

DESCRIPTION

WASHING MACHINE

5 TECHNICAL FIELD

The present invention relates to a washing machine equipped with an automatic liquid-agent feeding device.

BACKGROUND ART

10 PTL 1 discloses a washing machine configured to automatically feed a liquid agent, such as detergent liquid or softener liquid.

The above washing machine includes a housing, a water tub, a drum, a tank, a tank containing case, a supplied-water channel, and an automatic liquid-agent feeding device. The water tub is resiliently supported inside the
15 housing in a vibration-controlled manner. The drum is rotatably supported inside the water tub. The tank stores a liquid agent. The tank containing case houses the tank. The supplied-water channel is disposed at an upper part of the tank containing case, and tap water, a liquid agent, and the like flow through the supplied-water channel. The automatic liquid-agent feeding
20 device is equipped with a pump, and is configured to automatically feed the liquid agent stored in the tank into the drum. With this configuration, the pump causes the liquid agent stored in the tank to be supplied into the water tub through the supplied-water channel and the tank containing case.

However, washing machines are restricted in arrangement of each
25 component due to design factors, and the like. In other words, the liquid agent discharged from the automatic liquid-agent feeding device passes through various discharge channels, such as a tubular pipe, a connecting hose, a

channel having a rectangular track to be supplied into the water tub. Furthermore, washing machines equipped with a manual-feeding detergent case for powder detergent commonly have a configuration that a liquid agent discharged from the automatic liquid-agent feeding device is supplied into a washing tub through the detergent case. This configuration complicates and elongates a supplied-water channel and a channel for the liquid agent discharged from the automatic liquid-agent feeding device. Thus, the liquid agent may remain in and fix to the channels. Furthermore, the remaining liquid agent may dissolve at an unnecessary timing to hinder the basic performance, such as washing and rinsing. In addition, there is a possibility that a liquid agent cannot be discharged in the case where the remaining liquid agent is fixed and blocks the discharge channel.

Citation List

Patent Literature

- PTL 1: Unexamined Japanese Patent Publication No. 2004-313234

SUMMARY OF THE INVENTION

The present invention provides a washing machine capable of suppressing a liquid agent discharged from an automatic liquid-agent feeding device from remaining in and fixing to a liquid channel.

The washing machine of the present invention includes: a housing; a water tub supported inside the housing; a washing tub rotatably provided in the water tub; and a tank containing case disposed above the water tub and including a container. The washing machine further includes: a tank disposed in the container of the tank containing case and configured to store a liquid agent; and an automatic liquid-agent feeding device configured to automatically feed the liquid agent stored in the tank into the washing tub.

The automatic liquid-agent feeding device includes a pump unit configured to suck and discharge the liquid agent stored in the tank, and the liquid agent discharged from the pump unit falls freely into the water tub. This configuration suppresses the liquid agent discharged from the pump unit from
5 attaching and being fixed to a liquid channel leading to the water tub. As a result, a highly reliable washing machine can be provided.

BRIEF DESCRIPTION OF DRAWINGS

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

FIG. 2 is a vertical sectional view of the washing machine according to the exemplary embodiment.

FIG. 3 is a plan view of an automatic liquid-agent feeding device of the washing machine according to the exemplary embodiment.

15 FIG. 4 is a right side view of the automatic liquid-agent feeding device of the washing machine according to the exemplary embodiment.

FIG. 5 is a left side view of the automatic liquid-agent feeding device of the washing machine according to the exemplary embodiment.

20 FIG. 6 is a left sectional view of the automatic liquid-agent feeding device of the washing machine according to the exemplary embodiment.

FIG. 7 is an exploded perspective view of the automatic liquid-agent feeding device of the washing machine according to the exemplary embodiment.

FIG. 8A is a schematic view of a three-way valve unit of the washing machine according to the exemplary embodiment in supplying tap water.

25 FIG. 8B is a schematic view of the three-way valve unit of the washing machine according to the exemplary embodiment in supplying detergent liquid.

FIG. 8C is a schematic view of the three-way valve unit of the washing

machine according to the exemplary embodiment in supplying softener liquid.

FIG. 9 is a sectional view of a pump unit of the washing machine according to the exemplary embodiment.

FIG. 10 is a sectional view of a main portion of a detergent tank of the washing machine according to the exemplary embodiment.

FIG. 11 is a schematic configuration diagram of the automatic liquid-agent feeding device of the washing machine according to the exemplary embodiment.

FIG. 12 is an exploded perspective view of the detergent tank of the washing machine according to the exemplary embodiment.

FIG. 13 is a perspective view of a lower surface of a detergent tank lid equipped with a float of the washing machine according to the exemplary embodiment.

FIG. 14A is a schematic sectional side view of a remaining amount detector of the washing machine according to the exemplary embodiment.

FIG. 14B is a schematic view of the lower surface of the detergent tank lid equipped with the float of the washing machine according to the exemplary embodiment.

FIG. 15 is a schematic sectional side view of the remaining amount detector of the washing machine according to the exemplary embodiment in a state in which the detergent tank is filled with detergent liquid.

FIG. 16 is a view showing a relationship between a magnetic force sensed by a linear Hall element and an output voltage of the linear Hall element.

FIG. 17 is a view showing a relationship between frequency of feeding detergent of a remaining amount detector of detergent and an output voltage of the linear Hall element of the washing machine according to the exemplary

embodiment.

FIG. 18 is a flowchart of a method of determining insufficiency of the remaining amount of detergent in the washing machine according to the exemplary embodiment.

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DESCRIPTION OF EMBODIMENTS

Hereinafter, exemplary embodiments are described in detail with reference to the drawings. However, descriptions in more detail than necessary may be omitted. For example, detailed descriptions of well-known
10 matters and duplicate descriptions of substantially identical configurations may be omitted. This is to avoid unnecessary redundancy in the following description and to facilitate understanding of those skilled in the art.

(Exemplary embodiment)

A washing machine according to the present exemplary embodiment
15 will be described below step by step by each item with reference to FIGS. 1 to 18.

[1-1. Configuration]

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

First, a configuration of a washing machine according to the present
20 exemplary embodiment will be described with reference to FIGS. 1 and 2.

FIG. 1 is a perspective view of a washing machine according to an exemplary embodiment of the present invention. FIG. 2 is a vertical sectional view of the washing machine according to the exemplary embodiment.

As shown in FIGS. 1 and 2, the washing machine according to the
25 present exemplary embodiment includes housing 101, water tub 105 having a shape of a bottomed cylinder and disposed inside housing 101, and the like. Housing 101 forms an outer frame of washing machine 100. Water tub 105 is

resiliently supported inside housing 101 by a plurality of suspensions (not shown) and damper 163 in a vibration-controlled manner. Drum 106 (washing tub) having a shape of a bottomed cylinder is rotatably provided inside water tub 105. Drum 106 includes a plurality of baffles 106a on an inner wall surface of drum 106. During a low-speed rotation of drum 106, baffles 106a stir clothes by catching and lifting them up and then dropping them from above. Further, drum 106 includes a plurality of small through-holes (not shown) on a peripheral surface of drum 106. Water tub 105 includes a tub rotation motor (not shown) on a bottom of water tub 105. The tub rotation motor is configured to rotate drum 106.

Housing 101 includes clothes loading/unloading port 103 that is an opening formed on a front face of housing 101 for loading/unloading the clothes. Housing 101 also includes lid 102 on the front face of housing 101. Lid 102 covers clothes loading/unloading port 103 in an openable manner. In other words, a user can load the clothes into drum 106 through clothes loading/unloading port 103 by opening lid 102.

Housing 101 further includes automatic liquid-agent feeding device 109. Automatic liquid-agent feeding device 109 is disposed above water tub 105. A configuration of automatic liquid-agent feeding device 109 will be described in detail in [1-1-2. Configuration of automatic liquid-agent feeding device].

Housing 101 includes openable lid 114a at an upper part of housing 101. Opening lid 114a allows detergent tank 117 (tank) and softener tank 126 (tank) to be detachably attached inside opening 114b.

Lid 102 includes operation display 104 on an upper part of lid 102. Operation display 104 includes an operation unit configured to control operation of the washing machine and a display configured to display the operation state.

Housing 101 further includes a controller (not shown). The controller is configured to control the tub rotation motor and other components, and control and perform a series of steps such as washing, rinsing, and spin-drying, one after another. The controller includes a clothes amount determination unit (not shown), a liquid-agent feeding amount calculator (not shown), and the like. The clothes amount determination unit is configured to detect a torque current value in rotating the tub rotation motor at a fixed rotation speed, for example. Based on the detected value, the clothes amount determination unit determines the amount of the laundry up to 10 kg on a scale of one to ten, for example. The controller is also configured to determine the amount of water to be used in washing based on the determination result by the clothes amount determination unit. The liquid-agent feeding amount calculator is configured to calculate a feeding amount of detergent and a feeding amount of softener based on the amount of the clothes which has been determined by the clothes amount determination unit.

Washing machine 100 further includes a storage unit (not shown). The storage unit is formed of an electrically erasable and programmable read only memory (EEPROM), for example. The storage unit includes a detergent type storage unit (not shown) to store information on detergent types, and is configured to store various kinds of setting information relating to washing operation.

The washing machine according to the present exemplary embodiment is configured as described above.

[1-1-2. Configuration of automatic liquid-agent feeding device 109]

Next, a configuration of automatic liquid-agent feeding device 109 will be described below with reference to FIGS. 3 to 11.

FIG. 3 is a plan view of an automatic liquid-agent feeding device of the

washing machine according to the exemplary embodiment. FIG. 4 is a right side view of the automatic liquid-agent feeding device. FIG. 5 is a left side view of the automatic liquid-agent feeding device. FIG. 6 is a left sectional view of the automatic liquid-agent feeding device. FIG. 7 is an exploded perspective view of the automatic liquid-agent feeding device. FIG. 8A is a schematic view of a three-way valve unit of the washing machine in supplying tap water. FIG. 8B is a schematic view of the three-way valve unit of the washing machine in supplying detergent liquid. FIG. 8C is a schematic view of the three-way valve unit of the washing machine in supplying softener liquid, and FIG. 9 is a sectional view of a pump unit of the washing machine. FIG. 10 is a sectional view of a main portion of a detergent tank of the washing machine. FIG. 11 is a schematic configuration diagram of the automatic liquid-agent feeding device of the washing machine.

Automatic liquid-agent feeding device 109 is disposed above water tub 105 of housing 101, as described above. Automatic liquid-agent feeding device 109 includes water feeder 110, pump unit 111, three-way valve unit 113, tank containing case 114 to which detergent tank 117 and softener tank 126 are attached, etc., each of which will be described in detail below. In the following description, detergent tank 117 and softener tank 126 are simply referred to as a “tank” when distinction between them is unnecessary. In addition, detergent liquid and softener liquid are also simply referred to as a “liquid agent” when distinction between them is unnecessary.

(Water feeder 110)

Water feeder 110 is disposed at an upper part of housing 101, and includes water supply channel 110c, first water supply valve 110a, second water supply valve 110b, etc. In the following description, first water supply valve 110a and second water supply valve 110b are simply referred to as a

“water supply valve” when distinction between them is unnecessary.

Water supply channel 110c communicates with a faucet, such as a water pipe, through a water supply hose (not shown) at one end of water supply channel 110c. A liquid channel for tap water is selected by controlling opening and closing of first water supply valve 110a and second water supply valve 110b. The liquid channel for tap water will be described in (Configuration of liquid channels) below.

(Three-way valve unit 113)

Three-way valve unit 113 forms a unit configured to selectively discharge a liquid agent in detergent tank 117 and a liquid agent in softener tank 126 attached to tank containing case 114 to piston pump unit 112 (see FIG. 9).

As shown in FIG. 7, three-way valve unit 113 includes detergent-side three-way valve 113a, softener-side three-way valve 113b, detergent-side coil 113d, softener-side coil 113i, etc. Detergent-side coil 113d is configured to drive detergent-side three-way valve 113a. Softener-side coil 113i is configured to drive softener-side three-way valve 113b.

As shown in FIG. 8A, three-way valve unit 113 includes liquid channel 124 to allow detergent liquid or softener liquid to flow to pump unit 111. Three-way valve unit 113 is configured to control a flow of liquid in liquid channel 124. Liquid channel 124 communicates with detergent-side cylindrical portion 111b and softener-side cylindrical portion 111f on the front side. Liquid channel 124 further communicates with second liquid channel 182 (liquid channel) and suction channel 112h of piston pump unit 112.

Detergent-side three-way valve 113a is configured to selectively switch between a flow of tap water flowing in second liquid channel 182 and a flow of detergent liquid flown from detergent tank 117, as shown in FIG. 11. This

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

Then, specific operation of detergent-side three-way valve 113a will be described with reference to FIGS. 8A to 8C.

5 Detergent-side three-way valve 113a includes detergent-side cylinder 113l, detergent-side plunger 113e, detergent-side disc 113f, detergent-side spring 113c, etc. Detergent-side plunger 113e is provided inside detergent-side cylinder 113l and is configured to reciprocate back and forth. Detergent-side disc 113f is provided at a front end of detergent-side plunger 10 113e. Detergent-side spring 113c is arranged such that one end thereof is disposed on a rear wall of detergent-side cylinder 113l and the other end thereof is disposed on a rear end of detergent-side plunger 113e. Detergent-side cylinder 113l has opening a at a front end of detergent-side cylinder 113l. Detergent-side coil 113d is provided around detergent-side cylinder 113l so as to 15 surround detergent-side plunger 113e.

Firstly, detergent-side plunger 113e receives a forward biasing force from detergent-side spring 113c while detergent-side coil 113d is not energized, as shown in FIGS. 8A and 8C. This causes detergent-side disc 113f to be biased and close opening b formed at a rear end of detergent-side cylindrical 20 portion 111b. Thus, a flow of detergent liquid from detergent tank 117 is blocked by detergent-side disc 113f. At this time, opening a of detergent-side cylinder 113l is opened. This allows tap water to flow in liquid channel 124 from second liquid channel 182 in a direction of arrow X1. The flown-in tap water passes through opening a of detergent-side cylinder 113l (see arrow X2) 25 and flows to softener-side three-way valve 113b (see arrow X3).

When detergent-side coil 113d is energized as shown in FIG. 8B, a magnetic field is generated around detergent-side coil 113d. Accordingly, upon

receiving an electromagnetic force from the magnetic field, detergent-side plunger 113e moves backward against the biasing force of detergent-side spring 113c. This opens opening b of detergent-side cylindrical portion 111b. As a result, detergent liquid in detergent tank 117 flows to softener-side three-way valve 113b passing through opening b, as shown by arrows X5 and X6. At this time, detergent-side disc 113f closes opening a of detergent-side cylinder 113l. Thus, detergent-side disc 113f blocks a flow of tap water flowing in second liquid channel 182.

As described above, detergent-side three-way valve 113a operates to switch a flow of tap water from second liquid channel 182 and a flow of detergent liquid from detergent tank 117. With this configuration, either tap water or detergent liquid is selectively supplied to softener-side three-way valve 113b.

In the same manner as the operation of detergent-side three-way valve 113a, softener-side three-way valve 113b is configured to selectively switch a flow of liquid from detergent-side three-way valve 113a and a flow of softener liquid from softener tank 126. With this configuration, either tap water or softener is supplied to suction channel 112h of piston pump unit 112.

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 disc 113k, softener-side spring 113h, etc. Softener-side plunger 113j is provided inside detergent-side cylinder 113l and is configured to reciprocate back and forth. Softener-side disc 113k is provided at a front end of softener-side plunger 113j. Softener-side spring 113h is arranged such that one end thereof is disposed on a rear wall of softener-side cylinder 113m and the other end thereof is disposed on a rear end of softener-side plunger 113j. Liquid from detergent-side three-way valve 113a

flows in softener-side cylinder 113m. Softener-side cylinder 113m has opening c at a front end of softener-side cylinder 113m. Softener-side coil 113i is provided around softener-side cylinder 113m so as to surround softener-side plunger 113j.

5 Firstly, softener-side plunger 113j receives a forward biasing force from softener-side spring 113h while softener-side coil 113i is not energized, as shown in FIGS. 8A and 8B. This causes softener-side disc 113k to be biased and close opening d formed at a rear end of softener-side cylindrical portion 111f. This causes softener-side disc 113k, which closes opening d of
10 softener-side cylindrical portion 111f, to block a flow of softener liquid from softener tank 126. At this time, opening c of softener-side plunger 113j is opened. This causes detergent liquid or tap water supplied from detergent-side three-way valve 113a to softener-side three-way valve 113b to flow through opening c to suction channel 112h of piston pump unit 112 as
15 shown by arrow X4 or arrow X7.

When softener-side coil 113i is energized as shown in FIG. 8C, a magnetic field is generated around softener-side coil 113i. Accordingly, upon receiving an electromagnetic force from the magnetic field, softener-side plunger 113j moves backward against the biasing force of softener-side spring
20 113h. This opens opening d of softener-side cylindrical portion 111f. As a result, softener liquid in softener tank 126 flows to suction channel 112h of piston pump unit 112 passing through opening d, as shown by arrows X8 and X9. At this time, softener-side disc 113k closes opening c of softener-side plunger 113j. Thus, softener-side disc 113k blocks a flow of liquid from
25 detergent-side three-way valve 113a.

As described above, softener-side three-way valve 113b operates to switch a flow of liquid from detergent-side three-way valve 113a and a flow of

softener liquid from softener tank 126. With this configuration, either liquid or softener liquid is selectively supplied to suction channel 112h.

That is, according to the above configuration, as shown in FIG. 8A, tap water in second liquid channel 182 is supplied to piston pump unit 112 through three-way valve unit 113 when both detergent-side coil 113d and softener-side coil 113i are in a de-energized state. As shown in FIG. 8B, detergent liquid in detergent tank 117 is supplied to piston pump unit 112 through three-way valve unit 113 when detergent-side coil 113d is in an energized state and softener-side coil 113i is in a de-energized state. As shown in FIG. 8C, softener liquid in softener tank 126 is supplied to piston pump unit 112 through three-way valve unit 113 when detergent-side coil 113d is in a de-energized state and softener-side coil 113i is in an energized state.

(Pump unit 111)

As shown in FIG. 7, pump unit 111 forms a unit for sucking detergent liquid in detergent tank 117 or softener liquid in softener tank 126 and discharging the detergent liquid or softener liquid to water tub 105.

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

Outer frame 111a is made of a resin, such as polypropylene, and surrounds piston pump unit 112 to protect piston pump unit 112. Outer frame 111a is disposed between water feeder 110 and tank containing case 114, as shown in FIG. 5.

As shown in FIGS. 7 and 10, outer frame 111a includes detergent-side cylindrical portion 111b formed below an outer wall front surface of outer frame 111a so as to extend forward and backward. A front end 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 peripheral surface of

detergent-side cylindrical portion 111b includes a plurality of packings 111c that are disposed apart from each other. Protruding rib 111e extending forward is provided in front of detergent-side cylindrical portion 111b. As shown in FIG. 8A, the rear end of detergent-side cylindrical portion 111b is connected with liquid channel 124 so as to communicate with liquid channel 124. Liquid channel 124 communicates with suction channel 112h of pump unit 111.

As shown in FIG. 7, outer frame 111a includes softener-side cylindrical portion 111f formed below the outer wall front surface of outer frame 111a so as to extend forward and backward. A front end of softener-side cylindrical portion 111f is inserted into a cylindrical portion (not shown) formed on a lower rear wall of softener tank 126. A rear end of softener-side cylindrical portion 111f is connected with liquid channel 124 so as to communicate with liquid channel 124, as shown in FIG. 8A for example.

As shown in FIGS. 7 and 9, piston pump unit 112 includes cylinder 112d, suction channel 112h through which a liquid agent flows into cylinder 112d, discharge channel 112g through which the liquid agent is discharged from cylinder 112d, drive motor 112f, etc. Drive motor 112f is configured to drive piston 112e that is provided in cylinder 112d and is capable of reciprocating up and down.

That is, cylinder 112d is formed to have a hollow substantially cylindrical shape (including a cylindrical shape). Cylinder 112d includes piston 112e provided therein that is capable of reciprocating up and down. Piston 112e is joined to drive motor 112f through link 112a and cam 112b. With the above configuration, rotation of drive motor 112f is transmitted to piston 112e through link 112a and cam 112b, which causes piston 112e to reciprocate up and down.

Cylinder 112d is equipped with suction channel 112h and discharge channel 112g at a lower part of cylinder 112d so as to communicate with suction channel 112h and discharge channel 112g. Suction channel 112h and discharge channel 112g are disposed lower than piston 112e. This configuration allows a liquid agent discharged by piston 112e to be forcefully discharged downward.

As shown in FIG. 8A, suction channel 112h forms a liquid channel that communicates with discharge port e of liquid channel 124 and sucks liquid discharged from softener-side three-way valve 113b into container 112c provided inside cylinder 112d.

As shown in FIG. 9, suction channel 112h includes suction-side check valve 164 provided therein. Suction-side check valve 164 includes protrusion 164a formed at a lower part of suction-side check valve 164. Suction channel 112h further includes spring 164b configured to urge suction-side check valve 164 downward. Urged by spring 164b, protrusion 164a comes in contact with a shoulder of inner wall surface 112i of suction channel 112h. This causes suction-side check valve 164 not to move to a lower part of cylinder 112d beyond the contact portion of inner wall surface 112i of suction channel 112h, although suction-side check valve 164 is configured to move upward.

On the other hand, discharge channel 112g forms a liquid channel to discharge the liquid inside cylinder 112d. As shown in FIG. 5, discharge channel 112g is connected with branch liquid channel 129a of coupling hose 129.

Discharge channel 112g includes discharge-side check valve 165 provided therein. Discharge-side check valve 165 includes protrusion 165a at an upper part of discharge-side check valve 165. Discharge channel 112g further includes spring 165b configured to urge discharge-side check valve 165

upward. Urged by spring 165b, protrusion 165a comes in contact with a shoulder of inner wall surface 112j of discharge channel 112g. This causes discharge-side check valve 165 not to move to an upper part of cylinder 112d beyond the contact portion of inner wall surface 112j of discharge channel 112g,
5 although discharge-side check valve 165 is configured to move downward.

When piston 112e moves upward, container 112c of cylinder 112d is negatively pressurized, and an upward force is applied to suction-side check valve 164. When the upward force is larger than a resultant force of a gravity force (own weight) of suction-side check valve 164 and an elastic force of spring
10 164b, suction-side check valve 164 moves upward. This generates a gap between protrusion 164a of suction-side check valve 164 and inner wall surface 112i of suction channel 112h. As a result, liquid from three-way valve unit 113 flows in suction channel 112h through the gap and flows into cylinder 112d.

Whereas, when piston 112e moves downward, container 112c of cylinder
15 112d is positively pressurized, and a downward force is applied to discharge-side check valve 165. When a resultant force of a gravity force (own weight) of discharge-side check valve 165 and the downward force applied to discharge-side check valve 165 is larger than an elastic force of spring 165b to urge discharge-side check valve 165 upward, discharge-side check valve 165
20 moves downward. This generates a gap between protrusion 165a of discharge-side check valve 165 and inner wall surface 112j of discharge channel 112g. As a result, liquid in container 112c of cylinder 112d flows in discharge channel 112g through the gap and is discharged to branch liquid channel 129a.

As shown in FIG. 5, discharge channel 112g is connected with branch
25 liquid channel 129a of coupling hose 129 so as to communicate with branch liquid channel 129a. Coupling hose 129 is a hose that allows drain port 114c of tank containing case 114 to communicate with water tub 105. With this

configuration, downward movement of piston 112e allows a liquid agent in container 112c of cylinder 112d to be discharged into water tub 105 through branch liquid channel 129a of coupling hose 129 that communicates with discharge channel 112g.

5 As described above, piston 112e of piston pump unit 112 is configured to move upward and downward repeatedly. With this configuration, detergent liquid in detergent tank 117 or softener liquid in softener tank 126 is sucked into pump unit 111 and discharged into water tub 105, as shown in FIG. 11.

 At this time, according to the present exemplary embodiment, suction
10 channel 112h, discharge channel 112g, and branch liquid channel 129a, which are described above, are arranged in a substantially vertical direction (including a vertical direction) so as to cause a liquid agent and the like to fall freely.

(Tank containing case 114)

15 As shown in FIG. 3, tank containing case 114 constitutes a vessel having a container with an opened upper face. Tank containing case 114 includes detergent tank 117 and softener tank 126 detachably attached to a rear side of the container. Tank containing case 114 includes detergent case 115 detachably attached to a front side of the container.

20 As shown in FIG. 10, tank containing case 114 has insertion hole 114d at a lower rear wall of tank containing case 114. Detergent-side cylindrical portion 111b of pump unit 111 is inserted into insertion hole 114d.

 As shown in FIGS. 3 and 4, an upper part of tank containing case 114 includes supplied-water channel 116 through which tap water flows.
25 Supplied-water channel 116 communicates with first upper liquid inlet port 114e and second upper liquid inlet port 114f shown in FIG. 11 that are respectively formed on left and right side walls of an upper part of tank

containing case 114. Tap water flowing in supplied-water channel 116 is injected into detergent container 115b of detergent case 115 through first upper liquid inlet port 114e. Tap water flowing in supplied-water channel 116 is injected into softener container 115c of detergent case 115 through second
5 upper liquid inlet port 114f.

As shown in FIG. 5, tank containing case 114 includes linear Hall element 136 on each of the left and right side walls of tank containing case 114. Linear Hall element 136 is formed of an analog element, for example.

As shown in FIG. 4, tank containing case 114 is equipped with lower
10 liquid inlet port 114g at a lower part of the side wall of tank containing case 114. Lower liquid inlet port 114g communicates with bypass liquid channel 184 described later.

As shown in FIG. 6, tank containing case 114 includes drain port 114c formed at a bottom of tank containing case 114. Drain port 114c is connected
15 with one end of coupling hose 129. The other end of coupling hose 129 is connected with water tub 105 in a swingable manner. Coupling hose 129 is connected with branch liquid channel 129a that is branched in a vertical direction from a midpoint of coupling hose 129. Branch liquid channel 129a communicates with discharge channel 112g of pump unit 111, as described
20 above.

(Detergent tank 117, softener tank 126)

As shown in FIG. 10, detergent tank 117 and softener tank 126 each form a vessel with upper face opening 118 at an upper part thereof.

Detergent tank 117 includes first rib 117d and second rib 117e provided
25 on an upper periphery of detergent tank 117. First rib 117d and second rib 117e are configured to extend in an outer peripheral direction. Packing 117f is provided between first rib 117d and second rib 117e.

An upper part of detergent tank 117 is equipped with detergent tank lid 119 that covers upper face opening 118 in an openable manner. When detergent tank lid 119 is attached to the upper part of detergent tank 117, packing 117f is pressed to fix detergent tank 117 water-tightly. This configuration prevents leakage of detergent liquid from detergent tank 117 even when detergent tank 117 is turned sideways. Packing 117f may be provided on detergent tank lid 119 not on detergent tank 117. This configuration provides the same effect as packing 117f provided on detergent tank 117.

As shown in FIG. 10, detergent tank 117 includes cylindrical portion 123 that extends rearward at a lower part of rear wall 117a. Cylindrical portion 123 has through-hole 123a therein. Check valve 123b is provided on an inner peripheral surface of cylindrical portion 123. Check valve 123b is configured to rotate inwardly of detergent tank 117 (toward the front side in FIG. 10), but not to rotate outwardly of detergent tank 117 (toward the rear side in FIG. 10).

With the above configuration, when detergent tank 117 is attached to tank containing case 114, detergent-side cylindrical portion 111b of pump unit 111 is inserted to cylindrical portion 123 of detergent tank 117. At this time, protruding rib 111e of detergent-side cylindrical portion 111b expands check valve 123b. This allows detergent liquid in detergent tank 117 to flow through through-hole 123a to three-way valve unit 113.

Whereas, when detergent tank 117 is pulled out from tank containing case 114, check valve 123b rotates toward the rear side in FIG. 10. This causes check valve 123b to close through-hole 123a of cylindrical portion 123. This configuration prevents leakage of detergent liquid from detergent tank 117.

As shown in FIG. 12, detergent tank 117 includes grip 117g provided on a front outer wall surface of detergent tank 117. Grip 117g is provided away from a wall surface of detergent tank 117. This configuration allows the user to hold grip 117g. The user can pull out detergent tank 117 from tank containing case 114 by holding grip 117g and pulling detergent tank 117 toward the user. In this case, the user may hold grip 117g by inserting the fingers to a gap between grip 117g and detergent tank 117 from above or from below, for example. The user may also hold grip 117g by inserting the thumb to the gap between grip 117g and detergent tank 117 from above and also inserting two or three of the remaining fingers from below.

When the user pulls out detergent tank 117 inserted to the container of tank containing case 114 by holding grip 117g from below, the user needs to insert the wrist into a narrow space of a container of detergent case 115, and thus the wrist fits tightly. Accordingly, the user inserts the fingers into the gap between grip 117g and detergent tank 117 from above. This allows the user to easily pull out detergent tank 117 without feeling tight with the posture of the wrist.

Softener tank 126 has the same configuration as detergent tank 117, and thus the description thereof will be omitted.

(Mesh member 122)

As shown in FIG. 10, mesh member 122 is provided in detergent tank 117 in a detachable manner. Mesh member 122 is made of a resin such as polypropylene, for example. Mesh member 122 has through-holes 122a formed in a net shape and penetrating both sides of mesh member 122. Mesh member 122 filters detergent liquid in detergent tank 117. This suppresses foreign substances and fixed detergent liquid from being clogged in detergent-side cylindrical portion 111b.

As shown in FIG. 10, both ends of mesh member 122, that is, an upper end and lower end 122d in a longitudinal direction of mesh member 122 are folded, and mesh member 122 is equipped with engagement claw 122e on a rear surface thereof close to the upper end. Engagement claw 122e includes engagement rib 122b, protrusion 122c, etc. Engagement rib 122b is provided to extend rearward of mesh member 122. Protrusion 122c is provided to have a protruded shape at a tip end of engagement rib 122b.

Whereas, as shown in FIG. 10, detergent tank 117 includes hook 121 on bottom surface 120 of detergent tank 117. Hook 121 includes erected portion 121a and extending portion 121b. Erected portion 121a is erected from bottom surface 120 of detergent tank 117 in a substantially vertical direction (including a vertical direction). Extending portion 121b is provided to extend rearward of detergent tank 117 from a tip end of erected portion 121a. Hook 121 is engaged with lower end 122d of mesh member 122. Detergent tank 117 also includes projected portion 117b provided on rear wall 117a and projecting inward of detergent tank 117. Projected portion 117b is engaged with protrusion 122c of engagement claw 122e of mesh member 122.

In this configuration, mesh member 122 is diagonally engaged and fixed inside detergent tank 117 in view of the following.

Detergent liquid typically has a high viscosity. Thus, if mesh member 122 is disposed in a horizontal direction inside detergent tank 117, a liquid agent may not pass through through-holes 122a of mesh member 122. This may cause a pocket of air where detergent liquid does not exist below mesh member 122 of detergent tank 117. Thus, mesh member 122 is disposed diagonally in detergent tank 117. This configuration allows detergent liquid to pass through through-holes 122a while flowing downward on a surface of mesh member 122 due to the gravity. As a result, a pocket of air is suppressed

from occurrence below mesh member 122 of detergent tank 117.

Mesh member 122 is disposed inside detergent tank 117 in the following steps.

First, lower end 122d of mesh member 122 is inserted between
5 extending portion 121b and bottom surface 120 of detergent tank 117. While
keeping the above state, mesh member 122 is pressed in a direction of arrow C
shown in FIG. 10. At this time, as shown by the chain double-dashed line in
FIG. 10, protrusion 122c of mesh member 122 is bent in a direction of arrow D
and rear wall 117a of detergent tank 117 is bent in a direction of arrow E.
10 Bent protrusion 122c goes under projected portion 117b. This causes
protrusion 122c of engagement claw 122e and projected portion 117b of
detergent tank 117 to be engaged with each other. As a result, mesh member
122 is fixed and held diagonally in detergent tank 117.

On the other hand, mesh member 122 can be detached from detergent
15 tank 117 in the following steps.

Specifically, mesh member 122 is pushed in the direction of arrow C
shown in FIG. 10 to bend rear wall 117a in the direction of arrow E shown in
FIG. 10. This releases the engagement of engagement claw 122e and
projected portion 117b. As a result, mesh member 122 can be easily pulled out
20 from detergent tank 117.

(Detergent case 115)

As shown in FIG. 3, detergent case 115 is detachably provided forward
of detergent tank 117 and softener tank 126 in tank containing case 114.

Detergent case 115 is disposed in contact with detergent tank 117 and
25 softener tank 126. Thus, when detergent case 115 is attached to tank
containing case 114, detergent case 115 pushes detergent tank 117 and softener
tank 126 rearward. When detergent tank 117 is pushed rearward,

detergent-side cylindrical portion 111b is inserted into cylindrical portion 123 provided on outer frame 111a of pump unit 111, as shown in FIG. 10. This configuration reliably prevents leakage of detergent liquid and the like from detergent tank 117.

5 In the same manner, softener tank 126 is also securely mounted in tank containing case 114 by being pushed rearward by detergent case 115. This configuration reliably prevents leakage of softener liquid from softener tank 126.

10 As shown in FIG. 3, detergent case 115 forms a vessel with an opened upper face, and includes partition wall 115a. Partition wall 115a divides the container of detergent case 115 into detergent container 115b and softener container 115c. This configuration allows the user to manually feed powder detergent and softener respectively into detergent container 115b and softener container 115c.

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

20 When powder detergent which has been fed into detergent container 115b is washed off, a controller opens first water supply valve 110a as shown in FIG. 11. With this configuration, tap water supplied from a faucet flows in first liquid channel 181 and supplied-water channel 116, as shown by arrow A1 of FIG. 11. Then, tap water is injected into detergent container 115b of detergent case 115 through first upper liquid inlet port 114e.

25 On the other hand, softener container 115c further includes a conventionally-known siphon mechanism. Thus, when softener liquid which has been fed in softener container 115c is to flow, the controller opens second

water supply valve 110b shown in FIG. 11. This causes tap water to flow in third liquid channel 183 as shown by arrow A3 shown in FIG. 11. Then, tap water is injected to softener container 115c of detergent case 115 from second upper liquid inlet port 114f. The liquid level inside softener container 115c rises due to the injection of tap water. This causes the softener liquid in softener container 115c to completely flow out to water tub 105 without remaining in softener container 115c due to the siphon effect by the siphon mechanism.

(Configuration of liquid channels)

As shown in FIG. 11, in first liquid channel 181, water from first water supply valve 110a firstly flows through water supply channel 110c and supplied-water channel 116. Then, first liquid channel 181 forms a liquid channel that allows water to flow from first upper liquid inlet port 114e into detergent container 115b of detergent case 115. First liquid channel 181 branches into second liquid channel 182 upstream of supplied-water channel 116.

Second liquid channel 182 forms a liquid channel that allows water to flow through three-way valve unit 113 and pump unit 111 into branch liquid channel 129a of coupling hose 129. Second liquid channel 182 branches into bypass liquid channel 184 upstream of three-way valve unit 113 such that bypass liquid channel 184 extends vertically downward. Bypass liquid channel 184 communicates with lower liquid inlet port 114g of tank containing case 114.

In general, clogging with a foreign substance and/or deterioration over time sometimes cause a failure that an opening/closing part of detergent-side three-way valve 113a does not close completely. In such a case, detergent liquid in detergent tank 117 may flow back in second liquid channel 182.

However, according to the liquid channel configuration of the present exemplary embodiment, a liquid agent flowing back in second liquid channel 182 flows to bypass liquid channel 184. This makes it possible to reliably prevent the liquid agent from flowing back to the water supply faucet.

5 In third liquid channel 183, tap water from second water supply valve 110b firstly flows through water supply channel 110c and supplied-water channel 116. Then, third liquid channel 183 forms a liquid channel that allows water to flow from second upper liquid inlet port 114f into softener container 115c of detergent case 115.

10 Each of the liquid channels is configured as described above.

[1-1-3. Configuration of remaining amount detector]

A configuration of a remaining amount detector of a liquid agent of the washing machine according to the present exemplary embodiment will be described below with reference to FIGS. 12 to 16.

15 FIG. 12 is an exploded perspective view of the detergent tank of the washing machine according to the exemplary embodiment. FIG. 13 is a perspective view of a lower surface of a detergent tank lid equipped with a float of the washing machine. FIG. 14A is a schematic sectional side view of a remaining amount detector of the washing machine. FIG. 14B is a schematic
20 view of the lower surface of the detergent tank lid equipped with the float of the washing machine. FIG. 15 is a schematic side view of a detergent tank for illustrating a configuration of the remaining amount detector of the washing machine in a state in which the detergent tank is filled with detergent liquid. FIG. 16 is a view showing a relationship between a magnetic force sensed by a
25 linear Hall element and an output voltage of the linear Hall element.

Automatic liquid-agent feeding device 109 includes first remaining amount detector 130, a second remaining amount detector (not shown), etc.

First remaining amount detector 130 is configured to detect the amount of liquid detergent in detergent tank 117. The second remaining amount detector is configured to detect the amount of liquid detergent in softener tank 126. In the following description, first remaining amount detector 130 and the
5 second remaining amount detector are simply referred to as a “remaining amount detector” when distinction between them is unnecessary.

First remaining amount detector 130 is formed of float 130a, linear Hall element 136, etc. described below. The second remaining amount detector has the same configuration as first remaining amount detector 130, and thus the
10 description thereof will be omitted.

(Float 130a)

As shown in FIGS. 6 and 13, one end of float 130a is rotatably provided on a lower surface of detergent tank lid 119.

As shown in FIG. 12, float 130a includes link 133, rotation shaft 131
15 provided on an upper end of link 133, magnet box 135 provided on a lower end of link 133, etc. Rotation shaft 131 is rotatably disposed on the lower surface of detergent tank lid 119 (see FIG. 13).

Magnet box 135 is hollow inside, and constitutes a sealed vessel together with cover 135a. Magnet box 135 includes magnet 134 (a magnetic
20 body) therein. Magnet 134 is enclosed by magnet box 135 and cover 135a in a sealed state. This configuration prevents detergent liquid from infiltrating into and attaching to magnet 134. In addition, magnet box 135 includes holding rib 135c provided therein to hold magnet 134.

Since magnet box 135 is hollow inside, magnet box 135 itself undergoes
25 a buoyant force in detergent liquid. With this configuration, float 130a floats on a surface of detergent liquid in detergent tank 117 in a normal state. At this time, rotation shaft 131 of float 130a rotates vertically as shown by arrows

H in FIGS. 14A and 15, according to changes in liquid level of the detergent liquid.

Magnet box 135 further includes supporting unit 135b shown in FIG. 13 at a lower part of magnet box 135. On the other hand, detergent tank 117 includes magnet stopper 137 formed on a bottom surface of detergent tank 117. With this configuration, when a level of detergent liquid in detergent tank 117 decreases, float 130a rotates downward and supporting unit 135b comes in contact with magnet stopper 137. This prevents float 130a from rotating downward of magnet stopper 137.

As shown in FIGS. 13, 14A, 14B and 15, detergent tank lid 119 includes partition wall rib 119a on a lower surface of detergent tank lid 119. Partition wall rib 119a is provided around rotation shaft 131 of float 130a. This configuration prevents infiltration of detergent liquid into rotation shaft 131 and further prevents occurrence of defects, such as fixing of rotation shaft 131.

(Linear Hall element 136)

As shown in FIGS. 4 and 5, linear Hall element 136 is provided at a lower portion on an outer surface of each of left and right side walls of tank containing case 114. Linear Hall element 136 is configured to output a voltage according to a sensed magnetic flux density. Linear Hall element 136 is one example of a magnetic sensor.

In general, linear Hall element 136 has characteristics shown in FIG. 16. In FIG. 16, the horizontal axis represents values of a magnetic force sensed by linear Hall element 136 and the vertical axis represents output voltage values of linear Hall element 136.

Linear Hall element 136 outputs a voltage of $(1/2) V_{dd}$ (V) corresponding to half of the maximum voltage value V_{dd} (V) in the case where a sensed magnetic force is close to 0 Wb/m². The case where a sensed

magnetic force is close to 0 Wb/m² indicates a state in which the magnetic body and linear Hall element 136 are distant from each other to a degree at which linear Hall element 136 cannot sense a magnetic power of the magnetic body.

When a magnetic body with the north magnetic polarity approaches
5 linear Hall element 136 from the above state, linear Hall element 136 senses a strong north magnetic force. Thus, linear Hall element 136 outputs a voltage larger than (1/2) Vdd. That is, the output voltage increases in a direction shown by arrow J in FIG. 16, as a sensed north magnetic force increases.

In contrast, when a magnetic body with the south magnetic polarity
10 approaches linear Hall element 136, linear Hall element 136 senses a strong south magnetic force. Thus, linear Hall element 136 outputs a voltage less than (1/2) Vdd. That is, the output voltage decreases in a direction shown by arrow I in FIG. 16, as a sensed south magnetic force increases.

In other words, when a magnetic body has the north magnetic polarity,
15 the output voltage of linear Hall element 136 increases as a distance from magnet box 135 decreases, whereas the output voltage of linear Hall element 136 decreases as the distance from magnet box 135 increases. On the other hand, the relationship between the distance and the output voltage is inverted when a magnetic body has the south magnetic polarity.

20 As described above, linear Hall element 136 is disposed at a lower portion on the outer surface of each of the side walls of tank containing case 114. Thus, a distance between linear Hall element 136 and magnet box 135 decreases, when a level of detergent liquid in detergent tank 117 decreases. This causes a change in output voltage of linear Hall element 136, and thus a
25 level of detergent liquid in detergent tank 117 is detected.

If linear Hall element 136 is disposed on an outside of a bottom surface of detergent tank 117, linear Hall element 136 cannot sense a decrease in

detergent liquid in detergent tank 117, as detergent is accumulated on an inner bottom surface of detergent tank 117. However, linear Hall element 136 is disposed on the outer surface of each of the side walls of tank containing case 114 as described above. Thus, a decrease in detergent liquid can be reliably
5 detected, as detergent flows down along an inner surface of each side wall.

(Magnet stopper 137)

As shown in FIGS. 14A and 15, the inner bottom surface of detergent tank 117 includes magnet stopper 137 described above. Magnet stopper 137 is configured to come in contact with supporting unit 135b of magnet box 135
10 when the remaining amount of detergent is determined to be insufficient.

Even when the liquid level lowers beyond a predetermined amount of detergent at which detergent liquid in detergent tank 117 is determined to be insufficient, the above configuration prevents magnet box 135 from rotating further downward. Accordingly, an output voltage of linear Hall element 136
15 does not change, and linear Hall element 136 outputs a voltage around $(1/2)V_{dd}$ that is a set output voltage value.

[1-2. Operations and effects]

The operations and effects of the washing machine having the above configuration will be described below.

[1-2-1. Washing operation]

20

Washing operation of the washing machine according to the present exemplary embodiment will be described.

The washing operation of washing machine 100 normally includes a washing step, a rinsing step, a spin-drying step, and a drying step. In the
25 washing step, drum 106 is rotated while soaking the clothes in detergent water to remove soils. In the rinsing step, the clothes soaked in detergent water are rinsed with water. In the spin-drying step, the clothes containing water are

spin-dried. In the drying step, hot air is supplied to drum 106 to dry the clothes in drum 106.

First, before the washing operation by the washing machine is started, the user puts detergent liquid and softener liquid respectively in detergent
5 tank 117 and softener tank 126 in advance.

Specifically, the user opens lid 114a and removes detergent tank 117 from tank containing case 114 when detergent liquid is to be added to detergent tank 117. Then, the user opens detergent tank lid 119, puts detergent liquid into detergent tank 117, and returns detergent tank 117 into tank containing
10 case 114. Detergent liquid may be put directly to detergent tank 117 without removing detergent tank 117 from tank containing case 114.

In the same manner, the user opens lid 114a and removes softener tank 126 from tank containing case 114 when softener liquid is to be added to softener tank 126. Then, the user opens softener tank lid 128, puts softener
15 liquid into softener tank 126, and returns softener tank 126 into tank containing case 114. Softener liquid may be put directly to softener tank 126 without removing softener tank 126 from tank containing case 114.

According to the washing machine of the present exemplary embodiment, lid 114a, detergent tank lid 119, and softener tank lid 128 are
20 configured to be opened and closed while vertically rotating with a hinge mechanism, for example. Thus, when detergent tank lid 119 and softener tank lid 128 are to be closed in an opened state, closing lid 114a causes detergent tank lid 119 and softener tank lid 128 to be closed at the same time.

Then, the user opens lid 102 and loads the clothes into drum 106
25 through clothes loading/unloading port 103 when starting washing.

Then, the user turns on a power supply switch by operating operation display 104, and sets various types of washing courses and washing conditions,

such as washing, rinsing, spin-drying. Washing courses that can be set at this time include, for example, “washing only”, “rinsing only”, “spin-drying only”, etc.

An operation in a “washing course” will be described below.

5 In the “washing course”, the controller controls to sequentially perform a clothes amount determination step, a water supplying step, the washing step, the rinsing step, and the spin-drying step.

10 In the clothes amount determination step, the controller causes the clothes amount determination unit to measure a torque current value at the time when the tub rotation motor is rotated repeatedly in forward and reverse directions at a constant rotation speed. The clothes amount determination unit is configured to detect the amount of clothes loaded in drum 106 based on the measured torque current value.

15 Then, the controller drives pump unit 111 to automatically feed detergent liquid in the amount calculated by the liquid-agent feeding amount calculator from detergent tank 117 into drum 106.

 Then, the controller causes first water supply valve 110a to be opened and performs the water supplying step of supplying tap water in the amount corresponding to the detected amount of the clothes into drum 106.

20 After completion of the water supplying step, the controller drives the tub rotation motor to rotate drum 106. With this operation, the controller performs the washing step of stirring the laundry in drum 106.

 After completion of the washing step, the controller performs the spin-drying step, and then performs the rinsing step.

25 In the rinsing step, the controller causes first water supply valve 110a to be opened to supply a predetermined amount of tap water into water tub 105. Then, the controller drives pump unit 111 to automatically supply softener

liquid in the amount calculated by the liquid-agent feeding amount calculator from softener tank 126 into water tub 105.

After supplying detergent liquid or softener liquid, the controller then causes tap water to be supplied to liquid channels to wash off detergent and
5 softener liquid remaining in detergent tank 117, softener tank 126, and the liquid channels. This configuration prevents fixing of detergent liquid and softener liquid remaining in detergent tank 117, softener tank 126, and the liquid channels.

Then, after completion of the rinsing step, the controller performs the
10 spin-drying step. This completes a sequence of the washing course.

[1-2-2. Method of supplying water and method of supplying detergent]

A method of supplying water and a method of supplying detergent to water tub 105 will be described in detail below with reference to FIGS. 6 to 11.

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

15 In supplying tap water, the controller causes first water supply valve 110a to be opened and at the same time, causes second water supply valve 110b to be closed. The controller de-energizes detergent-side coil 113d, softener-side coil 113i, and drive motor 112f. This causes tap water supplied from a faucet such as a water pipe to flow in first liquid channel 181 shown in FIG. 11, and
20 then to be supplied to water tub 105 through tank containing case 114, coupling hose 129, etc.

After completion of supplying water, the controller causes detergent liquid in detergent tank 117 to be supplied to water tub 105. In this case, the controller energizes detergent-side coil 113d and drive motor 112f, and
25 de-energizes softener-side coil 113i. This causes detergent tank 117 and suction channel 112h of pump unit 111 to communicate with each other. At this time, check valve 123b in cylindrical portion 123 of detergent tank 117 is

rotated rearward as shown in FIG. 10. Accordingly, detergent liquid in detergent tank 117 flows in through-hole 123a of cylindrical portion 123 in a direction shown by arrows F and G. Then, detergent liquid flows in suction channel 112h of pump unit 111 through 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 cause piston 112e to reciprocate up and down inside cylinder 112d. With this configuration, negative pressure and positive pressure are alternately generated inside cylinder 112d.

At this time, upward movement of piston 112e generates negative pressure in cylinder 112d. This causes suction-side check valve 164 to move upward to allow detergent liquid to flow into container 112c in cylinder 112d through a gap between suction-side check valve 164 and suction channel 112h (see FIG. 9). On the other hand, downward movement of piston 112e generates positive pressure in cylinder 112d. This causes discharge-side check valve 165 to move downward. Accordingly, detergent liquid in container 112c in the cylinder is discharged vertically downward toward branch liquid channel 129a through a gap between discharge-side check valve 165 and inner wall surface 112j of discharge channel 112g, as shown by arrow B in FIG. 6. The discharged detergent liquid flows through branch liquid channel 129a of coupling hose 129 disposed in the vertical direction and is supplied to water tub 105 (see FIG. 6).

Since piston 112e repeats upward and downward movements for a predetermined period of time as described above, a predetermined amount of detergent liquid is supplied to water tub 105.

Here, second liquid channel 182 communicates with water tub 105. In a state in which lid 102 is open, water tub 105 is normally open to the

atmosphere. Thus, a liquid agent may be dried, fixed, and deposited in liquid channels through which the liquid agent flows from piston pump unit 112 to water tub 105.

In view of this, in the washing machine of the present exemplary
5 embodiment, discharge channel 112g of piston pump unit 112 is connected with branch liquid channel 129a of coupling hose 129. This configuration allows detergent liquid to be discharged and freely fall vertically downward toward water tub 105 without passing through supplied-water channel 116 of tank containing case 114 (see arrow B in FIG. 6). This shortens a length of
10 discharge channel 112g and also prevents complication of liquid channels. Accordingly, fixing of detergent liquid to the liquid channels can be suppressed more effectively.

Next, after completion of feeding detergent liquid, the controller de-energizes detergent-side coil 113d and softener-side coil 113i. At the same
15 time, the controller causes first water supply valve 110a to be opened for a predetermined period of time (for example, for 10 seconds). With this operation, tap water is supplied to three-way valve unit 113 and pump unit 111. Thus, tap water can wash off detergent liquid remained in coupling hose 129.

In general, water flow is weak at the start of water supply. Accordingly,
20 suction-side check valve 164 and discharge-side check valve 165 of piston pump unit 112 may not move sufficiently, and may block a flow of supplied water. In view of this, in the present exemplary embodiment, the controller may drive drive motor 112f of piston pump unit 112 for a predetermined period of time (for example, for 20 seconds) after starting to open first water supply valve 110a
25 and after completion of feeding detergent liquid. At this time, the controller may drive drive motor 112f of piston pump unit 112 intermittently. The above configuration causes piston 112e of piston pump unit 112 to reciprocate up and

down to generate positive pressure and negative pressure alternately in container 112c in the cylinder. This ensures suction-side check valve 164 and discharge-side check valve 165 move sufficiently, so that tap water can be forcefully flown into pump unit 111. As a result, detergent liquid remaining in
5 three-way valve unit 113, pump unit 111, coupling hose 129, etc. can be washed off more reliably.

In addition, according to the washing machine of the present exemplary embodiment, discharge channel 112g of pump unit 111 communicates with water tub 105 through coupling hose 129 without passing through tank
10 containing case 114. This configuration prevents a liquid agent from remaining in and fixing to liquid channels from pump unit 111 to water tub 105.

On the other hand, in the case where softener liquid is supplied from softener tank 126, the controller energizes softener-side coil 113i and drive
15 motor 112f, and de-energizes detergent-side coil 113d. A method of supplying softener liquid is the same as a method of supplying detergent liquid, and thus the description thereof will be omitted.

Here, in the case where a foreign substance is caught in the opening/closing part of detergent-side three-way valve 113a, a gap may be
20 formed in the opening/closing part of detergent-side three-way valve 113a. At this time, if a power outage or a water outage occurs, for example, while first water supply valve 110a is open, detergent liquid in detergent tank 117 may flow out through the gap formed at the opening/closing part of detergent-side three-way valve 113a and flow back inside second liquid channel 182 toward
25 the water supply faucet.

In view of this, second liquid channel 182 of the washing machine of the present exemplary embodiment includes bypass liquid channel 184 extending

downward. Lower liquid inlet port 114g which is an outlet port of bypass liquid channel 184 is disposed lower than detergent tank 117. This configuration causes detergent liquid flown back from detergent tank 117, which is described above, through detergent-side three-way valve 113a to flow
5 into bypass liquid channel 184 indicated by arrow A4 in FIG. 11, and further into water tub 105 through tank containing case 114 and coupling hose 129. As a result, detergent liquid is prevented from flowing back to the water supply faucet. Thus, a failure of the water supply faucet due to a backflow can be avoided. In this case, tap water flowing through bypass liquid channel 184
10 flows into tank containing case 114. Accordingly, at the time of water supply, the tap water can also be utilized to wash off detergent liquid fixed to tank containing case 114.

The same description as in the case of detergent liquid can be applied to a case where softener in softener tank 126 flows back, and thus a description
15 thereof will be omitted.

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

A method of supplying powder detergent and softener to water tub 105 in the case where manual feeding of detergent is set by the user, will be described with reference to FIGS. 3 and 11. This corresponds to a case where
20 automatic liquid-agent feeding device 109 is not set by the user.

Firstly, the controller causes first water supply valve 110a to be opened, and at the same time causes second water supply valve 110b to be closed, when powder detergent fed in detergent case 115 is supplied to water tub 105. At this time, tap water supplied from the faucet flows through first liquid channel
25 181, and is fed toward detergent container 115b of detergent case 115 through first upper liquid inlet port 114e, as shown by arrow A1 in FIG. 11. This causes powder detergent in detergent container 115b to flow out with the fed

tap water from drain port 114c through coupling hose 129 and to be supplied to water tub 105.

The tap water supplied from the faucet flows from second liquid channel 182 into bypass liquid channel 184 as shown by arrows A2 and A4 in FIG. 11, and is fed to an inner bottom surface of tank containing case 114 through lower liquid inlet port 114g. With this configuration, tank containing case 114 receives water supplied from above and water supplied from below. As a result, powder detergent which has been fed in detergent container 115b is washed off into coupling hose 129 without remaining in tank containing case 114.

On the other hand, in the case where softener which has been fed in softener container 115c of detergent case 115 is supplied to water tub 105, the controller causes first water supply valve 110a to be closed and at the same time causes second water supply valve 110b to be opened. With this configuration, tap water supplied from the faucet flows through third liquid channel 183, and is fed toward softener container 115c of detergent case 115 through second upper liquid inlet port 114f, as shown by arrow A3 in FIG. 11. This raises the liquid level inside softener container 115c. Then, a siphon effect produced by the siphon mechanism causes the fed softener liquid to flow out to tank containing case 114 without remaining in softener container 115c. The softener liquid, which has flown into tank containing case 114, then flows into coupling hose 129 through drain port 114c, and is supplied to water tub 105.

[1-2-4. Method of detecting the amount of detergent remaining in detergent tank/softener tank]

A method of detecting the amount of detergent liquid remaining in detergent tank 117 will be described below with reference to FIG. 17. The

same description can be applied to a method of detecting the amount of softener liquid remaining in softener tank 126, and thus the description thereof will be omitted.

FIG. 17 is a view showing a relationship between feeding frequency of detergent of a remaining amount detector of detergent and an output voltage of the linear Hall element of the washing machine according to the exemplary embodiment. In FIG. 17, the horizontal axis represents feeding frequency of detergent liquid into water tub 105, and the vertical axis represents output voltage of linear Hall element 136. In FIG. 17, solid line a represents changes in output voltage when a magnetic body with the north magnetic polarity approaches linear Hall element 136, and broken line b represents changes in output voltage when a magnetic body with the south magnetic polarity approaches linear Hall element 136.

In the following description, the upper limit of the output voltage of linear Hall element 136 is 5 V, the lower limit of the output voltage thereof is 0 V, and the output voltage of linear Hall element 136 is 2.5 V when the magnetic flux density is substantially 0 Wb/m², for example. The upper limit of linear Hall element 136 may be, for example, 10 V, or may be set arbitrarily without hindrance to detection accuracy.

Firstly, linear Hall element 136 and magnet 134 are distant from each other as shown in FIG. 15 when detergent tank 117 is filled with sufficient detergent liquid. Thus, magnetic field lines from magnet 134 do not reach linear Hall element 136. Thus, linear Hall element 136 outputs a voltage of 2.5 V, which corresponds to a case where the magnetic flux density is substantially 0 Wb/m² as shown by section K in FIG. 17.

After that, detergent liquid is repeatedly fed to water tub 105 from detergent tank 117 according to the washing operation. This reduces the

amount of detergent liquid inside detergent tank 117, and lowers a level of detergent liquid.

As a level of detergent liquid is lowered, magnet box 135 floating on a surface of detergent liquid rotates downward. Thus, magnet 134 (magnetic body) in magnet box 135 approaches linear Hall element 136. This causes linear Hall element 136 to detect more magnetic field lines (magnetic flux density).

At this time, in the case where linear Hall element 136 receives a north magnetic polarity from magnet 134, an output voltage of linear Hall element 136 increases as detergent liquid in detergent tank 117 decreases as shown by solid line a in FIG. 17. If feeding of detergent liquid is further continued, magnet box 135 comes in contact with magnet stopper 137. With this configuration, the output voltage of linear Hall element 136 converges to a predetermined value (for example, 4.0 V).

On the other hand, in the case where linear Hall element 136 receives a south magnetic polarity from magnet 134, an output voltage of linear Hall element 136 decreases as detergent liquid in detergent tank 117 decreases as shown by broken line b in FIG. 17. If feeding of detergent liquid is further continued, magnet box 135 comes in contact with magnet stopper 137. With this configuration, an output voltage of linear Hall element 136 converges to a predetermined value (for example, 1.0 V).

As described above, an output voltage of linear Hall element 136 converges to a predetermined value, when the remaining amount of detergent liquid is less than or equal to a predetermined value. Thus, in order to grasp insufficiency of detergent liquid in detergent tank 117, it is preferable to calculate a difference in output voltage of linear Hall element 136 between a value after feeding detergent and a corresponding value in the past record.

When the difference is less than or equal to a predetermined value, the controller determines that the remaining amount of detergent liquid is insufficient.

As described above, the remaining amount of detergent liquid in
5 detergent tank 117 is detected.

A method of determining insufficiency of the remaining amount of detergent liquid in the detergent tank will be described with reference to FIG. 18.

FIG. 18 is a flowchart of a method of determining insufficiency of the
10 remaining amount of detergent liquid in the washing machine of the exemplary embodiment.

Here, a storage unit includes at least a zeroth storage unit, a first storage unit, a second storage unit, and a third storage unit. Specifically, the zeroth storage unit is configured to store an output voltage of linear Hall
15 element 136 after the current feeding of detergent. The first storage unit is configured to store an output voltage of linear Hall element 136 after the last feeding of detergent. The second storage unit is configured to store an output voltage of linear Hall element 136 after the feeding of detergent before last. The third storage unit is configured to store an output voltage of linear Hall
20 element 136 after the feeding of detergent three times ago.

In the following description, a value stored in the zeroth storage unit is referred to as Y , a value stored in the first storage unit is referred to as $(Y - 1)$, a value stored in the second storage unit is referred to as $(Y - 2)$, and a value stored in the third storage unit is referred to as $(Y - 3)$. Further, a number of
25 successive times in which a difference in voltage values between Y and $(Y - 3)$ after feeding detergent is less than 0.1 V is referred to as CNT.

As shown in FIG. 18, when a washing operation of the washing machine

is started, the controller firstly determines whether detergent liquid in the amount required for a washing step has been fed from detergent tank 117 (step S0). If the detergent liquid is determined to have been fed (Yes in step S0), the controller stores an output voltage of linear Hall element 136 in the zeroth storage unit (step S1).

Then, the controller determines whether an output voltage of linear Hall element 136 is equal to or larger than a first predetermined value (for example, 2.0 V) and less than or equal to a second predetermined value (for example, 3.0 V) (step S2). If the output voltage of linear Hall element 136 is determined to be equal to or larger than the first predetermined value and less than or equal to the second predetermined value (Yes in step S2), detergent tank 117 is filled with detergent liquid. Thus, the controller causes: the third storage unit to store a value (Y - 2) that has been stored in the second storage unit; the second storage unit to store a value (Y - 1) that has been stored in the first storage unit; and the first storage unit to store a value Y that has been stored in the zeroth storage unit, without performing a detection operation of a remaining amount of detergent liquid (step S8). Then, the controller finishes determination of the remaining amount of detergent liquid.

On the other hand, if an output voltage of linear Hall element 136 is less than the first predetermined value or larger than the second predetermined value (No in step S2), the controller calculates an absolute value of $(Y - (Y - 3))$, that is, a difference in output voltage of linear Hall element 136 between a value Y and a value (Y - 3) after feeding detergent three times ago, and determines whether the calculated value is equal to or larger than 0.1 V (step S3).

If the absolute value of the difference $(Y - (Y - 3))$ is equal to or larger than 0.1 V (No in step S3), the controller determines that the remaining

amount of detergent is not insufficient as float 130a rotates downward. Then, the controller resets CNT, and sets $CNT = 0$ (step S5). Then, the controller causes: the third storage unit to store a value $(Y - 2)$ that has been stored in the second storage unit; the second storage unit to store a value $(Y - 1)$ that has been stored in the first storage unit, and the first storage unit to store a value Y that has been stored in the zeroth storage unit (step S8). Then, the controller finishes determination of the remaining amount of detergent liquid.

On the other hand, if the absolute value of the difference $(Y - (Y - 3))$ is less than $0.1 V$ (Yes in step S3), the controller determines that a level of detergent liquid in detergent tank 117 is low. Then, the controller increments CNT by +1 (step S4).

Next, the controller determines whether CNT is equal to or larger than 3 (step S6). If CNT is less than 3 (No in step S6), the controller causes: the third storage unit to store a value $(Y - 2)$ that has been stored in the second storage unit; the second storage unit to store a value $(Y - 1)$ that has been stored in the first storage unit; and first storage unit to store a value Y that has been stored in the zeroth storage unit (step S8). Then, the controller finishes determination of the remaining amount of detergent liquid.

On the other hand, if CNT is equal to or larger than 3 (Yes in step S6), the controller determines that the remaining amount of detergent in detergent tank 117 is less than a predetermined value. Then, the controller causes operation display 104 to display that the remaining amount of detergent is less than a predetermined value to notify the user (step S7). Then, the controller causes: the third storage unit to store a value $(Y - 2)$ that has been stored in the second storage unit; the second storage unit to store a value $(Y - 1)$ that has been stored in the first storage unit; and the first storage unit to store a value Y that has been stored in the zeroth storage unit (step S8). Then, the controller

finishes a determination operation of the remaining amount of detergent liquid.

The determination operation of insufficiency of the remaining amount of detergent liquid is performed as described above.

Here, when detergent tank 117 is sufficiently filled with detergent
5 liquid, linear Hall element 136 and magnet 134 (magnetic body) are distant
from each other. Thus, even if detergent is additionally fed to detergent tank
117, an output voltage of linear Hall element 136 remains unchanged keeping
about 2.5 V (corresponding to section K in FIG. 17). In this case, an absolute
value of a difference ($Y - (Y - 3)$) is less than 0.1 V, although detergent tank 117
10 is filled with detergent liquid. That is, the controller may erroneously detect
insufficiency of the remaining amount of detergent liquid. In view of this, in
the present exemplary embodiment, the controller does not perform the
detection operation of the remaining amount of detergent liquid, if an output
voltage Y of linear Hall element 136 is equal to or larger than a first
15 predetermined value and less than or equal to a second predetermined value
(Yes in step S2), as shown in FIG. 18. This can prevent erroneous detection of
insufficiency of detergent liquid in the above situation.

In addition, in the case where linear Hall element 136 receives a south
magnetic polarity from magnet 134, an output voltage of linear Hall element
20 136 forms a waveform as shown by broken line b in FIG. 17. Thus, when
linear Hall element 136 receives a south magnetic polarity, for example, and
when a relationship of $Y = 1.0$ V and $(Y - 3) = 1.2$ V is satisfied, a difference
value ($Y - (Y - 3)$) is - 0.2 V, which is smaller than 0.1 V, that is, a value for
determination. Accordingly, the controller may erroneously detect that the
25 remaining amount of detergent liquid is insufficient, although detergent tank
117 is filled with detergent liquid.

In view of this, an absolute value of a difference ($Y - (Y - 3)$) is compared

with 0.1 V in step S3 in FIG. 18 so as to prevent erroneous detection described above. With this configuration, erroneous detection caused by the polarity of magnet 134 can be prevented.

In addition, this configuration eliminates the need for considering a direction of magnetic field of magnet 134 in producing magnet box 135. This leads to a reduction in man-hours required for producing magnet box 135 and man-hours required for inspection and the like, and thus manufacturing costs of magnet box 135 can be suppressed.

As described above, insufficiency of the remaining amount of detergent liquid can be detected.

A method of detecting insufficiency of the remaining amount of detergent liquid after repeatedly feeding detergent by (N-1) number of times will be described below with reference to specific examples.

(Nth feeding of detergent)

Firstly, an output voltage Y of linear Hall element 136 after Nth feeding of detergent is assumed to be about 4.0 V. A value (Y - 3) stored in the third storage unit is assumed to be about 3.8 V.

At this time, an absolute value of a difference (Y - (Y - 3)) is 0.2 V. In other words, the absolute value of the difference is greater than 0.1 V, that is, a value for determination in step 3 (corresponding to No in step S3 in FIG. 18). Thus, CNT is reset as 0 in step S5 in FIG. 18. In step S8, the controller causes: the third storage unit to store a value (Y - 2) that has been stored in the second storage unit; the second storage unit to store a value (Y - 1) that has been stored in the first storage unit; and the first storage unit to store a value Y that has been stored in the zeroth storage unit.

((N + 1)th feeding of detergent)

Then, an output voltage of linear Hall element 136 after (N + 1)th

feeding of detergent is assumed to be about 4.02 V, and a value $(Y - 3)$ stored in the third storage unit is assumed to be 3.94 V.

At this time, an absolute value of a difference $(Y - (Y - 3))$ is 0.08 V. In other words, an absolute value of a difference is less than 0.1 V, that is, a value
5 for determination in step 3 (corresponding to Yes in step S3 in FIG. 18). Thus, CNT is incremented by +1 in step S4 ($CNT = 1$). Then, the controller determines whether CNT is equal to or larger than 3 in step S6.

At this time, CNT is 1, and thus the controller determines that the remaining amount of detergent liquid is not insufficient. In step S8, the
10 controller causes: the third storage unit to store a value $(Y - 2)$ that has been stored in the second storage unit; the second storage unit to store a value $(Y - 1)$ that has been stored in the first storage unit; and the first storage unit to store a value Y that has been stored in the zeroth storage unit.

In a state where the storage units respectively store the above values,
15 the controller is configured to wait for the next supply of detergent liquid from detergent tank 117.

((N + 2)th feeding of detergent)

Then, an output voltage of linear Hall element 136 after (N + 1)th feeding of detergent is assumed to be about 4.03 V, and a value $(Y - 3)$ stored in
20 the third storage unit is assumed to be about 3.95 V.

At this time, an absolute value of a difference $(Y - (Y - 3))$ is 0.08 V. In other words, an absolute value of a difference is less than 0.1 V, that is, a value for determination in step 3. Thus, CNT is further incremented by +1 in step S4 ($CNT = 2$).

25 CNT is 2, which means less than 3, that is, a value for determination also in this case. Thus, the controller determines that the remaining amount of detergent liquid is not insufficient. In step S8, the controller causes: the

third storage unit to store a value $(Y - 2)$ that has been stored in the second storage unit; the second storage unit to store a value $(Y - 1)$ that has been stored in the first storage unit; and the first storage unit to store a value Y that has been stored in the zeroth storage unit.

5 In a state where the storage units respectively store the above values, the controller is configured to wait for the next supply of detergent liquid from detergent tank 117.

(($N + 3$)th feeding of detergent)

10 Then, an output voltage of linear Hall element 136 after ($N + 2$)th feeding of detergent is assumed to be about 4.05 V, and a value $(Y - 3)$ stored in the third storage unit is assumed to be about 3.99 V.

 At this time, an absolute value of a difference $(Y - (Y - 3))$ is 0.06 V. In other words, an absolute value of a difference is less than 0.1 V, that is, a value for determination in step 3. Thus, CNT is further incremented by +1 in step
15 S4 (CNT = 3).

 At this time, CNT is 3, and thus the controller determines that the amount of detergent liquid in detergent tank 117 is less than a predetermined amount. Then, the controller causes operation display 104 to display a message indicating insufficiency of the remaining amount of detergent liquid to
20 notify the user.

 When confirming the message of insufficiency of the remaining amount of detergent liquid, the user extracts detergent tank 117 from a container of tank containing case 114 and adds detergent liquid into detergent tank 117. This increases a level of detergent liquid in detergent tank 117, and causes float
25 130a to rotate upward. In this state, detergent tank 117 is reattached to the container of tank containing case 114. At this time, magnet 134 and linear Hall element 136 become distant from each other, and thus an output voltage of

linear Hall element 136 approaches 2.5 V. Accordingly, the controller determines that detergent liquid is added to detergent tank 117. Then, the controller cancels the message of insufficiency of the remaining amount of detergent liquid on operation display 104.

5 As described above, in the present exemplary embodiment, a difference in output voltage of linear Hall element 136 between a value after feeding detergent liquid and a value after feeding detergent a predetermined number of times ago (for example, three times ago) is firstly calculated.

 If an absolute value of the calculated difference is less than a
10 predetermined value (for example, 0.1 V) continuously multiple times (for example, three times), the controller determines that detergent liquid in detergent tank 117 is less than a predetermined amount.

 In other words, the controller determines the remaining amount of detergent based on an absolute value of a difference from the past output
15 voltage of linear Hall element 136. This reduces the possibility of erroneous detection in determining insufficiency of the remaining amount of detergent liquid caused by a structural variation of washing machines, such as arrangement of linear Hall element 136 and sizes of devices.

 As shown in FIGS. 13, 14A, and 14B, partition wall rib 119a is provided
20 on the lower surface of detergent tank lid 119 so as to surround rotation shaft 131 of float 130a. Thus, as shown in FIG. 15, there is a pocket of air inside an area surrounded by partition wall rib 119a even when detergent tank 117 is filled with detergent liquid close to detergent tank lid 119. Accordingly, detergent liquid does not flow inside partition wall rib 119a. This
25 configuration prevents detergent liquid from attaching to rotation shaft 131 of float 130a. In addition, even when detergent tank lid 119 is put in an inclined manner in a state of being detached from detergent tank 117, partition wall rib

119a prevents a liquid agent attached to the lower surface of detergent tank lid 119 from flowing to rotation shaft 131. This configuration prevents occurrence of a malfunction in rotation movement of rotation shaft 131 caused by fixing of detergent liquid. As a result, degradation of accuracy in measuring the
5 remaining amount of detergent liquid is suppressed, and a high degree of measuring accuracy can be maintained stably for a long period of time.

In addition, the inner bottom surface of detergent tank 117 includes magnet stopper 137 that comes in contact with magnet box 135 when detergent liquid is in the amount where the remaining amount of detergent liquid is
10 determined to be insufficient. Thus, even when a liquid agent is further discharged in a state in which the remaining amount of the liquid agent is insufficient, further downward rotation of float 130a is prevented. With this configuration, an output voltage of linear Hall element 136 does not change in a state in which the remaining amount of detergent liquid is insufficient. As a
15 result, linear Hall element 136 is prevented from erroneously detecting that the remaining amount of detergent liquid is not insufficient.

[1-3. Effects and others]

As described above, in the washing machine of the present exemplary embodiment, liquid discharged from pump unit 111 flows vertically downward
20 through discharge channel 112g disposed perpendicularly downward from cylinder 112d, and is supplied to water tub 105. This configuration prevents a liquid agent from remaining in and fixing to liquid channels from pump unit 111 to water tub 105. Discharge channel 112g is merged with coupling hose 129 in which a large amount of water flows. This configuration suppresses
25 detergent from remaining in the liquid channels to water tub 105. In addition, after feeding detergent liquid, first water supply valve 110a is opened to supply water. This configuration suppresses detergent from remaining in pump unit

111 and in first liquid channel 181.

In addition, suction channel 112h and discharge channel 112g are provided at a lower part of cylinder 112d. Suction channel 112h and discharge channel 112g respectively include suction-side check valve 164 and
5 discharge-side check valve 165. Thus, detergent liquid remains in cylinder 112d even after detergent liquid is discharged. This configuration suppresses a liquid agent from drying inside cylinder 112d. As a result, fixing of a liquid agent inside cylinder 112d can be suppressed.

After detergent liquid in detergent tank 117 is supplied into water tub
10 105, a water supply valve is opened to supply tap water for a predetermined period of time. With this configuration, detergent liquid remaining in discharge channel 112g can be washed off with tap water.

After detergent liquid in detergent tank 117 is supplied into water tub 105, pump unit 111 is driven for a predetermined period of time after the water
15 supply valve is opened. With this configuration, water flow can be enhanced by a driving force of piston pump unit 112, even in a state in which water flow is weak just after water supply is started. Thus, rotation of suction-side check valve 164 and discharge-side check valve 165 allows detergent liquid remaining in the liquid channels from pump unit 111 to water tub 105 to be easily washed
20 off.

In the present exemplary embodiment, the description is made by taking a front load washing machine as an example, but the present invention is not limited thereto. For example, a top load washing machine has the same functions and effects.

25 In the present exemplary embodiment, an absolute value of a difference between a value Y and a value $(Y - 3)$ is compared with a predetermined value to determine insufficiency of the remaining amount of detergent liquid, but the

present invention is not limited thereto. For example, an absolute value of a difference between a value Y and a value $(Y - 1)$ may be compared with a predetermined value. In addition, for example, where an output voltage of linear Hall element 136 after feeding detergent four times ago is referred to as
5 (Y-4), an absolute value of a difference between a value Y and a value $(Y-4)$ may be compared with a predetermined value. These configurations can also provide the same functions and effects.

As described above, the washing machine of the present invention includes: a housing; a water tub supported inside the housing; a washing tub
10 rotatably provided in the water tub; and a tank containing case disposed above the water tub and including a container. The washing machine further includes: a tank disposed in the container of the tank containing case and configured to store a liquid agent; and an automatic liquid-agent feeding device configured to automatically feed the liquid agent stored in the tank into the
15 washing tub. The automatic liquid-agent feeding device includes a pump unit configured to suck and discharge the liquid agent stored in the tank, and the liquid agent discharged from the pump unit falls freely into the water tub. This configuration suppresses the liquid agent discharged from the pump unit from attaching and being fixed to a liquid channel leading to the water tub.

20 The washing machine of the present invention includes: a detergent case that is disposed in the container of the tank containing case, and is configured to store powder detergent for manual feeding; a drain port provided at a bottom of the tank containing case; and a coupling hose that allows the drain port to communicate with the water tub. The coupling hose may be
25 connected with a branch liquid channel, and the branch liquid channel may be connected with and communicate with a discharge channel of the pump unit. This configuration allows the liquid agent discharged from the pump unit to be

merged into the coupling hose in which a large amount of water flows. Thus, the liquid agent is prevented from fixing to the liquid channel leading to the water tub.

The washing machine of the present invention includes: a water supply
5 valve provided with the housing and configured to control supply of tap water into the water tub; and a liquid channel that allows the pump unit to communicate with the water supply valve. The water supply valve may be configured to be opened for a predetermined period of time after the liquid agent stored in the tank is supplied into the water tub. With this
10 configuration, a supply channel for a liquid agent can be washed off every time liquid agent stored in the tank is supplied into the water tub. As a result, fixing of a liquid agent to the supply channel can be suppressed more reliably.

In the washing machine of the present invention, subsequent to supplying of the liquid agent stored in the tank into the water tub, the pump
15 unit may be driven for a predetermined period of time after the water supply valve is opened. With this configuration, a water pressure can be increased by a driving force of the piston pump, even when a water pressure is low just after supplying water is started. As a result, a liquid agent remaining in the liquid channels can be easily washed off.

20 In the washing machine of the present invention, subsequent to supplying of the liquid agent stored in the tank into the water tub, the water supply valve may be configured to be opened and closed intermittently for a predetermined period of time. With this configuration, a liquid agent remaining in the liquid channels can be washed off more reliably.

25

INDUSTRIAL APPLICABILITY

A washing machine according to the present invention can supply

detergent liquid and the like to the water tub without passing through discharge channels (pipes, rubber hoses, etc.) and a detergent case. Thus, the present invention is useful for application of a washing machine that requires solution to a problem that detergent liquid and the like remain in and fix to a
5 discharge channel.

REFERENCE MARKS IN THE DRAWINGS

	100: washing machine
	101: housing
10	102, 114a: lid
	103: clothes loading/unloading port
	104: operation display
	105: water tub
	106: drum (washing tub)
15	106a: baffle
	109: automatic liquid-agent feeding device
	110: water feeder
	110a: first water supply valve (water supply valve)
	110b: second water supply valve (water supply valve)
20	110c: water supply channel
	111: pump unit
	111a: outer frame
	111b: detergent-side cylindrical portion
	111c, 117f: packing
25	111e: protruding rib
	111f: softener-side cylindrical portion
	112: piston pump unit

	112a: link
	112b: cam
	112c: container
	112d: cylinder
5	112e: piston
	112f: drive motor
	112g: discharge channel
	112h: suction channel
	112i, 112j: inner wall surface
10	113: three-way valve unit
	113a: detergent-side three-way valve
	113b: softener-side three-way valve
	113c: detergent-side spring
	113d: detergent-side coil
15	113e: detergent-side plunger
	113f: detergent-side disc
	113h: softener-side spring
	113i: softener-side coil
	113j: softener-side plunger
20	113k: softener-side disc
	113l: detergent-side cylinder
	113m: softener-side cylinder
	114: tank containing case
	114b: opening
25	114c: drain port
	114d: insertion hole
	114e: first upper liquid inlet port

	114f: second upper liquid inlet port
	114g: lower liquid inlet port
	115: detergent case
	115a: partition wall
5	115b: detergent container
	115c: softener container
	116: supplied-water channel
	117: detergent tank (tank)
	117a: rear wall
10	117b: projected portion
	117d: first rib
	117e: second rib
	117g: grip
	118: upper face opening
15	119: detergent tank lid
	119a: partition wall rib
	120: bottom surface
	121: hook
	121a: erected portion
20	121b: extending portion
	122: mesh member
	122a, 123a: through-hole
	122b: engagement rib
	122c, 164a, 165a: protrusion
25	122d: lower end
	122e: engagement claw
	123: cylindrical portion

	123b: check valve
	124: liquid channel
	126: softener tank (tank)
	128: softener tank lid
5	129: coupling hose
	129a: branch liquid channel
	130: remaining amount detector
	130a: float
	131: rotation shaft
10	133: link
	134: magnet (magnetic body)
	135: magnet box
	135a: cover
	135b: supporting unit
15	135c: holding rib
	136: linear Hall element (magnetic sensor)
	137: magnet stopper
	163: damper
	164: suction-side check valve
20	164b, 165b: spring
	165: discharge-side check valve
	181: first liquid channel
	182: second liquid channel
	183: third liquid channel
25	184: bypass liquid channel

CLAIMS

1. A washing machine comprising:

a housing;

5 a water tub supported inside the housing;

a washing tub rotatably provided in the water tub;

a tank containing case disposed above the water tub and including a container;

10 a tank disposed in the container of the tank containing case and configured to store a liquid agent; and

an automatic liquid-agent feeding device configured to automatically feed the liquid agent stored in the tank into the washing tub,

wherein the automatic liquid-agent feeding device includes a pump unit configured to suck and discharge the liquid agent stored in the tank, and

15 wherein the liquid agent discharged from the pump unit falls freely into the water tub.

2. The washing machine according to claim 1, comprising:

20 a detergent case that is disposed in the container of the tank containing case, and is configured to store powder detergent for manual feeding;

a drain port provided at a bottom of the tank containing case; and

a coupling hose that allows the drain port to communicate with the water tub,

wherein the coupling hose is connected with a branch liquid channel,

25 and

wherein the branch liquid channel is connected with and communicates with a discharge channel of the pump unit.

3. The washing machine according to claim 1 or 2, comprising:

a water supply valve provided with the housing and configured to control supply of tap water into the water tub; and

5 a liquid channel that allows the pump unit to communicate with the water supply valve,

wherein the water supply valve is configured to be opened for a predetermined period of time after the liquid agent stored in the tank is supplied into the water tub.

10

4. The washing machine according to claim 3,

wherein subsequent to supplying of the liquid agent stored in the tank into the water tub, the pump unit is driven for a predetermined period of time after the water supply valve is opened.

15

5. The washing machine according to claim 3,

wherein subsequent to supplying of the liquid agent stored in the tank into the water tub, the water supply valve is configured to be opened and closed intermittently for a predetermined period of time.