unit (step S10).

In contrast, if the absolute value of the difference between value Y stored in the first storage unit and value (Y - 1) stored in the second storage unit is more than or equal to 0.1 V (No in step S8), the trouble determination unit of the controller determines that any trouble due to fixation of the

detergent liquid or the like in detergent tank 117 has not occurred. The controller then stores value Y stored in the first storage unit, in the second storage unit (step S10).

In the above manner, determination of insufficiency of the remaining
5 amount of detergent and failure detection in detergent tank 117 are executed.

Note that a method of detecting a failure in softener tank 126 is the same as the method of detecting a failure in detergent tank 117, and hence a description will be omitted.

In this case, a supply amount of softener liquid to drum 106 in the
10 washing step is smaller than a supply amount of detergent liquid under normal conditions. For this reason, the predetermined discharge amount of softener liquid in step S4 is preferably smaller than the predetermined discharge amount of detergent (30 ml) and set to, for example, about 20 ml.

As described above, washing machine 100 according to this exemplary
15 embodiment includes the trouble determination unit that detects a trouble in detergent tank 117 or softener tank 126. More specifically, first of all, the trouble determination unit detects output voltages from linear Hall element 136 before and after a predetermined amount of liquid agent is injected from detergent tank 117, and calculates a value of a difference between the output
20 voltages. In this case, if the value of the difference is less than 0.1 V, the trouble determination unit determines that a liquid agent is fixed in detergent tank 117. The controller then displays occurrence of a trouble on operation display unit 104. This makes it possible to detect occurrence of a trouble in detergent tank 117 in an early stage. As a consequence, it is possible to make
25 the user quickly recognize a failure to discharge a desired amount of detergent liquid or insufficiency of the remaining amount of detergent liquid, and prompt the user to deal with the trouble.

Note that the controller according to this exemplary embodiment is configured so as not to perform trouble determination in detergent tank 117 when, for example, the output voltage from linear Hall element 136 falls within the range of 2.7 V to 2.9 V while detergent tank 117 is filled with the liquid agent. This makes it possible to prevent erroneous detection of a trouble by the trouble determination unit when no detergent liquid is fixed in detergent tank 117.

In this exemplary embodiment, a plurality of magnets are provided apart from each other at positions along the pivoting direction of float portion 130a in magnet box 135. This enables linear Hall element 136 to detect magnetic force from the magnets within a wide range in which float portion 130a pivots. Accordingly, it is possible to detect a trouble in detergent tank 117 even when the remaining amount of detergent in detergent tank 117 is large as compared with, for example, a configuration including one magnet.

The above description has exemplified the configuration in which, first of all, in step S8, the absolute value of the difference between value Y stored in the first storage unit and value (Y - 1) stored in the second storage unit is compared with the predetermined threshold voltage (0.1 V) to determine whether any trouble has occurred in detergent tank 117. However, this is not exhaustive. For example, there may be provided a configuration in which a threshold voltage is changed in accordance with the output voltage from linear Hall element 136. That is, as shown in FIG. 36, an amount of change in output voltage from linear Hall element 136 with respect to an amount of change in detergent in detergent tank 117 is not constant. Accordingly, a proper threshold voltage is changed and set in accordance with the output voltage from linear Hall element 136. This can improve accuracy of trouble determination in detergent tank 117.

This exemplary embodiment has exemplified the configuration in which float portion 130a pivots. However, this is not exhaustive. For example, float portion 130a may be configured to float on a liquid level of detergent liquid in detergent tank 117 instead of pivoting. This configuration can also
5 obtain the same functions and effects as described above. That is, float portion 130a may be configured to move up and down in accordance with a change in the level of detergent liquid while floating on the liquid level.

This exemplary embodiment has also exemplified the configuration in which the output voltage from linear Hall element 136 is measured to detect
10 the remaining amount of liquid agent in detergent tank 117. However, this is not exhaustive. For example, the remaining amount of liquid agent may be detected by using an optical sensor.

This exemplary embodiment has also exemplified the configuration in which when the trouble determination unit determines occurrence of an
15 abnormality in detergent tank 117, the occurrence of the abnormality is displayed on operation display unit 104 to notify the user of corresponding information. However, this is not exhaustive. For example, there may be provided a configuration in which the washing machine transmits information indicating occurrence of an abnormality in detergent tank 117 to a server via
20 an Internet line, and the server transmits the information to a smartphone or the like to display the occurrence of the abnormality on a screen of the smartphone. In addition, the washing machine may be configured to notify the user by voice via a loudspeaker. These configurations can immediately notify the user of occurrence of an abnormality and prompt the user to deal with the
25 abnormality even when the user is not near the washing machine.

This exemplary embodiment has also exemplified the configuration in which a value of a difference between output voltages from linear Hall element

136 before and after a predetermined amount (for example, 30 ml) of detergent liquid is discharged is calculated to determine a trouble in detergent tank 117. However, this is not exhaustive. For example, there may be provided a configuration in which determination is performed by calculating a value of a difference between the output voltage from linear Hall element 136 after the detergent liquid is discharged from detergent tank 117 and the output voltage from linear Hall element 136 after the detergent liquid is previously discharged from detergent tank 117.

The above description has exemplified the configuration in which the absolute value of $(Y - (Y - 1))$ is compared with the threshold (0.1 V) in step S8 in FIG. 37 to determine whether the remaining amount of detergent is insufficient. That is, a voltage detected by linear Hall element 136 is inverted in sign depending on a magnetic polarity of each magnet. However, comparing absolute values can prevent erroneous detection of a trouble due to the magnetic polarity of each magnet. In addition, it is not necessary to produce magnet box 135 in consideration of a direction of the magnetic polarity of each magnet. This makes it possible to reduce a number of steps required to produce magnet box 135, and a number of steps required for a confirmation test. It is therefore possible to suppress an increase in manufacturing cost of magnet box 135 and the like.

[1-2-8. Maintenance of coupling portions between detergent tank and automatic liquid agent injection device, and liquid agent supply water channels]

FIG. 38 is a timing chart showing each of states of detergent-side coil 113d, softener-side coil 113i, drive motor 112f, first water supply valve 110a, and the drain pump in "maintenance course".

In general, when the detergent liquid is repeatedly discharged from

detergent tank 117, metals such as magnesium and calcium contained in tap water are combined with fatty acid contained in the detergent liquid to precipitate metal soap. The precipitated metal soap adheres to a water channel (to be referred to as a "detergent liquid supply water channel" hereinafter) through which the detergent liquid flows from detergent tank 117 to water tub 105. Note that the detergent liquid supply water channel includes, for example, cylindrical portion 123, detergent-side cylindrical portion 111b, detergent-side three-way valve 113a, softener-side three-way valve 113b, suction water channel 112h, storage portion 112c, discharge water channel 112g, branch water channel 129a, and coupling hose 129, which are shown in FIG. 24. The metal soap adhering to the detergent liquid supply water channel becomes resistance against flows of detergent liquid discharged from detergent tank 117 and supplied tap water. This may reduce a discharge amount of detergent liquid and weaken force of flowing water. In addition, the metal soap may intrude drum 106 and adhere to laundry.

In order to suppress the above trouble, it is necessary to periodically wash away and remove the metal soap adhering to the detergent liquid supply water channel as will be described below.

First of all, when maintaining the detergent liquid supply water channel, the user removes detergent tank 117 from the storage portion of tank storage case 114 and cleans an inside of detergent tank 117. The user then replenishes detergent tank 117 with, for example, 200 ml of citric acid water.

Subsequently, the user attaches detergent tank 117 in the storage portion of tank storage case 114 again. The user then selects a "maintenance mode" via operation display unit 104.

When the "maintenance mode" is selected, the controller drives the drain pump (not shown) and alternately executes a first step and a second step

to be described below.

Note that the first step is a step of closing first water supply valve 110a, energizing detergent-side coil 113d, and deenergizing softener-side coil 113i.

The second step is a step of opening first water supply valve 110a, and
5 deenergizing detergent-side coil 113d and softener-side coil 113i.

First of all, executing the first step causes the citric acid water in detergent tank 117 to flow through the detergent liquid supply water channel and be supplied to water tub 105. In general, metal soap has a property of being dissolved by acidic aqueous solution. Accordingly, acidic citric acid water
10 flows in the detergent liquid supply water channel while dissolving and washing away the adhering metal soap. The washed-away metal soap is supplied to water tub 105, together with the citric acid water. Driving the drain pump then causes the citric acid water containing the metal soap to flow in a drain hose (not shown) through a drain port (not shown) and be
15 discharged out of housing 101.

Executing the second step causes tap water supplied from a water supply faucet to flow in first water channel 181 through first water supply valve 110a, as shown in FIG. 24. Part of tap water flowing through first water channel 181 flows to second water channel 182, as indicated by arrow A2 in
20 FIG. 24. The water flowing through second water channel 182 flows through detergent-side three-way valve 113a, softener-side three-way valve 113b, suction water channel 112h, storage portion 112c, discharge water channel 112g, branch water channel 129a, and coupling hose 129 and is supplied to water tub 105. With this operation, the citric acid water remaining in the
25 detergent liquid supply water channel is washed away with water supplied in the second step.

A control operation at the time of execution of the "maintenance mode"

will be described in detail below with reference to FIG. 38.

FIG. 38 is a timing chart showing states of detergent-side coil 113d, softener-side coil 113i, drive motor 112f, first water supply valve 110a, and the drain pump in the "maintenance mode" for detergent tank 117 of washing
5 machine 100.

When the user selects the "maintenance mode", the controller energizes detergent-side coil 113d and starts the first step at time T0. At this time, as shown in FIG. 10B, detergent-side plunger 113e and detergent-side valve body 113f move backward. This causes the citric acid water in detergent
10 tank 117 to flow into water channel 124 through opening portion b formed behind detergent-side cylindrical portion 111b. The inflowing citric acid water flows to suction water channel 112h of piston pump unit 112.

At time T1 0.5 sec after time T0, the controller drives drive motor 112f and the drain pump. Driving drive motor 112f causes piston 112e to vertically
15 reciprocate. This repeatedly switches a pressure state in storage portion 112c between a positive pressure state and a negative pressure state.

That is, when piston 112e moves upward as shown in FIG. 11, an inside of storage portion 112c is set in a negative pressure state. Accordingly, suction-side check valve 164 moves upward against biasing force of spring
20 164b. This causes the citric acid water to flow into storage portion 112c through suction water channel 112h.

When piston 112e moves downward, the inside of storage portion 112c is set in a positive pressure state. Accordingly, discharge-side check valve 165 moves downward against biasing force of spring 165b. This causes the citric
25 acid water in storage portion 112c to flow through discharge water channel 112g, branch water channel 129a, and coupling hose 129 and be supplied to water tub 105.

Repeating the above operation causes the citric acid water to flow in the detergent liquid supply water channel while dissolving the metal soap.

Driving the drain pump causes the citric acid water in water tub 105 to flow from the drain port to the drain hose and be discharged out of housing 101.

5 At this time, driving drive motor 112f may lead to a state in which detergent-side valve body 113f cannot move backward despite setting detergent-side coil 113d in an energized state. That is, as drive motor 112f is driven, because force of a flow of water indicated by X1 in FIG. 10A increases, the flow of water becomes resistance. This can lead to a state in which
10 detergent-side valve body 113f cannot move backward. The controller controls to start energizing detergent-side coil 113d first at time T0 and then drive drive motor 112f at time T1 0.5 sec after time T0. This can avoid occurrence of the above state.

 In this exemplary embodiment, the controller controls to make a
15 discharge amount (for example, 200 ml) of citric acid water larger than a maximum discharge amount (for example, 120 ml) of detergent liquid in the washing step and a maximum discharge amount (for example, 100 ml) of softener in the rinsing step. This makes it possible to satisfactorily dissolve the metal soap in the detergent liquid supply water channel.

20 Next, the controller stops driving drive motor 112f at time T2 55 sec after time T1. The controller then deenergizes detergent-side coil 113d at time T3 0.5 sec after time T2. This causes detergent-side plunger 113e and detergent-side valve body 113f to move forward, as shown in FIG. 10A. Detergent-side valve body 113f then closes opening portion b formed behind
25 detergent-side cylindrical portion 111b. This makes detergent-side valve body 113f block a flow of citric acid water from detergent tank 117.

 At time T3, the first step is terminated.

At this time, driving drive motor 112f may lead to a state in which detergent-side valve body 113f cannot move forward despite setting detergent-side coil 113d in a deenergized state. That is, as drive motor 112f is driven, because force of a flow of water (corresponding to X1) in a state shown in FIG. 10B increases, the flow of water becomes resistance. This can lead to a state in which detergent-side valve body 113f cannot move forward. The controller controls to deenergize drive motor 112f at time T2 and then deenergize detergent-side coil 113d at time T3 0.5 sec after time T2. This can avoid occurrence of the above state.

At time T4 0.5 sec after time T3, the controller drives drive motor 112f and opens first water supply valve 110a. With this operation, the controller starts the second step. In the second step, as shown in FIG. 10A, supplied tap water flows through second water channel 182, flows into water channel 124 of three-way valve unit 113 through opening portion a, and flows toward suction water channel 112h of piston pump unit 112. At this time, the inflowing tap water washes away the citric acid water remaining in three-way valve unit 113 and piston pump unit 112.

As described above, the force of inflowing tap water at the start of water supply is weak under normal conditions. Accordingly, with only hydraulic pressure of supplied tap water, it may fail to move suction-side check valve 164 and discharge-side check valve 165 of piston pump unit 112 shown in FIG. 11 upward and downward, respectively. In order to avoid the above state, the controller drives drive motor 112f and pressurizes tap water in the second step. This allows the tap water to certainly pass through piston pump unit 112.

Driving drive motor 112f may hinder movement of detergent-side valve body 113f of three-way valve unit 113. The controller then controls to drive motor 112f at time T4 0.5 sec after end of energization of detergent-side coil

113d (time T3). This can avoid occurrence of the above state.

At time T5 5 sec after time T4, the controller then controls to stop driving drive motor 112f and close first water supply valve 110a. With this operation, the second step is terminated.

5 At time T6 0.5 sec after time T5, the controller then executes the same control as that executed at time T0, and starts the first step.

Subsequently, in an interval from time T6 to time T11 and an interval from time T12 to Time T17, the controller executes the same control as that in an interval from time T0 to time T5.

10 At time T17, the controller terminates the second step. Subsequently, at time T18 40 sec after time T17, the controller stops driving the drain pump. This will discharge the citric acid water and the tap water remaining in drum 106.

Note that an operation of each unit in the "maintenance mode" for
15 softener tank 126 is the same as described above, and hence a description will be omitted.

[1-3. Effects and others]

As described above, the washing machine according to this exemplary embodiment includes bottomed cylindrical water tub 105 elastically anti-
20 vibration supported in housing 101, detergent tank 117 having an opening in an upper surface and containing liquid, and detergent tank lid 119 constituting a tank lid provided on an upper portion of detergent tank 117. The washing machine further includes automatic liquid agent injection device 109 configured to supply detergent liquid inside detergent tank 117 to water tub
25 105, a remaining amount detector configured to detect the remaining amount of liquid agent in detergent tank 117, and a controller. The remaining amount detector includes float portion 130a that is provided on a lower surface of

detergent tank lid 119 and floats on a liquid surface, first and second magnets 134a and 134b provided in float portion 130a, and linear Hall element 136. First magnet 134a and second magnet 134b are disposed apart from each other at positions along a moving direction of float portion 130a in accordance with changes in level of the liquid agent in detergent tank 117. In addition, first magnet 134a and second magnet 134b are alternately disposed to have different magnetic polarities with respect to linear Hall element 136. According to this configuration, the controller detects the remaining amount of liquid agent in detergent tank 117 based on an output voltage from linear Hall element 136. This makes it possible to expand a detection range for the remaining amount of detergent and improve convenience.

(Second exemplary embodiment)

A washing machine according to a second exemplary embodiment will be described below with reference to FIG. 36.

The washing machine according to this exemplary embodiment detects a remaining amount of detergent as a remaining amount of liquid agent in detergent tank 117 based on an output voltage from linear Hall element 136 as in the first exemplary embodiment. The washing machine is configured to display the remaining amount of liquid agent on a display unit of operation display unit 104. Note that other configurations are the same as those of the first exemplary embodiment, and hence a description will be omitted.

As shown in FIG. 36, when the output voltage from linear Hall element 136 is higher than line S in FIG. 36, there are two remaining amounts of detergent with respect to one output voltage. For this reason, the controller may erroneously determine the remaining amount of detergent.

In this exemplary embodiment, the controller causes the storage unit to store the output voltage from linear Hall element 136 when detergent liquid

is discharged.

The controller then calculates a difference between the output voltage from linear Hall element 136 when the detergent liquid is discharged currently and the output voltage from linear Hall element 136 when the detergent liquid has been previously discharged, which is stored in the storage unit.

At this time, if the value of the calculated difference is positive, it indicates that the output voltage from linear Hall element 136 has increased. Accordingly, the controller determines that the remaining amount of detergent falls within an interval between a0 and a2 in FIG. 36. If the difference value is negative, it indicates that the output voltage from linear Hall element 136 has decreased, and hence the controller determines that the remaining amount of detergent falls within the interval between a2 and a3 in FIG. 36.

First magnet 134a and second magnet 134b are disposed apart from each other at positions along the pivoting direction of float portion 130a in magnet box 135. This allows linear Hall element 136 to detect magnetic force from the magnets in a wide range when float portion 130a passes through linear Hall element 136. This can expand the detection range for the remaining amount of detergent.

This exemplary embodiment has exemplified the configuration using the drum washing machine. However, this is not exhaustive. For example, a top-loading washing machine may be used. This configuration can also have the same functions and effects as those described above.

As described above, a washing machine according to the present invention includes a housing, a water tub supported in the housing, a tank containing a liquid agent, a liquid supply device configured to automatically supply the liquid agent inside the tank to the water tub, a remaining amount

detector configured to detect a remaining amount of liquid agent in the tank,

and a controller configured to control a washing operation of the washing machine. The remaining amount detector includes a float portion floating on a surface of the liquid agent in the tank, a plurality of to-be-detected portions provided on the float portion, and a detector configured to detect the to-be-
5 detected portions. The plurality of to-be-detected portions are disposed apart from each other at positions along a moving direction of the float portion in accordance with changes in level of the liquid agent surface. This configuration allows the detector to detect magnetic force from the to-be-
10 detected portions of the float portion pass through the detector. This makes it possible to expand a detection range for the remaining amount of liquid agent.

The controller of the washing machine according to the present invention may be configured to detect the remaining amount of liquid agent in the tank based on a detection value from the detector, and notify the
15 remaining amount of liquid agent. This configuration allows the detector to detect magnetic force in a wide moving range of the float portion when the float portion passes through the detector. This makes it possible to expand the detection range for the remaining amount of liquid agent.

The washing machine according to the present invention may further
20 include a display unit, and the controller may display the remaining amount of liquid agent in the tank on the display unit. This enables the user to easily grasp the remaining amount of liquid agent.

The controller of the washing machine according to the present invention may determine, based on detection values concerning the to-be-
25 detected portions, whether an amount of liquid agent in the tank is smaller than a predetermined amount. This makes it possible to detect magnetic force of the to-be-detected portions in a wide

moving range of the

float portion. It is therefore possible to accurately determine sufficiency or insufficiency of the remaining amount of liquid agent.

The washing machine according to the present invention may also include a display unit. Upon determining that the remaining amount of liquid agent in the tank is smaller than the predetermined amount, the controller
5 may cause the display unit to display corresponding information. This enables the user to easily grasp that the remaining amount of liquid agent is insufficient.

The washing machine according to the present invention may include a
10 tank lid configured to open and close an opening formed in an upper portion of the tank, and the float portion may be pivotally disposed on a lower surface of the tank lid. This makes it possible to grasp the remaining amount of liquid agent with a simple configuration.

In the washing machine according to the present invention, the
15 plurality of to-be-detected portions may be constituted by a plurality of magnetic force generators, and the detector may be constituted by a magnetic force sensor. This makes it possible to grasp the remaining amount of liquid agent with a simple configuration.

In the washing machine according to the present invention, the
20 plurality of magnetic force generators may be constituted by a plurality of magnets, and the plurality of magnets may be disposed so as to make adjacent magnets of the plurality of magnets have different polarities with respect to the magnetic force sensor. According to this configuration, when the float portion passes through the magnetic force sensors and one of the magnets
25 having different polarities with respect to the magnetic force sensor moves away, the other magnet approaches. This can increase an amount of change in

output voltage from the magnetic force sensor with respect to a movement amount of the float portion. This can improve accuracy of determination of sufficiency or insufficiency of the remaining amount of liquid detergent.

A washing machine according to the present invention includes a housing, a water tub supported in the housing, a tank having an opening in an upper portion and containing a liquid agent, and a tank lid provided on an upper portion of the tank and configured to open and close the opening. The washing machine also includes a liquid supply device configured to automatically supply the liquid agent inside the tank to the water tub, a to-be-detected portion floating on a surface of the liquid agent in the tank, a detector configured to detect the to-be-detected portion, a storage unit configured to store a detection value from the detector, and a controller configured to control a washing operation. The controller may further include a trouble determination unit. The trouble determination unit may be configured to calculate a difference between a detection value from the detector after the liquid agent is discharged from the tank and a detection value from the detector after the liquid agent has been previously discharged, which is stored in the storage unit, and determine that the liquid agent is fixed in the tank if a value of the calculated difference is less than a predetermined value. This makes it possible to detect occurrence of a trouble in the tank in an early stage.

A washing machine according to the present invention includes a housing, a water tub supported in the housing, a tank having an opening in an upper portion and containing a liquid agent, and a tank lid provided on an upper portion of the tank and configured to open and close the opening. The washing machine includes a liquid supply device configured to automatically supply a liquid agent inside the tank to the water tub, a to-be-detected portion floating on a liquid agent surface in the tank, a detector configured to detect

the to-be-detected portion, a liquid agent injection amount calculator configured to calculate an injection amount of liquid agent to the water tub, a storage unit configured to store a detection value from the detector, and a controller configured to control a washing operation. The controller further includes a trouble determination unit. The trouble determination unit may be configured to calculate a difference between a detection value from the detector when an accumulated liquid agent discharge amount from the tank exceeds a predetermined value and a detection value from the detector when a previous accumulated liquid agent discharge amount exceeds a predetermined value, which is stored in the storage unit, and determine that the liquid agent is fixed in the tank if a value of the calculated difference is less than a predetermined value. This makes it possible to detect occurrence of a trouble in the tank in an early stage.

The controller of the washing machine according to the present invention may be configured so as not to perform trouble determination in the tank via the trouble determination unit when a detection value from the detector coincides with a detection value in a state in which the tank is filled with the liquid agent. This makes it possible to prevent erroneous detection of occurrence of a trouble.

The washing machine according to the present invention may include a float portion pivotally provided on a lower surface of the tank lid. The to-be-detected portion may be constituted by a magnet provided in the float portion. The detector may be constituted by a magnetic force sensor. This makes it possible to easily detect the remaining amount of liquid agent in the tank with a simple configuration.

The washing machine according to the present invention may include a plurality of magnets provided apart from each other at positions along the

pivoting direction of the float portion. This can detect the remaining amount of liquid agent in the tank in a wide range.

The washing machine according to the present invention may include a display unit. Upon determining occurrence of a trouble in the tank via the trouble determination unit, the controller may display corresponding information on the display unit. This allows the user to quickly recognize occurrence of a trouble in the tank, thereby prompting the user to deal with the trouble.

10 INDUSTRIAL APPLICABILITY

The present invention can detect sufficiency or insufficiency of a remaining amount of liquid agent in a wide range with high determination accuracy, and hence is useful for applications including not only household washing machines but also industrial washing machines.

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REFERENCE MARKS IN THE DRAWINGS

100: washing machine

101: housing

102, 114a: lid body

20 103: clothes load and unload port

104: operation display unit

105: water tub

106: drum (washing tub)

106a: baffle

25 109: automatic liquid agent injection device (liquid supply device)

110: water supply device

110a: first water supply valve (water supply valve)

	110b: second water supply valve (water supply valve)
	110c: water supply channel
	111: pump unit
	111a: outer frame
5	111b: detergent-side cylindrical portion (second cylindrical portion)
	111c, 117f: packing
	111e: protruding rib
	111f: softener-side cylindrical portion (second cylindrical portion)
	112: piston pump unit
10	112a: link
	112b: cam
	112c: storage portion
	112d: cylinder
	112e: piston
15	112f: drive motor
	112g: discharge water channel
	112h: suction water channel
	112i, 112j: inner wall surface
	113: three-way valve unit (switching section)
20	113a: detergent-side three-way valve
	113b: softener-side three-way valve
	113c: detergent-side spring
	113d: detergent-side coil
	113e: detergent-side plunger
25	113f: detergent-side valve body
	113h: softener-side spring
	113i: softener-side coil

	113j: softener-side plunger
	113k: softener-side valve body
	113l: detergent-side cylinder
	113m: softener-side cylinder
5	114: tank storage case (tank storage portion)
	114b: opening
	114c: drain port
	114d: insertion hole
	114g: lower water injection port (water injection port)
10	114h, 114i: guide rib
	114j: inclined surface
	114k: hole (first water injection port)
	115: detergent case
	115a: partition wall
15	115b: detergent storage portion
	115c: softener storage portion
	116: water injection case
	116a: pawl portion
	116b: first upper water injection port
20	116c: second upper water injection port
	116d: third upper water injection port (second water injection port)
	117: detergent tank (tank)
	117a: rear wall
	117b: protruding portion
25	117c: downward recessed portion
	117g, 126g: grip
	117h, 126h: receiving portion

	117i, 126i: extending portion
	117j, 126j: projection
	117k, 126k: concave portion
	118: upper surface opening portion
5	119: detergent tank lid (tank lid)
	119a: partition rib
	119b: small window (liquid agent replenishment lid)
	119c: first bearing portion
	119d: first hole
10	119e: second bearing portion
	119f: second hole
	120: bottom surface
	121: hook portion
	122: filter
15	122a: downward extending rib
	122b: extending rib
	122c, 164a, 165a: convex portion
	122d: lower end
	122e: longitudinal rib portion
20	122f: transverse rib portion
	123: cylindrical portion (first cylindrical portion)
	123b: check valve
	124: water channel
	126: softener tank (tank)
25	128: softener tank lid (tank lid)
	129: coupling hose
	129a: branch water channel

	130: remaining amount detector
	130a: float portion
	131: pivot shaft
	131a: first pivot shaft
5	131b: second pivot shaft
	132: stopper rib
	133: link
	134: magnet (portion to be detected)
	134a: first magnet (portion to be detected)
10	134b: second magnet (portion to be detected)
	135: magnet box
	135a: cover
	135b: receiving portion
	135c: holding rib
15	136: linear Hall element (detector)
	137: magnet stopper
	137a: abutment portion
	138a: first longitudinal rib (longitudinal rib)
	138b: second longitudinal rib (longitudinal rib)
20	138c: third longitudinal rib (longitudinal rib)
	139: opening portion
	140: bathwater pump
	141: auxiliary hose (auxiliary water channel)
	142: discharge hose (discharge water channel)
25	163: damper
	164: suction-side check valve
	164b, 165b: spring

	165: discharge-side check valve
	170: back-flow prevention device
	171: water flow channel
	172: aspirator
5	172a, 172b: inner circumferential upper portion
	173: inflow water channel
	174: negative pressure generator
	174a: air inlet
	174b: chamfered portion
10	175: outflow water channel
	176: atmosphere introduction hose
	176a: connecting port
	177: upper lid
	177a: protruding portion
15	177b: connecting portion
	177c: opening
	177d: cavity
	181: first water channel
	181a: first branch point
20	182: second water channel
	181b: second branch point
	183: third water channel
	183a: third branch point
	184: bypass water channel
25	185: branch water channel
	200: air pool
	a, b, c, d: opening portion

e: discharge port

m: step

CLAIMS

1. A washing machine comprising:
a housing;
5 a water tub supported in the housing;
a tank containing a liquid agent;
a liquid supply device configured to automatically supply the liquid agent inside the tank to the water tub;
a remaining amount detector configured to detect a remaining amount of liquid agent
10 in the tank; and
a controller configured to control a washing operation of the washing machine, wherein the remaining amount detector includes
a float portion floating on a surface of the liquid agent in the tank,
a plurality of to-be-detected portions provided on the float portion, and
15 a detector configured to detect the to-be-detected portions, and
the plurality of to-be-detected portions are disposed apart from each other at positions along a moving direction of the float portion in accordance with changes in level of the liquid agent, and the to-be-detected portion at a lowest position of the plurality of to-be-detected portions is provided at a position higher than the detector while the tank is filled with the liquid agent.
20
2. The washing machine according to claim 1, wherein the controller is configured to detect the remaining amount of liquid agent in the tank based on a detection value from the detector, and notify the remaining amount of liquid agent.
25
3. The washing machine according to claim 1 or 2, further comprising a display unit, wherein the controller causes the display unit to display the remaining amount of liquid agent in the tank.
- 30 4. The washing machine according to claim 1, wherein the controller determines, based on a detection value detected by the to-be-detected portion, whether the remaining amount of liquid agent in the tank is smaller than a predetermined amount.
5. The washing machine according to claim 4, further comprising a display
35 unit,

wherein upon determining that the remaining amount of liquid agent in the tank is smaller than the predetermined amount, the controller displays corresponding information on the display unit.

- 5 6. The washing machine according to claim 1, further comprising a tank lid configured to open and close an opening formed in an upper portion of the tank, wherein the float portion is pivotally disposed on a lower surface of the tank lid.
- 10 7. The washing machine according to claim 1, wherein the plurality of to-be-detected portions are constituted by a plurality of magnetic force generators, and the detector is constituted by a magnetic force sensor.
- 15 8. The washing machine according to claim 7, wherein the plurality of magnetic force generators are constituted by a plurality of magnets, and the plurality of magnets are disposed so as to make adjacent magnets of the plurality of magnets have different polarities with respect to the magnetic force
- 20 sensor.