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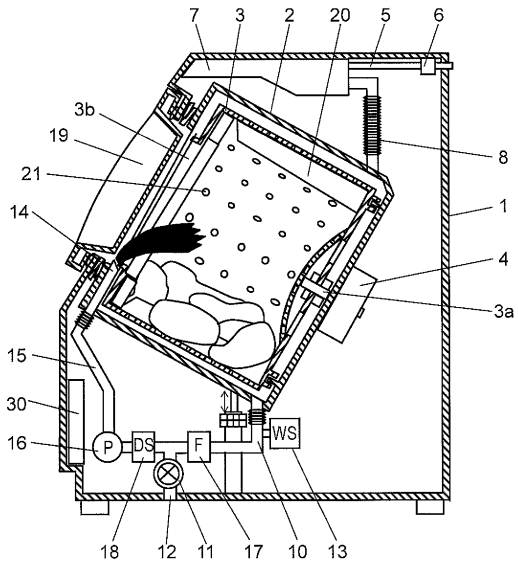
(54) DRUM-TYPE WASHING MACHINE

(57) A drum-type washing machine includes a drum drive unit (4) that rotationally drives a drum (3), and a controller (30) that receives an output from a dirt detector (18) serving as a state detector that detects a state of laundry in the drum for which dirt of the laundry in the drum is detected, and sequentially controls steps including washing, rinsing, and spin-drying steps. The washing step includes an agitating step for rotating the drum (3) at a low speed which does not stick the laundry to the inside of the drum (3), and a centrifugal cleaning step for rotating the drum (3) at a high speed which stick the laundry to an inner peripheral wall surface of the drum (3) to discharge washing water from the laundry by centrifugal force, and the controller (30) changes a rotational speed of the drum in the centrifugal cleaning step according to the output from the dirt detector (18).

FIG. 1



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Description

TECHNICAL FIELD

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

BACKGROUND ART

[0002] In a conventional drum-type washing machine of this type, after laundry is put into a drum, a water supply unit supplies tap water from the outside of the washing machine and injects the water into a water tab including the drum through a detergent box in which a predetermined amount of detergent is loaded in advance. After the water is poured, the laundry is sufficiently wetted with washing water while the drum is rotated at a low speed. Then, while the drum is rotated for a predetermined period of time at a low speed at which the laundry is not stuck to the wall surface of the drum, the wetted laundry is cleaned such that dirt is removed by impact generated when the laundry is dropped from the upper part of the drum with the rotation of the drum. In such a drum-type washing machine, in particular, when an amount of laundry is large, since the laundry such as clothes put in the drum is difficult to be uniformly wetted in the step of wetting laundry, nonuniform washing and considerable deterioration of washing efficiency occur as problems.

[0003] Thus, after the water supply, the drum is rotated at a relatively low rotational speed to perform beat washing, and the drum is rotated at a rotational speed equal to or higher than an angular speed at which washing water in the laundry can be discharged out of the drum with centrifugal force and at a rotational speed higher than a predetermined rotational speed to perform wringer washing, so that pieces of laundry may more mingle with each other and are agitated (for example, see PTL 1).

[0004] In another conventional washing machine, the quality of cloth of clothes is determined on the basis of a weight rank of the clothes detected by a weight detector before the washing step and a torque output rank detected by a torque detector when the clothes contain water. When the clothes are determined as clothes having low water absorption, an amount of water in the rinsing step is reduced (for example, see PTL 2).

[0005] In still another conventional washing machine, the quality of cloth of laundry such as clothes is determined to change a rotational speed of the drum in washing. More specifically, the rotational speed of the drum is set such that the laundry is subjected to beat washing when the laundry includes a large amount of cotton clothes, and the rotational speed is reduced such that the laundry is lifted up without being stuck to the drum to apply beat washing to the laundry when the laundry includes a large amount of chemical-fiber clothes (for example, see PTL 3).

[0006] However, in the configuration described in PTL 1, since a predetermined high speed rotating operation is performed regardless of the degree of dirt of the laundry, the predetermined-high-speed rotating operation is performed even though the degree of dirt of the laundry is low, and unnecessary electric power is consumed to pose a problem concerning power saving.

[0007] In the configuration described in PTL 1, since a predetermined-high-speed rotating operation is performed regardless of an amount of loaded detergent, when the amount of detergent is large to cause cleaning liquid having a high detergent concentration to easily act on dirt of the clothes, an unnecessary predetermined-high-speed rotating operation is performed. In this manner, the configuration disadvantageously has a poor energy saving performance.

[0008] Furthermore, in the configurations described in PTLs 1 to 3, the quality of cloth of laundry such as clothes is determined to optimally perform washing. However, a problem in which cleaning cannot be effectively performed according to the quality of cloth is posed. More specifically, in PTL 3, the rotational speed of the drum when the number of cotton clothes is large is different from that when the number of chemical-fiber clothes is large. However, in any case, beat washing is subjected to laundry. In particular, since the chemical-fiber clothes have a low water content and a light weight, mechanical impact acting on the laundry is low in beat washing to pose a problem in which the removal efficiency of dirt is low.

[0009] The present invention has been made to solve the conventional problem and an object thereof is to provide a drum washing machine that performs a washing operation at low power consumption with optimum, good detergency according to the degree of dirt.

[0010] The present invention has been made to solve the conventional problems and another object thereof is to provide a drum-type washing machine that performs optimum cleaning according to an amount of detergent and can perform a washing operation with a high energy saving performance.

[0011] The present invention has been made to solve the conventional problems and still another object thereof is to provide a drum-type washing machine that optimally drives a drum in the washing step according to determined quality of cloth.

Citation List

Patent Literature

[0012]

PTL 1: Unexamined Japanese Patent Publication No. 8-299658
PTL 2: Unexamined Japanese Patent Publication No. 2008-6179
PTL 3: Unexamined Japanese Patent Publication No. 11-114278

SUMMARY OF THE INVENTION

[0013] In order to solve the conventional problems, a drum-type washing machine according to the present invention includes a water tab elastically supported in a housing, a drum rotatably disposed in the water tab, a drum drive unit that rotationally drives the drum, a state detector that detects a state of laundry in the drum, and a controller that receives an output from the state detector and sequentially controls steps including washing, rinsing, spin-drying steps. The washing step includes an agitating step for rotating the drum at a low speed which dose not stick the laundry to the inside of the drum, and the centrifugal cleaning step for rotating the drum at a high speed which stick the laundry to an inner peripheral wall surface of the drum to discharge washing water from the laundry by centrifugal force. Thus, the controller controls the operation of the drum drive unit in the washing step according to outputs from the state detector.

[0014] In order to solve the conventional problems, in the drum-type washing machine according to the present invention, the state detector is used as a dirt detector that detects dirt of laundry in the drum, and the controller changes the rotational speed of the drum in the centrifugal cleaning step according to the dirt detected by the dirt detector.

[0015] In order to solve the conventional problems, in the drum-type washing machine according to the present invention, the state detector is used as a detergent amount determining unit that determines an amount of detergent, and the controller sets the rotational speed of the drum in the centrifugal cleaning step lower as the amount of detergent determined by the detergent amount determining unit is larger.

[0016] In order to solve the conventional problems, the drum-type washing machine according to the present invention uses the state detector as a cloth quality determining unit that determines the quality of cloth of laundry and has a circulating unit that circulates washing water in a water tab into a drum. The controller performs the agitating step in the washing step when the cloth quality determining unit determines that the laundry includes a large amount of chemical-fiber clothes. Furthermore, when the cloth quality determining unit determines that the cloths of the laundry include a large amount of cotton clothes, the centrifugal cleaning step is performed in the washing step, and the circulating unit sprays the washing water in the water tab onto the laundry in the drum.

BRIEF DESCRIPTION OF DRAWING

[0017]

FIG. 1 is a side sectional view showing a schematic configuration of a drum-type washing machine according to a first embodiment of the present invention.
FIG. 2 is a control block diagram showing a schematic configuration of the drum-type washing machine according to the first embodiment of the present invention.
FIG. 3A is a flow chart showing an operation of a controller in a washing operation of the drum-type washing machine according to the first embodiment of the present invention.
FIG. 3B is a flow chart showing an operation of the controller in the washing operation of the drum-type washing machine according to the first embodiment of the present invention.
FIG. 4 is a side sectional view showing a schematic configuration of a drum-type washing machine according to a second embodiment of the present invention.
FIG. 5 is a control block diagram showing a schematic configuration of the drum-type washing machine according to the second embodiment of the present invention.
FIG. 6A is a flow chart showing an operation of a controller in a washing operation of the drum-type washing machine according to the second embodiment of the present invention.
FIG. 6B is a flow chart showing an operation of the controller in the washing operation of the drum-type washing machine according to the second embodiment of the present invention.
FIG. 7 is a side sectional view showing a schematic configuration of a drum-type washing machine according to a fifth embodiment of the present invention.
FIG. 8 is a side sectional view showing a schematic configuration of a drum-type washing machine according to a

seventh embodiment of the present invention.

FIG. 9 is a control block diagram showing a schematic configuration of the drum-type washing machine according to the seventh embodiment of the present invention.

FIG. 10A is a diagram showing a rotational behavior of laundry in a rotating drum in the drum-type washing machine according to the seventh embodiment of the present invention.

FIG. 10B is a diagram showing a state in which laundry is stuck to the inside of the rotating drum in the drum-type washing machine according to the seventh embodiment of the present invention.

FIG. 11 is a time chart showing an operation of a drum-type washing machine according to an eighth embodiment of the present invention.

DESCRIPTION OF EMBODIMENT

FIRST EXEMPLARY EMBODIMENT

[0018] FIG. 1 is a main sectional view showing a schematic configuration of a drum-type washing machine according to a first embodiment of the present invention, and FIG. 2 is a control block diagram showing a schematic configuration of the drum-type washing machine.

[0019] In FIG. 1 and FIG. 2, cylindrical water tab 2 is elastically supported in housing 1 to collect washing water. In this case, the washing water includes detergent water that supplies a detergent component in a washing step to wash laundry and rinse water to rinse the laundry to get the detergent component off in a rinsing step. In water tab 2, bottomed cylindrical drum 3 having a front opening for accommodating laundry is rotatably included. Drum drive motor 4 (drum drive unit) that rotates rotary shaft 3a of drum 3 while keeping the shaft upwardly sloped is attached to the rear surface of water tab 2.

[0020] Water supply valve 6 is disposed in water supply path 5 connected to a faucet, and water is supplied to water tab 2 through water supply valve 6 and caused to flow into drum 3. Detergent case 7 (detergent dispenser) to load a predetermined amount of detergent in advance is disposed between water supply valve 6 and water tab 2, and water is supplied to water tab 2 through water supply pipe 8 while dissolving the detergent with the supplied water.

[0021] At the lowermost part of water tab 2, a heater (heating unit) (not shown) that heats washing water collected in water tab 2 is disposed. Even though the tap water has a low temperature, the temperature of the washing water is increased (for example, 30°C to 40°C) to make it possible to improve the cleaning effect by the detergent.

[0022] Water intake 10 is connected to the lowermost part of water tab 2 to make it possible to discharge washing water used in washing and rinse water used in rinsing from drain pipe 12 to the outside of the machine through drain valve 11. In water intake 10, water level sensor 13 (water level detector) that detects a water level of the washing water supplied to water tab 2 and drum 3 is installed.

[0023] Circulating water path 15 connected to discharge port 14 that discharges washing water taken out of water intake 10 from opening 3b formed in the front surface of drum 3 into drum 3 is connected to communicate between water intake 10 and drain valve 11, and washing water and rinse water in water tab 2 can be circulated into drum 3. The washing water is taken into circulating water path 15 by circulating pump 16. In this manner, since circulation of the washing water by circulating water path 15 can be performed by only the control of circulating pump 16, the circulation can be performed regardless of cleaning control that controls a normal detergency of a water flow or the like obtained by the rotation of drum 3.

[0024] When the washing water flowing in circulating water path 15 includes a large amount of foreign substances such as fibers of laundry or hairs, circulating pump 16 may be clogged. For this reason, drain filter 17 is disposed in circulating water path 15 on the upstream side of circulating pump 16 to remove the foreign substances such as the fibers of laundry or the hairs. In circulating water path 15, dirt sensor 18 (dirt detector) serving as a state detector that detects a state of laundry in drum 3 is disposed to detect dirt of the washing water flowing in circulating water path 15.

[0025] On the front side of housing 1, door 19 is disposed to face opening 3b of drum 3. A user opens door 19 to make it possible to put or take laundry (clothes) in/out of drum 3.

[0026] On the inner peripheral wall of drum 3, a plurality of protrusions 20 are formed. When drum 3 is rotated at a low speed, an agitating operation (tumbling operation) is performed in which clothes are caught by the protrusions 20 to be lifted upward and are dropped from certain height. A plurality of through holes 21 are formed in the inner peripheral wall of drum 3 such that washing water or air can freely move between drum 3 and water tab 2.

[0027] As shown in FIG. 2, the drum-type washing machine has controller 30. Controller 30 displays, on display unit 32, setting information input by a user through input setting unit 31 and controls, on the basis of the setting information and operation state monitoring of the respective parts, a series of driving operations including washing, rinsing, and spin-drying.

[0028] Controller 30 can include, for example, CPU (Central Processing Unit), a ROM (Read Only Memory) that stores programs, a RAM (Random Access Memory) that stores programs or data in execution of various processes, an in-

put/output interface, and a bus that connects the components to each other (all not shown).

[0029] Controller 30 has timer 33. As timer 33, an internal timer built as an internal function on the operation of controller 30 can be used. As timer 33, a timer device being independent of controller 30 can also be used.

[0030] In the drum-type washing machine, rectifier 41 rectifies AC power 40, and, thereafter, a smoothing circuit including choke coil 42 and smoothing capacitor 43 smoothes the rectified power. The smoothed DC power is used as drive power to cause inverter circuit 44 to rotationally drive drum drive motor 4.

[0031] Controller 30 controls the rotation of drum drive motor 4 on the basis of an operation designation input from input setting unit 31 and monitoring information of an operation state detected by each detector. Furthermore, controller 30 controls operations of necessary loads such as water supply valve 6, heating unit 9, drain valve 11, and circulating pump 16 through load drive unit 45.

[0032] Drum drive motor 4 can be configured as a DC brushless motor including, for example, a stator having three-phase coils 4a, 4b, and 4c and a rotor having a permanent magnet having two poles, and including three position detecting elements 27a to 27c disposed thereon. Drum drive motor 4 can be rotationally controlled by inverter circuit 44 that is configured to be able to be PWM-controlled by switching elements 44a to 44f.

[0033] In this case, rotor position detection signals detected by position detecting elements 27a to 27c are input to controller 30. Controller 30 outputs a control signal to inverter drive circuit 46 on the basis of the rotor position detection signals, and PWM-controls the on/off states of switching elements 44a to 44f through inverter circuit 44.

[0034] In this manner, controller 30 controls energization to three-phase coils 4a, 4b, and 4c of the stator to rotate the rotor of drum drive motor 4 at a desired rotational speed. Controller 30 detects the cycle of any one of three position detecting elements 27a to 27c each time the state of a signal of the selected one of position detecting elements 27a to 27c changes, and, on the basis of the cycles, the rotational speed of the rotor is calculated by rotational speed detector 34 serving as an internal function. Furthermore, controller 30 also has a function that detects a current signal flowing in drum drive motor 4 by cloth volume detector 35 to determine the weight of drum 3, i.e., the weight of laundry.

[0035] The operation and the operational advantage of the drum-type washing machine configured as described above will be described below in detail with reference to FIG. 3A and FIG. 3B.

[0036] When laundry is put in drum 3 to start washing, controller 30 detects an amount of laundry (S1). The amount of laundry is detected by detecting a magnitude of a current signal of drum drive motor 4 when drum 3 is rotated together with the laundry by controlling drum drive motor 4.

[0037] A basic water supply is determined on the basis of the amount of laundry. For example, when the amount of laundry is determined as "small", "low" water level WL1 is set as a set water level. For example, when the amount of laundry is determined as "medium", "medium" water level WL2 is set as a set water level. For example, when the amount of laundry is determined as "large", "high" water level WL3 is set as a set water level (S2).

[0038] Subsequently, controller 30 opens water supply valve 6 (S3) to supply water into water tab 2 and drum 3 until water tab 2 and drum 3 have a set water level (S4).

[0039] During the water supply, controller 30 controls circulating pump 16 to circulate washing water supplied together with detergent from discharge port 14 into drum 3 through circulating water path 15, thereby accelerating blending of the detergent into the water. When the washing water is discharged from discharge port 14 into drum 3, clothes absorb water before the detergent is dissolved in the water. For this reason, the rotational speed of circulating pump 16 is desired to be lowered not to discharge a very large amount of washing water into drum 3.

[0040] Subsequently, when the set water level is achieved (YES in S4), water supply valve 6 is closed (S5), and agitating is started while drum 3 is rotated at a low speed (S6). The rotational speed of drum 3 is preferably set to a rotational speed not to stick the laundry to the inner peripheral wall surface of drum 3 with centrifugal force such that the laundry is lifted upward in drum 3 and dropped from the upper part in drum 3 by gravitation to effectively apply kinetic energy generated in dropping to the laundry. Although the rotational speed depends on amounts of laundry, the rotational speed is preferably set to 50 rpm or less. A rotation direction may be uniquely determined or may be switched to a forward/backward direction.

[0041] At this time, controller 30 controls circulating pump 16 to circulate washing water obtained by sufficiently dissolving detergent in water from discharge port 14 into drum 3 through circulating water path 15 so as to enhance penetration of washing water into the laundry. For this reason, the rotational speed of circulating pump 16 is set to a rotational speed at which the washing water is circulated in drum 3 and certainly discharged to make it easy to penetrate the washing water into the laundry.

[0042] When a predetermined time (for example, 2 minutes) has elapsed after the low-speed rotation of drum 3 is started (YES in S7), dirt sensor 18 detects a degree of dirt (S8). Controller 30 determines the degree of dirt on the basis of an output from dirt sensor 18. A timing at which dirt is detected by the dirt sensor is time at which dirt begins to be dissolved in the washing water.

[0043] When the output from dirt sensor 18 is predetermined value A (for example, 100) or more (YES in S9), parameter R is set to 300 rpm (S10). When the output is predetermined value B (for example, 50) or more (YES in S11), the parameter R is set to 200 rpm (S12), otherwise (NO in S11), parameter R is set to 150 rpm (S13). More specifically, the

parameter is increased when the output value of dirt sensor 18 is large.

[0044] Thereafter, drum 3 is rotated at a high speed, i.e., the rotational speed of parameter R set as described above (S14). With the centrifugal force generated by rotating drum 3 at a high speed, the laundry is stuck to the wall surface of drum 3. Water contained in the laundry is squeezed out and then moves to water tab 2 side through through holes 21 of drum 3.

[0045] The speed at which drum 3 is rotated at a high speed is required to be 100 rpm or more at which water contained in the laundry can be forcibly separated by centrifugal force. The speed is more preferably set to be 150 rpm or more at which water contained in the laundry can be forcibly separated, and is even more preferably set to be 300 rpm or more.

[0046] In the embodiment, the rotational speed is varied according to a detection output from dirt sensor 18. More specifically, drum 3 need not be rotated at a high speed up to 300 rpm when a degree of dirt is small, and is rotated at up to 150 rpm that is the minimum rotational speed required to separate water contained in the laundry, so that an energy-saving operation is performed while keeping small power consumption in drum drive motor 4.

[0047] On the other hand, when a degree of dirt is large, drum 3 is rotated at a high speed of up to 300 rpm to remove a dirty material. As a unit operation used when the high-speed rotation is performed, even one continuous operation or an operation that intermittently performs an on/off operation within a short time may be used.

[0048] In the centrifugal cleaning step in which drum 3 is rotated at a high speed, in the agitating step in which drum 3 is previously rotated at a low speed, washing water near clothing fibers containing detergent configured by interfacial active agent adhering to the dirty material on the clothing fibers is removed by centrifugal force to make it possible to efficiently remove the dirty material from the fibers together with the washing water.

[0049] In the high-speed rotation of drum 3, when the washing water is discharged toward the laundry in drum 3 by circulating pump 16, the washing water that has not been dirty is effectively absorbed in the laundry to make it possible to enhance replacement of the washing water contained in the clothing fibers with new washing water.

[0050] A time for which drum 3 is rotated at a high speed may be a relatively short time because the washing water contained in the laundry need only be squeezed. For example, the rotation is performed for only 30 seconds (YES in S15).

[0051] The agitating step in which drum 3 is rotated at a low speed again is executed (S16). In the agitating step, circulating pump 16 is driven as in the step S6, and the washing water is discharged from discharge port 14 into drum 3 through circulating water path 15. At this time, drum 3 is rotated at a rotational speed at which the laundry tumbles in drum 3 without being stuck, and timings at which circulating pump 16 is driven to discharge the washing water from discharge port 14 may be continuously or intermittently set.

[0052] After the centrifugal cleaning step in which drum 3 is rotated at a high speed, the agitating step in which drum 3 is rotated at a low speed is continuously performed to make it possible to further pick the dirty material remaining on the fibers away from the fibers by chemical kinetics of the detergent and mechanical force generated by rotation of drum 3. Although there is fear that a dirty material readhers to the fibers when a dirty material concentration in washing water between fibers is high, dirt adhering to and surrounded by the interfacial active agent of the detergent is difficult to readhere to the fibers, and only the interfacial active agent that does not adhere to dirt is stuck to the laundry. For this reason, the interfacial active agent can be applied to the remaining dirt.

[0053] Since a time for the agitating step in which drum 3 is rotated at a low speed need only be a time required to sufficiently penetrate the remaining detergent in the laundry, the time may be fixed to a predetermined time regardless of a cloth volume. For example, in the embodiment, when the washing step is designed to be ended 5 minutes after the second agitating step is started (YES in S17), a small number of calculates and a small number of constant tables need only be used, and a load on controller 30 can be reduced.

[0054] As described above, when the rotational speed of drum 3 in the centrifugal cleaning step is increased when the output from dirt sensor 18 is large, washing water including detergent near the laundry and dirt adhering to the detergent can be strongly removed when a degree of dirt of the laundry is large, and the detergency can be enhanced. On the other hand, when the rotational speed of drum 3 in the centrifugal cleaning step is reduced when the output from dirt sensor 18 is small, cleaning can be performed by drum drive motor 4 driven at minimum power consumption when a degree of dirt of the laundry is small, and an energy-saving operation can be achieved.

[0055] The embodiment described above exemplifies the washing step in which the centrifugal cleaning step (S14) for rotating drum 3 at a high speed is performed only once. However, the washing step need not be always used. For example, when an amount of laundry and a degree of dirt are large, the centrifugal cleaning step (S14) and the agitating step (S16) are alternatively repeated more than once, a frequency of the centrifugal cleaning step (S14) is increased to make it possible to strongly remove dirt.

[0056] The embodiment describes the drum-type washing machine including only a washing function. However, the present invention is not limited to the drum-type washing machine, and can also be applied to a drum-type washing/drying machine including both a washing function and a cloth drying function.

[0057] The drum-type washing machine according to the present invention includes a water tab elastically supported in a housing, a drum rotatably disposed in the water tab, a drum drive unit that rotationally drives the drum, a dirt detector that detects dirt of laundry in the drum, and a controller that receives an output from the dirt detector and sequentially

controls steps including washing, rinsing, spin-drying steps. The washing step includes the agitating step for rotating the drum at a low speed which does not stick the laundry to the inside of the drum, and the centrifugal cleaning step for rotating the drum at a high speed which stick the laundry to an inner peripheral wall surface of the drum to discharge washing water from the laundry by centrifugal force. Furthermore, the control unit is designed to change the rotational speed of the drum in the centrifugal cleaning step according to dirt detected by the dirt detector. In this manner, the rotational speed of the drum in the centrifugal cleaning step can be changed according to dirt detected by the dirt detector. When a degree of dirt of the laundry is high, the rotational speed is increased to efficiently remove dirt so as to improve the detergency. When a degree of dirt of the laundry is low, the rotational speed is reduced to suppress power consumption of the drum drive motor so as to make it possible to reduce the power consumption of the washing machine.

[0058] In the drum-type washing machine according to the present invention, since the controller is configured to increase the rotational speed of the drum in the centrifugal cleaning step when a degree of dirt detected by the dirt detector is high, when dirt is sufficiently dissolved from the laundry into the washing water and saturated, the drum is rotated at a high speed to make it possible to further remove the dirt from the laundry and to improve the detergency.

[0059] The drum-type washing machine according to the embodiment includes a wetting unit that wets laundry with washing water. The wetting unit wets the laundry with the washing water in the centrifugal cleaning step to cause the washing water to act on dirt adhering to the laundry so as to make it possible to improve the detergency.

[0060] In the drum-type washing machine according to the embodiment, the laundry is partially submerged in and wetted with the washing water collected on the bottom in the water tab, so that the washing water that has not been dirty is effectively absorbed in the laundry to enhance replacement of the washing water contained in the clothing fibers so as to improve the detergency.

[0061] Since the drum-type washing machine according to the embodiment is configured by a circulating shower that sucks washing water collected on the bottom of the water tab to discharge the washing water onto the laundry in the drum, circulation of the washing water can be performed by controlling only a circulating pump. For this reason, the washing water can be circulated regardless of cleaning control that controls normal detergency such as a water flow obtained by rotation of the drum, and washing water that has not been dirty is effectively absorbed in the laundry to enhance replacement of the washing water contained in the clothing fibers so as to improve the detergency.

[0062] The drum-type washing machine according to the embodiment is designed to detect dirt by using, as the dirt detector, at least one of sensors for turbidity, conductivity, and color (loss) so as to make it possible to cope with accurate dirt detection according to various dirt components included in the laundry and cleaning according to dirt.

[0063] The drum washing machine according to the embodiment includes a drying unit that dries washed clothes to make it possible to obtain a low-power-consumption drum-type washing/drying machine that can achieve high detergency according to a degree of dirt of laundry.

SECOND EXEMPLARY EMBODIMENT

[0064] FIG. 4 is a side sectional view showing a schematic configuration of a drum-type washing machine according to a second embodiment of the present invention. FIG. 5 is a control block diagram showing the drum-type washing machine according to the second embodiment of the present invention.

[0065] In FIG. 4, water tab 102 is a cylindrical water tab that is elastically supported in housing 100 and collects washing water containing a detergent component. Bottomed cylindrical drum 101 having a front opening is rotatably included in water tab 102 and accommodates laundry. Drum drive motor 103 (drum drive unit) that rotates a rotary shaft of drum 101 while keeping the shaft upwardly sloped is attached to the rear surface of water tab 102.

[0066] Water supply inlet 104 is connected to a faucet to sequentially fill water tab 102 and drum 101 with water through water supply valve 105.

[0067] Detergent case 118 (detergent dispenser) to load detergent in advance is disposed between water supply valve 105 and water tab 102. Supplied water and loaded detergent are poured into drum 101 through water supply pipe 119 while being mixed with each other.

[0068] At the lowermost part of water tab 102, a heater (heating unit) (although not shown) to heat washing water collected in water tab 102 is disposed. Even though the tap water has a low temperature, the temperature of the washing water can be increased to make it possible to improve the cleaning capability of the detergent.

[0069] Water intake 106 is connected to the lowermost part of water tab 102 to discharge washing water used in washing and rinse water used in rinsing from drain pipe 108 to the outside of the machine through drain valve 107.

[0070] In water intake 106, water level sensor 109 (water level detector) to detect a water level of the water supplied to water tab 102 and drum 101 is installed.

[0071] Circulating water path 111 connected to discharge port 110 that discharges washing water and rinse water taken from water intake 106 to drum 101 is connected to communicate between water intake 106 and drain valve 107. The washing water and the rinse water in water tab 102 are taken out of water intake 106 and sent from discharge port 110 into drum 101 through circulating water path 111 to make it possible to complete circulation. When water is taken

into circulating water path 111 by using circulating pump 112 serving as a wetting unit, since circulation of the washing water by circulating water path 111 can be performed by only the control of circulating pump 112, the circulation can be performed regardless of cleaning control that controls a normal detergency of a water flow or the like obtained by rotation of drum 101.

[0072] When the washing water (washing water and rinse water) in circulation includes many foreign substances such as fibers of laundry and hairs, circulating pump 112 may be clogged. For this reason, drain filter 113 is disposed on the upstream side of circulating pump 112. Drain filter 113 removes foreign substances such as fibers of laundry and hairs.

[0073] In the embodiment, in order to detect an amount of detergent, turbidity sensor 114 that can detect the degree of transparency of water passing in circulating water path 111 is disposed, as a state detector that detects the state of laundry in drum 101, in circulating water path 111. Turbidity sensor 114 includes an LED serving a light-emitting element and a phototransistor serving as a light-receiving element, and the LED and the phototransistor are disposed at substantially horizontal left and right positions to face each other through circulating water path 111. When the loaded detergent and water are mixed with each other and dissolved, the transmittance (turbidity) of the washing water varies according to the amount of detergent. For this reason, the amount of detergent is detected according to an output result of turbidity sensor 114. Turbidity sensor 114 includes the light-emitting element that emits infrared light and the light-receiving element that receives the infrared light emitted from the light-emitting element. The light-emitting element and the light-receiving element are disposed outside circulating water path 111 to face each other. Thus, since a light axis of the infrared light is formed between the light-receiving element and the light-receiving element, circulating water path 111 to which turbidity sensor 114 is attached includes a material that at least partially transmits the infrared light. The infrared light emitted from the light-emitting element passes through the washing water in circulating water path 111 corresponding to the position where turbidity sensor 114 is attached. When the washing water includes a large amount of detergent and is highly turbid, an amount of infrared light reaching the light-receiving element becomes small. When the washing water includes a small amount of detergent and is less turbid, an amount of infrared light reaching the light-receiving element becomes large. Thus, turbidity sensor 114 outputs an output according to the turbidity of the washing water to make detergent amount determining unit 132 to possible to determine an amount of detergent.

[0074] Door 115 is disposed on housing 100 to face the opening end side of drum 101. A user opens door 115 to make it possible to put or take laundry (clothes) in/out of drum 101.

[0075] A plurality of protrusions 116 are formed on the inner peripheral wall of drum 101. When drum 101 is rotated at a low speed, clothes are caught by the protrusions 116 to be lifted upward. Thereafter, the clothes are dropped from certain height. In this manner, by using protrusions 116, an agitating operation (tumbling operation) can be performed.

[0076] A plurality of through holes 117 are formed in the inner peripheral wall of drum 101 such that water can freely move between drum 101 and water tab 102.

[0077] As shown in FIG. 5, the drum-type washing machine has controller 170. Controller 170 displays setting information input by a user through input setting unit 130 on display unit 131 and controls, and on the basis of the setting information and a monitoring situation of operation states of the units, a series of driving operations including washing, rinsing, and spin-drying.

[0078] Controller 170 can include, for example, a CPU (Central Processing Unit), a ROM (Read Only Memory) that stores programs, a RAM (Random Access Memory) that stores programs or data in execution of various processes, an input/output interface, and a bus that connects the components to each other (all not shown). Controller 170 has detergent amount determining unit 132 and timer 171. Detergent amount determining unit 132 determines an amount of loaded detergent. As timer 171, an internal timer built as an internal function on the operation of controller 170 is used. As timer 171, a timer device being independent of controller 170 may also be used.

[0079] In the drum-type washing machine according to the embodiment, rectifier 124 rectifies AC power 120, and, thereafter, a smoothing circuit including choke coil 125 and smoothing capacitor 126 smoothes the rectified power. The smoothed DC power is used as drive power to cause inverter circuit 122 to rotationally drive drum drive motor 103. Controller 170 controls the rotation of drum drive motor 103 on the basis of an operation designation input from input setting unit 130 and monitoring information of an operation state detected by each detector. Furthermore, controller 170 controls operations of necessary loads such as water supply valve 105, drain valve 107, and circulating pump 112 through load drive unit 123.

[0080] Drum drive motor 103 can be configured as a DC brushless motor including, for example, a stator having three-phase coils 103a, 103b, and 103c and a rotor having a permanent magnet having two poles, and including three position detecting elements 127a to 127c disposed thereon. Drum drive motor 103 can be rotationally controlled by inverter circuit 122 that is configured to be able to be PWM-controlled by switching elements 122a to 122f. In this case, rotor position detection signals detected by position detecting elements 127a to 127c are input to controller 170. Controller 170 outputs a control signal to an inverter drive circuit 121 on the basis of the rotor position detection signal, and PWM-controls the on/off states of switching elements 122a to 122f through inverter drive circuit 121. In this manner, controller 170 controls energization to three-phase coils 103a, 103b, and 103c of the stator to rotate the rotor of drum drive motor 103 at a desired rotational speed. Controller 170 detects the cycle of any one of three position detecting elements 127a, 127b,

and 127c each time the state of a signal of the selected one of position detecting elements 127a to 127c changes, and, on the basis of the cycles, the rotational speed of the rotor is calculated by rotational speed detector 172 serving as an internal function.

[0081] Furthermore, controller 170 also has a function that causes cloth volume detector 173 to detect a current signal flowing in drum drive motor 103 so as to determine the weight of drum 101, i.e., a weight of laundry.

[0082] The operation and the operational advantage of the drum-type washing machine configured as described above will be described in detail with reference to FIG. 6A and FIG. 6B.

[0083] When laundry is put in the washing machine to start washing, cloth volume detector 173 of controller 170 detects an amount of laundry (S1). An amount of laundry is detected by detecting a magnitude of a current signal of drum drive motor 103 when drum 101 is rotated together with laundry by controlling drum drive motor 103, an acceleration, an acceleration time, and the like.

[0084] A basic water supply is determined on the basis of amount of laundry. For example, when cloth volume detector 173 determines the amount of laundry as "small", controller 170 sets "low" water level WL1 as a set water level. When cloth volume detector 173 determines the amount of laundry as "medium", controller 170 sets "medium" water level WL2 as a set water level. When cloth volume detector 173 determines the amount of laundry as "large", controller 170 sets "high" water level WL3 as a set water level (S2).

[0085] Controller 170 opens water supply valve 105 (S3) to supply water into water tab 102 and drum 101 until water tab 102 and drum 101 have a set water level (S4).

[0086] Subsequently, when water reaches the predetermined water level (YES in S4), water supply valve 105 is closed (S5), and detergent amount determining unit 132 determines an amount of detergent (S6).

[0087] When circulating pump 112 and drum 101 are driven, clothes absorb washing water before the detergent is dissolved in water. For this reason, an amount of detergent is desirably determined before the components are driven. Alternatively, in order to dissolve the detergent in water at a uniform concentration, circulating pump 112 is driven at a rotational speed at which the washing water is not discharged onto the clothes, and the amount of detergent may be determined.

[0088] When a determination result of detergent amount determining unit 132 is an amount of detergent that is predetermined value A or less (YES in S7), parameter R (rotational speed obtained when the drum is rotated at a high speed) is set to 300 rpm (S8). When the determination result is larger than the predetermined value A and an amount of detergent that is 1.2 or less times predetermined value A (YES in S9), parameter R is set to 200 rpm (S10). If not (NO in S9), i.e., when the determination result is an amount of detergent that is larger than 1.2 times predetermined value A, parameter R is set to 150 rpm (S17). More specifically, when the amount of detergent determined by detergent amount determining unit 132 is small, parameter R is set to a large value. In this manner, when the amount of detergent is large, the rotational speed of the high-speed rotation is reduced to suppress the power consumption of the drum drive motor so as to make it possible to improve the energy saving performance. Since the rotational speed of the high-speed rotation of the drum is reduced in a high-concentration-detergent state due to a large amount of detergent, occurrence of abnormal foaming can be suppressed. On the other hand, when the amount of detergent is small, the rotational speed of the high-speed rotation is increased to efficiently apply cleaning liquid to dirt of the clothes so as to make it possible to improve the detergency.

[0089] Subsequently, agitating step in which drum 101 is rotated at a low speed at which the laundry is not stuck to the inside of drum 101 is started (S12). Rotational speed of drum 101 is set to a rotational speed not to stick the laundry to the wall surface of drum 101 with centrifugal force such that the laundry is lifted up in drum 101 and dropped from the upper part in drum 101 by gravitation to effectively apply kinetic energy in dropping to the laundry. Although the rotational speed depends on amounts of laundry, the rotational speed is preferably set to 50 rpm or less. A rotation direction may be uniquely determined or may be periodically switched.

[0090] At this time, controller 170 controls circulating pump 112 to obtain a circulating shower in which washing water obtained by sufficiently dissolving detergent in water from discharge port 110 is circulated into drum 101 through circulating water path 111 so as to enhance penetration of washing water into the laundry. For this reason, the rotational speed of circulating pump 112 is set to a rotational speed at which the circulating water is certainly discharged into drum 101 to make it easy to penetrate the washing water into the laundry. The laundry in drum 101 is submerged in washing water collected in an inner bottom portion of water tab 102. Drum 101 is rotated to repeatedly submerge the entire laundry in the washing water, and wetting and spin-drying of the washing water are repeated to enhance penetration of the washing water into the laundry.

[0091] After a predetermined time (for example, 2 minutes) has elapsed (YES in S13), the centrifugal cleaning step is performed (S14). A rotational speed at this time is a high rotational speed given as the rotational speed of parameter R.

[0092] With the centrifugal force generated by rotating drum 101 at a high speed, the laundry is stuck to the wall surface of the drum. Water contained in the laundry is squeezed out and then moves to water tab 102 side through through holes 117 of drum 101.

[0093] The speed at which drum 101 is rotated at a high speed is at least required to be 100 rpm at which water

contained in the laundry can be forcibly separated by centrifugal force. The speed is more preferably set to be 150 rpm or more at which water contained in the laundry can be forcibly separated, and is even more preferably set to be 300 rpm or more.

[0094] However, as described above, the rotational speed is varied according to the amount of detergent determined by detergent amount determining unit 132. More specifically, the drum is not rotated at a high speed up to 300 rpm when an amount of detergent is large (the detergent concentration of the washing water is high), and is rotated at up to 150 rpm that is the minimum rotational speed required to separate water contained in the laundry, so that an energy-saving operation is performed with low power consumption in the motor. On the other hand, when the amount of detergent is small (the detergent concentration of the washing water is low), the drum is rotated at a high speed of up to 300 rpm to effectively replace the cleaning liquid contained in the laundry with new one. As a unit operation used when the high-speed rotation is performed, even one continuous operation or an operation that intermittently performs an on/off operation within a short time may be used.

[0095] In the centrifugal cleaning step in which drum 101 is rotated at a high speed, in the agitating step that has been previously performed, washing water near clothing fibers containing detergent configured by interfacial active agent adhering to the dirty material on the clothing fibers is removed by centrifugal force. In this manner, both the dirty material and the washing water can be efficiently removed from the fibers. Furthermore, when it is assumed that the washing water is discharged toward the laundry in drum 101 by circulating pump 112 in a high-speed rotation, the washing water that has not been dirty is effectively absorbed in the laundry to make it possible to enhance replacement of the washing water contained in the clothing fibers with new washing water.

[0096] A time for the centrifugal cleaning step may be a relatively short time because the washing water contained in the laundry need only be squeezed, and, for example, it is assumed that the centrifugal cleaning step is performed for only 30 seconds (YES in S15).

[0097] Subsequently, the agitating step in which drum 101 is rotated at a low speed again is executed (S16). In this step, circulating pump 112 is activated as in the step S12, and the washing water is discharged from discharge port 110 into drum 101 through circulating water path 111. At this time, drum 101 is rotated at a rotational speed at which the laundry tumbles in drum 101 without being stuck, and timings at which circulating pump 112 is operated to discharge the washing water from discharge port 110 may be continuously or intermittently set.

[0098] After the step in which drum 101 is rotated at a high speed, the agitating step is continuously performed to make it possible to further pick the dirty material remaining on the fibers away from the fibers by chemical kinetics of the detergent and mechanical force generated by rotation of drum 101 again. Although there is fear that a dirty material readhers to the fibers when a dirty material concentration in washing water between fibers is high, dirt adhering to and surrounded by the interfacial active agent of the detergent is difficult to readhere to the fibers, and only the interfacial active agent that does not adhere to dirt is stuck to the laundry. For this reason, the chemical kinetics of the detergent can be applied to the remaining dirt.

[0099] When timer 171 confirms that 5 minutes have elapsed after the agitating step subsequent to the centrifugal cleaning step is started (YES in S17), the rotation of drum 101 is stopped to end the washing step.

[0100] Since a time for the agitating step subsequent to the centrifugal cleaning step may be a time for which the remaining detergent is sufficiently penetrated in the laundry, the time is fixed to a specific time regardless of a cloth volume. Since a small number of calculates and a small number of constant tables need only be used, the load on controller 170 can be reduced. In the embodiment, the time that has elapsed after the start of the agitating step subsequent to the centrifugal cleaning step is set to 5 minutes. However, a time for the washing step may be regulated, and the agitating step subsequent to the centrifugal cleaning step may be ended after the regulated time, for example, 10 minutes have elapsed after the start of the washing step. In this manner, the washing step is not performed for an unnecessarily long time.

[0101] As described above, when the rotational speed of the drum in the centrifugal cleaning step is small when the amount of detergent determined by detergent amount determining unit 132 is large, cleaning can be performed by the drum drive motor driven at minimum power consumption at which the washing water having a high detergent concentration is replaced with washing water contained in the laundry. For this reason, an energy-saving operation can be achieved. On the other hand, when the rotational speed of the drum in the centrifugal cleaning step is increased when the amount of detergent determined by detergent amount determining unit 132 is small, replacement of the washing water contained in the laundry can be effectively enhanced to make it possible to improve the detergency.

[0102] In the embodiment, although the unit configured by the turbidity sensor 114 is explained as a detergent amount detector, the present invention is not limited to the configuration. For example, a unit configured by a conductivity sensor that detects the conductivity of water may be used. More specifically, since the conductivity of water changes according to components dissolved when detergent is mixed with water and dissolved in the water, the amount of detergent may be determined according to a change rate of the conductivity. Detergent amount determining unit 132 may be configured by a chromaticity sensor that detects the chromaticity of water. More specifically, since the chromaticity of water changes according to components dissolved when detergent is mixed with water and dissolved in the water, the amount of

detergent may be determined according to a change rate of the chromaticity.

[0103] The embodiment described above exemplifies the washing step in which the centrifugal cleaning step (S14) is performed only once. However, the washing step need not be always used. For example, when an amount of laundry is large, the centrifugal cleaning step (S14) and the agitating step (S15) are alternatively repeated once or more to increase a frequency of a high-speed drum rotation, and the washing step in which dirt can be more strongly discharged can also be achieved.

[0104] In each of the embodiments, the drum-type washing machine including only a washing function is described. However, the present invention is applied to not only a drum-type washing machine, but also a drum-type washing/drying machine that includes a drying unit to dry washed clothes to achieve a drum drying function.

[0105] The drum-type washing machine according to the embodiment includes a drum that accommodates laundry and rotates, a water tab that houses the drum, a drum drive unit that drives the drum, and a controller that has a detergent amount determining unit for determining an amount of detergent, and sequentially controls the steps including the washing step, the rinsing step, and the spin-drying step on the basis of a determination result of the detergent amount determining unit. The washing step includes the agitating step for rotating the drum at a low speed which does not stick the laundry to the inside of the drum, and the centrifugal cleaning step for rotating the drum at a high speed which stick the laundry in a wall surface direction of the drum to discharge washing water from the laundry by centrifugal force. Furthermore, the controller is configured such that the rotational speed of the drum in the centrifugal cleaning step is reduced when the amount of detergent determined by the detergent amount determining unit is large.

[0106] With the configuration, when the amount of detergent is large, the rotational speed of the high-speed rotation is reduced to suppress the power consumption of the drum drive motor so as to make it possible to improve the energy saving performance. In the drum-type washing machine according to the embodiment, since the rotational speed of the high-speed rotation of the drum is reduced in a state in which a detergent concentration is high due to a large amount of detergent, occurrence of abnormal foaming can be suppressed. On the other hand, when the amount of detergent is small, the rotational speed of the high-speed rotation is increased to efficiently apply cleaning liquid to dirt of the clothes so as to make it possible to improve the detergency.

[0107] The drum-type washing machine according to the embodiment further includes a wetting unit that wets laundry with washing water, and the wetting unit wets the laundry with the washing water in the centrifugal cleaning step.

[0108] With the configuration, washing water containing a detergent component is actively applied to dirt adhering to laundry to make it possible to improve detergency.

[0109] The drum-type washing machine according to the embodiment is characterized in that the wetting unit partially submerges laundry in washing water collected in the inner bottom portion of the water tab to wet the laundry with the washing water.

[0110] With the configuration, the washing water that is collected in the inner bottom portion of the water tab and has not been dirty is effectively absorbed in the laundry, and the washing water containing dirt contents is discharged from the laundry with centrifugal force to make it possible to enhance replacement of the washing water contained in the clothing fibers with new washing water.

[0111] The drum-type washing machine according to the embodiment is characterized in that the wetting unit is a circulating shower that sucks washing water collected in the inner bottom portion of the water tab to discharge the washing water onto the laundry in the drum again.

[0112] With the configuration, since circulation of the washing water can be performed by only the control of the circulating pump, the washing water can be circulated regardless of cleaning control that normally controls a detergency such as a water flow or the like obtained by rotation of the drum. The washing water that has not been dirty is effectively absorbed in the laundry, and the washing water containing dirt contents is discharged from the laundry with centrifugal force to make it possible to enhance replacement of the washing water contained in the clothing fibers with new washing water.

[0113] The drum-type washing machine according to the embodiment is designed to determine an amount of detergent by the detergent amount determining unit by using at least one of sensors for turbidity, conductivity, and chromaticity.

[0114] With the configuration, the detergent amount determining unit can perform an accurate detergent amount determination according to a type of detergent or a detergent component to make it possible to cope with cleaning according to an amount of detergent.

[0115] The drum-type washing machine according to the embodiment includes a dryer to dry washed clothes.

[0116] In this manner, when the drum-type washing machine is applied, an energy-saving drum-type washing/drying machine having high detergency is operated according to an amount of detergent.

THIRD EXEMPLARY EMBODIMENT

[0117] The drum-type washing machine according to the embodiment includes cloth volume detector 173 serving as a state detector that detects the state of laundry in drum 101 for which an amount of accommodated laundry is detected,

and detergent amount determining unit 132 serving as the state detector that detects the state of the laundry in drum 101 is designed to determine an amount of detergent according to the amount of laundry detected by cloth volume detector 173. More specifically, detergent amount determining unit 132 indirectly determines an amount of detergent required for washing. The other configurations are the same as those in the second embodiment of the present invention.

[0118] Detergent amount determining unit 132 determines an amount of detergent according to an amount of laundry detected by cloth volume detector 173 that detects an amount of put laundry. More specifically, an amount of detergent recommended according to an amount of laundry is determined by a type or brand of detergent. Since an indication of an amount of detergent loaded by a user can be known when the amount of laundry is detected, the amount of detergent is determined according to a detection result of the cloth volume detector. In this manner, when the amount of detergent is indirectly determined on the basis of an output from cloth volume detector 173, a new detergent amount detector need not be disposed to make it possible to achieve a determination of an amount of detergent at a low cost.

FOURTH EXEMPLARY EMBODIMENT

[0119] The drum-type washing machine according to the embodiment includes cloth volume detector 173 serving as a state detector that detects the state of laundry in drum 101 for which an amount of accommodated laundry is detected and an automatic detergent loading device, and detergent amount determining unit 132 serving as the state detector that detects the state of the laundry in drum 101 is designed to determine an amount of detergent according to the amount of laundry detected by cloth volume detector 173 and to supply detergent the amount of which depends on the amount of detergent determined by controller 170 into water tab 102 with the automatic detergent loading device. More specifically, detergent amount determining unit 132 determines an amount of detergent to be automatically loaded. The other configurations are the same as those in the second embodiment of the present invention.

[0120] Detergent amount determining unit 132 determines an amount of detergent according to an amount of laundry detected by cloth volume detector 173 that detects an amount of put laundry. More specifically, detergent amount determining unit 132 can reliably determine an amount of loaded detergent without detecting an amount of detergent to be loaded or estimating an amount of detergent. An amount of detergent is determined according to a detection result of cloth volume detector 173, and controller 170 determines a rotational speed of drum 101 in the centrifugal cleaning step on the basis of the amount of detergent. In this manner, when the automatic detergent loading device is disposed to make it possible to accurately determine an amount of detergent. Thus, centrifugal force washing can be performed according to an amount of actually put detergent, and improvement of an energy saving performance and securement of detergency can be achieved.

FIFTH EXEMPLARY EMBODIMENT

[0121] The drum-type washing machine according to the embodiment further includes detergent weight detector 133 that detects a weight of detergent in detergent case 118 (detergent dispenser), and detergent amount determining unit 132 serving as the state detector that detects the state of the laundry in drum 101 is designed to determine an amount of detergent according to the weight of detergent detected by detergent weight detector 133. The other configurations are the same as those in the second embodiment of the present invention.

[0122] FIG. 7 is a side sectional view showing a schematic configuration of a drum-type washing machine according to the fifth embodiment of the present invention. Detergent weight detector 133 that detects a weight of detergent in detergent case 118 is disposed.

[0123] When detergent is loaded in detergent case 118, detergent weight detector 133 that detects a weight of detergent case 118 detects a weight of detergent. According to the detected weight of detergent, detergent amount determining unit 132 determines an amount of detergent. In this manner, since an amount of detergent is determined such that the weight of the detergent dispenser that changes according to a weight of loaded detergent is directly detected, a detergent put by a user can be directly detected as the weight of detergent, and the amount of detergent can be accurately determined. Thus, centrifugal force washing can be performed according to an amount of actually put detergent, and improvement of an energy saving performance and securement of detergency can be achieved.

SIXTH EXEMPLARY EMBODIMENT

[0124] The drum-type washing machine according to the embodiment includes input setting unit 130, and detergent amount determining unit 132 is designed to determine an amount of detergent according to an amount of detergent set through input setting unit 130. More specifically, detergent amount determining unit 132 determines an amount of detergent on the basis of an amount of detergent that reflects the will of a user. The other configurations are the same as those in the second embodiment of the present invention.

[0125] The user sets an amount of detergent through input setting unit 130. Controller 170 determines a rotational

speed of centrifugal force washing according to a set amount of detergent. More specifically, a user determines an amount of detergent on the basis of an amount of put laundry or the degree of dirt to decide an amount of detergent and to cause detergent amount determining unit 132 to determine the input amount of detergent through input setting unit 130. With the configuration, a new detergent amount detector need not be disposed, and a determination time is not required. For this reason, a simple configuration can be achieved.

SEVENTH EXEMPLARY EMBODIMENT

[0126] FIG. 8 is a main sectional view showing a drum-type washing machine according to the seventh embodiment of the present invention, and FIG. 9 is a block diagram of the drum-type washing machine.

[0127] In FIGS. 8 and 9, in housing 201 of the drum-type washing machine, water tab 202 to collect washing water therein is disposed while being upwardly sloped and elastically supported with a suspension spring (not shown) and a damper (not shown). Bottomed cylindrical drum 203 that accommodates laundry is rotatably disposed in water tab 202. On the peripheral side wall surface of drum 203, a plurality of baffles 204 and a large number of through holes 205 that communicate with the inside of water tab 202 are formed. On the front side, opening 206 through which laundry is put into and taken out of the drum is formed.

[0128] Drum drive motor 207 that rotationally drives drum 203 is fixed to a lower portion of the circumference of water tab 202 and is configured to rotate drum 203 through belt 208 and pulley 209. Water supply valve 210 serving as a water supply unit that supplies washing water into water tab 202 supplies the washing water into water tab 202 through detergent case 212 disposed in water supply path 211 and loaded with detergent.

[0129] Water collecting portion 213 to collect washing water is disposed on the bottom in water tab 202. Heater 214 is disposed in water collecting portion 213 in almost parallel with the water level of washing water collected in water tab 202 to make it possible to heat the washing water collected in water collecting portion 213 to a predetermined temperature (for example, 30°C to 40°C) suitable for washing. A temperature of water collecting portion 213 is detected by temperature detector 215 such as a thermister.

[0130] Washing water collected in water collecting portion 213 in water tab 202 can be circulated into drum 203 by circulating pump 217 serving as a circulating unit disposed on circulating water path 216. Sucking unit 218 that communicates with circulating water path 216 and sucks washing water is disposed on the bottom of water collecting portion 213, and discharging unit 219 is disposed on an upper portion of opening 206 formed on the front side of drum 203 such that the washing water is discharged toward the inside of drum 203.

[0131] On circulating water path 216, switching valve 220 is disposed on the downstream side of circulating pump 217 and can selectively be switched to any one of circulating water path 216 communicating with discharging unit 219 and drain path 221 that discharges the washing water to the outside of the machine. In washing and rinsing, the washing water in water collecting portion 213 can be discharged from discharging unit 219 toward the laundry in drum 203 through circulating water path 216, and washing water used in the washing and rinsing can be discharged to the outside of the machine through drain path 221.

[0132] Controller 222 disposed in housing 201 drives drum drive motor 207, water supply valve 210, heater 214, circulating pump 217, switching valve 220, and the like to sequentially control steps including washing, rinsing, and spin-drying steps.

[0133] The operation and function of the drum-type washing machine configured as described above will be described below. Door 223 that is openably disposed on the front side of housing 201 is opened to put laundry into drum 203 through opening 206, a power switch (not shown) of an operation unit 224 is turned on, and a start switch (not shown) is operated to start the operation. At this time, weight detector 225 serving as a state detector that detects a state of the laundry in drum 203 detects an amount of put laundry, and water supply valve 210 operates to start water supply.

[0134] An amount of water is set in advance according to a put cloth volume, and the washing water is supplied into water tab 2 together with detergent loaded into detergent case 212. When water level detector 226 detects that a set amount of washing water is supplied, the water supply is stopped to drive drum drive motor 207.

[0135] In the washing step, drum drive motor 207 drives drum 203 to rotate drum 203 forward and backward, baffles 204 lift up the laundry in drum 203 and drop the laundry from the upper part in drum 203 onto the water surface so as to perform beat washing. When the temperature of the supplied washing water is low, heater 214 is turned on to heat the washing water in water collecting portion 213 to a temperature suitable for washing. A heating temperature of the washing water in a warmed-water cleaning is generally 30°C to 40°C. When heating is performed in a case where a temperature in water supply is a low temperature, for example, 10°C or less, a cleaning effect can be effectively improved.

[0136] Heater 214 heats washing water collected on the bottom of water tab 202, temperature detector 215 disposed on an outer bottom of water collecting portion 213 detects the temperature of water collecting portion 213, and controller 222 controls the temperature such that the washing water has a preset temperature. Controller 222 switches switching valve 220 to circulating water path 216 side, and circulating pump 217 is driven at a preset rotational speed. A predetermined amount of washing water is circulated in drum 203 to spray the washing water onto the laundry agitated in

drum 203 to make it possible to penetrate the washing water into the laundry.

[0137] When warm water heated with water collecting portion 213 is discharged from discharging unit 219 to quickly penetrate the water into the laundry, solution of the detergent can be accelerated, and a function of separating dirt from the clothes is enhanced to make it possible to improve the cleaning effect.

[0138] When circulating pump 217 circulates the washing water in water collecting portion 213 into drum 203, a water level in water tab 202 decreases. When the temperature of water collecting portion 213 detected by temperature detector 215 exceeds a predetermined temperature (for example, 70°C), the rotational speed of circulating pump 217 is reduced to deteriorate the capability of circulating the washing water.

[0139] In this manner, an amount of circulated washing water decreases, the water level in water tab 202 can be raised. When the water level is raised, the temperature of water collecting portion 213 decreases and is controlled to the set temperature again. Heater 214 sinks into the raised washing water, and controller 222 suitably maintains the set temperature. Thus, heater 214 is held in a state in which heat can be radiated to the washing water without being exposed from the water surface of the washing water, and the washing water can be circulated in drum 203 while heating the washing water to an optimum temperature.

[0140] Controller 222 causes cloth quality determining unit 227 serving as a state detector for detecting the state of the laundry in the drum to determine the quality of cloth of the clothes wetted with the washing water in drum 203. Drum 203 is rotationally driven to measure a current value of drum drive motor 207 in a rotating state, and an output torque characteristic of drum drive motor 207 is measured. Although the output torque increases in proportion to an increase in rotational speed of drum drive motor 207 that drives drum 203, it is known that the increase of torque varies according to the weight of clothes in drum 203.

[0141] The output torque is in proportion to a q-axis current value obtained when a DC brushless motor is vector-controlled as generally known, and the current value of drum drive motor 207 is measured by using the property to make it possible to determine the quality of cloth on the basis of the output torque characteristic of drum drive motor 207.

[0142] With the detected current value, torque values are ranked on the basis of the output torque characteristic of drum drive motor 207, and, on the basis of data of a cloth weight derived from weight determination of clothes and the torque rank of drum drive motor 207 derived from the output torque determination rank, the quality of cloth is determined with reference to a cloth quality criterion stored in controller 222.

[0143] Clothes put into drum 203 are wetted with washing water to absorb water and increase in weight. When the quality of cloth is cotton, the clothes have water absorption higher than that of chemical-fiber clothes and increase in water content. For this reason, by using a difference between water contents changing before and after the clothes are wetted with the washing water, a difference between the qualities of clothes is determined.

[0144] Cloth quality levels determined by the cloth quality determining unit 227 are classified in three stages, and the cloth quality levels are held as a table to determine the water absorptions as "low", "standard", and "high". When the water absorption is determined as "low", it is understood that the clothes in drum 203 include a large amount of chemical-fiber clothes. For this reason, controller 222 controls drum drive motor 207 to rotate drum 203 at 37 rpm to 41 rpm.

[0145] In this manner, as shown in FIG. 10A, when drum 203 rotates in the direction of arrow A, the clothes are lifted up by baffles 204 in the rotation direction. The clothes collide with baffles 204 while rolling on the bottom in drum 203, and mechanical force generated by the collision with baffles 204 can effectively clean laundry including chemical-fiber clothes (agitating step).

[0146] When the water absorption is determined as "high", it is understood that the clothes in drum 3 include a large amount of cotton clothes. For this reason, controller 222 controls drum drive motor 207 to cause circulating pump 217 to circulate the washing water in water collecting portion 213 into drum 203, and drum 203 is rotated at a rotational speed increased from 150 rpm to 200 rpm.

[0147] In this manner, as shown in FIG. 10B, when drum 203 rotates in the direction of arrow A, the laundry is stuck to the inner surface of drum 203 with centrifugal force. At this time, when the washing water contained in the laundry is temporarily discharged out of the laundry with centrifugal force to remove dirt collected between fibers and to make it possible to enhance an exchange of washing water in the fibers. For this reason, the laundry of cotton clothes can be effectively cleaned (centrifugal cleaning step).

[0148] As in the rinsing step executed subsequent to the washing step, after the washing water in water tab 202 is drained, water supply valve 210 opens to start water supply, and a predetermined amount of rinse water is supplied into water tab 202. When water level detector 226 detects that set amount of washing water is supplied, the water supply is stopped to drive drum drive motor 207. In the rinsing step, drum 203 is rotationally driven in forward/backward direction by drum drive motor 207, and the laundry in drum 203 is lifted up and dropped on the water surface.

[0149] At this time, heater 214 disposed on the bottom of water tab 202 is turned on to heat rinse water in water tab 202 to make it possible to perform rinsing. For this reason, also in the rinsing step, when the switching valve 220 is switched to circulating water path 216 side to operate circulating pump 217, the rinse water is circulated in drum 203, detergent component and remaining dirt are early separated from the clothes, and rinse effect can be improved.

[0150] As described above, in the embodiment, when cloth quality determining unit 227 determines that the clothes

of laundry include large amount of chemical-fiber clothes, in the washing step, drum 203 is rotationally driven at a rotational speed at which the laundry rolls on the bottom of drum 203. When it is determined that the clothes include a large amount of cotton clothes, in the washing step, drum 203 is rotationally driven at a rotational speed at which the laundry is stuck to the inner surface of drum 203. In this manner, even though the laundry includes a large amount of cotton clothes or a large amount of chemical-fiber clothes, in the washing step, drum 203 is optimally driven, cleaning can be effectively performed regardless of the quality of cloth, and removal efficiency of dirt of the chemical-fiber clothes can be improved.

EIGHTH EXEMPLARY EMBODIMENT

[0151] FIG. 11 is a time chart showing an operation of a drum-type washing machine according to the eighth embodiment of the present invention. As a characteristic feature of the embodiment, when cloth quality determining unit 227 serving as a state detector that detects a state of laundry in drum 203 determines that the laundry equally includes cotton clothes and chemical-fiber clothes, in the washing step, forward/backward rotation is repeated at a rotational speed (agitating step) at which the laundry rolls on the bottom of drum 203 and a rotational speed (centrifugal cleaning step) at which the laundry is stuck to the inner surface of drum 203. The other configurations are the same as those in the seventh embodiment, the same reference numerals as in the seventh embodiment denote the same configurations, and, as a detailed description, the detailed description of the seventh embodiment is invoked.

[0152] When water absorption of a cloth quality level determined by cloth quality determining unit 227 serving as a state detector that detects a state of laundry in drum 203 is determined as "standard", i.e., when it is determined that the laundry equally includes cotton clothes and chemical-fiber clothes, in the washing step, after forward/backward rotational driving is performed for a predetermined time at a rotational speed at which the laundry rolls on the bottom of drum 203, forward/backward rotation is performed for a predetermined time at a rotational speed at which the laundry is stuck to the inner surface of drum 203 and this rotation is repeated.

[0153] With the above configuration, even though the laundry almost equally includes both cotton clothes and chemical-fiber clothes, replacement of positions of the laundry in drum 203 can be enhanced. For this reason, uneven washing is eliminated to make it possible to improve a cleaning effect.

NINTH EXEMPLARY EMBODIMENT

[0154] As a characteristic feature of the embodiment, when weight detector 225 determines that an amount of laundry is large and when cloth quality determining unit 227 determines that the laundry includes a large amount of cotton clothes, in the washing step, drum 203 is rotated at a rotational speed at which the laundry is stuck to the inner surface of drum 203, and circulating pump 217 serving as a circulating unit sprays the washing water in water tab 202 onto the laundry in drum 203. The other configurations are the same as those in the seventh and eighth embodiments, the same reference numerals as in the seventh and eighth embodiments denote the same configurations, and, as a detailed description, the detailed descriptions of the seventh and eighth embodiments are invoked.

[0155] When weight detector 225 and cloth quality determining unit 227 determine that an amount of laundry is large and that the laundry includes a large amount of cotton clothes, controller 222 controls drum drive motor 207 to cause circulating pump 217 to circulate washing water in water collecting portion 213 into drum 203 and drum 203 is rotated at a rotational speed increased from 150 rpm to 200 rpm.

[0156] In this manner, as shown in FIG. 10B, when drum 203 rotates in the direction of arrow A, the laundry is stuck to the inner surface of drum 203 with centrifugal force (centrifugal cleaning step). At this time, when the washing water contained in the laundry is temporarily discharged out of the laundry with centrifugal force to remove dirt collected between fibers and to make it possible to enhance an exchange of washing water in the fibers. For this reason, the laundry of cotton clothes can be effectively cleaned.

[0157] In particular, when a large amount of laundry that is the rated capacity of drum 203 or an amount being close thereto is put into drum 203, drum 203 has a small space in which the laundry can freely move. Thus, in low-speed rotation or beat washing (55 rpm to 65 rpm), mechanical force cannot be applied to the laundry, and dirt of the laundry cannot be effectively removed. For this reason, since drum 3 is rotated at a high speed (150 rpm to 200 rpm) to apply centrifugal force to the laundry to make it possible to actively exchange washing water between fibers, effective cleaning can be performed.

INDUSTRIAL APPLICABILITY

[0158] As described above, since a drum-type washing machine according to the present invention can perform a low-power-consumption washing operation with optimum high detergency according to a degree of dirt of laundry, the present invention is useful for the drum-type washing machine.

REFERENCE MARKS IN THE DRAWINGS

[0159]

1, 100, 201	housing
2, 102, 202	water tab
3, 101, 203	drum
3a	rotary shaft
3b, 206	opening
4, 103, 207	drum drive motor (drum drive unit)
4a to 4c, 103a to 103c	three-phase coil
5, 211	water supply path
6, 105, 210	water supply valve
7, 118, 212	detergent case
8, 119	water supply pipe
10, 106	water intake
11, 107	drain valve
12, 108	drain pipe
13, 109	water level sensor
14, 110	discharge port
15, 111, 216	circulating water path
16, 112, 217	circulating pump (circulating unit)
17, 113	drain filter
18	dirt sensor (dirt detector)
19, 115, 223	door
20, 116	protrusion
21, 117, 205	through hole
27a to 27c, 127a to 127c	position detecting element
30, 170, 222	controller
31, 130	input setting unit
32, 131	display unit
33, 171	timer
34, 172	rotational speed detector
35, 173	cloth volume detector
40, 120	AC power
41, 124	rectifier
42, 125	choke coil
43, 126	smoothing capacitor
44, 122	inverter circuit
44a to 44f, 122a to 122f	switching element
45, 123	load drive unit
46, 121	inverter drive circuit
104	water supply inlet
114	turbidity sensor
132	detergent amount determining unit
133	detergent weight detector
204	baffle
208	belt
209	pulley
213	water collecting portion
214	heater
215	temperature detector
218	sucking unit
219	discharging unit
220	switching valve
221	drain path
224	operation unit
225	weight detector

227 cloth quality determining unit

Claims

1. A drum-type washing machine comprising:

   a water tab elastically supported in a housing;
   a drum rotatably disposed in the water tab;
   a drum drive unit that rotationally drives the drum;
   a state detector that detects a state of laundry in the drum; and
   a controller that receives an output from the state detector and sequentially controls steps including washing, rinsing, and spin-drying steps,
   wherein the washing step includes an agitating step for rotating the drum at a low speed which does not stick the laundry to the inside of the drum, and a centrifugal cleaning step for rotating the drum at a high speed which stick the laundry to an inner peripheral wall surface of the drum to discharge washing water from the laundry by centrifugal force, and
   the controller controls an operation of the drum drive unit in the washing step according to the output from the state detector.

2. The drum-type washing machine according to claim 1, wherein the state detector is a dirt detector that detects dirt of the laundry in the drum, and
   the controller changes a rotational speed of the drum in the centrifugal cleaning step according to the dirt detected by the dirt detector.

3. The drum-type washing machine according to claim 2, wherein the controller increases the rotational speed of the drum in the centrifugal cleaning step with increase in a degree of dirt detected by the dirt detector.

4. The drum-type washing machine according to claim 2, comprising a wetting unit that wets the laundry with the washing water,
   wherein the wetting unit wets the laundry with the washing water in the centrifugal cleaning step.

5. The drum-type washing machine according to claim 4, wherein the wetting unit partially submerges the laundry in the washing water in the water tab to wet the laundry.

6. The drum-type washing machine according to claim 4, wherein the wetting unit is configured of a circulating unit that circulates the washing water in the water tab into the drum.

7. The drum-type washing machine according to claim 2, wherein the dirt detector performs detection by using at least one of sensors for turbidity, conductivity, and color (loss).

8. The drum-type washing machine according to claim 1, wherein the state detector is a detergent amount determining unit that determines an amount of detergent, and
   the controller decreases a rotational speed of the drum in the centrifugal cleaning step with increase in the amount of detergent determined by the detergent amount determining unit.

9. The drum-type washing machine according to claim 8, further comprising a wetting unit that wets the laundry with the washing water,
   wherein the wetting unit wets the laundry with the washing water in the centrifugal cleaning step.

10. The drum-type washing machine according to claim 9, wherein the wetting unit partially submerges the laundry in the washing water collected in an inner bottom portion of the water tab to wet the laundry.

11. The drum-type washing machine according to claim 9, wherein the wetting unit is configured of a circulating unit that circulates the washing water in the water tab into the drum.

12. The drum-type washing machine according to claim 8, wherein determination of the amount of detergent by the detergent amount determining unit is performed by using at least one of sensors for turbidity, conductivity, and

chromaticity.

13. The drum-type washing machine according to claim 8, further comprising a cloth volume detector that detects an amount of accommodated laundry,
wherein the detergent amount determining unit determines the amount of detergent according to the amount of laundry detected by the cloth volume detector.

14. The drum-type washing machine according to claim 8, further comprising:

a detergent dispenser to load the detergent; and
a detergent weight detector that detects a weight of the detergent in the detergent dispenser, wherein
the detergent amount determining unit determines the amount of detergent according to the weight of the detergent detected by the detergent weight detector.

15. The drum-type washing machine according to claim 8, further comprising an input setting unit,
wherein the detergent amount determining unit determines the amount of detergent according to an amount of detergent set through the input setting unit.

16. The drum-type washing machine according to claim 1, wherein the state detector is a cloth quality determining unit that determines a quality of cloth of the laundry.

17. The drum-type washing machine according to claim 16, comprising
a circulating unit that circulates the washing water in the water tab into the drum,
wherein the controller
performs the agitating step in the washing step when the cloth quality determining unit determines that the laundry includes a large amount of chemical-fiber clothes, or
performs the centrifugal cleaning step in the washing step when the cloth quality determining unit determines that the laundry includes a large amount of cotton clothes, and causes the circulating unit to spray the washing water in the water tab onto the laundry in the drum.

18. The drum-type washing machine according to claim 17, wherein the controller repeats forward/backward rotation in the agitating step and the centrifugal cleaning step in the washing step when the cloth quality determining unit determines that the laundry is not substantially uneven in amounts between cotton clothes and chemical-fiber clothes.

19. The drum-type washing machine according to claim 17, wherein the state detector additionally includes a weight detector that detects an amount of the laundry put into the drum, and
the controller performs the centrifugal cleaning step in the washing step to cause the circulating unit to spray the washing water in the water tab onto the laundry in the drum, when the weight detector determines that the amount of laundry is large and when the cloth quality determining unit determines that the laundry includes a large amount of cotton clothes.

FIG. 1

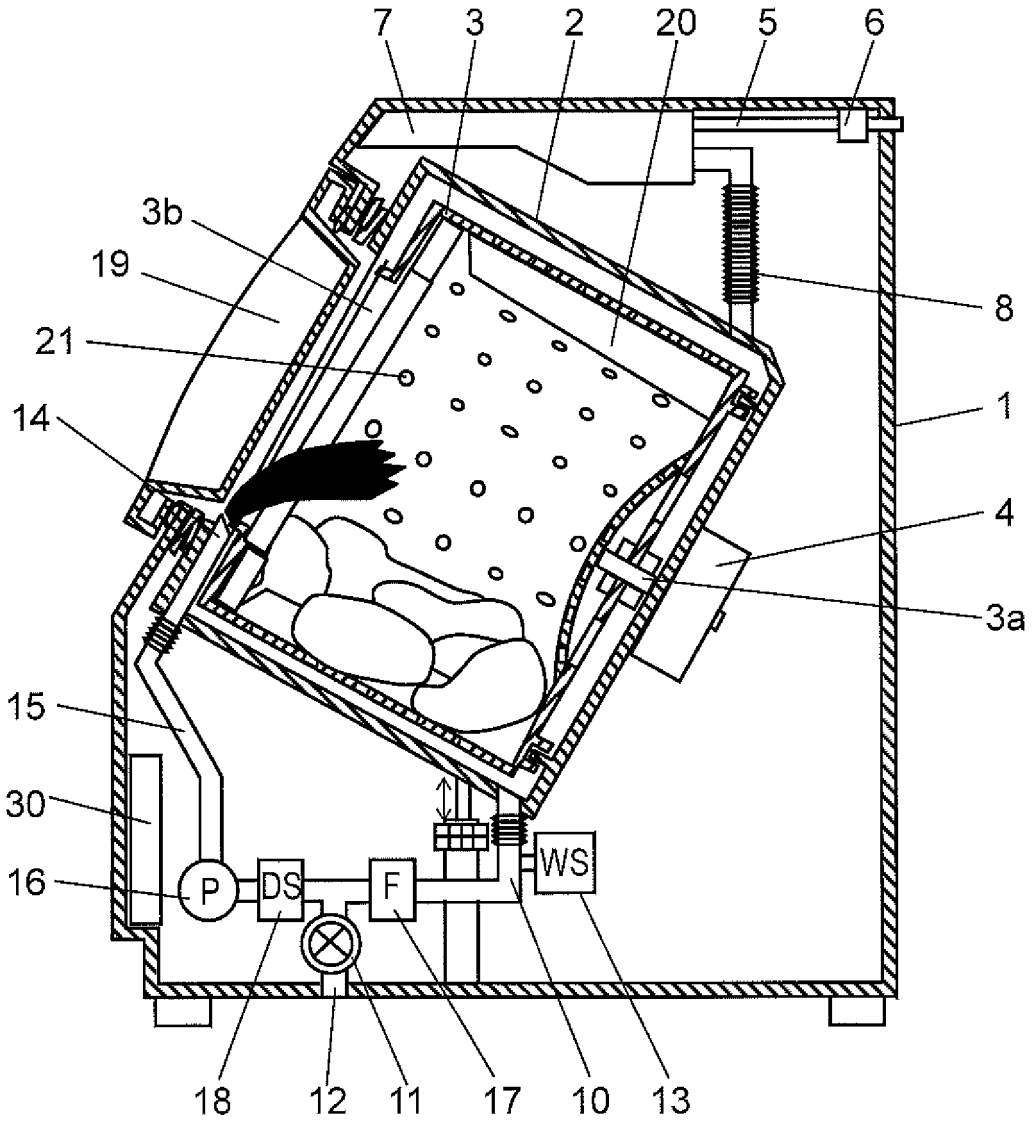


FIG. 2

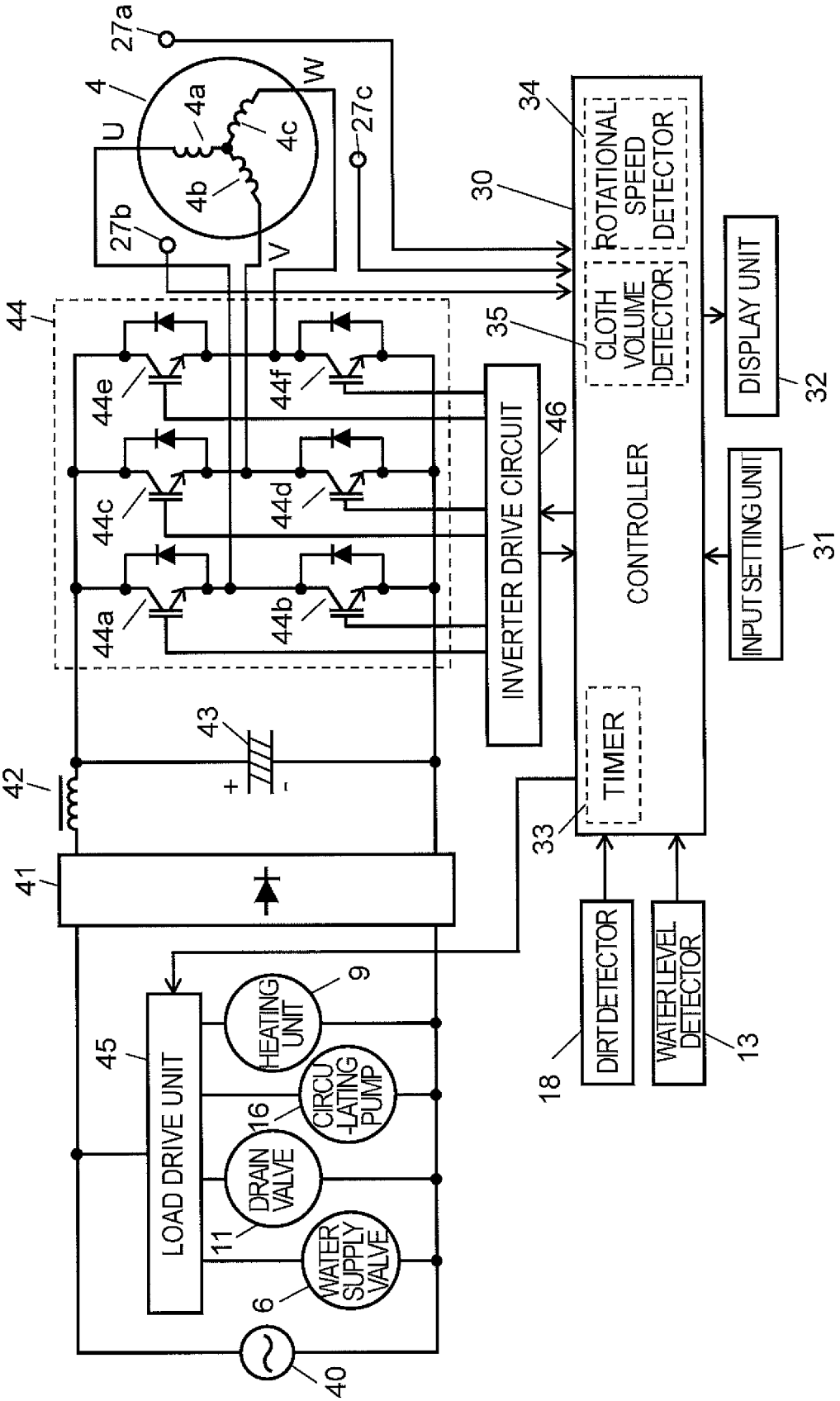

27a
4
U
4a
W
4c
27c
4b
27b
V
34
30
ROTATIONAL SPEED DETECTOR
CLOTH VOLUME DETECTOR
44
35
DISPLAY UNIT
32
44e
44f
INVERTER DRIVE CIRCUIT
46
44c
44d
CONTROLLER
INPUT SETTING UNIT
31
44a
44b
43
42
TIMER
33
41
45
HEATING UNIT
9
LOAD DRIVE UNIT
CIRCU-LATING PUMP
16
DRAIN VALVE
11
WATER SUPPLY VALVE
6
40
DIRT DETECTOR
18
WATER LEVEL DETECTOR
13

FIG. 3A

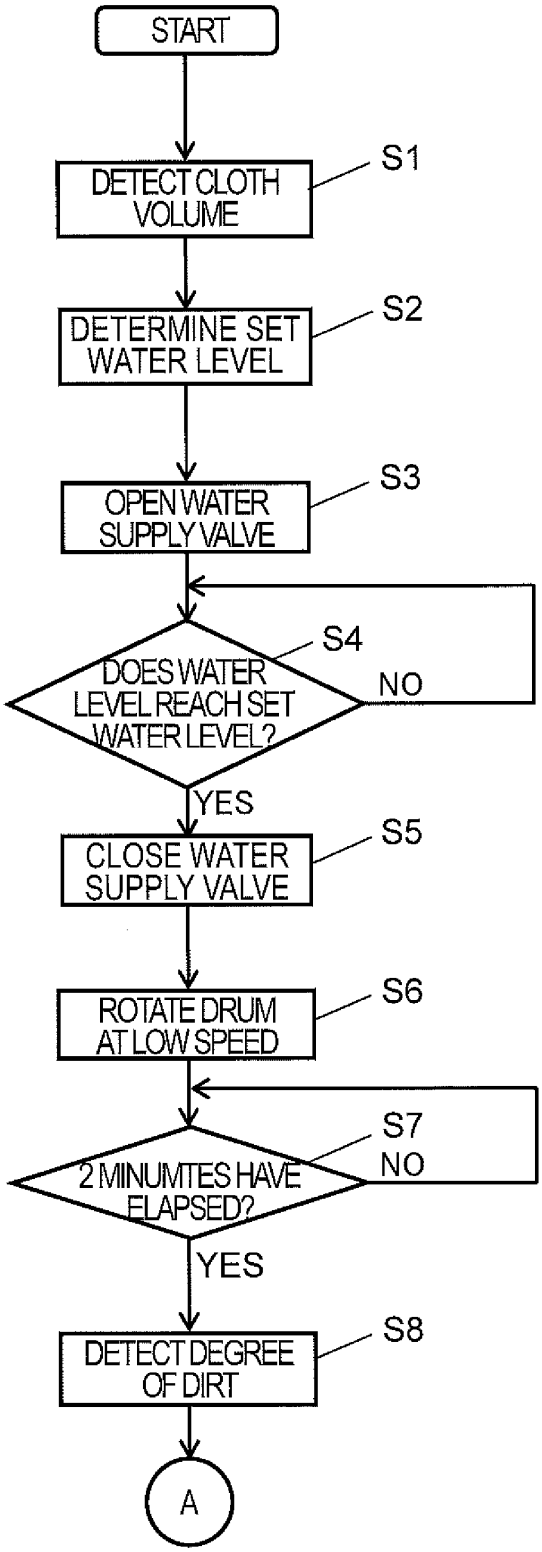

START
DETECT CLOTH VOLUME
S1
DETERMINE SET WATER LEVEL
S2
OPEN WATER SUPPLY VALVE
S3
DOES WATER LEVEL REACH SET WATER LEVEL?
S4
NO
YES
CLOSE WATER SUPPLY VALVE
S5
ROTATE DRUM AT LOW SPEED
S6
2 MINUMTES HAVE ELAPSED?
S7
NO
YES
DETECT DEGREE OF DIRT
S8
A

FIG. 3B

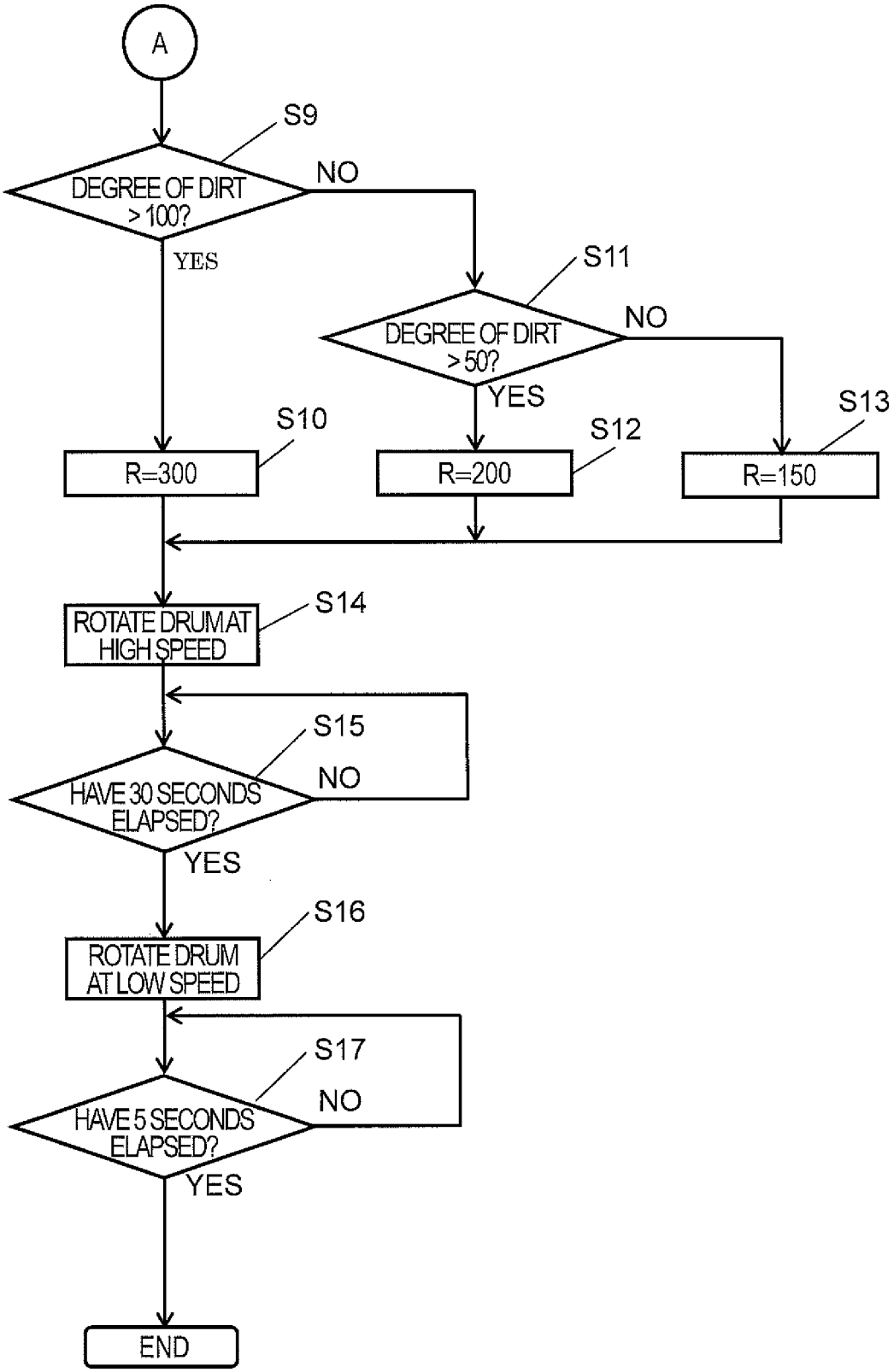

A
S9
DEGREE OF DIRT > 100?
NO
YES
S11
DEGREE OF DIRT > 50?
NO
YES
S10
S12
S13
R=300
R=200
R=150
S14
ROTATE DRUM AT HIGH SPEED
S15
HAVE 30 SECONDS ELAPSED?
NO
YES
S16
ROTATE DRUM AT LOW SPEED
S17
HAVE 5 SECONDS ELAPSED?
NO
YES
END

FIG.4

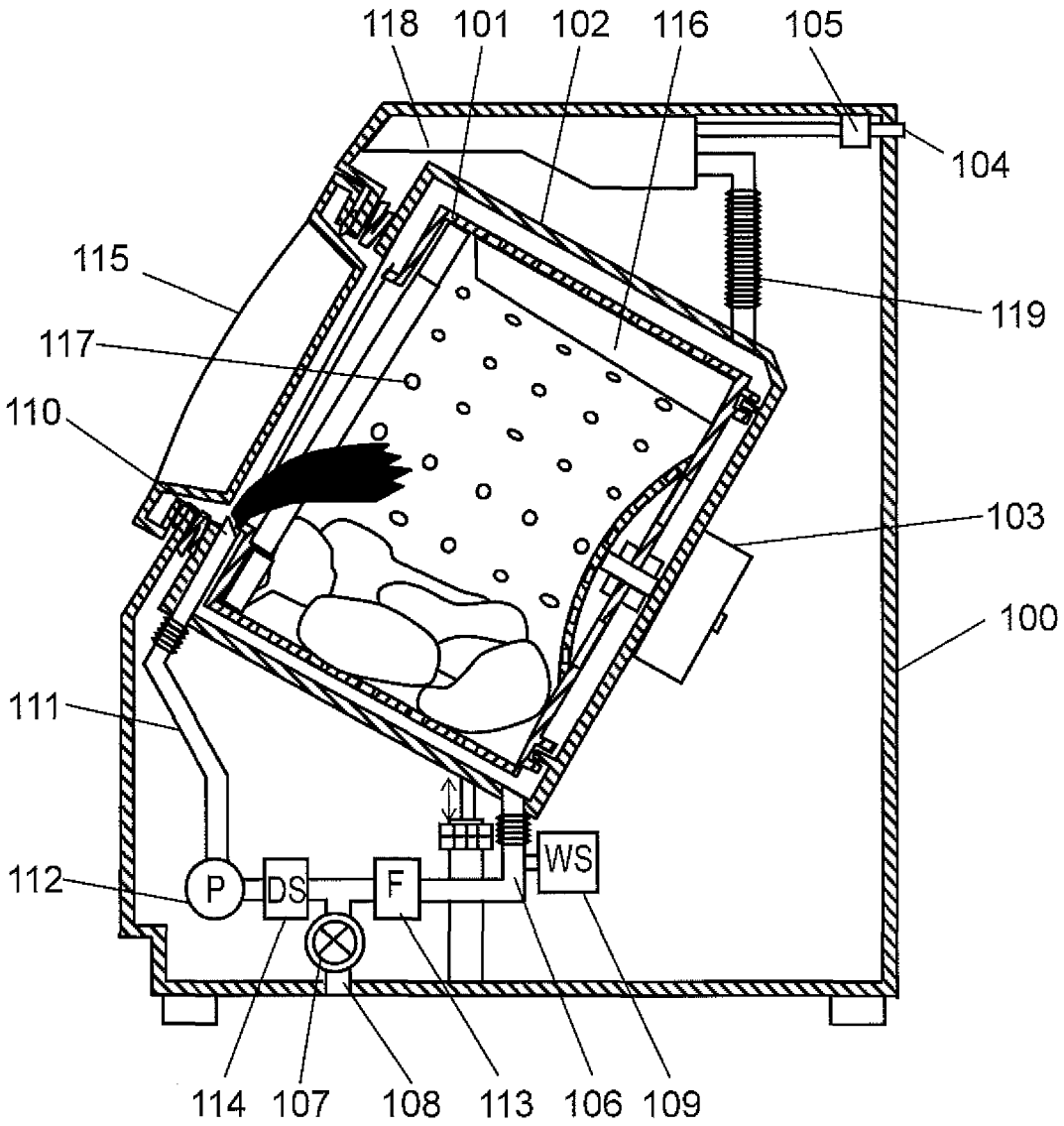

118
101
102
116
105
104
115
119
117
110
103
100
111
112
P
DS
F
WS
114
107
108
113
106
109

FIG. 5

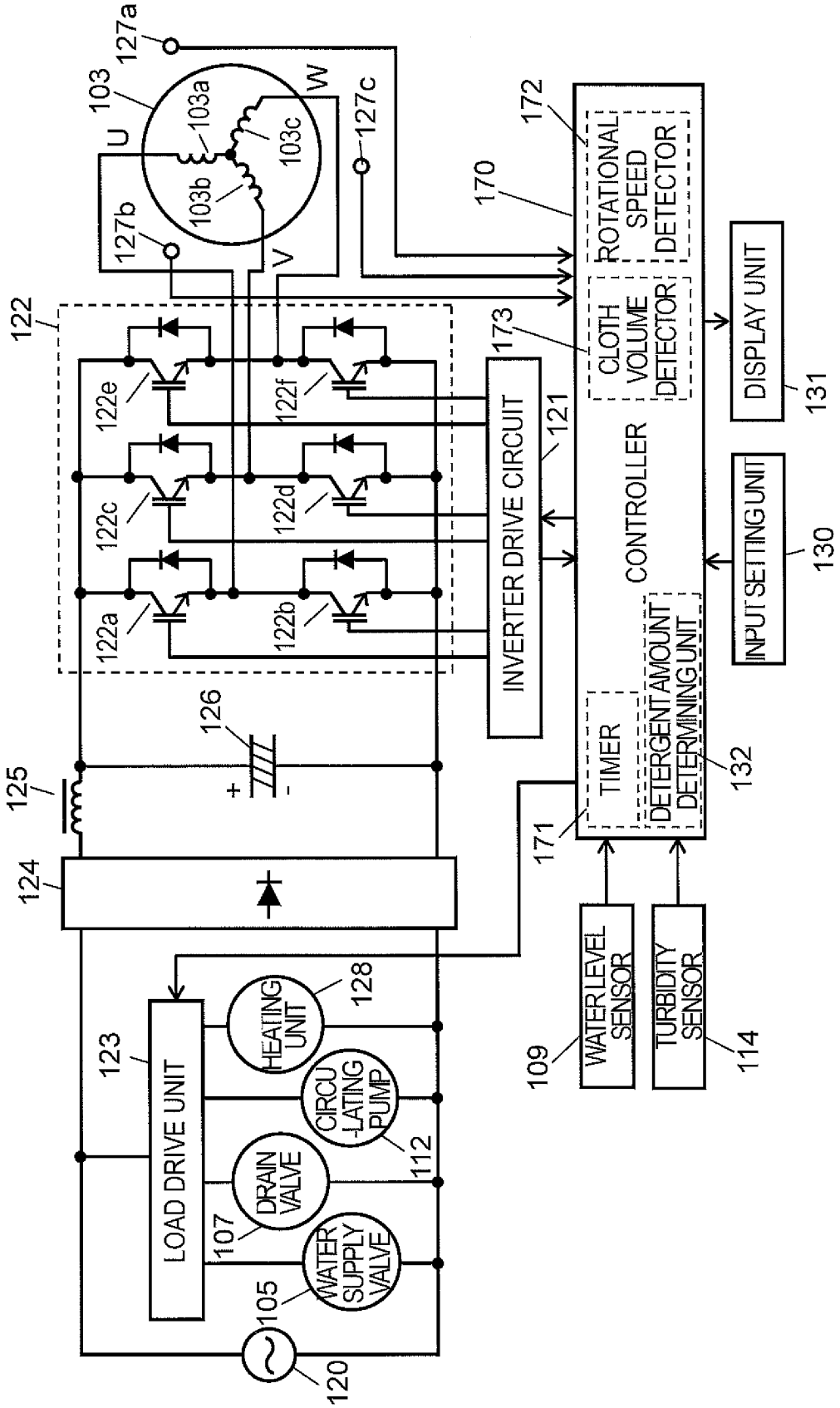

127a
103
U
103a
W
103c
127c
103b
127b
V
122
122e
122f
122c
122d
122a
122b
126
125
124
123
LOAD DRIVE UNIT
HEATING UNIT
128
CIRCU LATING PUMP
112
DRAIN VALVE
107
WATER SUPPLY VALVE
105
120
INVERTER DRIVE CIRCUIT
173
121
170
172
ROTATIONAL SPEED DETECTOR
CLOTH VOLUME DETECTOR
CONTROLLER
TIMER
DETERGENT AMOUNT DETERMINING UNIT
171
132
DISPLAY UNIT
131
INPUT SETTING UNIT
130
WATER LEVEL SENSOR
109
TURBIDITY SENSOR
114

FIG. 6A

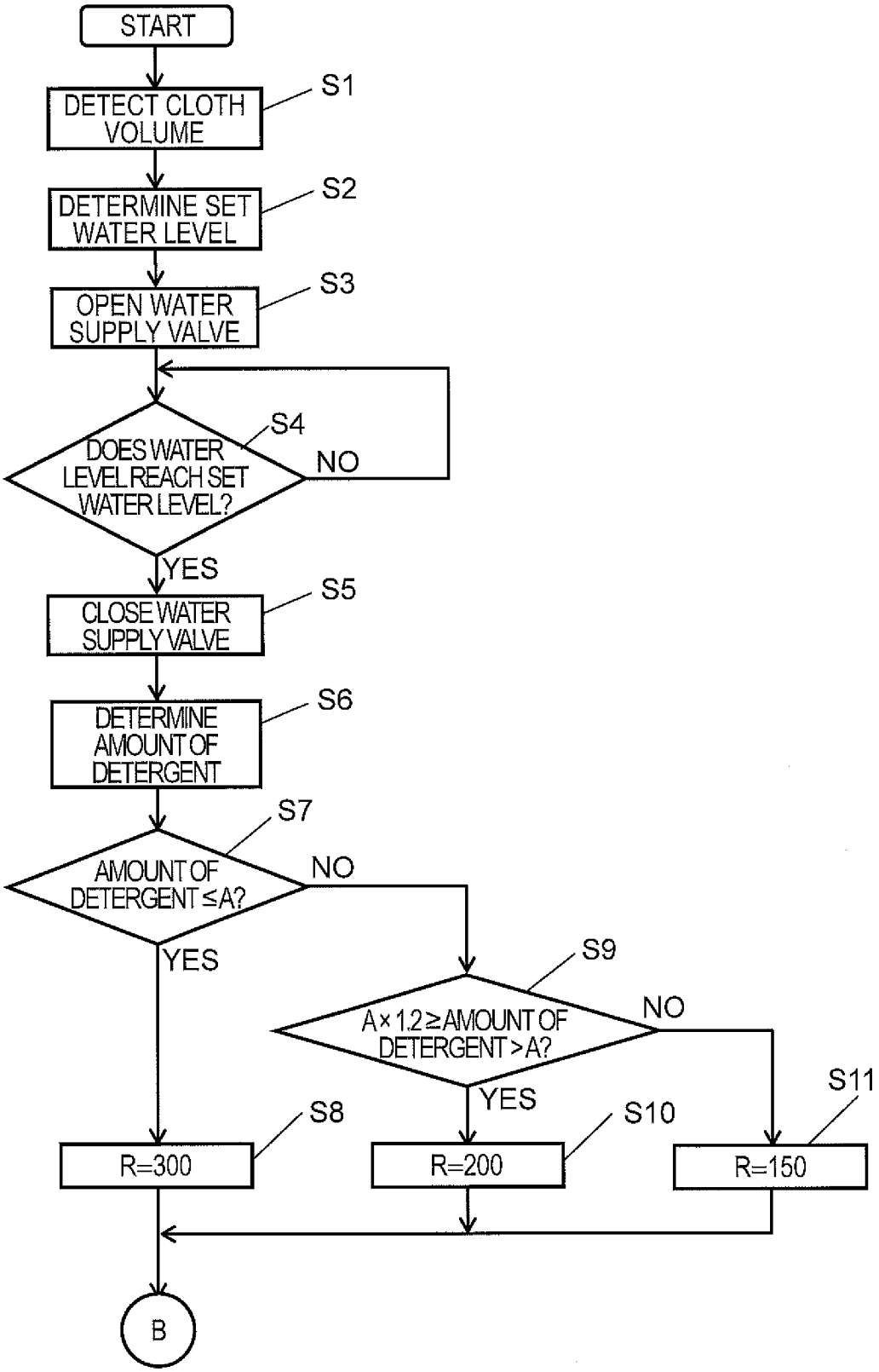

START
DETECT CLOTH VOLUME
S1
DETERMINE SET WATER LEVEL
S2
OPEN WATER SUPPLY VALVE
S3
DOES WATER LEVEL REACH SET WATER LEVEL?
S4
NO
YES
CLOSE WATER SUPPLY VALVE
S5
DETERMINE AMOUNT OF DETERGENT
S6
AMOUNT OF DETERGENT ≤ A?
S7
NO
YES
A × 1.2 ≥ AMOUNT OF DETERGENT > A?
S9
NO
YES
R=300
S8
R=200
S10
R=150
S11
B

FIG. 6B

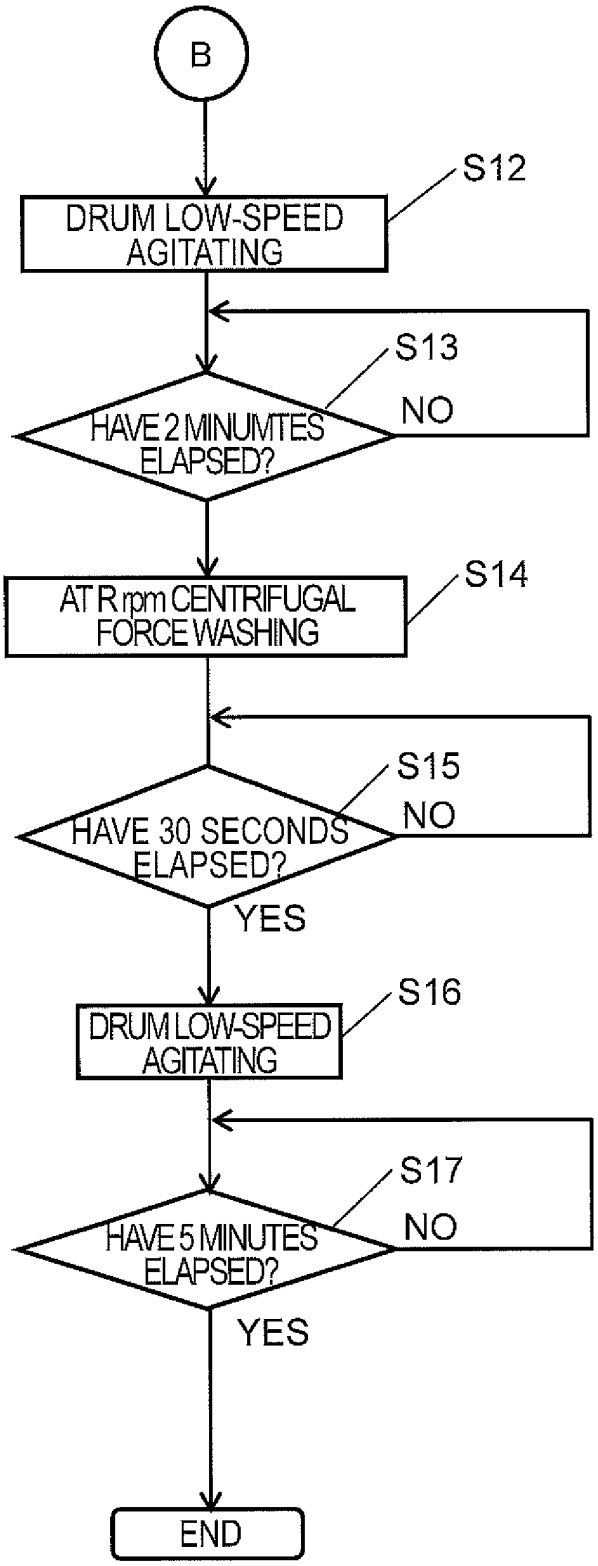

B
S12
DRUM LOW-SPEED AGITATING
S13
HAVE 2 MINUMTES ELAPSED?
NO
S14
AT R rpm CENTRIFUGAL FORCE WASHING
S15
HAVE 30 SECONDS ELAPSED?
NO
YES
S16
DRUM LOW-SPEED AGITATING
S17
HAVE 5 MINUTES ELAPSED?
NO
YES
END

FIG. 7

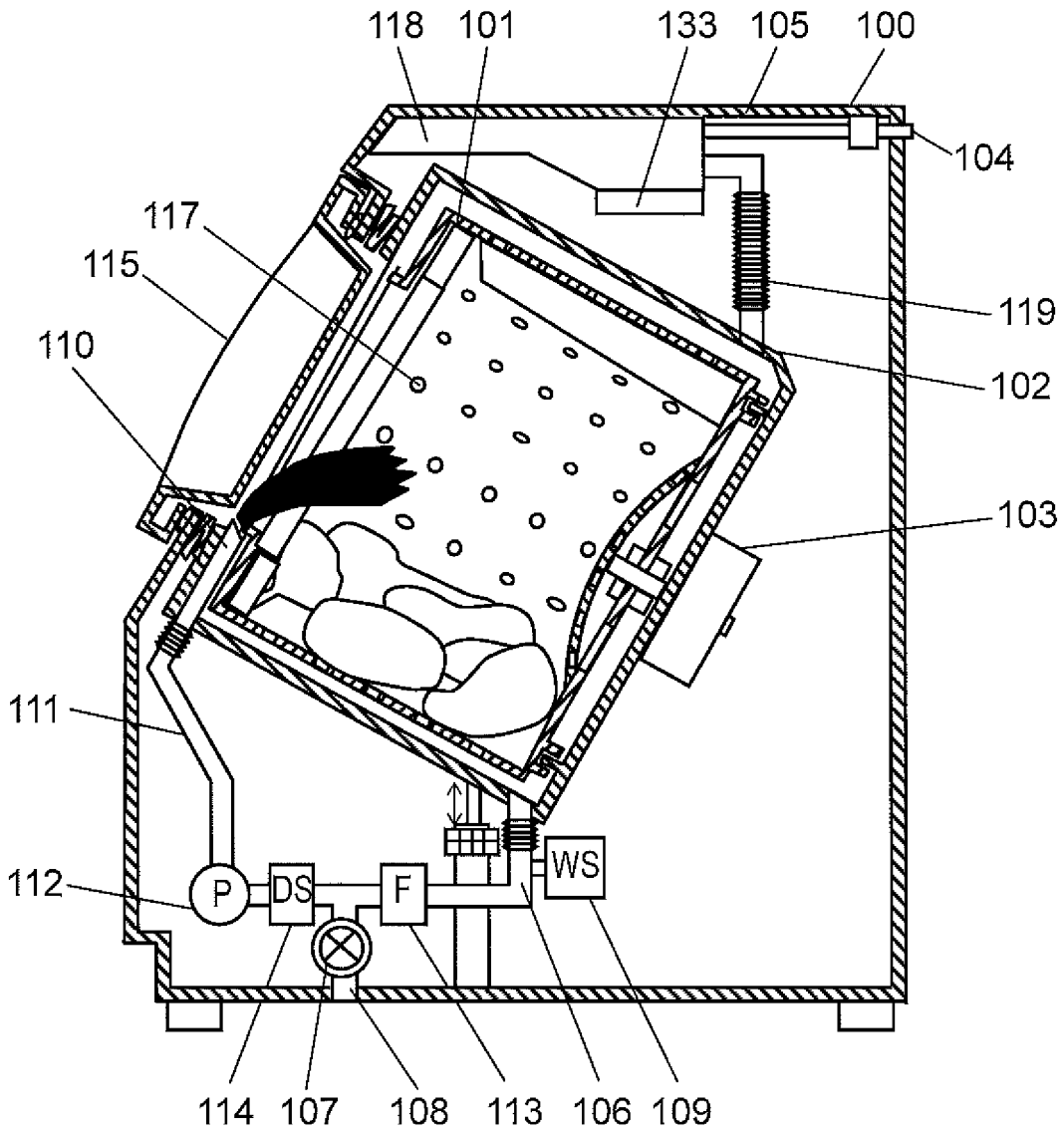

118
101
133
105
100
104
117
115
110
119
102
103
111
112
P
DS
F
WS
114
107
108
113
106
109

FIG. 8

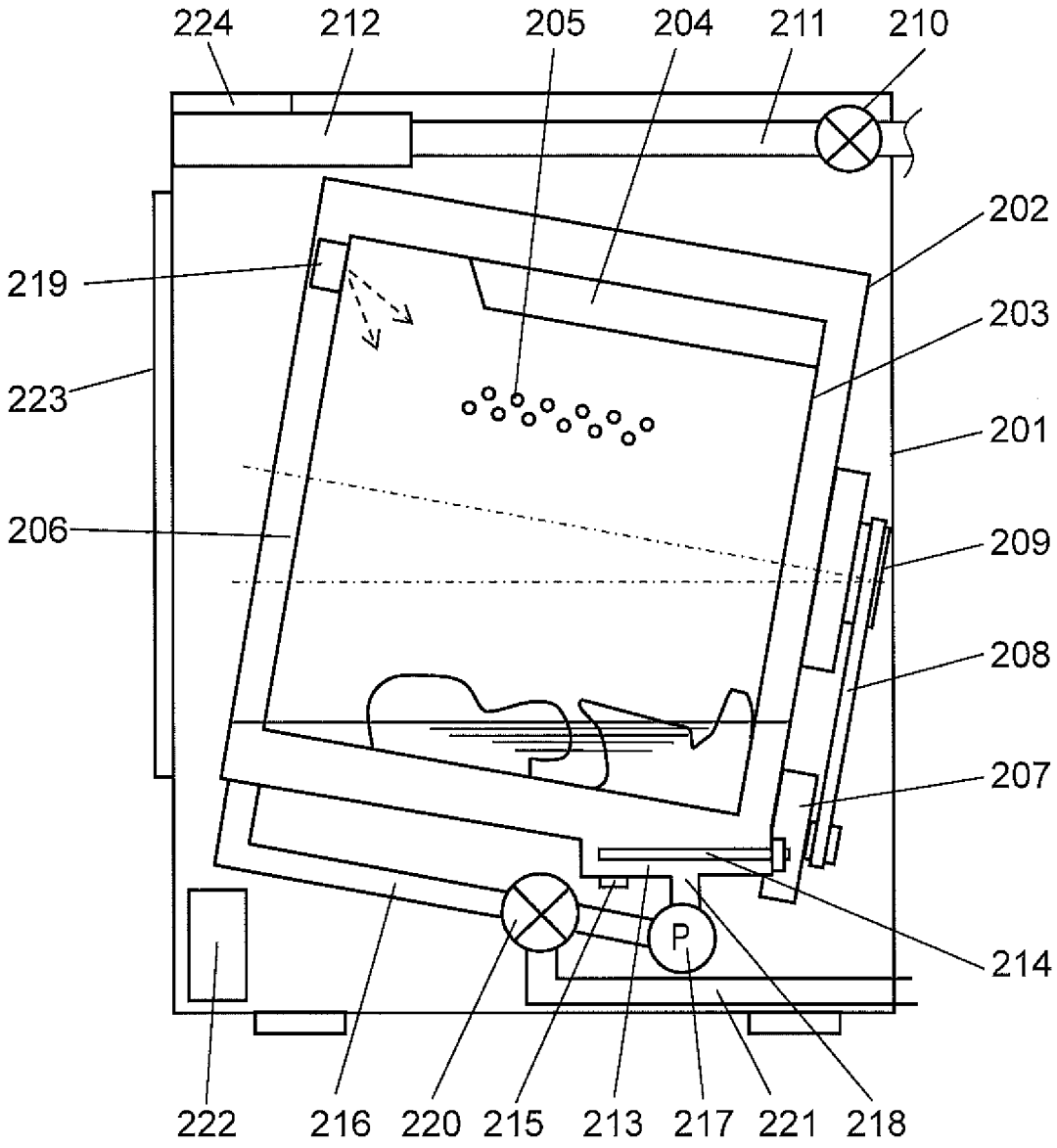

224
212
205
204
211
210
202
219
203
223
201
206
209
208
207
214
P
222
216
220
215
213
217
221
218

FIG. 9

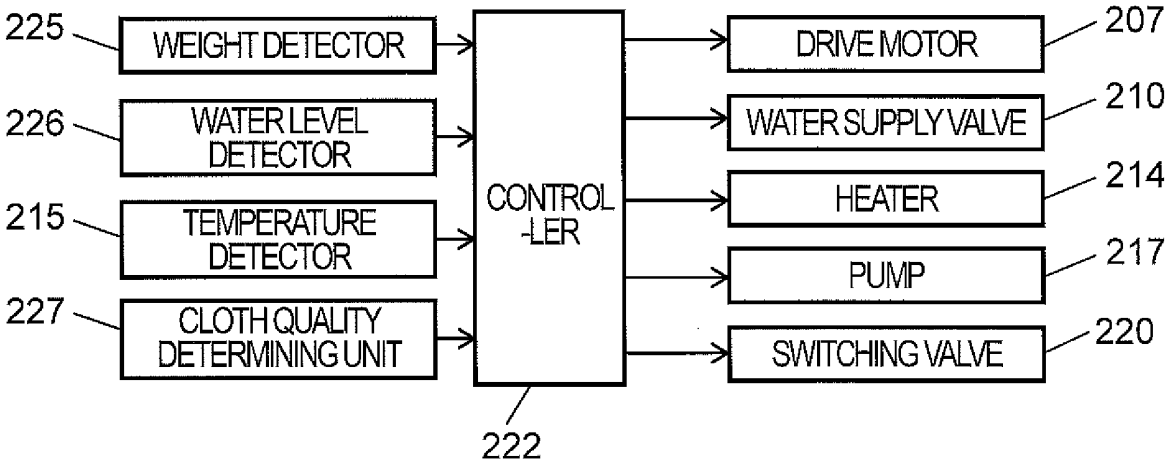


FIG. 10A

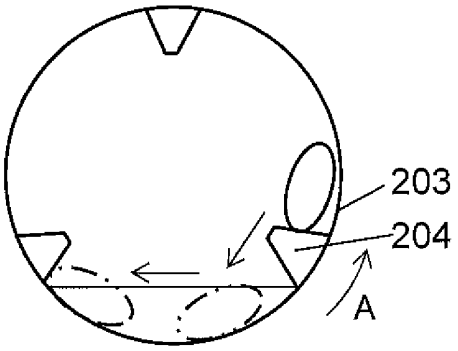


FIG. 10B

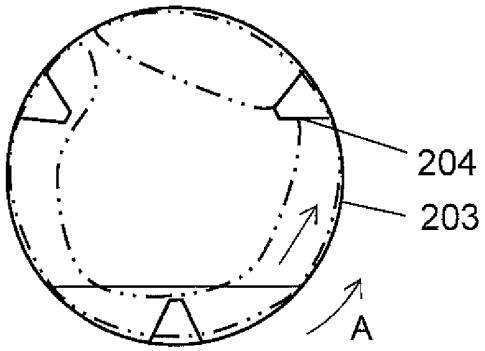
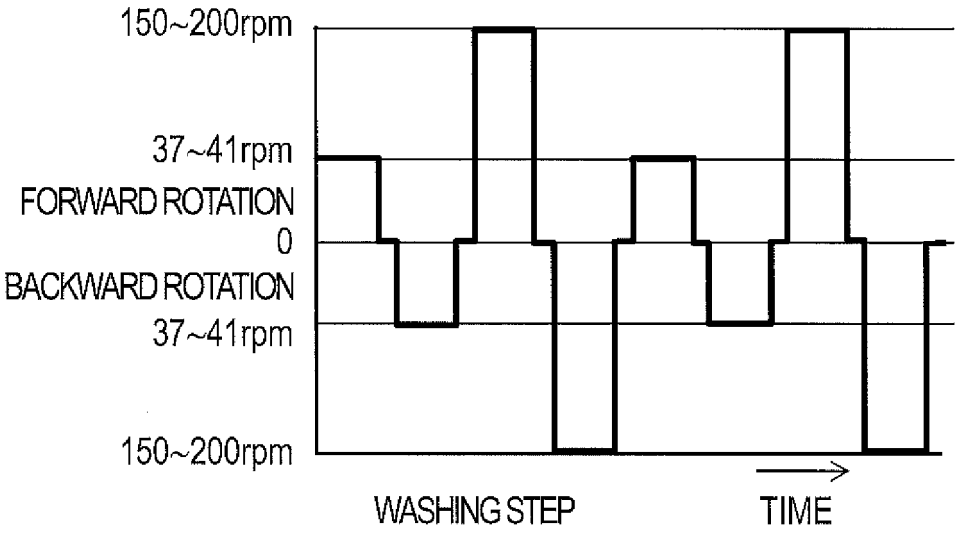


FIG. 11


150~200rpm
37~41rpm
FORWARD ROTATION
0
BACKWARD ROTATION
37~41rpm
150~200rpm
WASHING STEP
TIME

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/001756

A. CLASSIFICATION OF SUBJECT MATTER
D06F33/02(2006.01)i, *D06F25/00*(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)
D06F33/02, D06F25/00

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 A	JP 08-299658 A (Toshiba Corp.), 19 November 1996 (19.11.1996), entire text; all drawings & US 5870905 A & EP 742307 A1 & DE 69614306 D & DE 69635590 D & KR 10-0220275 B	1-7,16-19 8-15
Y	JP 2010-268938 A (Panasonic Corp.), 02 December 2010 (02.12.2010), paragraph [0033] (Family: none)	1-7

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

* Special categories of cited documents:
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"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	Date of mailing of the international search report
11 June, 2012 (11.06.12)	19 June, 2012 (19.06.12)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/001756

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 06-327879 A (Toshiba Corp.), 29 November 1994 (29.11.1994), paragraphs [0053] to [0056], [0068] to [0073]; fig. 11, 16 to 18 & US 5469719 A & GB 2276394 A & GB 9405739 A0 & KR 10-0129685 B	1-7,16-19 8-15
Y A	JP 2011-152251 A (Panasonic Corp.), 11 August 2011 (11.08.2011), paragraph [0036] (Family: none)	7 12
Y	JP 2008-006179 A (Toshiba Corp.), 17 January 2008 (17.01.2008), paragraphs [0023] to [0025] (Family: none)	16-19
A	JP 2000-116979 A (Matsushita Electric Industrial Co., Ltd.), 25 April 2000 (25.04.2000), paragraphs [0023] to [0029]; fig. 2 to 5 (Family: none)	8-15
A	JP 2003-340188 A (Matsushita Electric Industrial Co., Ltd.), 02 December 2003 (02.12.2003), entire text; all drawings & CN 1460744 A	8-15

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 8299658 A **[0012]**
- JP 2008006179 A **[0012]**
- JP 11114278 A **[0012]**