

WASHING MACHINE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a washing machine equipped with a rotary vane rotatably provided at an inner bottom section of a washing and dewatering tub thereof.

2. Description of the Related Art

A description is given to a washing machine recited in Unexamined Japanese Patent Publication No. 2000-302198 (Patent Document 1) which is an example of the conventional washing machine of the foregoing type. The washing machine recited in Patent Document 1 has a feature in that number of rotations of a rotary vane is equally set in one clockwise rotation and one anticlockwise rotation, and the rotary vane is rotated for a plurality of different times of rotation respectively having different numbers of rotations. A relatively long time of rotation with a small number of rotations and a relatively short time of rotation with a large number of rotations are alternately practiced in the rotation of the rotary vane.

Fig. 12 is a sectional view of the conventional washing machine recited in Patent Document 1. Fig. 13 is a timing chart showing rotations of the rotary vane for generating a basic water flow in the washing machine.

As shown in Fig. 12, the conventional washing machine has washing and dewatering tub 103 rotatably provided in support tub 101, and rotary vane 102 rotatably provided at an inner bottom section of washing and

dewatering tub 103. Rotary vane 102 is formed substantially in a shape of a pan having an inclined surface increasing in its vertical height toward an outer periphery thereof. Rotary vane 102 has a protruding bulge portion for agitation on an upper surface thereof. The conventional washing machine is further provided with motor 106 which is a driving unit for rotating washing and dewatering tub 103 and rotary vane 102, and controller 114 for controlling a sequence of steps of washing, rinsing, and dewatering.

As shown in Fig. 13, controller 114 drives motor 106 so that rotary vane 102 currently rotating clockwise starts to rotate anticlockwise or rotary vane 102 currently rotating anticlockwise starts to rotate clockwise (hereinafter, called "reverse" or "reversal"). When rotary vane 102 is thus rotated, controller 114 can practice a plurality of times of rotation respectively having different numbers of rotations, wherein controller 114 alternately employs a relatively long time of rotation with a small number of rotations and a relatively short time of rotation with a large number of rotations.

In the conventional washing machine, number of rotations of rotary vane 102 is equally set in its clockwise rotation and anticlockwise rotation. Therefore, laundry (for example, clothes) put in washing and dewatering tub 103 merely moves back and forth repeatedly at substantially the same position in washing and dewatering tub 103. In other words, the conventional washing machine is not expected to frequently change positions of clothing pieces to be washed by, for example, creating upward and downward movements and reversing the upward and downward movements of the laundry. In the washing machine thus failing to variously change the

positions of the clothing pieces to be washed, problems occur; part of detergent may be left undissolved, and it is less likely to evenly wash the laundry.

On the other hand, a prospective aspect of the washing machine is to reduce water consumption in view of environment conservation and energy saving. A specific example is to reduce a bath ratio in wash and rinse (water consumption required per unit amount of laundry). The conventional washing machine having such disadvantages as the failure to completely dissolve detergent and evenly wash the laundry, however, is unable to reduce its water consumption, thereby failing to contribute to water saving.

SUMMARY OF THE INVENTION

To solve the conventional problems, an object of the present invention is to provide a washing machine capable of reducing the likelihood of undissolved detergent and uneven washing with less water consumption, thereby accomplishing water saving.

A washing machine according to the present invention has a washing and dewatering tub rotatably provided in a support tub, a rotary vane rotatably provided at an inner bottom section of the washing and dewatering tub, a driving unit for rotating the washing and dewatering tub and the rotary vane, and a controller for controlling a sequence of washing, rinsing, and dewatering steps. In the washing machine according to the present invention, the controller drives the rotary vane by the driving unit in a clockwise and an anticlockwise direction so that the number of rotations of

the rotary vane in a clockwise rotation and the number of rotations of the rotary vane in an anticlockwise rotation are different to each other.

Accordingly, laundry during wash can be moved around in the tub so that clothing pieces to be washed can change their positions through upward and downward movements and reversal of the upward and downward movements. As a result, the washing machine can lessen the likelihood that part of detergent is left undissolved and that the laundry is unevenly washed, thereby making improvements in its water saving capacity and washing performance.

BRIEF DESCRIPTION OF DRAWINGS

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

Fig. 2 shows a sectional view of a rotary vane cut along line 2-2 according to the first embodiment;

Fig. 3 shows a partially cutaway perspective view of an outer tub of the washing machine according to the first embodiment;

Fig. 4 shows a partially cutaway perspective view of the washing machine according to the first embodiment;

Fig. 5 shows a block diagram of the washing machine according to the first embodiment;

Fig. 6 shows a timing chart of the washing machine according to the first embodiment;

Fig. 7 shows a timing chart of a washing machine according to a second embodiment of the present invention;

Fig. 8 shows a timing chart of a washing machine according to a third embodiment of the present invention;

Fig.9 shows a timing chart of a washing machine according to a fourth embodiment of the present invention;

Fig. 10A shows a timing chart of a washing machine according to a fifth embodiment of the present invention in a case where a large amount of laundry is to be washed;

Fig. 10B shows a timing chart of the washing machine according to the fifth embodiment in a case where a small amount of laundry is to be washed;

Fig. 11 shows a timing chart of a washing machine according to a sixth embodiment of the present invention;

Fig. 12 shows a sectional view of a conventional washing machine; and

Fig. 13 is a timing chart of the conventional washing machine.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Hereinafter, embodiments of the present invention are described referring to the drawings.

FIRST EMBODIMENT

Fig. 1 shows a sectional view of a washing machine according to a first embodiment of the present invention. Fig. 2 is a sectional view of Fig. 1 cut along line 2-2. Fig. 3 is a perspective view of an outer tub of the washing machine according to the first embodiment from which a part is

removed. Fig. 4 is a perspective view of the washing machine according to the first embodiment from which a part is removed.

In Fig. 1, support tub 1, which is an outer tub, encompasses washing and dewatering tub 3 rotatably provided on an inner side thereof. Support tub 1 is provided with rotary vane 2 rotatably disposed at an inner bottom section of washing and dewatering tub 3 connected to decelerating mechanism 4. Support tub 1 is hung in washing machine outer frame 8 by hanging bar 7. An upper opening portion of support tub 1 is provided with support tub cover 6 with packing 5 interposed therebetween.

Motor 9, which is a driving unit, rotates washing and dewatering tub 3 and rotary vane 2 by way of decelerating mechanism 4. When water supply valve 10 is opened, water is supplied into washing and dewatering tub 3. Water level detecting unit 11 detects a water level in support tub 1. When drainage valve 12 is opened, washing fluid in support tub 1 is drained.

As shown in Fig. 3, an inner surface of support tub 1 is provided with bubble chamber 13 disposed at a position vertically higher than inner bottom section 1a of support tub 1. An upper opening portion of bubble chamber 13 is sealed with cap 14 formed in support tub cover 6 with packing 5 interposed therebetween. The portion of bubble chamber 13 covered with cap 14 constitutes a part of circulating path 15 as shown in Fig. 4. Bubble discharge portion 16 is provided at an edge of circulating path 15.

As shown in Fig. 3, side member 17 constituting an outer peripheral portion of bubble chamber 13 is formed so as to expand outward from the inner surface of support tub 1. Bubble chamber 13 has partition member 18 for separating bubble chamber 13 from the interior of support tub 1. Guide

plate 19 constituting a bottom surface of bubble chamber 13 is formed in such a shape that curves upward in a direction where support tub 1 rotates.

As shown in Fig. 4, bubble discharge portion 16 is formed so that bubbles are discharged in the same direction as a direction where washing and dewatering tub 3 is rotated. Moreover, bubble discharge portion 16 is formed so that discharged bubbles 13a are poured into washing and dewatering tub 3 so as to spread from substantially central part 3a through outer peripheral portion 3b thereof.

Fig. 5 is a block diagram of the washing machine according to the present embodiment. As shown in Fig. 5, control device 20 including a microcomputer is equipped with controller 21 connected to input setting unit 24 and display unit 25, and power switching unit 22. Control device 20 controls such structural components as motor 9, water supply valve 10, and drainage valve 12 via power switching unit 22, thereby controlling a sequence of steps of washing, rinsing, and dewatering. A clothing amount detecting unit 23 detects the amount of laundry in washing and dewatering tub 3.

A user sets, for example, an operation course of the washing machine using input setting unit 24. The information thus set is transmitted to controller 21 and displayed on display unit 25. Control device 20 is fed with power from commercial power supply 26, and turned on or off through power supply switch 27.

An operation of the abovementioned washing machine is described below. When the washing machine is put in motion after the laundry and detergent are put in washing and dewatering tub 3, controller 21 opens

water supply valve 10 to start water supply. Water level detecting unit 11 transmits a signal to controller 21 when detecting that the water level reached a predetermined water level lower than a usual water level for washing (for example, about 1/4 of the washing water level). In response to the signal transmitted from water level detecting unit 11, controller 21 closes water supply valve 10 to discontinue the water supply.

Then, the operation advances to a detergent dissolving step. Controller 21 drives motor 9 to rotate washing and dewatering tub 3. The number of rotations then is set to be lower than that of a bubble step described later to prevent too early discharge of the washing fluid from bubble discharge portion 16 before the detergent is dissolved. As a result, the detergent is fully dissolved.

The operation advances to the bubble step for discharging bubbles. In this step, washing and dewatering tub 3 is rotated by a larger number of rotations than that of the detergent dissolving step. Such a fast rotation sends a large amount of air into the washing fluid between washing and dewatering tub 3 and support tub 1. The air is mixed with the washing fluid, and a large amount of bubbles are thereby generated. A small specific gravity of the generated large amount of bubbles makes the bubbles transfer above the washing fluid. Then, the bubbles sloosh into bubble chamber 13 while rotating inside support tub 1.

As soon as the bubbles enter bubble chamber 13, they travel along guide plate 19 and convert their horizontal velocity components into vertical velocity components, thereby heading upward. The bubbles that transferred upward travel through circulating path 15 to be discharged into

washing and dewatering tub 3 from bubble discharge portion 16. Bubble discharge portion 16 is formed so that the bubbles are discharged in the same direction as the direction where washing and dewatering tub 3 is rotated. The structural characteristic of bubble discharge portion 16 moderates a difference between velocities of the discharged bubbles and washing and dewatering tub 3 or the laundry in washing and dewatering tub 3. The moderated velocity difference consequently avoids clash of the dropped bubbles with washing and dewatering tub 3 or the laundry in washing and dewatering tub 3, thereby preventing the bubbles from splattering.

Bubble discharge portion 16 spreads the discharged bubbles from substantially central part 3a through outer peripheral portion 3b of washing and dewatering tub 3. Therefore, the bubbles are evenly spread on the laundry in washing and dewatering tub 3 as far as washing and dewatering tub 3 is rotated even in the case where a part of the laundry in washing and dewatering tub 3 sticks out of a surface of the washing fluid.

After the bubble step is implemented, controller 21 opens water supply valve 10 to start the water supply. Water level detecting unit 11 transmits a signal to controller 21 when detecting that the water level reached the predetermined water level (usual washing water level). In response to the signal transmitted from water level detecting unit 11, controller 21 closes water supply valve 10 to discontinue the water supply. After that, controller 21 drives motor 9 so that rotary vane 2 is rotated in the reverse directions for a predetermined time. A washing step thus starts, and the laundry is washed.

Fig. 6 is a timing chart of the washing machine according to the present embodiment. Referring to Fig. 6, a description is given to number of rotations and a time of rotation of rotary vane 2 in the washing step. As shown in Fig. 6, rotary vane 2 is rotated clockwise and anticlockwise for an equal time of rotation in the washing step, whereas its number of rotations differs in the clockwise and anticlockwise rotations. Rotary vane 2 is rotated clockwise for t second (for example, 0.8 second) by B rpm (for example, 110 rpm) which is a small number of rotations, and then halted for t second. Rotary vane 2 is then rotated anticlockwise for t second by A rpm (for example, 120 rpm) which is a large number of rotations. Rotary vane 2 thus reverses its rotation repeatedly for a given period of time.

According to the present embodiment, wherein rotary vane 2 is rotated clockwise and anticlockwise by the numbers of rotations thus differently set, there is generated a difference between the clockwise and anticlockwise movements of the laundry. As a result of these different movements, positions of clothing pieces to be washed can be variously changed. Further, a difference between accelerating forces in the reversal of the rotational direction of rotary vane 2 generates a force which pushes the laundry upward. The force creates upward and downward movements of the laundry and further reverses the upward and downward movements. For example, the clothing pieces in an upper section of washing and dewatering tub 3 transfer downward, while the clothing pieces in a lower section of washing and dewatering tub 3 transfer upward. The various movements of the laundry can lessen the likelihood of any detergent left undissolved and uneven washing. As a result, water consumption can be

reduced, which leads to improvements in water saving and a washing performance.

Rotary vane 2 is formed substantially in the shape of a pan having a surface inclined toward an outer periphery thereof as shown in Fig. 1. Rotary vane 2 is provided with protruding bulge portion 31 for agitation formed in a radial manner. As shown in Fig. 2, protruding bulge portion 31 for agitation has a substantially trapezoidal shape in which a cross section perpendicular to a radial direction has slopes at both sides. According to the given structure, when rotary vane 2 is rotated with its rotational direction successively reversed, the laundry can move toward the outer periphery keeping a slight contact with a surface of the substantially pan shape of rotary vane 2 by a centrifugal force, which facilitates the upward and downward movements of the laundry. Thus, the laundry can collectively move upward and downward very easily, variously changing the positions of the clothing pieces to be washed and reversing the positions up and down. Another advantage is to reduce a load applied to motor 9 which is a driving unit for driving rotary vane 2.

SECOND EMBODIMENT

Fig. 7 is a timing chart showing an operation of a washing machine according to a second embodiment of the present invention. Any constitutive elements similar to those of the first embodiment will be described with the same reference symbols.

In the washing machine according to the present embodiment, rotary vane 2 is rotated clockwise by B rpm which is a small number of rotations for

t1 second (for example, 0.8 second), and then halted for t2 second shorter than t1 second (for example, 0.6 second). Then, rotary vane 2 is rotated anticlockwise for t1 second by A rpm which is a large number of rotations. Rotary vane 2 thus reverses its rotation repeatedly for a given period of time, meaning that rotary vane 2 more quickly changes its clockwise and anticlockwise rotations. This quick reversal easily generates the force which pushes the laundry upward, thereby increasing the movements of the laundry. Then, the likelihood of any detergent left undissolved and uneven washing can be diminished, and water consumption can be reduced. As a result, water saving can be achieved and the washing performance can be improved.

THIRD EMBODIMENT

Fig. 8 is a timing chart showing an operation of a washing machine according to a third embodiment of the present invention. Any constitutive elements similar to those of the first embodiment will be described with the same reference symbols.

In the washing machine according to the present embodiment, a time of rotation in a first number of rotations is longer than a time of rotation in a second number of rotations larger than the first number of rotations. For example, rotary vane 2 is rotated clockwise for t1 second by B rpm which is a small number of rotations, and then halted for t2 second shorter than t1 second. Then, rotary vane 2 is rotated anticlockwise by A rpm which is a large number of rotations for t3 second shorter than t1 second, and then halted for t4 second shorter than t3 second. Rotary vane 2 thus reverses its

rotation repeatedly for a given period of time. The repeatedly performed reversal increases the accelerating force for reversing the rotational direction of rotary vane 2. As a result, the positions of clothing pieces to be washed can be easily changed, and the washing performance can be improved. Moreover, a centrifugal force generated in the rotation by the smaller number of rotations is smaller than that of the rotation by the larger number of rotations. Along with the reduction of the centrifugal force, vibrations of support tub 1 and washing and dewatering tub 3 during the rotation of the laundry are lessened, which favorably results in less vibration of the washing machine.

FOURTH EMBODIMENT

Fig. 9 is a timing chart showing an operation of a washing machine according to a fourth embodiment of the present invention. Any constitutive elements similar to those of the first embodiment will be described with the same reference symbol.

First, one clockwise rotation and one anticlockwise rotation of rotary vane 2 for a predetermined time and halts of the respective rotations for a predetermined time are denoted as one reversal P1. More specifically, one reversal P1 denotes a sequence of operation steps in which rotary vane 2 is rotated clockwise or anticlockwise for a predetermined time and then halted for a predetermined time, and rotary vane 2 is rotated in the direction reverse to that of the first rotation and then halted for a predetermined time. An operation pattern, in which one reversal P1 is repeated a plurality of times, is called cyclic pattern P2. An operation pattern, in which the times

of rotation and the numbers of rotations in the clockwise and anticlockwise rotations are reverse to those of cyclic pattern P2, is called reverse cyclic pattern P3. The washing machine according to the present embodiment alternately implements cycle pattern P2 and reverse cycle pattern P3 as one cycle.

If the same cyclic pattern, for example, cyclic pattern P2 alone is repeated, the clothing pieces to be washed are more or less entangled with one another because the laundry is likely to move in the same rotational direction. As opposed to the exemplified case, the present embodiment further employs reverse cyclic pattern P3 in the rotational operation to allow the laundry to move in the opposite rotational directions, thereby disentangling the clothing pieces. As a result, possible entanglement of the clothing pieces to be washed is alleviated.

FIFTH EMBODIMENT

Figs. 10A and 10B are timing charts showing an operation of a washing machine according to a fifth embodiment of the present invention. Any constitutive elements similar to those of the first embodiment will be described with the same reference symbol.

The washing machine according to the present embodiment sets the times of rotation and halt of rotary vane 2 based on an output of clothing amount detecting unit 23, namely the amount of laundry. A specific example is as follows, for example. As shown in Fig. 10A, rotary vane 2 is rotated for t_5 second longer than a reference time t second (similar to the first embodiment) when it is detected that the amount of laundry is larger

than a predetermined amount. In addition, t_5 second is set to be longer than t_9 second. The time of halt is similarly set in the case where the amount of laundry is larger than the predetermined amount, more specifically, rotary vane 2 is halted for t_7 second longer than the reference time t second.

When it is detected that the amount of laundry is smaller than the predetermined amount, rotary vane 2 is rotated for t_6 second shorter than the reference time t second, and then halted for t_8 second shorter than the reference time t second, as shown in Fig. 10B.

When it is detected that a large amount of laundry is to be washed, the numbers of rotations of rotary vane 2 are respectively set to number of rotations C and number of rotations D respectively larger than reference numbers of rotations A and B ($C > A$, $D > B$), as shown in Fig. 10A. When it is detected that a small amount of laundry is to be washed, the numbers of rotations of rotary vane 2 are respectively set to number of rotations E and number of rotations F respectively smaller than the reference numbers of rotations A and B ($E < A$, $F < B$), as shown in Fig. 10B. Accordingly, rotary vane 2 can be rotated by the numbers of rotations thus suitably set depending on the amount of laundry, and these suitable rotations of rotary vane 2 can prevent such an unfavorable event that a small amount of laundry is washed by too fast rotations and thereby damaged.

Conventionally, an abnormal sound may be made when outer tub 1 is bumped against washing machine outer frame 8 as a reaction generated when the rotation of rotary vane 2 is reversed. The washing machine according to the present embodiment can avoid the occurrence of such an

adverse impact and an abnormal sound thereby generated. It is not just the numbers of rotations in the clockwise and anticlockwise directions and times of rotation of rotary vane 2 that are changeable, but the respective times of halt of rotary vane 2 can also be changed.

SIXTH EMBODIMENT

As shown in a timing chart of Fig. 11, a washing machine according to a sixth embodiment of the present invention implements at least once an agitation step in which the numbers of rotations in the clockwise and anticlockwise directions are differently set and an agitation step in which the numbers of rotations in the clockwise and anticlockwise directions are equally set. In other words, the washing machine implements at least once step pattern P4 in which the numbers of rotations in the clockwise and anticlockwise directions are differently set and step pattern P5 in which the numbers of rotations in the clockwise and anticlockwise directions are equally set. The operation thus carried out can further diversify the movements of the laundry such as reversal of the vertical positions and back and forth movements of the clothing pieces. As a result, possible unevenness in the wash can be prevented from happening, and the washing performance can be improved. As shown in Fig. 11, reverse step pattern P6 may be further set, in which the numbers of rotations in the clockwise and anticlockwise directions are reverse to the numbers of rotations in the clockwise and anticlockwise directions of step pattern P4 which are differently set.

SEVENTH EMBODIMENT

According to a seventh embodiment of the present invention, controller 21 repeats an agitation step and a tub rotation step a predetermined number of times after the water level reached the preset water level (usual washing water level). The agitation step is a step in which controller 21 drives motor 9 via power switching unit 22 to thereby rotate rotary vane 2 for a predetermined time period in the two opposite directions. The tub rotation step is a step in which controller 21 drives motor 9 via power switching unit 22 to thereby rotate washing and dewatering tub 3.

In the tub rotation step, number of rotations of washing and dewatering tub 3 is increased. As the number of rotations of washing and dewatering tub 3 is increased, a force for agitating detergent fluid in washing and dewatering tub 3 is increased. As shown in Fig. 1, a central part of water level 36 of the detergent fluid in washing and dewatering tub 3 is lowered, while a peripheral part thereof is elevated toward an inner wall of washing and dewatering tub 3. Water level 36 is further elevated to be finally higher than an upper end section of washing and dewatering tub 3. Then, the detergent fluid is dispersed from bubble discharge portion 16 into washing and dewatering tub 3. Further, a centrifugal force generated by the rotation of washing and dewatering tub 3 serves to press the laundry against the central part and the inner wall of washing and dewatering tub 3, thereby alleviating possible entanglement of the clothing pieces to be washed.

In a manner similar to the sixth embodiment, the agitation step

includes an agitation step in which the numbers of rotations in the clockwise and anticlockwise directions are differently set and an agitation step in which the numbers of rotations in the clockwise and anticlockwise directions are equally set, which are respectively implemented at least once. In the agitation step in which the numbers of rotations in the clockwise and anticlockwise directions are differently set, the laundry is tumbled about in the tub more frequently. Therefore, this step improves the washing performance of the washing machine, while increasing the entanglement of the clothing pieces. On the other hand, the agitation step in which the numbers of rotations in the clockwise and anticlockwise directions are equally set is less likely to entangle the clothing pieces and serves to disentangle the entangled clothing pieces. By combining the agitation step in which the numbers of rotations in the clockwise and anticlockwise directions are differently set with the agitation step in which the numbers of rotations in the clockwise and anticlockwise directions are equally set, the washing machine can improve its washing performance, while reducing the entanglement of the laundry. When the agitation step in which the numbers of rotations in the clockwise and anticlockwise directions are differently set is implemented first, followed by the agitation step in which the numbers of rotations in the clockwise and anticlockwise directions are equally set, the washing performance can be most effective. The order of the agitation steps may be reversed, in which case possible damage and entanglement of the laundry is reduced.

Further, the tub rotation step for rotating washing and dewatering tub 3 serves to disentangle the laundry, thereby minimizing the

entanglement of the laundry after the detergent fluid is discharged, in other words, before a dewatering step starts. Vibrations and noises in the dewatering step are often caused by lopsided clothing pieces in the tub. Therefore, the present embodiment can provide a washing machine which is unlikely to generate vibrations and noises in the dewatering step.

So far were described the rotation and halt of rotary vane 2 according to the first to seventh embodiments. Below is described an actual control operation executed by controller 20. Controller 20 outputs an electric signal for driving motor 9 via power switching unit 22. When rotary vane 2 is rotated anticlockwise by A rpm, for example, controller 20 outputs an electric signal equivalent to A rpm for rotating motor 9 anticlockwise. When rotary vane 2 is halted, controller 20 ceases to output the signal. Controller 20 rotates rotary vane 2 in this manner.

To be strict, rotary vane 2 may not be always rotated or halted exactly as shown in Figs. 5 to 10. More specifically, it is possible that rotary vane 2 is unable to instantly start its rotation by a predetermined number of rotations (for example, A rpm, B rpm) and instantly halt its rotation (0 rpm) due to a force of inertia acting on motor 9, decelerating mechanism 4 and rotary vane 2.

As described so far, the washing machine according to the present invention can effectively move the clothing pieces up and down and variously changes the positions thereof in the tub. The washing machine thus characterized can lessen the likelihood of any detergent left undissolved and uneven washing, thereby improving its water saving capacity and washing performance.

As described so far, the present invention provides a washing machine including a washing and dewatering tub rotatably provided in a support tub, a rotary vane rotatably provided at an inner bottom section of the washing and dewatering tub, a driving unit for rotating the washing and dewatering tub and the rotary vane, and a controller for controlling a sequence of steps of washing, rinsing and dewatering. In the washing machine according to the present invention, the controller drives the rotary vane by the driving unit in a clockwise and an anticlockwise direction so that number of rotations of the rotary vane in the clockwise rotation and number of rotations of the rotary vane in the anticlockwise rotation are different to each other. Accordingly, laundry during wash can be moved around in the tub through upward and downward movements and reversal of the upward and downward movements. As a result, the washing machine can lessen the likelihood of any detergent left undissolved and uneven washing and make improvements in its water saving and washing performance.

According to the present invention, the controller drives the driving unit to rotate and halt the rotary vane so that a time of the halt of the rotary vane is shorter than a time of the rotation of the rotary vane. As a result, time necessary for reversing the clockwise and anticlockwise rotations is shortened, and clothing pieces to be washed can be more actively moved around with their positions changing frequently.

According to the present invention, the controller controls the rotation of the rotary vane so that rotations by a first number of rotations and a second number of rotations larger than the first number of rotations are successively reversed, and a time of rotation in the first number of

rotations is longer than a time of rotation in the second number of rotations. Accordingly, an accelerating force for moving the laundry up and down is increased, and the clothing pieces can be moved around easily in the tub with their positions changing frequently. As a result, any detergent left undissolved and uneven washing are less likely to occur, and the water saving capacity and washing performance can be both improved.

According to the present invention, in a case where one clockwise rotation and one anticlockwise rotation of the rotary vane for a predetermined time and halts of the respective rotations for a predetermined time are denoted as one reversal, the controller alternately implements a cyclic pattern in which the one reversal is repeated a plurality of times and a reverse cyclic pattern in which the times of rotation and the numbers of rotations in the clockwise and anticlockwise directions are reverse to those of the cyclic pattern. This reduces possible entanglement of the laundry.

According to the present invention, a clothing amount detecting unit for detecting the amount of laundry put in the washing and dewatering tub is further provided, wherein at least one of times of rotation of the rotary vane and times of halt of the rotary vane is changed depending on a detection result obtained by the clothing amount detecting unit. As a result, the washing performance can be optimized depending on the amount of laundry.

According to the present invention, a clothing amount detecting unit for detecting the amount of laundry put in the washing and dewatering tub is further provided, wherein at least one of the number of rotations in the clockwise rotation of the rotary vane and the number of rotations in the anticlockwise rotation of the rotary vane is changed depending on a detection

result obtained by the clothing amount detecting unit. As a result, the washing performance can be optimized depending on the amount of laundry.

According to the present invention, the rotary vane is formed substantially in the shape of a pan having a protruding bulge portion for agitation radially provided, wherein the protruding bulge portion for agitation has a substantially trapezoidal shape in which a cross section perpendicular to a radial direction has slopes at both sides. This particular shape of the rotary vane easily generates a force for vertically reversing the positions of the clothing pieces to be washed.

According to the present invention, the controller implements at least once an agitation step in which the numbers of rotations in the clockwise and anticlockwise directions of the rotary vane are differently set and an agitation step in which the numbers of rotations in the clockwise and anticlockwise directions of the rotary vane are equally set. The operation thus carried out can further diversify the movements of the laundry such as reversal of the vertical positions of the clothing pieces. As a result, possible unevenness in the wash can be prevented from happening.

According to the present invention, the controller further implements a tub rotation step for rotating the washing and dewatering tub. This step lessens possible damage and entanglement of the laundry.

Claims:

1. A washing machine, comprising:
 - a washing and dewatering tub rotatably provided in a support tub;
 - a rotary vane rotatably provided at an inner bottom section of the washing and dewatering tub;
 - a driving unit for rotating the washing and dewatering tub and the rotary vane; and
 - a controller for controlling a sequence of steps of washing, rinsing, and dewatering, wherein
 - the controller drives the rotary vane by the driving unit in a clockwise and an anticlockwise direction so that the number of rotations of the rotary vane in a clockwise rotation and the number of rotations of the rotary vane in an anticlockwise rotation are different to each other.
2. The washing machine according to claim 1, wherein the controller drives the driving unit to rotate and halt the rotary vane so that a time of the halt of the rotary vane is shorter than a time of the rotation of the rotary vane.
3. The washing machine according to claim 1 or 2, wherein
 - the controller controls the rotation of the rotary vane by a first number of rotations and a second number of rotations, which is reversed and larger than the first number of rotations, and a time of rotation in the first number of rotations is longer than a time of rotation in the second number of rotations.

4. The washing machine according to any one of the preceding claims,

wherein, in a case where one clockwise rotation and one anticlockwise rotation of the rotary vane for a predetermined time and halts of the respective rotations for a predetermined time are denoted as one reversal, the controller alternately implements a cyclic pattern and a reverse cyclic pattern,

wherein the cyclic pattern is a pattern in which the one reversal is repeated a plurality of times, and

the reverse cyclic pattern is a pattern, in which times of rotation and the numbers of rotations in the clockwise and anticlockwise directions are reverse to the times of rotation and the numbers of rotations in the cyclic pattern.

5. The washing machine according to any one of the preceding claims, further comprising:

a clothing amount detecting unit for detecting amount of laundry put in the washing and dewatering tub, wherein

at least one of times of rotation of the rotary vane and times of halt of the rotary vane is changed depending on a detection result obtained by the clothing amount detecting unit.

6. The washing machine according to any one of the preceding claims, further comprising:

a clothing amount detecting unit for detecting amount of laundry put in the washing and dewatering tub, wherein

at least one of the number of rotations in the clockwise rotation of the rotary vane and the number of rotations in the anticlockwise rotation of the rotary vane is changed depending on a detection result obtained by the clothing amount detecting unit.

7. The washing machine according to any one of the preceding claims,

wherein the rotary vane is formed substantially in a shape of a pan having a protruding bulge portion for agitation radially provided,

wherein the protruding bulge portion for agitation has a substantially trapezoidal shape in which a cross section perpendicular to a radial direction has slopes at both sides.

8. The washing machine according to any one of the preceding claims, wherein the controller implements at least once an agitation step in which the numbers of rotations in the clockwise and anticlockwise directions of the rotary vane are differently set and an agitation step in which the numbers of rotations in the clockwise and anticlockwise directions of the rotary vane are equally set.

9. The washing machine according to any one of the preceding claims, wherein the controller further controls a tub rotation step for rotating the washing and dewatering tub.