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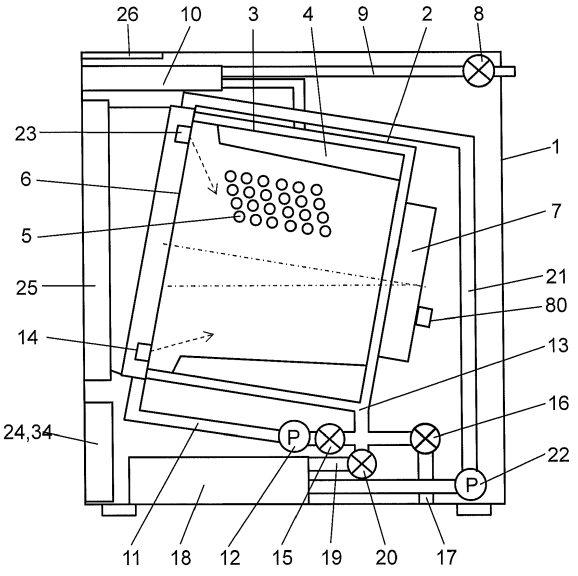
(54) Drum-type washing machine

(57) A drum-type washing machine (50) includes: a housing (1); a water tub (2) elastically supported in the housing; a drum (3) having a cylinder-like shape having a bottom, the drum being rotatably provided in the water tub; a water supply section (8) for supplying washing water into the water tub (2); a water drainage section (17) for draining the washing water in the water tub (2); a motor (7) for driving the drum to rotate; and a control section for controlling the driving of the motor. The control section (24) controls, in a step of washing laundry, the first agitation washing step (T1) of rotating the drum at a low speed so that the laundry can tumble in the drum, a high-speed rotation step (T2) of rotating the drum at a high speed so that the laundry clings to the inner periphery of the drum, and the second agitation washing step (T3) of rotating the drum at a low speed so that the laundry can tumble in the drum. The time during which the first agitation washing step performed firstly is carried out is longer than the time during which the second agitation washing step is carried out and the time during which the high-speed rotation step is carried out at other timings.

FIG. 1



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Description

TECHNICAL FIELD

[0001] The present invention relates to a drum-type washing machine for washing laundry such as clothes.

BACKGROUND ART

[0002] Conventionally, this drum-type washing machine performs washing by a so-called beat washing. In the beat washing, a drum storing therein laundry is caused to rotate in forward and reverse directions at a low speed to thereby raise and drop the laundry repeatedly. As a result, dirt is cleaned by the impact caused when the laundry wet with washing water is caused to drop from the upper part of the drum by drum rotation.

[0003] When laundry is in a high amount, the laundry is washed unevenly because it is difficult to evenly wet the laundry in the drum. At the same time, a disadvantage is caused where the laundry in a high volume causes a reduced distance along which the laundry is allowed to drop in the drum to thereby cause a decreased tumbling effect, which causes a decreased washing performance.

[0004] In order to solve such a disadvantage, it has been suggested to perform, in a washing step, a beat washing and a squeeze washing. In the beat washing, the drum is rotated at such a low speed that allows the laundry to drop in the drum while tumbling. In the squeeze washing, the drum is rotated at such a high speed that allows the laundry to cling to the drum interior. As a result, dirt as well as washing water is removed by using a centrifugal force. It has been also suggested to be able to change the drum rotation number during the squeeze washing depending on the amount of the laundry (see Japanese Patent Unexamined Publication No. H8-299658 for example).

[0005] FIG. 5 illustrates a cross-sectional structure of a conventional drum-type washing machine. As shown in FIG. 5, drum-type washing machine 100 is configured so that water tub 52 provided in housing 51 receives drum 53 having a cylinder-like shape having a bottom so that drum 53 can be rotated in forward and reverse directions. A bottom part of water tub 52 is attached to motor 54. Motor pulley 55 attached to the driving axis of motor 54 is rotated and power is transmitted via driving belt 56 to driving pulley 57 attached to the rotation axis of drum 53 to thereby rotate drum 53.

[0006] Washing water is supplied by feed-water valve 58 to water tub 52. Washing water in water tub 52 is drained from drainage water opening 59 via drainage water valve 60 to the outside of the machine through drainage water path 61. A front face of housing 51 has openable-and-closable door 62. Laundry 64 can be inputted and outputted through cloth input opening 63 opened at the front face-side of drum 53.

[0007] The following section will describe an operation in the washing step of conventional drum-type washing machine 100 having the configuration as described above.

[0008] FIG. 6 is a time chart of the operation of conventional drum-type washing machine 100 in the washing step. The amount of laundry 64 inputted to the interior of drum 53 is determined. Then, washing water set depending on the amount is supplied from feed-water valve 58 into water tub 52. Then, motor 54 is driven.

[0009] First, in order to immerse laundry 64 in washing water, the first washing step is performed in which drum 53 is rotated at such a rotation number that allows laundry 64 to tumble in drum 53 (e.g., 50rpm). Then, the second washing step is performed in which drum 53 is rotated at a rotation number for subjecting the laundry to the squeeze washing (e.g., 200rpm). During the washing step, the first washing step and the second washing step are repeated alternately.

[0010] Another conventional technique has been suggested to jet cleaning liquid to the laundry and to wash the laundry while changing the drum rotation number (see Japanese Patent Unexamined Publication No. H8-66578 for example).

[0011] However, in the case of the conventional configuration, the time during which the first washing step and the second washing step are performed is predetermined depending on the amount of inputted laundry 64. This has caused a disadvantage where it is difficult to improve a cleaning effect within a limited set time for the washing step and within a shorter time.

[0012] When the rotation number of drum 53 for the squeeze washing is changeable depending on the amount of laundry, a high amount of laundry tends to cause, when including some kind of laundry such as long or big clothes, an unbalanced weight distribution in drum 53. Another disadvantage was that a higher rotation number of drum 53 requires a longer time to reach a set rotation number, which finally caused a difficulty in reaching the set rotation number itself.

SUMMARY OF THE INVENTION

[0013] The present invention has been made in view of the above-described disadvantages of the conventional technique. The present invention provides a drum-type washing machine that achieves reduced uneven washing and a superior washing performance within a limited time for the washing step, even when laundry is in a high amount.

[0014] The drum-type washing machine of the present invention includes: a housing; a water tub elastically supported in the housing; a drum having a cylinder-like shape having a bottom, the drum being rotatably provided in the water tub;

a water supply section for supplying washing water into the water tub; a water drainage section for draining the washing water in the water tub; a motor for driving the drum to rotate; and a control section for controlling the driving of the motor. The control section switches, in a step of washing laundry, the first agitation washing step of rotating the drum at a low speed so that the laundry can tumble in the drum, a high-speed rotation step of rotating the drum at a high speed so that the laundry clings to the inner periphery of the drum, and the second agitation washing step of rotating the drum at a low speed so that the laundry can tumble in the drum. The time during which the first agitation washing step performed firstly is carried out is longer than the time during which the second agitation washing step is carried out and the time during which the high-speed rotation step is carried out at other timings.

[0015] The drum-type washing machine of the present invention can provide reduced uneven washing and a superior washing performance within a limited time for the washing step, even when laundry is in a high amount.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

FIG. 1 illustrates a cross-sectional configuration of the drum-type washing machine in an embodiment of the present invention.

FIG. 2 is a time chart illustrating the operation in the washing step of the drum-type washing machine in the first embodiment of the present invention.

FIG. 3 is a time chart illustrating the operation in the washing step of the drum of the drum-type washing machine in the first embodiment of the present invention.

FIG. 4 is a time chart illustrating the operation in the washing step of the drum-type washing machine in the second embodiment of the present invention.

FIG. 5 illustrates the cross-sectional structure of a conventional drum-type washing machine.

FIG. 6 is a time chart illustrating the operation of the conventional drum-type washing machine in the washing step.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0017] The following section will describe an embodiment of the present invention with reference to the drawings. The present invention is not limited to these embodiments.

(First embodiment)

[0018] First, the following section will describe the configuration of drum-type washing machine 50 in the first embodiment of the present invention.

[0019] FIG. 1 illustrates the cross-sectional configuration of drum-type washing machine 50 in the first embodiment of the present invention.

[0020] As shown in FIG. 1, housing 1 of drum-type washing machine 50 includes therein water tub 2 elastically supported by a damper for example. Water tub 2 includes therein drum 3 having a cylindrical shape having a bottom so that drum 3 is rotatable. The rotation axis of drum 3 is upwardly inclined from the rear side to the front side. Drum 3 has, at the inner circumference side face thereof, baffles 4 inwardly protruding in the rotation axis direction and many through holes 5 communicating with the interior of water tub 2. Drum 3 has, at the front face side thereof, opening section 6 through which laundry is inputted and outputted.

[0021] Water tub 2 has, at the rear face, motor 7 for driving drum 3 to rotate. Motor 7 is configured by a brushless direct-current motor and can freely change the rotating speed by an inverter control. Feed-water valve 8 functions as a water supply section to supply washing water into water tub 2. Feed-water valve 8 supplies washing water into water tub 2 via detergent receiving case 10. Detergent receiving case 10 is provided in water supply path 9 and is used to input detergent. The washing water supplied to the interior of water tub 2 flows from through holes 5 into drum 3.

[0022] The washing water in water tub 2 can be circulated into drum 3 by first circulation pump 12 provided in first circulating water path 11. Water tub 2 has, at the lower part thereof, suction section 13. Suction section 13 communicates with first circulating water path 11 and is used to suck washing water. At the lower part of opening section 6 provided at the front face-side of drum 3, discharge section 14 is provided that communicates with first circulating water path 11 so that the washing water is discharged into drum 3.

[0023] First circulating water path 11 has first on-off valve 15 that is provided at the upstream side of first circulation pump 12 (i.e., between suction section 13 and first circulation pump 12). First circulating water path 11 between suction section 13 and first on-off valve 15 is connected to drainage water path 17 having drainage water valve 16.

[0024] In order to drive first circulation pump 12 to discharge the washing water in water tub 2 into drum 3 through discharge section 14, drainage water valve 16 is closed and first on-off valve 15 is opened. As a result, the washing

water in water tub 2 can be sucked through suction section 13 into first circulating water path 11 and can be circulated through discharge section 14 into drum 3.

[0025] At the lower side of water tub 2 in housing 1, water storage section 18 is provided into which the washing water in water tub 2 can be caused to flow. Water storage section 18 is connected to the interior of water tub 2 via inflow path 19. Inflow path 19 is connected to first circulating water path 11 between suction section 13 and first on-off valve 15. Inflow path 19 has second on-off valve 20 (on-off valve).

[0026] The washing water in water storage section 18 can be circulated into drum 3 by second circulation pump 22 provided in second circulating water path 21. Second circulating water path 21 is structured so that one side is connected to water storage section 18 and the other side is connected to discharge section 23. Discharge section 23 is provided at the upper side of opening section 6 provided at the front face-side of drum 3 so that washing water is discharged into drum 3.

[0027] In order to drive second circulation pump 22 to discharge the washing water in water tub 2 through discharge section 23 into drum 3, first on-off valve 15 and drainage water valve 16 are closed and second on-off valve 20 is opened. As a result, the washing water in water tub 2 can be caused to flow into water storage section 18 from suction section 13 through inflow path 19 and can be circulated into drum 3 from discharge section 23 through second circulating water path 21.

[0028] In order to drain the washing water in water tub 2, first on-off valve 15 and second on-off valve 20 are closed and drainage water valve 16 is opened. As a result, the washing water in water tub 2 can be drained to the outside of the machine through drainage water path 17.

[0029] Control section 24 provided in housing 1 drives motor 7, feed-water valve 8, first circulation pump 12, first on-off valve 15, drainage water valve 16, second on-off valve 20, and second circulation pump 22 for example and sequentially controls the respective steps such as washing, rinsing, and dewatering.

[0030] Laundry can be inputted and outputted through opening section 6 provided at the front face-side of drum 3 by opening openable-and-closable door 25 provided in the front face of housing 1.

[0031] Next, the following section will describe the operation and effect of drum-type washing machine 50 having the configuration as described above.

[0032] A user opens door 25 provided at the front face-side of housing 1 and inputs laundry into drum 3 through opening section 6. Then, when the user turns ON a power source switch of operation section 26 provided at the front part of the upper face of housing 1 and operates a start switch, then drum-type washing machine 50 starts operation. Then, cloth amount sensing section 80 determines the amount of the inputted laundry. Cloth amount sensing section 80 can use various known methods. For example, the amount of the laundly can be determined by measuring time from when motor 7 which drives rotation of drum 3 is stopped until when drum 3 stoppes actual rotation.

[0033] Washing is carried out in an order of a washing step, a rinsing step, and a dewatering step. The following section will describe the washing step in detail based on the time charts of FIG. 2 and FIG. 3 and will not further describe the rinsing step and the dewatering step.

[0034] FIG. 2 is a time chart illustrating the washing step of drum-type washing machine 50 in the first embodiment of the present invention. FIG. 3 is a time chart illustrating the operation of drum 3 of drum-type washing machine 50 in the washing step.

[0035] The washing step of drum-type washing machine 50 of the present invention is performed after the above-described determination of the amount of the inputted laundry.

[0036] The washing step starts with the first water supply step to introduce, depending on the sensed laundry weight, water of a predetermined amount into water tub 2 and drum 3. In the first water supply step, feed-water valve 8 is firstly opened and water is supplied through a clean water piping, thereby starting the water supply. The amount of water supply and the respective times for the washing operation are predetermined depending on the weight of inputted laundry.

[0037] Washing water is supplied into water tub 2 via water supply path 9 while dissolving the detergent inputted in a predetermined amount into detergent case 10. The washing water supplied to the interior of water tub 2 flows from through holes 5 into drum 3.

[0038] The washing water supplied to water tub 2 enters first circulating water path 11 from suction section 13 through opened first on-off valve 15 and reaches first circulation pump 12. The amount of supplied water is sensed by a water level sensing section (not shown). When a predetermined amount of washing water is supplied into water tub 2, control section 24 drives first circulation pump 12 to circulate the washing water in water tub 2 into drum 3.

[0039] As described above, in the first water supply step, the washing water including the one having entered drum 3 through through holes 5 by the increased water level of the washing water in water tub 2 is discharged from discharge section 14 into drum 3 by driving first circulation pump 12. This can promote the permeation of washing water into the laundry. When the water level sensing section senses that the set amount of washing water is supplied to the interior of water tub 2, control section 24 closes feed-water valve 8 and stops water supply.

[0040] Next, the first water supply step is followed by the first agitation washing step. The first agitation washing step is performed for predetermined time T1. As in the first water supply step, the first agitation washing step is performed

while first on-off valve 15 is being opened and second on-off valve 20 and drainage water valve 16 are being closed. First circulation pump 12 is used to suck the washing water in water tub 2 from suction section 13 into first circulating water path 11 and is discharged from discharge section 14 to the laundry in drum 3.

[0041] In the first agitation washing step, the rotating speed of drum 3 is set so that the laundry is raised by baffle 4 provided in drum 3 along the rotation direction of drum 3 and is dropped by its weight from the upper side of drum 3 and the mechanical action during drop is effectively applied to the laundry. The rotating speed of drum 3 is set to such a rotating speed that prevents the laundry from clinging by a centrifugal force to the side wall face of the inner circumference of drum 3 (e.g., 30 to 60rpm). Although the rotating speed of drum 3 depends on the amount of laundry, the rotating speed of drum 3 is preferably 50rpm. As shown in FIG. 3, drum 3 is repeatedly rotated in alternate forward and reverse directions.

[0042] Predetermined time T1 of the first agitation washing step is set to 6 minutes for example. Predetermined time T1 is set so that the laundry is sufficiently wet with washing water and predetermined time T1 is longer than predetermined time T2 of the subsequent high-speed rotation step and predetermined time T3 of the second agitation washing step. The operation of first circulation pump 12 for circulating washing water may be performed continuously or intermittently.

[0043] Discharge section 14 preferably has such a shape that allows washing water to diffuse in a fan-like form in order to quickly wet the laundry with the washing water. Discharge section 14 may be provided at the lower part of opening section 6 provided at the front face-side of drum 3 or also may be provided so that washing water flows into drum 3 while flowing along the circumference wall face of drum 3. When drum 3 is rotated during the discharge of washing water, the relative displacement of the laundry can be promoted in drum 3, thus uniformly wetting the laundry.

[0044] Next, the high-speed rotation step is started. In this high-speed rotation step, first circulation pump 12 is stopped, first on-off valve 15 is closed, second on-off valve 20 is opened, and water tub 2 is allowed to communicate with water storage section 18. Drainage water valve 16 is still closed.

[0045] When second on-off valve 20 is opened to cause the washing water in water tub 2 to flow through inflow path 19 into water storage section 18, control section 24 drives second circulation pump 22. Then, the washing water in water storage section 18 is discharged to the laundry in drum 3 through second circulating water path 21 from discharge section 23 positioned at the upper side of opening section 6 provided at the front face-side of drum 3.

[0046] The rotating speed of drum 3 in the high-speed rotation step rotating speed is set to 100 to 400rpm and preferably 300rpm for example so that the washing water included in the laundry can be forcedly discharged by a centrifugal force.

[0047] In this high-speed rotation step, as shown in FIG. 3, the first high-speed rotation is performed while a high amount of washing water is being absorbed by the laundry. Thus, the rotation number increases only about to 200rpm at about 30 seconds. After motor 7 is stopped and the rotation number decreases, drum 3 is again allowed to rotate at a high-speed, thus increasing the rotation number to about 300rpm.

[0048] At the second high-speed rotation after stopping the first high-speed rotation, the rotation number of drum 3 is decreased so that the laundry in drum 3 is caused to drop from the inner circumference side face of drum 3. Thus, the relative positional change of the laundry can be caused in drum 3. Although this high-speed rotation step is performed at least one time in the washing step, this high-speed rotation step is preferably performed a plurality of times, preferably in a continuous manner.

[0049] A cleaning effect is higher with an increase of the time during which washing water contacts with laundry. Thus, the high-speed rotation step also causes the washing water to be discharged to the laundry in drum 3. Specifically, the washing water having flowed from water tub 2 to the interior of water storage section 18 by the gravity is continuously discharged by second circulation pump 22 to the laundry in drum 3.

[0050] By doing this, the centrifugal force obtained by the high-speed rotation of drum 3 can be used to supply the washing water from discharge section 23 to the laundry while removing the washing water among the fibers of the laundry. Thus, the washing water among the fibers is substituted continuously, thus providing a higher cleaning effect.

[0051] In the high-speed rotation step, predetermined time T2 is set so that drum 3 is rotated at a high speed for a longer time depending on the amount of the laundry inputted to the interior of drum 3 that is determined by cloth amount sensing section 80. A higher amount of laundry means an increased amount of washing water included in the laundry. In other words, a higher amount of laundry means an increased thickness of the laundry layered in drum 3 (i.e., the distance from the surface of the laundry to through holes 5 provided in the inner circumference side face of drum 3). Specifically, a higher amount of laundry means that a longer time is required for the washing water to go through the fibers to enter water tub 2 via through holes 5. Thus, predetermined time T2 is set as described above.

[0052] Table 1 shows the amount of the laundry inputted to the interior of drum 3 and the time of the high-speed rotation step. Predetermined time T2 for the high-speed rotation is set in a range from 30 seconds to 120 seconds depending on the amount of the laundry.

[Table 1]

Amount of laundry	Time of high-speed rotation step
Lower than 2kg	30s
2kg or more and lower than 4.5kg	45s
4.5kg or more and lower than 6kg	60s
6kg or more	120s

[0053] By doing this, a high amount of washing water included in laundry can be removed from the laundry by a centrifugal force by the high-speed rotation. Furthermore, the washing water including dissolved dirt also can be effectively removed from the fibers. Since predetermined time T2 for the high-speed rotation of drum 3 is set to be longer with an increase of the amount of laundry, the dirt substance in fibers can be effectively removed together with washing water.

[0054] Next, the second water supply step is started. In this second water supply step after the high-speed rotation step, second circulation pump 22 is driven to discharge the washing water in water storage section 18 to the laundry in drum 3 via second circulating water path 21. In the second water supply step, first on-off valve 15, second on-off valve 20, and drainage water valve 16 are closed to collect the washing water at bottom part of water tub 2. When the move of the washing water in water storage section 18 to the interior of water tub 2 is completed, the second agitation washing step is carried out.

[0055] In the second agitation washing step, as in the first agitation washing step, first on-off valve 15 is opened and drainage water valve 16 and second on-off valve 20 are closed to thereby allow first circulation pump 12 to communicate with water tub 2. Thereafter, first circulation pump 12 is driven. Then, the washing water collected at the bottom part of water tub 2 is sucked through first circulation pump 12 and is discharged from discharge section 14 into drum 3 via first circulating water path 11. During this, drum 3 is rotated at such a rotation number that allows the laundry to tumble in the drum 3 without clinging to the circumference-side wall face. In this embodiment, as shown in FIG. 3, drum 3 is repeatedly rotated at 50rpm in alternate forward and reverse directions.

[0056] By performing the second agitation washing step for predetermined time T3 after the high-speed rotation step, the fibers of the laundry is allowed to again include thereamong the washing water including dissolved detergent. Thus, by the chemical action of the detergent and the mechanical action obtained by the rotation of drum 3, the dirt substance remaining in the fibers can be peeled off. If the fibers include thereamong washing water including a dirt substance of a high concentration, a risk is caused where the dirt substance may be attached to the fibers again. However, the dirt substance can be suppressed from being attached to the fibers again by forcedly substituting the washing water among the fibers.

[0057] The first agitation washing step that is firstly performed among the above-described washing steps is carried out for predetermined time T1 that is set to be longer than predetermined time T2 for the high-speed rotation step to rotate drum 3 at a high-speed and to be longer than predetermined time T3 for the second agitation washing step performed after the high-speed rotation step. Specifically, predetermined time T1 for the first agitation washing step and predetermined time T3 for the second agitation washing step have a relation of T1>T3.

[0058] During the first agitation washing step performed first among the washing steps, the laundry is wet insufficiently and the conditions to permeate the washing water among the fibers of the laundry (or the conditions to peel dirt off from the fibers) are most disadvantageous. Thus, the first agitation washing step can provide an effective cleaning effect by being performed for a time longer than the time for an agitation washing performed at another timing (the second agitation washing step).

[0059] The present invention is not limited to the above illustrative number of the high-speed rotation step in the washing step to rotate drum 3 at a high speed. However, the high-speed rotation step is preferably performed a plurality of times because this means an increased number of substitution of washing water. The high-speed rotation step may be performed continuously or the high-speed rotation steps also may be performed discontinuously to include thereamong a step such as an agitation washing step.

[0060] As described above, in drum-type washing machine 50, the laundry washing step causes first circulation pump 12 to be driven to circulate the washing water in water tub 2 into drum 3. Then, the processing proceeds to the low-speed rotation for allowing the laundry to tumble in drum 3 (i.e., for preventing the laundry from clinging to the inner circumference face of drum 3) and the high-speed rotation for allowing the laundry to cling to the inner circumference face of drum 3. Furthermore, the time for the low-speed rotation of drum 3 (i.e., the first agitation washing step) that is firstly performed is set to be longer than the time for another low-speed rotation (i.e., the time for the second agitation washing step) and the time for the high-speed rotation step. As a result, the permeation of the washing water in the laundry and the removal of the dirt substance among the fibers can be carried out effectively. Thus, uneven washing can be reduced and a cleaning effect can be improved within a limited time for the washing step.

[0061] In the laundry washing step, during the high-speed rotation of drum 3, the washing water in water tub 2 is caused to flow into water storage section 18 and second circulation pump 22 is driven to circulate the washing water in water storage section 18 into drum 3. As a result, a centrifugal force obtained by the high-speed rotation of drum 3 can be used to remove the washing water including dissolved dirt from the fibers. Furthermore, by causing the washing water in water tub 2 removed from laundry to flow into water storage section 18 to allow the washing water to fall on the laundry in drum 3 through discharge section 23, the washing water among the fibers can be substituted continuously while wetting the laundry. Thus, a cleaning effect can be improved and the lower part of drum 3 immersed in the washing water in water tub 2 can be allowed to exposed out of the water surface of the washing water. At the same time, the resistance by the washing water during the high-speed rotation can be excluded to thereby reduce the load applied to motor 7, thus allowing drum 3 to smoothly rotate at a high speed.

(Second embodiment)

[0062] Next, the following section will describe drum-type washing machine 70 in the second embodiment of the present invention. Drum-type washing machine 70 has the same configuration as that of drum-type washing machine 50 described in the first embodiment. However, a difference therebetween is that the operation performed by control section 34 is different from the one performed by control section 24 of drum-type washing machine 50. The components having the same configuration will be denoted with the same reference numerals and the detailed description of such components is the same as that in the first embodiment.

[0063] FIG. 4 is a time chart illustrating the operation in the washing step of drum-type washing machine 70 in the second embodiment of the present invention. Drum-type washing machine 70 of this embodiment is configured so that, in the first agitation washing step of the laundry washing step, second on-off valve 20 (on-off valve) is opened during the low-speed rotation of drum 3 to start the water drainage from water tub 2 and, when the lower part of drum 3 is above the water surface, the high-speed rotation step is started.

[0064] As shown in FIG. 4, during the first agitation washing step that is ahead of the high-speed rotation step for rotating drum 3 at a high speed by predetermined time T4, second on-off valve 20 as an on-off valve is opened. Then, the washing water in water tub 2 is allowed to flow into water storage section 18 from suction section 13 through inflow section 19 for water removal. Predetermined time T4 is set to a time required from the opening of second on-off valve 20 through the decline of the water level of the washing water in water tub 2 to a predetermined depth. To be more specific, time T4 is set to a time required from the opening of second on-off valve 20 until the lowest point on the circumference located in a predetermined distance from the bottom plane of drum 3 moves to a position above the water surface.

[0065] By doing this, during the first agitation washing step, the flow of the washing water to water storage section 18 can be started. When the water level of the washing water in water tub 2 lowers to a predetermined depth after predetermined time T4, the high-speed rotation step can be started. Thus, the resistance by the washing water collected at the bottom part of water tub 2 can be excluded when the first agitation washing step shifts to the high-speed rotation step. At the same time, the load applied to motor 7 to rotate drum 3 at a high speed can be reduced and the torque can be reduced and the washing step can be performed efficiently. Furthermore, a disadvantage also can be solved where the washing water collected at the bottom part of water tub 2 is agitated and foamed by drum 3 to thereby hindering the rotation number of drum 3 from increasing.

[0066] Another configuration also can be used where, by sensing the water level of the washing water collected in water tub 2, the water level is sensed at which the lowest point on the circumference located in a predetermined distance from the bottom plane of drum 3 is exposed out of the washing water collected in water tub 2 to thereby start the high-speed rotation step.

[0067] In the high-speed rotation step, the circulation amount of the washing water in water storage section 18 by second circulation pump 22 can be increased to thereby cause the water level in water tub 2 to fall, thus allowing the lower part of drum 3 to be exposed out of the washing water collected in water tub 2. First circulation pump 12 also may be used. In this case, second circulating water path 21, first circulating water path 11, or both of second circulating water path 21 and first circulating water path 11 are filled with the washing water. This can substantially reduce the amount of the washing water existing in water tub 2.

[0068] The above-described configurations of drum-type washing machines 50 and 70 also can be applied to a drum-type wash dryer having a dry function.

[0069] As described above, in drum-type washing machines 50 and 70, among the times for the washing steps of the entire washing process, the time for the first beat washing is increased for which the highest amount of dirt is strongly attached to laundry. This allows, during the subsequent high-speed rotation step, more dirt to be removed from the fibers of the clothes. This also allows, during the subsequent beat washing step, dirt remaining in the fibers of the clothes to be already peeled off by the chemical action by the washing water and the mechanical action by the beat washing. As a result, dirt can be removed from the fibers within a shorter time. Thus, the washing performance can be improved

within a limited short time. Even when laundry exists in a high amount, an uneven washing can be reduced and the cleaning effect can be improved within a shorter time without reducing the time for the beat washing by securing the time to sufficiently wet the laundry in drum 3 with washing water including dissolved detergent and by subjecting the wet laundry to the beat washing.

(Illustrative Embodiment 1)

[0070] Drum-type washing machine 50 having a rating capacity of 9kg as described in the first embodiment of the present invention was compared with a conventional method. Specifically, comparison was made for the case where time T1 for the first agitation washing step was longer than time T3 for the second agitation washing step in the washing step. A cleaning test was performed by a sample laundry of 9kg specified by Japan Electrical Manufacturers' Association (JEMA).

[0071] The washing performance was evaluated in the manner as described below. 25 JIS (Japanese Industrial Standards) -standard contaminated clothes sold by Foundation for Sentaku Kagaku Kyoukai were attached to test clothes. Then, the optical reflectivities before and after the washing process were measured by a color-difference meter ZE-2000 (NIPPON DENSHOKU INDUSTRIES CO., LTD.). Then, cleaning levels defined by the mathematical formula 1 were calculated. Then, the washing performances were compared.

[Mathematical formula 1]

[0072]

$$D = (R_w - R_1)/(R_0 - R_1)$$

D: Cleaning level
R_w: Reflectivity after washing contaminated cloth
R_1: Reflectivity before washing contaminated cloth
R_0: Reflectivity of cloth before contamination

[0073] A general washing process was carried out with a water temperature of 20 degrees C to include a washing step, a rinsing step, and a dewatering step. The steps after the rinsing step were carried out with substantially the same water amount and time. The washing time was set to 10 minutes, both for the embodiment of the present invention and the conventional method.

[0074] The washing step of drum-type washing machine 50 was composed of the first agitation washing step of 6 minutes, two continuous high-speed rotation steps of 30 seconds each (total 1 minute), the first water supply step and the second water supply step of the total of 1 minute, and the second agitation washing step of 2 minutes, all of which constituted the washing process of 10 minutes.

[0075] In this illustrative embodiment, in the high-speed rotation step for rotating drum 3 at a high speed, the rotation number reached to 140rpm within the first 30 seconds and to 250rpm within the subsequent 30 seconds. Thereafter, the second agitation washing step was performed for 2 minutes. The measurement result of the cleaning level of the JIS-standard contaminated cloth showed that the average value of the cleaning level of the conventional method was "0.32" while the average value of the present invention "0.38", showing an improved cleaning level.

[0076] With regard to the dispersion of the measurement results of the cleaning level, while the dispersion of the conventional method was "0.07", the dispersion of the present invention was "0.06", which substantially either equaling or surpassing the dispersion of the conventional method. As described above, the drum-type washing machine of the present invention showed a superior cleaning level and an improved washing performance.

[0077] The present invention can provide reduced uneven washing and an improved cleaning effect even when a high amount of laundry is washed within a washing process of a limited time. Thus, the present invention is useful for a drum-type washing machine for example.

Claims

1. A drum-type washing machine comprising:

a housing;

a water tub elastically supported in the housing;
a drum having a cylinder-like shape having a bottom, the drum being rotatably provided in the water tub;
a water supply section for supplying washing water into the water tub;
a water drainage section for draining the washing water in the water tub;
a motor for driving the drum to rotate; and
a control section for controlling the driving of the motor,
characterized in that:

the control section switches, in a step of washing laundry,
a first agitation washing step of rotating the drum at a low speed so that the laundry can tumble in the drum,
a high-speed rotation step of rotating the drum at a high speed so that the laundry clings to an inner periphery of the drum, and
a second agitation washing step of rotating the drum at a low speed so that the laundry can tumble in the drum, and
a time during which the first agitation washing step performed firstly is carried out is longer than a time during which the second agitation washing step is carried out and a time during which the high-speed rotation step is carried out at other timings.

2. The drum-type washing machine according to claim 1, wherein:

the drum-type washing machine further includes a cloth amount sensing section for determining the amount of the laundry inputted to the drum, and
the control section increases the time for the high-speed rotation step of the drum with an increase of the amount of the laundry in the step of washing laundry.

3. The drum-type washing machine according to claim 1 or claim 2, further comprising:

a first circulating water path for circulating the washing water in the water tub into the drum, and
a first circulation pump provided in the first circulating water path.

4. The drum-type washing machine according to claim 1 or claim 2, further comprising:

a water storage section for collecting the washing water having flowed out of the water tub,
an on-off valve for causing the washing water in the water tub to flow to the water storage section,
a second circulating water path for circulating the washing water in the water storage section into the drum, and
a second circulation pump provided in the second circulating water path,
wherein:

the control section is configured to cause, in the step of washing laundry, the on-off valve to be opened during the high-speed rotation step to cause the washing water in the water tub to flow to the water storage section so that the washing water in the water storage section is circulated in the drum by the second circulation pump.

5. The drum-type washing machine according to claim 1 or claim 2, further comprising:

a water storage section for collecting the washing water having flowed out of the water tub, and
an on-off valve for causing the washing water in the water tub to flow to the water storage section,
wherein:

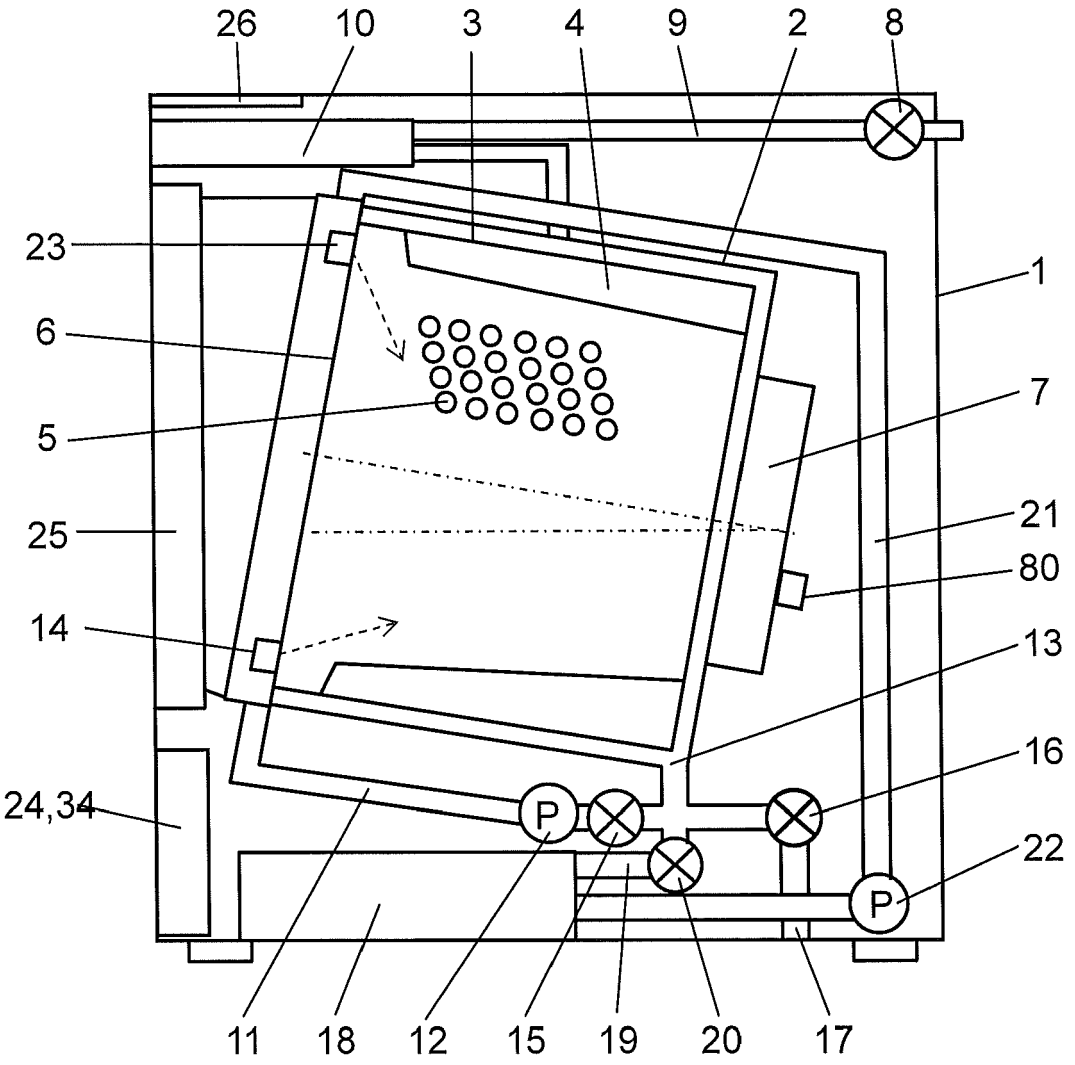
the control section causes, in the step of washing laundry, the on-off valve to be opened during the first agitation washing step to start water drainage to the water storage section and causes, when a water level of the washing water in the water tub lowers to a predetermined depth, the high-speed rotation step to be performed.

6. The drum-type washing machine according to claim 4, wherein:

the control section causes, in the step of washing laundry, the on-off valve to be opened during the first agitation washing step to start water drainage to the water storage section and causes, when a water level of the washing

water in the water tub lowers to a predetermined depth, the high-speed rotation step to be performed.

FIG. 1



50,70

FIG. 2

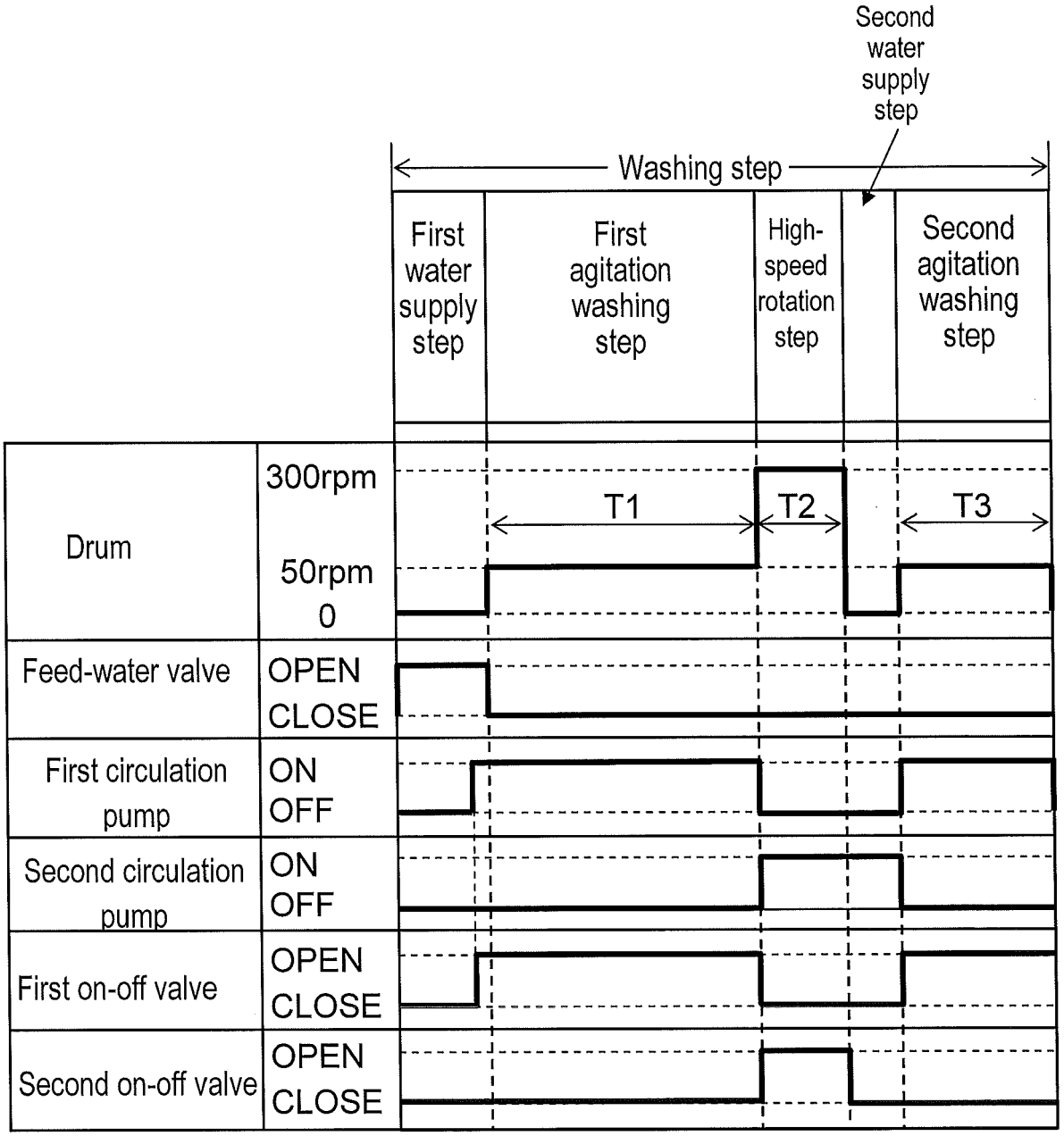

Second water supply step
Washing step
First water supply step
First agitation washing step
High-speed rotation step
Second agitation washing step
Drum
300rpm
50rpm
0
T1
T2
T3
Feed-water valve
OPEN
CLOSE
First circulation pump
ON
OFF
Second circulation pump
ON
OFF
First on-off valve
OPEN
CLOSE
Second on-off valve
OPEN
CLOSE

FIG. 3

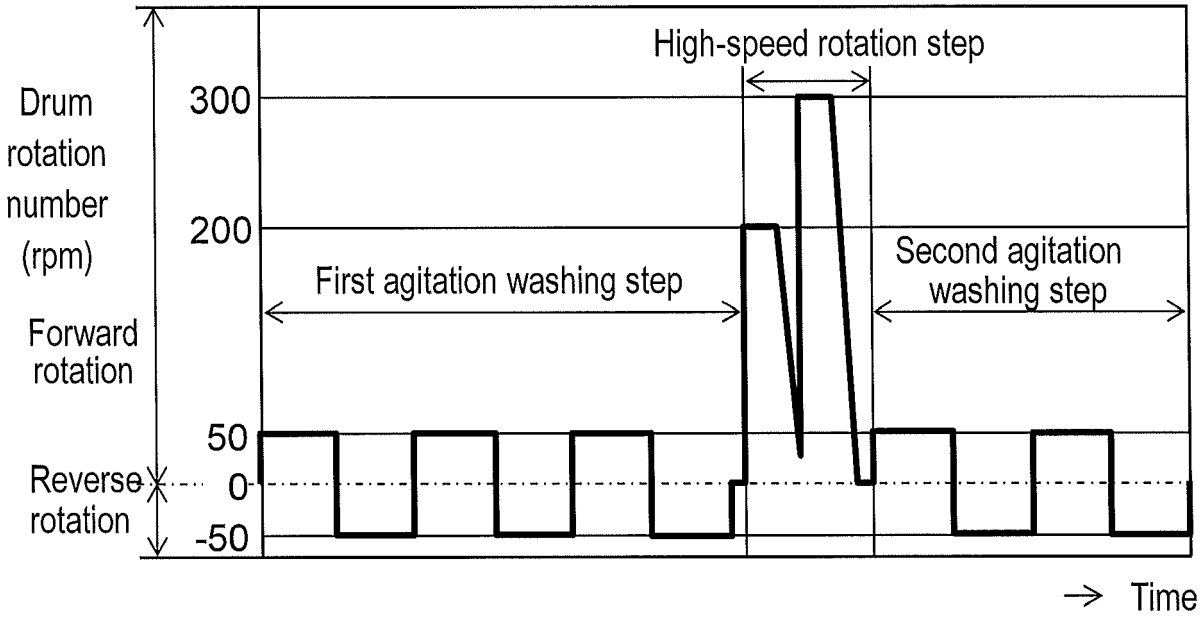

High-speed rotation step
Drum rotation number (rpm)
300
200
First agitation washing step
Second agitation washing step
Forward rotation
50
Reverse rotation
0
-50
Time

FIG. 4

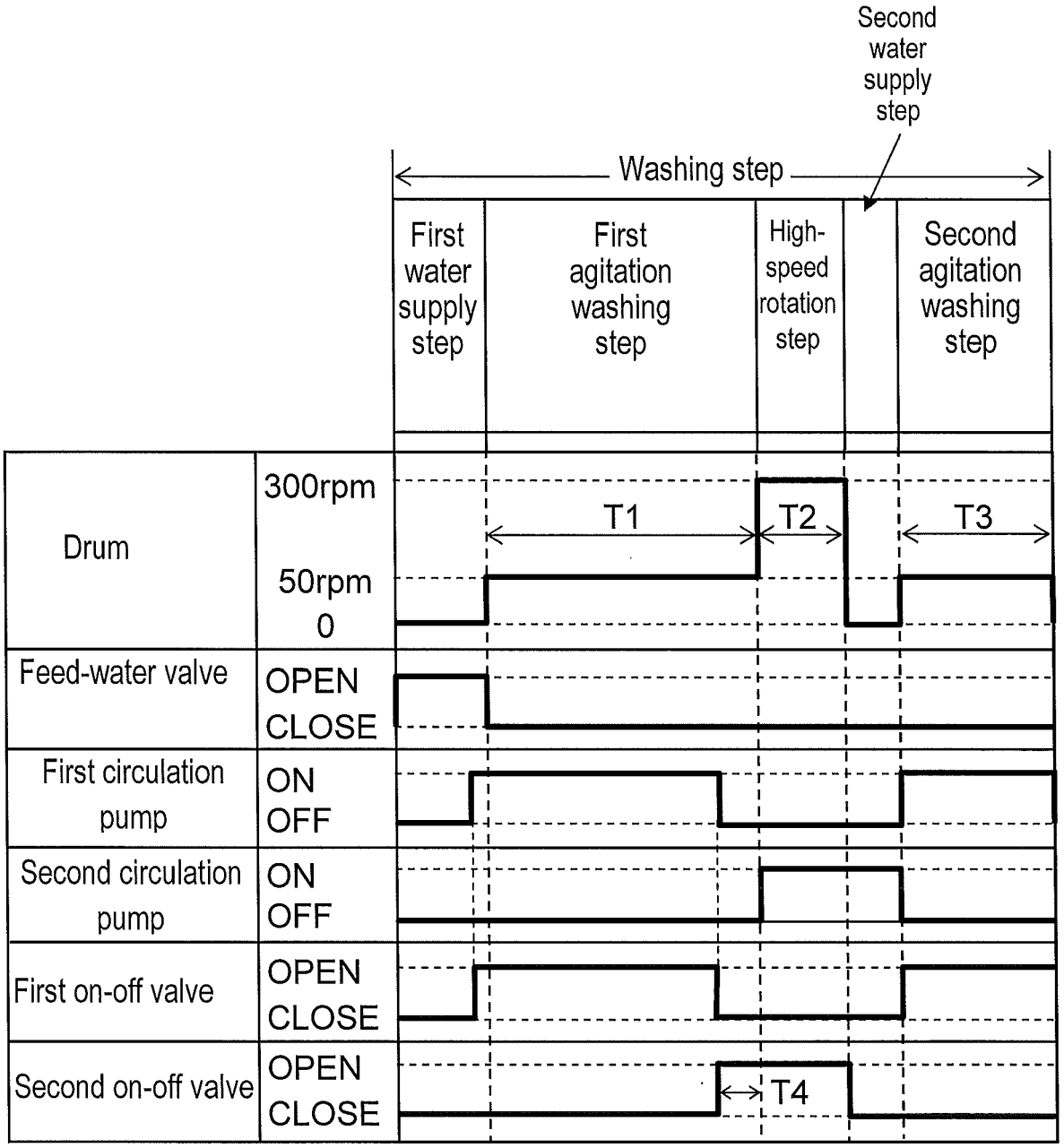

Second water supply step
Washing step
First water supply step
First agitation washing step
High-speed rotation step
Second agitation washing step
Drum
300rpm
50rpm
0
T1
T2
T3
Feed-water valve
OPEN
CLOSE
First circulation pump
ON
OFF
Second circulation pump
ON
OFF
First on-off valve
OPEN
CLOSE
Second on-off valve
OPEN
CLOSE
T4

FIG. 5

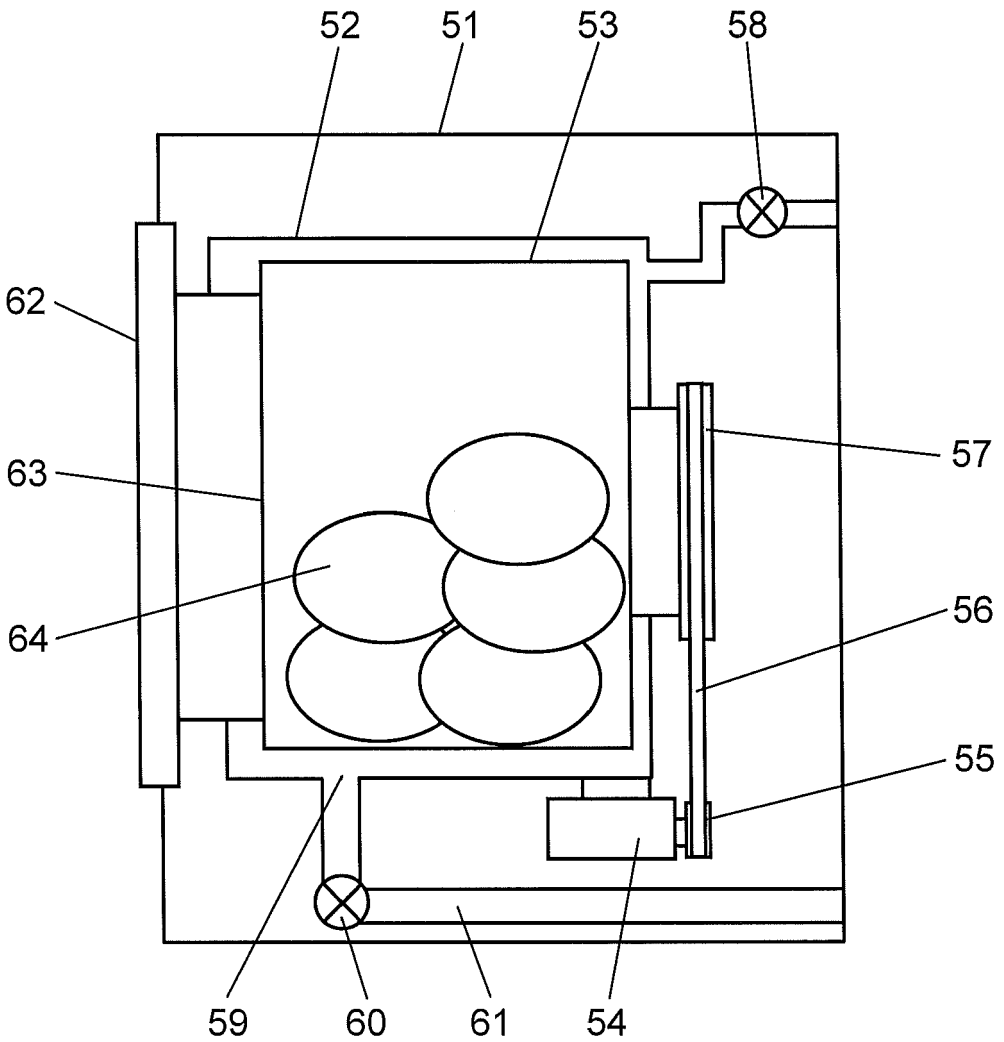
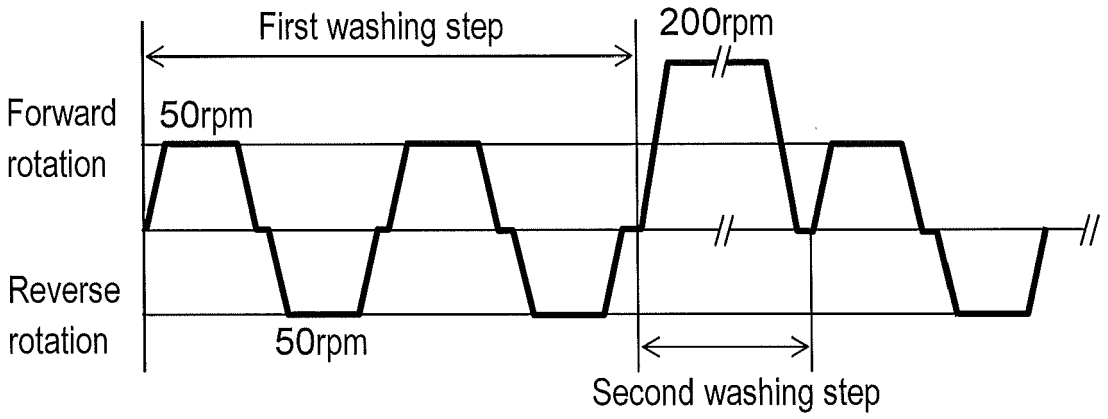


FIG. 6


First washing step
200rpm
Forward rotation
50rpm
Reverse rotation
50rpm
Second washing step

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EUROPEAN SEARCH REPORT

Application Number
EP 11 17 1960

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

D06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	12 January 2012	Stroppa, Giovanni

CATEGORY OF CITED DOCUMENTS

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1

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- JP H866578 B **[0010]**