

WASHING MACHINE

BACKGROUND OF THE INVENTION

5 1. Field of the Invention

Embodiments of the present invention relate to washing machines having wash, rinse, and spin-dry cycles and managing the rinse cycle efficiently with a small amount of water.

10 2. Background Art

For resource saving purposes, conventional washing machines of this type perform a rinse cycle in which water is sprayed onto laundry in the washing/spin-drying tub from above while rotating the tub without storing the water in the tub.

15 Fig. 6 is a sectional side view of such a conventional washing machine. In Fig. 6, the washing machine includes cabinet 1 in which outer tank 3 is resiliently suspended by a plurality of suspensions 2. Suspensions 2 absorb vibration during spin drying. Inside outer tank 3 is washing/spin-drying tub 4 for holding laundry. Tub 4 is arranged

20 rotatably around washing shaft 5a and spin-drying shaft 5. Washing shaft 5a is hollow and double structured. Washing/spin-drying tub 4 is provided at its inner bottom with pulsator 6 rotating to agitate the laundry and is further provided at its bottom with drain hole 7 and drain valve 8.

25 Washing/spin-drying tub 4 is further provided in its inner wall with a large number of small holes 4a for drainage. The washing machine further includes motor 9 under the bottom of outer tank 3.

Motor 9 transmits rotation via belt 10 to drive mechanism 11 having a clutch mechanism and a braking mechanism.

Drive mechanism 11 includes a clutch switching device (not illustrated) which applies or releases the brakes of spin-drying shaft 5. During the wash cycle, spin-drying shaft 5 is braked, and washing shaft 5a is driven to rotate pulsator 6 for agitating the laundry. During the spin-dry cycle, on the other hand, spin-drying shaft 5 is released from braking and drain valve 8 is opened to rotate washing/spin-drying tub 4.

The washing water or the rinsing water in outer tank 3 is drained outside the machine through drain hole 7 and drain valve 8 at the bottom of outer tank 3. The washing machine further includes water level detector 12 formed of a pressure sensor or the like, which detects the water level in washing/spin-drying tub 4. At the start of the wash cycle, water level detector 12 controls so that water is supplied, for example, up to a predetermined water level "A".

The washing machine further includes cabinet cover 14 for covering the top of cabinet 1. Cabinet cover 14 includes openable lid 15 and control device 16 having an operation display part. Cabinet cover 14 further includes feed valve 17, which is connected to a water tap or the like for supplying water to washing/spin-drying tub 4.

Control device 16 includes a microcomputer and other components so as to control motor 9, a clutch switching device (not illustrated), feed valve 17, and drain valve 8, thereby controlling the wash, rinse, and spin-dry cycles.

The conventional washing machine structured as above operates as follows.

Fig. 7 a flowchart showing a wash cycle of the washing machine. In the flowchart, when a wash cycle is started (S100), drain valve 8 is in the closed state. The user opens lid 15, loads laundry into washing/spin-drying tub 4 (S101), turns on the power switch (S102) and turns on the start switch (S103). As a result, feed valve 17 is opened (S104) and water is supplied to the predetermined water level "A" (S105, S106). Then, motor 9 is started (S107) to rotate pulsator 6 for washing the laundry.

When a predetermined time period has passed, motor 9 is turned off (S108, S109) to complete the wash cycle (S110).

Fig. 8 is a flowchart showing a rinse cycle of the washing machine. In the flowchart, when a rinse cycle is started (S200) after the completion of the wash cycle, drain valve 8 is opened (S201), and the clutch switching device in drive mechanism 11 is switched. As a result, spin-drying shaft 5 is released from braking, so that washing/spin-drying tub 4 is ready to rotate around spin-drying shaft 5 (S202).

When drainage is completed (S203), motor 9 is turned on to perform an intermediate spin-dry (S204) during which washing/spin-drying tub 4 is rotated at a speed of 700 to 800 r/min. The laundry is thus centrifugally dehydrated, so that the detergent residue on the laundry is removed with the washing water.

When a predetermined time period has passed (S205), motor 9 is turned off (S206). Consequently, the rotation speed of washing/spin-drying tub 4 is gradually reduced, and the clutch switching device in drive mechanism 11 is switched. As a result, spin-drying shaft 5 is braked (S207) to once stop washing/spin-drying

tub 4.

Later, the clutch switching device in drive mechanism 11 is switched again. As a result, spin-drying shaft 5 is released from braking, so that washing/spin-drying tub 4 is ready to rotate around spin-drying shaft 5 (S208). Motor 9 is repeatedly turned on (S209) and off (S210), allowing washing/spin-drying tub 4 to be rotated at a low speed of 30 to 50 r/min on average for a predetermined period of time. At the same time, feed valve 17 is opened (S211) to supply tap water or the like in the form of a shower into washing/spin-drying tub 4. The water is evenly distributed to the laundry clung to the inner wall of washing/spin-drying tub 4. This allows the detergent residue on the laundry to be diluted or removed.

When water has been supplied for a predetermined period of time (S212), feed valve 17 is turned off (S213), drain valve 8 is turned off (S214), and the clutch switching device in drive mechanism 11 is switched. As a result, spin-drying shaft 5 is braked (S215) to stop washing/spin-drying tub 4, thereby completing the rinse cycle (S216).

When the rinse cycle is completed, washing/spin-drying tub 4 is rotated at a speed of 700 to 800 r/min. This high-speed centrifugal dehydration removes water from the laundry. When the spin-dry cycle is completed, the series of cycles are completed.

In the aforementioned conventional rinse method, when the laundry weight is, for example, 8 kg, the wash cycle uses 50 to 70 L of water corresponding to the water level "A", and the rinse cycle uses 15 to 25 L of water in the form of a shower. The rinse cycle is intended to provide sufficient rinsing effect with a minimum amount of water.

This technique is disclosed in Japanese Patent Unexamined

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In the rinse cycle of this conventional structure, when tap water is used, the rinse time is controlled by opening and closing the feed valve for a predetermined period of time. This causes a reduction in the amount of water to be supplied when the tap water pressure is low, supplying an insufficient amount of water to the laundry. Particularly when the amount of fabric is large, the rinse cycle can be over without making water fully permeate the laundry, thereby resulting in inadequate rinsing.

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SUMMARY OF THE INVENTION

Embodiments of the present invention provide a washing machine that provides efficient and stable rinsing effect with a small amount of water when the tap water pressure is low.

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

- a motor for driving a pulsator;
- 5 a washing/spin-drying tub having the pulsator arranged rotatably at an inner bottom thereof;
- an outer tank having the washing/spin-drying tub therein;
- a top cover fixed to a top of the outer tank;
- a drive mechanism under a bottom of the outer tank, the drive
- 10 mechanism having a clutch mechanism selectively switching rotation of the pulsator and the washing/spin-drying tub;
- a drain hole at the bottom of the outer tank;
- a drain valve for opening and closing the drain hole;
- a feed valve for controlling water supply to the
- 15 washing/spin-drying tub;
- a water level detector for detecting a water level in the washing/spin-drying tub; and
- a control device for controlling operations of the motor, the drive mechanism, the drain valve, and the feed valve, and further controlling
- 20 a wash cycle, a rinse cycle, and a spin-dry cycle, wherein
- the washing/spin-drying tub has a rear fan arranged at a bottom outer edge thereof;
- the top cover has a top inlet port and an outlet;
- the outer tank has a bottom inlet port at an inner circumference
- 25 of a bottom thereof, and a water flow path communicated with the bottom inlet port and the top inlet port of the top cover;
- in the rinse cycle, when the drain valve is in a closed state and

the water level in the washing/spin-drying tub has reached a predetermined water level as low as a vicinity of an outer edge of the pulsator, the washing/spin-drying tub is started to rotate, and the rinsing water stored in the bottom of the outer tank is raised through
5 the water flow path and sprinkled through the outlet of the top cover into the washing/spin-drying tub.

This structure keeps constant the amount of water to be applied to the laundry regardless of the tap water pressure, allowing a predetermined amount of water to be force-circulated so as to remove the detergent residue on the laundry in the washing/spin-drying tub. Thus, the washing machine according to embodiments of the present invention, provides stable rinsing performance with low water consumption.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional side view of a washing machine according to a first embodiment of the present invention.

Fig. 2 is a flowchart showing a wash cycle of the washing machine according to the first embodiment of the present invention.

Fig. 3 is a flowchart showing a rinse cycle of the washing machine according to the first embodiment of the present invention.

Fig. 4 is a sectional side view of a washing machine according to a second embodiment of the present invention.

Fig. 5A is a flowchart showing a part of wash and rinse cycles of the washing machine according to the second embodiment of the
5 present invention.

Fig. 5B is a flowchart showing the remaining part of the wash and rinse cycles of the washing machine according to the second embodiment of the present invention.

Fig. 6 is a sectional side view of a conventional washing
10 machine.

Fig. 7 is a flowchart showing a wash cycle of the conventional washing machine.

Fig. 8 is a flowchart showing a rinse cycle of the conventional washing machine.

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DETAILED DESCRIPTION OF THE INVENTION

Embodiments of the present invention will be described as follows with reference to drawings. Like components are labeled with like reference numerals with respect to the aforementioned
20 conventional example, and hence the description thereof will be omitted. Note that the present invention is not limited to these embodiments.

FIRST EMBODIMENT

25 Fig. 1 is a sectional side view of a washing machine according to a first embodiment of the present invention. In Fig. 1, the washing machine includes washing/spin-drying tub 18 whose inner wall has a

large number of small holes 18a. Tub 18 is provided at its inner bottom with pulsator 6 rotating to agitate the laundry. When a wash cycle is started, water is supplied up to a predetermined water level "A" (shown by a chain line), and pulsator 6 is rotated for wash the 5 laundry. Washing/spin-drying tub 18 is provided under its bottom with a plurality of fin-shaped rear fans 19 radiated downward.

The washing machine further includes outer tank 20 having rotatable washing/spin-drying tub 18 therein, and further includes drain hole 7 and drain valve 8 for water drainage at the bottom of outer 10 tank 20. Outer tank 20 and inner wall 21 form tubular water flow path 23 for conveying water. Outer tank 20 further includes bottom inlet port 22 at the bottom of inner wall 21. The water which has entered bottom inlet port 22 can be drawn upward through water flow path 23.

15 Outer tank 20 further includes flat doughnut-shaped top cover 26 fixed to the top opening edge thereof. Top cover 26 has opening 30 at its center through which to load the laundry to be washed.

Top cover 26 includes water filling port 27 and top cover outlet 29. Water filling port 27 is formed of a plurality of holes as the 20 passages of water to be supplied to washing/spin-drying tub 18 via feed valve 17. Top cover outlet 29 located below water filling port 27 is directed to the inside of washing/spin-drying tub 18. Top cover 26 further includes top inlet port 28 in a location corresponding to the top end of water flow path 23 in such a manner that top inlet port 28 is 25 water-tightly fixed to tub 18.

With this structure, the water supplied via feed valve 17 passes through water filling port 27 of top cover 26 and top cover outlet 29,

and is sprinkled into washing/spin-drying tub 18. On the other hand, the water drawn upward through water flow path 23 passes through top inlet port 28 and is sprinkled through top cover outlet 29 into washing/spin-drying tub 18.

5 Washing/spin-drying tub 18 is started to rotate when the water has reached a level where pulsator 6 is not completely soaked in outer tank 20. This level is shown as a water level "B" of Fig. 1. As a result, the water is stirred by the pumping action of rear fans 19 radially arranged under the bottom of tub 18. Then, the water enters
10 bottom inlet port 22, rises water flow path 23 and sprinkled through top cover outlet 29 into washing/spin-drying tub 18 in a circulating manner.

The washing machine further includes control device 25 and water level detector 24. Control device 25 includes a microcomputer
15 and controls the wash, rinse, and spin-dry cycles. Water level detector 24, which is formed of a pressure sensor or the like, is communicated with the bottom portion of outer tank 20. Water level detector 24 converts the water pressure in outer tank 20 into an electric signal, and compares the signal with water level values
20 predetermined by control device 25, thereby detecting the washing water level in washing/spin-drying tub 18. More specifically, water level detector 24 detects, for example, the predetermined water level "A" at the start of the wash cycle and the low water level "B" at the start of the rinse cycle.

25 The washing machine of the present invention operates as follows. Fig. 2 is a flowchart showing a wash cycle of the washing machine according to the first embodiment. In the flowchart, when a

wash cycle is started (S400), drain valve 8 is in the closed state. The user loads laundry into washing/spin-drying tub 18 (S401), turns on the power switch (S402) and turns on the start switch (S403). As a result, feed valve 17 is opened (S404) and water is supplied to the
5 predetermined water level "A" (S405). Then, feed valve 17 is closed (S406) and motor 9 is started (S407). At this moment, the power of motor 9 is transmitted to pulsator 6 via washing shaft 5a so as to rotate pulsator 6. Pulsator 6 removes stains from the laundry with its agitating power and the water stream generated by its rotation.
10 When a predetermined time period has passed, motor 9 is turned off (S408, S409) to complete the wash cycle (S410).

Fig. 3 is a flowchart showing a rinse cycle of the washing machine according to the first embodiment. In the flowchart, when a rinse cycle is started (S500) after the completion of the wash cycle,
15 drain valve 8 is opened (S501), and the clutch switching device switches a clutch (not illustrated) of drive mechanism 11. As a result, spin-drying shaft 5 is released from braking, so that washing/spin-drying tub 18 is ready to rotate around spin-drying shaft 5 (S502).

20 When drainage is completed (S503), an intermediate spin-dry is performed. More specifically, motor 9 is turned on (S504) to rotate washing/spin-drying tub 18 at a speed of 700 to 800 r/min. The laundry is thus centrifugally dehydrated, so that the detergent residue on the laundry is removed with the washing water. The washing
25 water is drained outside washing/spin-drying tub 18 through the large number of small holes 18a in the inner wall of tub 18 and discharged outside the machine through drain hole 7 and drain valve 8.

When a predetermined time period has passed (S505), motor 9 is turned off (S506). Consequently, the rotation speed of washing/spin-drying tub 18 is gradually reduced, and the clutch switching device in drive mechanism 11 is switched. As a result, spin-drying shaft 5a is braked (S507) to once stop washing/spin-drying tub 18. At the same time, drain valve 8 is turned off, so that water can be stored in outer tank 20 (S508).

Later, the clutch switching device in drive mechanism 11 is switched again. As a result, spin-drying shaft 5a is released from braking, so that washing/spin-drying tub 18 is ready to rotate around spin-drying shaft 5a (S509). Feed valve 17 is opened again (S510), and water is supplied to the predetermined water level "B", which is as low as the vicinity of the outer edge of pulsator 6 (S511, S512). Motor 9 is turned on again (S513), and washing/spin-drying tub 18 continues to rotate at a speed of 180 to 200 r/min for a predetermined period of time (S514). After being stirred in the circumferential direction by rear fans 19, the rinsing water enters bottom inlet port 22 and rises through water flow path 23. The rinsing water then passes through top inlet port 28 and evenly sprinkled through top cover outlet 29 onto the laundry in washing/spin-drying tub 18.

Consequently, the detergent, which has permeated the laundry is removed therefrom by centrifugal force. The rinsing water containing the detergent residue is drained outside washing/spin-drying tub 18 through the large number of small holes 18a in the inner wall of washing/spin-drying tub 18 and drops to the bottom of outer tank 20. The rinsing water is again raised by rear fans 19, passing through bottom inlet port 22, water flow path 23, and

top inlet port 28 in this order, and is sprinkled through top cover outlet 29 into washing/spin-drying tub 18. The forced circulation operation is repeated for a predetermined period of time (S514), so that the detergent residue on the laundry can be evenly diluted.

5 When a predetermined time period has passed (S514), motor 9 is turned off (S515), and the clutch switching device switches the clutch of drive mechanism 11. As a result, spin-drying shaft 5a is braked (S516) to stop washing/spin-drying tub 18, thereby completing the rinse cycle (S517).

10 When the rinse cycle is completed, washing/spin-drying tub 4 is rotated at a speed of 700 to 800 r/min to remove water from the laundry. This high-speed centrifugal dehydration is performed longer as a finishing process than the intermediate spin-dry in the rinse cycle. Thus, the whole cycles of wash, rinse, and spin-dry are completed.

15 In rinse cycle, when the laundry weight is, for example, 8 kg, 15 to 25 L of water is once stored, which corresponds to the water level "B" as low as the vicinity of the outer edge of pulsator 6. In this situation, washing/spin-drying tub 18 is rotated so as to force-circulate the rinsing water. During this rinsing process, water is sprinkled and
20 permeated into the laundry and then removed therefrom, and again sprinkled and permeated into the laundry and then removed therefrom, thus increasing the effect of diluting the detergent residue on the laundry.

 Unlike the method in which water is applied to the laundry
25 while controlling the opening time of feed valve 17, the rinse cycle in the present embodiment uses a small amount of water stored in the tub. This keeps constant the amount of water to be supplied regardless of

the tap water pressure. As a result, the washing machine provides stable rinsing performance with low water consumption, thereby preventing inadequate rinsing.

5 SECOND EMBODIMENT

Fig. 4 is a sectional side view of a washing machine according to a second embodiment of the present invention. Before starting the wash cycle (before applying water and detergent), control device 25 drives motor 9 for a short time with the laundry in washing/spin-drying tub 18. Thus, control device 25 detects the load such as the current flowing to motor 9 to detect the laundry weight, thereby setting a predetermined water level. More specifically, control device 25 controls so that the water level for the wash cycle can be set at one of a plurality of levels, for example, three levels: A1, A2, 15 and A3 (shown by chain lines) in Fig. 4.

Control device 25 also controls so that the water level for the rinse cycle can be set at one of three levels: B1, B2, and B3 (shown by chain lines) in Fig. 4. The water levels B1, B2, and B3 are all as low as the vicinity of the outer edge of pulsator 6 and associated with the 20 three water levels for the wash cycle.

At the start of the wash cycle, water level detector 24 can determine the water level according to the laundry weight. When the laundry weight is large, water is supplied to a high water level A1. When the weight is medium, water is supplied to a medium water level A2 and when the weight is small, water is supplied to a low water level 25 A3.

The water level for rinsing is also set at one of the plurality of

levels. When the laundry weight is large, the water level is set at B1. When the weight is medium, the level is set at B2. When the weight is small, the level is set at B3.

Figs. 5A and 5B are flowcharts showing the wash and rinse cycles of the washing machine according to the second embodiment of the present invention. In the flowcharts, when a wash cycle is started (S600), drain valve 8 is in the closed state. The user loads laundry into washing/spin-drying tub 18 (S601), turns on the power switch (S602), and turns on the start switch (S603). As a result, the amount of fabric detection control starts to operate (S604) to detect laundry weight from the load such as the current flowing to the motor. Then, the water level of A1 (high), A2 (medium) or A3 (low) is displayed, and the recommended quantity of detergent is also displayed (S605). The user can introduce an appropriate amount of detergent into washing/spin-drying tub 18 according to this display (S606).

When 30 seconds has passed after the laundry weight is detected, and then the water level and the recommended quantity of detergent are displayed (S605), feed valve 17 is opened to start to supply water (S608). Water is supplied to the set water level of A1, A2, or A3 (S609, S610), and motor 9 starts to rotate for a washing process.

A rinse cycle is started (S701). First intermediate spin-dry is performed (S702), and then water for rinsing is supplied (S703). Water is supplied up to the water level B1, B2, or B3 when the laundry weight is large, medium, or small, respectively (704).

After this, in the same manner as in the first embodiment, motor 9 is turned on again (S705) to rotate washing/spin-drying tub 18,

performing a rinse cycle with force-circulated water.

As described hereinbefore, the second embodiment provides a plurality of washing water levels, that is, a plurality of levels of washing water consumption according to the laundry weight, and also
5 provides a plurality of rinsing water levels according to the laundry weight. As a result, when the laundry weight is small, rinsing is performed with a small amount of water, thereby saving water.

The washing machine of the present invention prevents inadequate rinsing when the tap water pressure is low, thus providing
10 stable rinsing performance with low water consumption. This water-saving feature is useful for types with a comparatively high water consumption (for example, the maximum load is 7 kg or more)

In addition, the washing machine of the present invention, which provides a plurality of water levels according to the laundry
15 weight, and force-circulates water in a predetermined amount according to the water level, minimizes waste water and stabilizes the rinsing effect.