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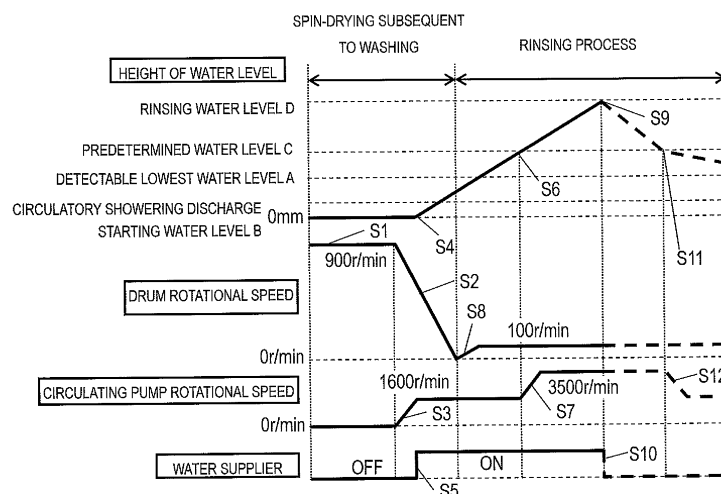
WASHING MACHINE AND RINSING METHOD USING SAME

(57)

A washing machine includes a rotary drum, a water tub, a water supplier for supplying water into the water tub, a water level detector for detecting water level of washing water in the water tub, and a circulating pump capable of rotating at a variable rotational speed. The washing machine further includes a water circulation system for circulating the washing water in the water tub into the rotary drum with the circulating pump, and a controller for controlling the rotational speed of the circulating

pump. In a rinsing process, the controller also drives to rotate the circulating pump at a first rotational speed (S3) before the water level detector detects the water level (S4), and drives to rotate the circulating pump at a second rotational speed faster than the first rotational speed (S7) after the water supplier starts water supply (S5) and after the water level detector detects that the water level of the washing water is not lower than predetermined water level (S6).

FIG. 3



Description

Citation List

TECHNICAL FIELD

Patent Literature

[0001] The present invention relates to a washing machine, and particularly relates to a washing machine for executing circulatory showering and a rinsing method using the same.

5 **[0009]** PTL 1: Unexamined Japanese Patent Publication No. 2010-46124

BACKGROUND ART

SUMMARY OF THE INVENTION

[0002] A conventional front-loading-type washing machine is provided therein with a circulating pump and a circulating channel allowing water in a water tub discharged through a water discharge port to return into the water tub. The washing machine executes circulatory showering onto a washing target (see PTL 1, for example).

10 **[0010]** The present invention has been achieved in order to solve the problems mentioned above, and provides a washing machine that shortens rest time for a circulating pump and improves drive efficiency so as to reduce operation time while keeping rinsing performance.

[0003] Such a washing machine executes shower rinsing by circulatory showering in the rinsing process. In this shower rinsing, the circulating pump starts to be driven when water level detected by a water level sensor rises to predetermined water level during the supply of water into the water tub.

15 **[0011]** A washing machine according to the present invention includes: a rotary drum having a bottomed cylindrical shape; a water tub accommodating the rotary drum; a water supplier for supplying water into the water tub; and a water level detector for detecting water level of washing water in the water tub. The washing machine further includes: a circulating pump capable of rotating at a variable rotational speed; a water circulation system for circulating the washing water in the water tub into the rotary drum through a circulating channel connected to the water tub with the circulating pump located in the circulating channel; and a controller for controlling the rotational speed of the circulating pump. Moreover, in a rinsing process, the controller drives to rotate the circulating pump at a first rotational speed before the water level detector detects the water level, and drives to rotate the circulating pump at a second rotational speed faster than the first rotational speed after the water supplier starts water supply and after the water level detector detects that the water level of the washing water is not lower than predetermined water level.

[0004] Driving of the circulating pump is stopped when the water level detected by the water level sensor falls to detectable lowest water level set as the lowest water level that can be detected with the water level sensor.

[0005] In the front-loading-type washing machine thus configured, the circulating pump is driven after water is supplied to reach the predetermined water level in the water tub. This extends rest time for the circulating pump. In other words, it takes more time for the circulating pump to achieve the shower rinsing effect. Operation time is thus extended in order to achieve the desired shower rinsing effect.

20 **[0012]** The present invention also provides a rinsing method using a washing machine including: a rotary drum having a bottomed cylindrical shape; a water tub accommodating the rotary drum; a water supplier for supplying water into the water tub; a water level detector for detecting water level of washing water in the water tub; a circulating pump capable of rotating at a variable rotational speed; a water circulation system for circulating the washing water in the water tub into the rotary drum through a circulating channel connected to the water tub with the circulating pump located in the circulating channel; and a controller for controlling the rotational speed of the circulating pump.

[0006] This problem is more remarkable if the flow rate of the supplied water is low at the location or if the circulating pump is located around the lowermost position in the circulating channel and is capable of circulating a small amount of water.

[0007] For example, if the flow rate of the supplied water is low, it takes a long period of time for the water in the water tub to reach the predetermined water level after supply of water starts. This extends the rest time for the circulating pump.

25 **[0013]** The method includes: a first step of driving, with the controller, to rotate the circulating pump at a first rotational speed; and a second step of starting, with the water supplier, water supply after the first step. The method further includes: a third step of detecting, with the water level detector, that the water level of the washing water is not lower than predetermined water level after the second step; and a fourth step of driving, with the controller, to rotate the circulating pump at a second rotational speed faster than the first rotational speed after the third

[0008] The circulating pump is driven after the water is supplied to the predetermined water level in order to prevent air entrainment of the circulating pump. However, the water level at which the circulating pump can be driven without causing air entrainment is typically much lower than the detectable lowest water level for the water level detector. There is wait time for the circulating pump waiting to be driven, despite the fact that the circulating pump can start to be driven actually with no problem.

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step.

[0014] In this configuration and the method, the circulating pump is driven before the water level detector detects the water level. This improves drive efficiency of the circulating pump. Furthermore, the circulating pump is controlled to rotate at the first rotational speed and at the second rotational speed higher than the first rotational speed. Circulating water can be thus supplied and scattered onto both of a washing target around the front side of an opening of the rotary drum and a washing target around the rear side of the rotary drum.

[0015] It is accordingly possible to supply and scatter the circulating water evenly onto the washing targets in the rotary drum for a longer period of time. This shortens rinsing time while keeping rinsing performance.

[0016] As described above, the present invention shortens the rest time for the circulating pump and improves drive efficiency so as to reduce operation time while keeping rinsing performance.

BRIEF DESCRIPTION OF DRAWINGS

[0017]

FIG. 1 is a sectional view depicting a schematic structure of a washing machine according to an exemplary embodiment of the present invention.

FIG. 2 is a functional block diagram of the washing machine according to the exemplary embodiment of the present invention.

FIG. 3 is a timing chart indicating spin-drying subsequent to washing and rinsing of the washing machine according to the exemplary embodiment of the present invention.

DESCRIPTION OF EMBODIMENT

[0018] An exemplary embodiment of the present invention is to be described below with reference to the drawings. It is noted that the following exemplary embodiment is merely an example and is not to limit the technical scope of the present invention.

[0019] FIG. 1 is a sectional view depicting a schematic structure of washing machine 100 according to the exemplary embodiment of the present invention.

[0020] Washing machine 100 includes washing machine body 2. Washing machine body 2 accommodates water tub 3 that is swingable. Water tub 3 is provided therein with rotary drum 4 that is rotatable about rotary shaft 4a. Rotary shaft 4a of rotary drum 4 is directly coupled to motor 6 that is located on the rear surface of water tub 3 and is attached to the outer periphery of rotary shaft 4a. Motor 6 drives to rotate rotary drum 4.

[0021] Rotary drum 4 is provided, entirely in wall surface 4c, with a plurality of through holes 4e, so as to allow water and air to communicate between water tub 3 and rotary drum 4. Rotary drum 4 is provided, on the inner side of the wall surface, with a plurality of agitating pro-

jections 4b, so that rotation of rotary drum 4 allows a washing target in rotary drum 4 to be lifted upward.

[0022] In the above example, through holes 4e are provided entirely in wall surface 4c of rotary drum 4. It is noted that the present invention is not limited to this example. Alternatively, through holes 4e can be provided partially in wall surface 4c of rotary drum 4. Through holes 4e have only to be provided so as to secure air communication and water communication between water tub 3 and rotary drum 4 and cause no trouble in the respective processes from washing to drying.

[0023] Rotary shaft 4a of rotary drum 4 is inclined downward from the front open end toward the rear bottom end. More specifically, rotary shaft 4a is inclined downward from the horizontal direction, so as to have inclination angle θ of 20 ± 10 degrees or the like.

[0024] Rotary shaft 4a thus inclined allows front end opening 13 of water tub 3 to be located at an upper position. A user is thus capable of unloading a washing target in rotary drum 4 through opening 13 of water tub 3 without stooping too low. Furthermore, in comparison to a case where rotary shaft 4a is located horizontally, washing water supplied into water tub 3 is stored nearer the rear end and even a small amount of water is stored so as to have larger depth.

[0025] Water tub 3 is located so as to have the same inclination angle as rotary drum 4 and to be close to and along rotary drum 4. In this configuration, a washing target in rotary drum 4 can be supplied with water efficiently.

[0026] Rotary drum 4 can be located horizontally or have inclination angle θ of less than 10 degrees, if the amount of supplied water is not taken into consideration.

[0027] Water tub 3 is provided thereabove with water supply system 7 that includes water supply valve 7a serving as a water supplier and detergent accommodating section 7b. When water supply valve 7a is opened, tap water is supplied from outside washing machine 100. The tap water thus supplied is fed through a water supply channel into water tub 3 along with detergent in detergent accommodating section 7b.

[0028] Water tub 3 is provided therebelow with drain system 8 that includes drain pipe 8a and drain valve 19. Drain pipe 8a has an end connected to the lower end, more particularly, the lowest bottom, of water tub 3. When drain valve 19 is opened, the washing water in water tub 3 is drained through drain pipe 8a as necessary at the completion of the washing process, the rinsing process, or the like.

[0029] Washing water herein includes washing water containing a detergent component in the washing process and rinsing water used for removing a detergent component from a washing target in the rinsing process.

[0030] Drain pipe 8a is provided downstream thereof with drain filter 8b that is detachable from outside washing machine body 2. Drain filter 8b collects yarn waste included in drain water.

[0031] Drain system 8 drains the washing water that has passed through drain pipe 8a and drain filter 8b when

drain valve 19 is opened, as necessary at the completion of the washing process, the rinsing process, or the like (a dotted arrow).

[0032] Drying system 9 circulates, with use of blower 12, air in water tub 3 and rotary drum 4 as indicated by dashed arrows in FIG. 1. Drying system 9 includes a filter (not shown) for collecting yarn waste and removing dust, a dehumidifier (not shown) for dehumidifying guided air after removal of dust, and a heater (not shown) for heating the air after dehumidification to obtain dry and hot air.

[0033] Water circulation system 16 circulates the washing water in water tub 3 as necessary in the washing process, the rinsing process, or the like, so as to cause detergent to be quickly dissolved or improve washing or rinsing performance.

[0034] Water circulation system 16 drives circulating pump 20 so as to repetitively circulate the washing water in water tub 3 in the following manner. The washing water in water tub 3 circulates by passing through drain pipe 8a and drain filter 8b, then passing through inlet channel 31a toward circulating pump 20 in circulating channel 31, circulating pump 20, and discharge channel 31b from circulating pump 20, and returning from jet port 51 into water tub 3.

[0035] As shown in FIG. 1, circulating pump 20 is fixed onto base plate 2a that is located at the bottom of washing machine body 2 and sucks washing water and transfers to circulating channel 31.

[0036] The washing water transferred from circulating pump 20 passes through circulating channel 31 and is discharged from jet port 51 of rotary drum 4 into rotary drum 4 as circulating water. The washing water in water tub 3 is utilized in this manner to execute circulatory showering of supplying and scattering washing water circulated as the circulating water onto a washing target.

[0037] More specifically, discharge channel 31b of circulating channel 31 is connected from outside to jet port 51 that is located in the front end wall near opening 13 of water tub 3. The circulating water is transferred into a space between the inner surface of the front end wall of water tub 3 and the opposite outer surface of the front end wall of rotary drum 4, passes through a channel provided therebetween, and is jetted into rotary drum 4.

[0038] Jet port 51 is located so as not to be in contact with a washing target in rotary drum 4. Jet port 51 does not catch the washing target and thus does not disturb behavior necessary for washing, rinsing, spin-drying, drying, or the like. This configuration also prevents the washing target from being damaged or torn. Furthermore, jet port 51 does not affect good outer appearance.

[0039] In a case where washing water or rinsing water is simply jetted into rotary drum 4 as circulating water, the circulating water having circulated is jetted only partially to a washing target in rotary drum 4 and the circulation effect is not fully achieved.

[0040] Meanwhile, if a special jet nozzle is adopted in order to jet circulating water into the wide area, the cost will be increased due to such a special jet nozzle, in-

crease in necessary pump pressure, and the like.

[0041] In view of the above, according to the present exemplary embodiment, a DC brushless motor or the like, of which rotational speed can be controlled, is used for causing circulating pump 20 to circulate the circulating water in water tub 3, so as to regulate a flow rate and a flow speed of discharged circulating water. This configuration enables variation in angle in the vertical direction, as well as variation in expansion degree in the horizontal direction, of the discharged circulating water, without adopting the special jet nozzle. It is noted that the motor for circulating pump 20 is not limited to the DC brushless motor. It is possible to adopt any motor as long as its rotational speed can be controlled.

[0042] Circulating pump 20 is thus capable of supplying circulating water evenly onto a washing target in rotary drum 4 and to an optimum position. This improves washing performance and rinsing performance. It is also possible to prevent useless supply of circulating water to a space where no washing target is located. This reduces unnecessary power consumption and excessive foaming of circulating water containing detergent.

[0043] The rotational speed of circulating pump 20 is set so that water is discharged into the wide area from around the front side of opening 13 to around the rear side in rotary drum 4 during ordinary washing operation, as indicated by arrows a in FIG. 1. The rotational speed of the motor of circulating pump 20 is 3500 r/min or the like in this case. Washing performance and rinsing performance are improved by supplying and scattering circulating water of about 20 L per minute onto a washing target in rotary drum 4.

[0044] When the motor for circulating pump 20 is set to have a relatively low rotational speed, e.g. 1600 r/min, as indicated by arrow b in FIG. 1, the circulating water is discharged around the front side of opening 13 of rotary drum 4. When circulating pump 20 has such a low rotational speed, the discharged circulating water has a vertical angle close to the horizontal direction and a smaller expansion degree in the horizontal direction.

[0045] By setting in this manner, it is possible to prevent the discharged circulating water from failing to hit even a small amount of washing target located at the lower portion in rotary drum 4, and the circulating water can be thus supplied efficiently.

[0046] As described above, by controlling the rotational speed of circulating pump 20, the circulating water can be supplied and scattered onto a washing target lifted upward to the upper portion in rotary drum 4 or a washing target located at the front portion or the rear portion in rotary drum 4.

[0047] It is noted that jet port 51 is not necessarily located at the lower end of water tub 3 as described above. Jet port 51 can be located at any position as long as not being in contact with a washing target in rotary drum 4. For example, even when jet port 51 is located at the upper end of water tub 3, the circulating water can be supplied and scattered onto a washing target that is lifted upward

to the upper portion in rotary drum 4.

[0048] Circulating pump 20 according to the present exemplary embodiment is provided on base plate 2a at the bottom of washing machine body 2. However, the present invention is not limited to this configuration. Circulating pump 20 can be alternatively located at the lower end of water tub 3 so as to circulate the washing water in water tub 3.

[0049] Washing machine 100 according to the present exemplary embodiment is further provided with water level detector 10 for detecting the amount of water supplied into rotary drum 4. Water level detector 10 includes an air trapper and a pressure detector connected to each other by means of a hose. The air trapper is located at a predetermined position near the lowermost portion of water tub 3.

[0050] The pressure detector includes ferrite provided integrally with a bellows portion shifted by pressure, and a fixed coil surrounding the outer periphery of the ferrite. The pressure detector converts a shifted stroke distance to pressure variation in the air trapper with use of its inductance variation. The air trapper having no washing water is brought into an atmosphere releasing state, in which case water level detector 10 has constant output.

[0051] In this manner, water level detector 10 is capable of sensing by measuring air internal pressure with use of an air trap mechanism. Measurement of time in which air internal pressure varies from stable atmosphere releasing pressure achieves an appropriate calculation method that is not affected by variation of a water level sensor.

[0052] Output of water level detector 10 is varied depending on rotation of rotary drum 4 during washing, more particularly, depending on whether or not rotary drum 4 rotates, the rotational speed of rotary drum 4, and the like. There are thus a plurality of tables indicating the relationship between a frequency and water level in accordance with the rotational speed of rotary drum 4. In other words, water level detector 10 is capable of detecting water level in each of cases where rotary drum 4 is stopped and rotating.

[0053] Described in detail next is the function of controller 22.

[0054] FIG. 2 is a functional block diagram of washing machine 100 according to the exemplary embodiment of the present invention.

[0055] Controller 22 includes a microcomputer. Controller 22 automatically controls motor 6 (denoted by "M" in FIG. 2; the same applies hereinafter), water supply valve 7a (FV), drain valve 19 (DV), circulating pump 20 (P), and the like, with use of power switching section 40 on the basis of a set mode and a control program. Controller 22 has a function of controlling at least the washing process, the rinsing process, and the spin-drying process. Controller 22 also controls the rotational speed of circulating pump 20.

[0056] Washing machine 100 further includes power supply 50 for supplying each constituent element with

power.

[0057] Cloth amount detection of detecting the amount of a washing target loaded into rotary drum 4 is executed with use of a rotational speed detector (not shown) for detecting the rotational speed of rotary drum 4. The cloth amount detection is exemplified below.

[0058] Controller 22 initially drives to rotate motor 6. At this stage, the rotational speed of rotary drum 4 is increased to a speed that allows a washing target to be stuck to the inner peripheral wall of rotary drum 4, e.g. about 100 r/min to 140 r/min.

[0059] After this rotational speed is kept for a predetermined period of time, controller 22 stops supply of power to motor 6. Motor 6 is thus rotated by inertia rotation of rotary drum 4. In this case, inertia torque of rotary drum 4 is gradually decreased by frictional torque, and rotary drum 4 stops in the course of time.

[0060] The period of time from the stop of power supply to the stop of rotary drum 4 is long when the amount of the washing target is large and is short when the amount of the washing target is small. The amount of the washing target can be detected on the basis of the fact that difference in time necessary for the stop is substantially in proportion to the amount of the washing target.

[0061] Washing machine 100 according to the present exemplary embodiment further includes a system for managing, with use of a timer, any input/output control including supply and drain of water, a command for driving rotary drum 4, as well as output from various sensors such as water level detector 10. The timer is thus capable of measuring necessary time for each behavior and at each timing.

[0062] A mode such as an operation course and each function are selected in accordance with input by a user to input setting section 21a of operation panel 21 that is provided at an upper front portion of washing machine body 2. Controller 22 causes display 21b on operation panel 21 to display predeterminedly on the basis of information on the input, so as to inform the user.

[0063] When the user inputs operation start to input setting section 21a on operation panel 21, controller 22 receives data from water level detector 10 for detecting water level in water tub 3 or the like to start driving. Controller 22 then controls behavior of drain valve 19, water supply valve 7a, and the like with use of power switching section 40, so as to execute operation in each of the processes of washing, rinsing, spin-drying, drying, and the like.

[0064] Described below is the behavior of front-loading-type washing machine 100 thus configured.

[0065] When a washing target is initially loaded into rotary drum 4 and a door is closed, controller 22 detects the amount of the washing target.

[0066] Controller 22 then opens water supply valve 7a so that water tub 3 is supplied with tap water corresponding to the amount of the washing target. In this case, the water is supplied by way of detergent accommodating section 7b. Water tub 3 is thus supplied with detergent

along with the tap water.

[0067] The washing process starts when water level detector 10 detects that washing water containing detergent and tap water has reached water level corresponding to the amount of the washing target. Controller 22 drives motor 6 so as to rotate rotary drum 4. Rotary drum 4 has a rotational speed of about 40 r/min to 60 r/min, though depending on the size of rotary drum 4, the cloth amount of the washing target, the cloth properties thereof, and the like.

[0068] Rotary drum 4 repeats positive rotation and negative rotation. Rotation of rotary drum 4 causes agitating projections 4b to lift a washing target upward for beating and washing. When controller 22 drives circulating pump 20, washing water is replaced actively and washing performance is improved.

[0069] After washing is executed for a predetermined period of time, draining and spin-drying are executed. Controller 22 causes drain valve 19 to open so that the washing water in water tub 3 is drained to the outside of the machine (draining).

Description is given with reference to a drawing.

[0070] FIG. 3 is a timing chart indicating spin-drying subsequent to washing and rinsing of washing machine 100 according to the exemplary embodiment of the present invention.

[0071] Controller 22 increases the rotational speed of rotary drum 4 to reach a speed that causes washing water to be removed from the washing target (see "spin-drying subsequent to washing" in FIG. 3). The washing water containing dirt is thus drained from the washing target (spin-drying, S1).

[0072] After the spin-drying is executed for a predetermined period of time, controller 22 stops motor 6 to stop rotation of rotary drum 4 (S2). As indicated in FIG. 3, when driving of motor 6 stops, in other words, when the rotational speed of rotary drum 4 starts to be decreased, controller 22 starts to drive circulating pump 20 (S3). In this manner, a water supply waiting state does not last uselessly, so that rinsing time can be shortened.

[0073] Air entrainment can be possibly caused if circulating pump 20 is driven to rotate at a relatively high rotational speed, e.g. 3500 r/min, before water level detector 10 detects that the washing water has reached detectable lowest water level A. In view of this, in step S3 according to the present exemplary embodiment, circulating pump 20 is driven to rotate at a relatively low rotational speed, e.g. 1600 r/min (first rotational speed). It is noted that the first rotational speed is not limited to 1600 r/min described above, because the first rotational speed is dependent on the structure of water circulation system 16.

[0074] It is thus possible to execute circulatory showering efficiently and quickly without causing air entrainment. The motor for circulating pump 20 requires several seconds from the start of driving to actual achievement

of a predetermined rotational speed. In the present exemplary embodiment, circulating pump 20 starts to be driven when driving of motor 6 stops before water starts to be supplied through water supply valve 7a of water supply system 7.

[0075] Assume a comparative example in which water starts to be supplied through water supply valve 7a of water supply system 7 after the completion of spin-drying subsequent to washing, and circulating pump 20 starts to be driven after water level detector 10 detects that the water has reached detectable lowest water level A.

[0076] In this case, it is necessary to wait for a long period of time before driving circulating pump 20. This is remarkable if the flow rate of supplied water is low at the location. More specifically, circulatory showering discharge starting water level B for circulating pump 20 is much lower than detectable lowest water level A if circulating pump 20 rotates at a relatively low rotational speed, e.g. 1600 r/min. On top of this, despite the fact that air entrainment is not caused even if both of water tub 3 and drain system 8 hold no washing water, the water supply waiting state lasts uselessly.

[0077] In view of these, circulating pump 20 according to the present exemplary embodiment is driven at a relatively low rotational speed (S3) before water level detector 10 detects water level (S4). This configuration allows the circulating water to be automatically discharged into rotary drum 4 as indicated by arrow b in FIG. 1 when the water reaches circulatory showering discharge starting water level B for circulating pump 20. Circulatory showering discharge starting water level B is lower than detectable lowest water level A for water level detector 10 (see FIG. 1). At the circulatory showering discharge starting water level, circulating water is jetted into rotary drum 4 if circulating pump 20 rotates at the first rotational speed.

[0078] In this configuration, circulatory showering is automatically executed when the circulating water reaches dischargeable water level without waiting for detection of water level detector 10. This further improves rinsing performance. In other words, the same rinsing performance is achieved in a shorter period of time.

[0079] When circulating pump 20 starts to be driven, controller 22 opens water supply valve 7a to start supply of water (S5). When water level detector 10 detects that the water has reached predetermined water level C not lower than detectable lowest water level A (S6), controller 22 drives to rotate circulating pump 20 at a relatively high rotational speed, e.g. 3500 r/min (second rotational speed) (S7). It is thus possible to jet the circulating water into the wide area from around the front side of opening 13 to around the rear side in rotary drum 4, as indicated by arrows a in FIG. 1.

[0080] Accordingly, even after the water has reached predetermined water level C from prior to the start of water supply, circulating pump 20 is constantly driven to discharge the circulating water as indicated by arrows b and a in FIG. 1. It is thus possible to exert the rinsing

effect by constant and even circulatory showering into rotary drum 4.

[0081] As described above, in the rinsing process, controller 22 of washing machine 100 drives to rotate circulating pump 20 at the first rotational speed before the water supplier starts supply of water.

[0082] Circulating pump 20 is driven before the start of water supply in the rinsing process, so that circulating pump 20 achieves higher drive efficiency. By rotating circulating pump 20 at the first rotational speed and at the second rotational speed faster than the first rotational speed, the circulating water can be supplied to both of a washing target around the front side of the opening of rotary drum 4 and a washing target around the rear side of rotary drum 4.

[0083] It is thus possible to supply and scatter the circulating water evenly to the washing targets in rotary drum 4 for a longer period of time. This shortens rinsing time while keeping rinsing performance.

[0084] When circulating pump 20 is driven to rotate at a higher rotational speed, the circulating water can be discharged into a wider area in rotary drum 4 and the amount of the circulating water is larger per unit time. This enhances the rinsing effect of circulatory showering. It is thus desired to drive to rotate circulating pump 20 at a high rotational speed for as long as possible.

[0085] When circulating pump 20 is controlled to rotate at the first rotational speed and at the second rotational speed higher than the first rotational speed in this manner, the circulating water can be supplied and scattered onto both of a washing target around the front side of opening 13 of rotary drum 4 and a washing target around the rear side of rotary drum 4. It is thus possible to supply and scatter the circulating water evenly to the washing targets in rotary drum 4 for a longer period of time. This shortens rinsing time while keeping rinsing performance.

[0086] When rotary drum 4 stops rotating, in order to start the rinsing process, controller 22 restarts rotating rotary drum 4 to execute rinsing (S8). At this stage, rotary drum 4 rotates in one direction at a rotational speed that allows a washing target to be stuck to the inner peripheral wall of rotary drum 4. The rinsing effect of circulatory showering can be achieved more efficiently because the washing target is stuck to the inner peripheral wall of rotary drum 4.

[0087] In this case, rotary drum 4 is desired to rotate at a rotational speed lower than a resonant rotational speed. It is thus possible to avoid vibration and noise due to resonance. The desirable rotational speed in this case is about 100 r/min, for example.

[0088] When water level detector 10 detects that the water has reached rinsing water level D (S9), controller 22 closes water supply valve 7a to stop supply of water (S10).

[0089] Thereafter, if the washing target absorbs rinsing water and water level detector 10 detects that the water level in water tub 3 is not higher than predetermined water level C (S11), controller 22 controls circulating pump 20

to rotate at a relatively low rotational speed, e.g. 1600 r/min (S12).

[0090] It is thus possible to certainly prevent air entrainment. This prevents generation of uncomfortable noise due to air entrainment and allows the circulating water to be discharged into rotary drum 4 as indicated by arrow b in FIG. 1.

[0091] As described above, when circulating pump 20 rotates at the second rotational speed and water level detector 10 detects the water level not higher than the predetermined water level, controller 22 of washing machine 100 controls to rotate circulating pump 20 at the first rotational speed.

[0092] It is thus possible to avoid air entrainment of circulating pump 20 due to absorption of the circulating water by the washing target or the like and decrease in water level in water tub 3.

[0093] Alternatively, circulating pump 20 can be stopped or driven intermittently when the water level in water tub 3 is not higher than predetermined water level C (S11).

[0094] In this case, drive efficiency of circulating pump 20 deteriorates and other defects may occur. More specifically, when the motor of circulating pump 20 is driven intermittently, noise is varied by repetitively starting and stopping the motor. The user may feel uncomfortable due to such buzzing noise.

[0095] Furthermore, if the circulating water is discharged and stopped repetitively, the machine may be erroneously recognized as being in trouble. Circulating pump 20 according to the present exemplary embodiment is controlled to rotate at a low rotational speed and buzzing noise is not generated. The user does not auditorily recognize erroneously that the machine is in trouble.

[0096] Furthermore, circulating pump 20 is neither stopped nor driven intermittently. This prevents useless deterioration in drive efficiency of circulating pump 20 and generation of buzzing noise due to intermittent drive. Moreover, the circulating water is scattered also onto a washing target around the front side of opening 13 of rotary drum 4. This sufficiently achieves the rinsing effect of circulatory showering.

[0097] After the washing target is rinsed for a predetermined period of time, controller 22 opens drain valve 19 to start draining. If rinsing is set to be executed for a plurality of times, the operation same as the rinsing described above is repeated for the set number of times. If rinsing is set to be executed once, the rinsing process ends and the spin-drying process is to be executed subsequently.

[0098] In the spin-drying process, similarly to the spin-drying executed subsequently to the washing process, controller 22 controls motor 6 to increase the rotational speed of rotary drum 4 so as to reach 900 r/min, and the rinsing water is removed from the washing target. After the spin-drying is executed for a predetermined period of time, controller 22 stops motor 6 so as to stop rotation

of rotary drum 4. The washing operation is thus completed.

[0099] As described above, washing machine 100 according to the present exemplary embodiment includes rotary drum 4 having the bottomed cylindrical shape, water tub 3 accommodating rotary drum 4, water supply valve 7a serving as a water supplier for supplying water into water tub 3, and water level detector 10 for detecting water level of washing water in water tub 3.

[0100] Washing machine 100 further includes circulating pump 20 capable of rotating at a variable rotational speed, water circulation system 16 for circulating the washing water in water tub 3 into rotary drum 4 through circulating channel 31 connected to water tub 3 with use of circulating pump 20 located in circulating channel 31, and controller 22 for controlling the rotational speed of circulating pump 20. In the rinsing process, controller 22 also drives to rotate circulating pump 20 at a first rotational speed before water level detector 10 detects the water level, and drives to rotate circulating pump 20 at a second rotational speed faster than the first rotational speed after the water supplier starts water supply and after water level detector 10 detects that the water level of the washing water is not lower than predetermined water level.

[0101] In this configuration, circulating pump 20 is driven before water level detector 10 detects the water level, so that circulating pump 20 can be improved in drive efficiency. By rotating circulating pump 20 at the first rotational speed and at the second rotational speed faster than the first rotational speed, circulating water can be supplied to both of a washing target around the front side of the opening of rotary drum 4 and a washing target around the rear side of rotary drum 4.

[0102] It is thus possible to supply and scatter the circulating water evenly to the washing targets in rotary drum 4 for a longer period of time. This shortens rinsing time while keeping rinsing performance.

[0103] In the present exemplary embodiment, water circulation system 16 is configured as shown in FIG. 1 to circulate water in water tub 3. It is noted that the present invention is not limited to this example. It is possible to exert the equivalent effect also in an exemplary configuration in which jet port 51 of water circulation system 16 is provided as a nozzle located on the outer periphery of opening 13 of water tub 3.

INDUSTRIAL APPLICABILITY

[0104] As described above, the present invention achieves the significant effect that rest time for the circulating pump is shortened and drive efficiency is improved so as to reduce operation time while keeping rinsing performance. The present invention is thus useful in a washing machine, particularly a washing machine for efficiently rinsing with a small amount of rinsing water by means of circulatory showering, in a rinsing method using the washing machine, and the like.

REFERENCE MARKS IN THE DRAWINGS

[0105]

5	2	washing machine body
	2a	base plate
	3	water tub
	4	rotary drum
	4a	rotary shaft
10	4b	agitating projection
	4c	wall surface
	4e	through hole
	6	motor
	7	water supply system
15	7a	water supply valve
	7b	detergent accommodating section
	8	drain system
	8a	drain pipe
	8b	drain filter
20	9	drying system
	10	water level detector
	13	opening
	16	water circulation system
	19	drain valve
25	20	circulating pump
	21	operation panel
	21a	input setting section
	21b	display
	22	controller
30	31	circulating channel
	37a	inlet channel
	31b	discharge channel
	40	power switching section
	50	power supply
35	51	jet port
	100	washing machine

Claims

1. A washing machine comprising:

- a rotary drum having a bottomed cylindrical shape;
- a water tub accommodating the rotary drum;
- a water supplier for supplying water into the water tub;
- a water level detector for detecting water level of washing water in the water tub;
- a circulating pump capable of rotating at a variable rotational speed;
- a water circulation system for circulating the washing water in the water tub into the rotary drum through a circulating channel connected to the water tub with the circulating pump located in the circulating channel; and
- a controller for controlling the rotational speed of the circulating pump; wherein

- in a rinsing process, the controller drives to rotate the circulating pump at a first rotational speed before the water level detector detects the water level, and drives to rotate the circulating pump at a second rotational speed faster than the first rotational speed after the water supplier starts water supply and after the water level detector detects that the water level of the washing water is not lower than predetermined water level. 5 10
2. The washing machine according to claim 1, wherein the controller drives to rotate the circulating pump at the first rotational speed before the water supplier starts water supply in the rinsing process. 15
3. The washing machine according to claim 1, wherein the controller drives to rotate the circulating pump at the first rotational speed if the water level detector detects that the water level of the washing water is not higher than the predetermined water level while the circulating pump is driven to rotate at the second rotational speed. 20
4. The washing machine according to claim 2, wherein the controller drives to rotate the circulating pump at the first rotational speed if the water level detector detects that the water level of the washing water is not higher than the predetermined water level while the circulating pump is driven to rotate at the second rotational speed. 25 30
5. A rinsing method using a washing machine including: a rotary drum having a bottomed cylindrical shape; a water tub accommodating the rotary drum; a water supplier for supplying water into the water tub; a water level detector for detecting water level of washing water in the water tub; a circulating pump capable of rotating at a variable rotational speed; a water circulation system for circulating the washing water in the water tub into the rotary drum through a circulating channel connected to the water tub with the circulating pump located in the circulating channel; and a controller for controlling the rotational speed of the circulating pump; the method comprising: 35 40 45
- a first step of driving, by the controller, to rotate the circulating pump at a first rotational speed; a second step of starting, by the water supplier, water supply after the first step; 50
- a third step of detecting, by the water level detector, that the water level of the washing water is not lower than predetermined water level after the second step; and
- a fourth step of driving, by the controller, to rotate the circulating pump at a second rotational speed faster than the first rotational speed after the third step. 55
6. The rinsing method using the washing machine according to claim 5, the method further comprising:
- a fifth step of detecting, by the water level detector, that the water level of the washing water is not higher than the predetermined water level after the fourth step; and
- a sixth step of driving, by the controller, to rotate the circulating pump at the first rotational speed.

FIG. 1

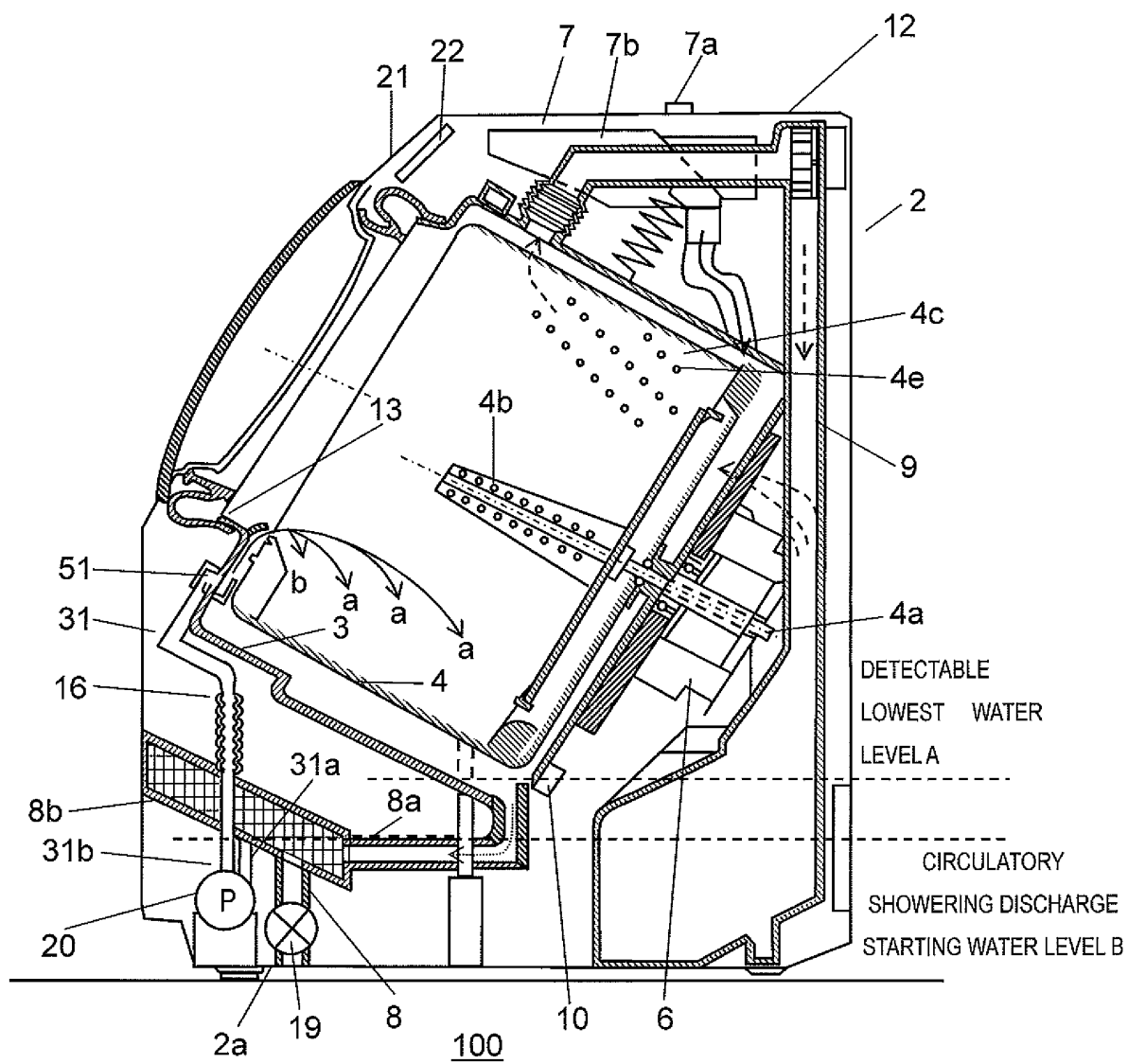


FIG. 2

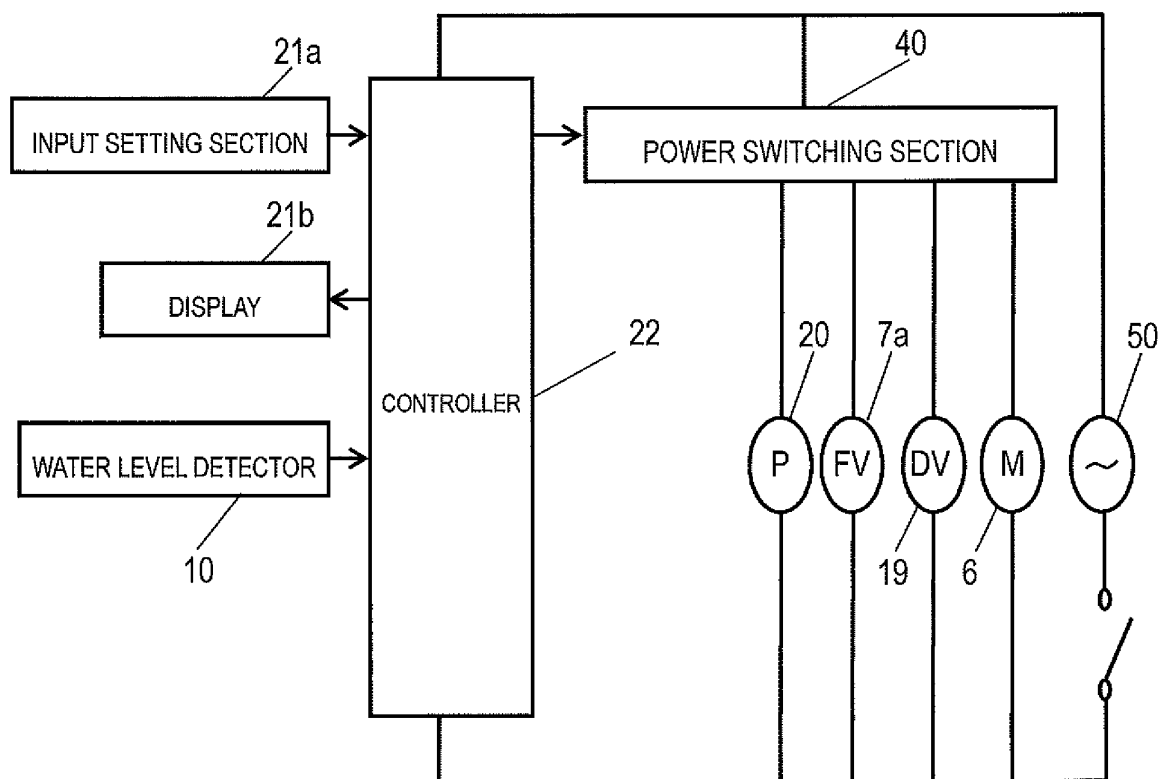
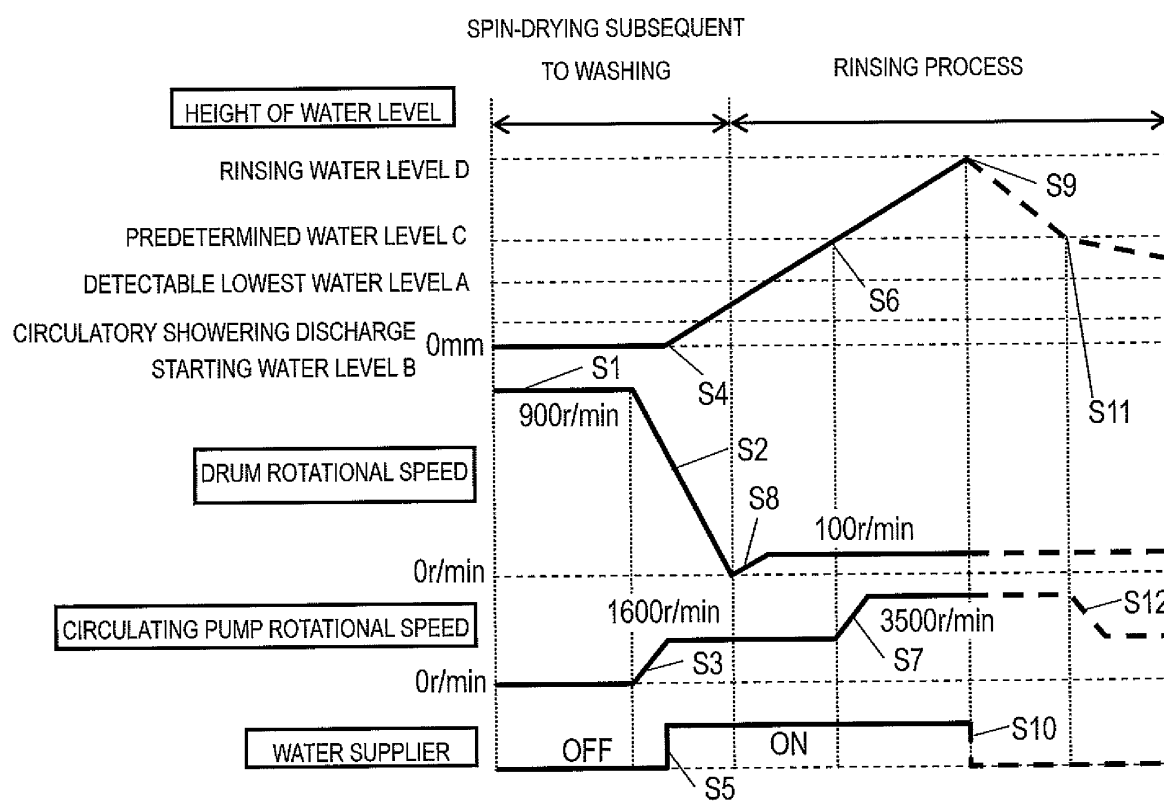


FIG. 3



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/005479

A. CLASSIFICATION OF SUBJECT MATTER

D06F25/00 (2006.01) i, D06F33/02 (2006.01) i, D06F39/08 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

D06F25/00, D06F33/02, D06F39/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2012

Kokai Jitsuyo Shinan Koho 1971-2012 Toroku Jitsuyo Shinan Koho 1994-2012

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2010-46124 A (Toshiba Corp., Toshiba Consumer Electronics Holdings Corp., Toshiba Home Appliances Corp.), 04 March 2010 (04.03.2010), paragraphs [0002] to [0003], [0031] to [0032]; fig. 1 to 4 (Family: none)	1-6
Y	JP 2011-67312 A (Panasonic Corp.), 07 April 2011 (07.04.2011), paragraphs [0033] to [0034] (Family: none)	1-6

☒ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search
24 September, 2012 (24.09.12)Date of mailing of the international search report
02 October, 2012 (02.10.12)Name and mailing address of the ISA/
Japanese Patent Office

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Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/005479

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2009-261451 A (Toshiba Corp., Toshiba Consumer Electronics Holdings Corp., Toshiba Home Appliances Corp.), 12 November 2009 (12.11.2009), paragraph [0005] & TW 200944635 A	3, 4, 6
A	JP 2006-204427 A (Toshiba Corp., Toshiba Consumer Electronics Holdings Corp., Toshiba Home Appliances Corp.), 10 August 2006 (10.08.2006), claims 1 to 3 (Family: none)	1-6

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2010046124 A [0009]