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(71) Applicant: **Panasonic Intellectual Property Management Co., Ltd.**
Osaka-shi, Osaka 540-6207 (JP)

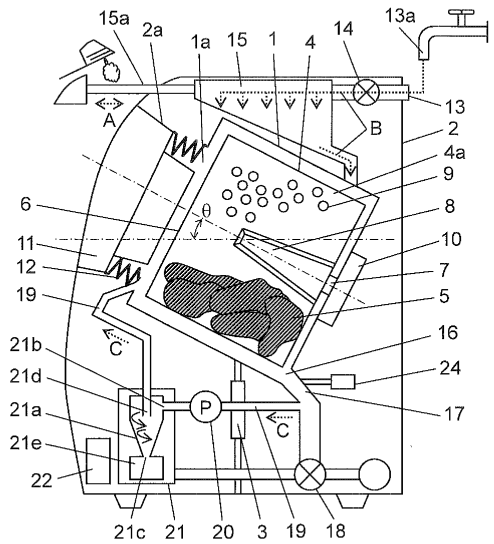
(72) Inventor: **KURAKAKE, Toshiyuki**
Osaka-shi,
Osaka 540-6207 (JP)

(74) Representative: **SSM Sandmair**
Patentanwälte Rechtsanwalt Partnerschaft mbB
Joseph-Wild-Straße 20
81829 München (DE)

(54) WASHING MACHINE

(57) A washing machine according to the present disclosure includes: an outer tank elastically supported in a chassis; a washing tub rotatably provided in the outer tank; a motor that rotationally drives the washing tub; a centrifugal separator that centrifugally separates foreign substances contained in washing water in the outer tank; a water supply passage that returns the washing water in the outer tank into the outer tank through the centrifugal separator; a pump that circulates the washing water in the outer tank through the centrifugal separator provided on the water supply passage; and a controller that performs a washing operation by sequentially controlling each of a washing step, a rinsing step, and a spin-drying step. In the washing step, the controller causes the centrifugal separator to start centrifugal separation after hardness of washing water in the outer tank has decreased.

FIG. 1



EP 3 428 339 A1

Description

TECHNICAL FIELD

[0001] The present disclosure relates to a washing machine that washes textile goods such as clothes.

BACKGROUND ART

[0002] In conventional washing machines, it is considered to clean washing water by separating impurities such as dirt and lint released from laundry during washing and to prevent the impurities from attaching to the laundry again (see PTLs 1 and 2, for example).

[0003] FIG. 21 is a schematic configuration diagram of a conventional washing machine. As shown in FIG. 21, cyclone type separator 54 is provided on a bath water supply passage configured with first water supply pipe 51, second water supply pipe 52, and third water supply pipe 53. When bath water supply pump 55 is driven at a time of washing, water in drum 56 is introduced from connecting pipe 57 into cyclone type separator 54. Then, cyclone type separator 54 removes impurities such as dirt and lint released from laundry. Water from which the impurities are removed is returned into drum 56 through second water supply pipe 52 and first water supply pipe 51.

[0004] Further, in PTL 2, in a so-called top-loading-type washing machine in which a rotation axis of the washing tub is set in a vertical direction, it is considered to separate, by a cyclone type lint separator, lint and solid substances mixed in washing water.

[0005] Tap water to be used as washing water contains metal ions such as calcium and magnesium. The metal ions bind with much anionic surfactant contained in a detergent, thereby reducing detergency of the surfactant. To address this issue, in order to prevent the metal ions contained in the washing water from lowing detergency, a powdery detergent for washing contains a water softening agent such as zeolite as an auxiliary washing agent that traps metal ions.

[0006] However, with the above conventional configuration, the cyclone type separator removes not only the impurities but also the water softening agent from the washing water. Therefore, there is an issue that the performance of the water softening agent that traps the metal ions in the washing water is weakened and that the detergency of the surfactant is accordingly lowered.

Citation List

Patent Literature

[0007]

PTL 1: Unexamined Japanese Patent Publication No. 2005-152212

PTL 2: Unexamined Japanese Patent Publication No. 2001-70694

SUMMARY OF THE INVENTION

[0008] The present disclosure is to solve the above conventional issue, and an object of the present disclosure is to provide a washing machine that can increase washing effect by decreasing reattachment of dirt to laundry without decreasing detergency.

[0009] To solve the above conventional issue, a washing machine of the present disclosure includes: an outer tank elastically supported in a chassis; a washing tub rotatably provided in the outer tank; a motor that rotationally drives the washing tub; a centrifugal separator that centrifugally separates foreign substances contained in washing water in the outer tank; a water supply passage that returns the washing water in the outer tank into the outer tank through the centrifugal separator; a pump that circulates the washing water in the outer tank through the centrifugal separator provided on the water supply passage; and a controller that performs a washing operation by sequentially controlling each of a washing step, a rinsing step, a spin-drying step, and the like. In the washing step, the controller causes the centrifugal separator to start centrifugal separation after hardness of washing water in the outer tank has decreased.

[0010] With this configuration, after the water softening agent contained in the detergent traps metal ions such as calcium and magnesium contained in the washing water and the hardness of the washing water is decreased, the washing water is supplied to the centrifugal separator to start centrifugal separation. This arrangement enables dirt substances to be separated from the washing water without decreasing the performance of the surfactant. As a result, the dirt is prevented from being reattaching to laundry, and a washing effect can be therefore increased.

[0011] A washing machine of the present disclosure can separate dirt substances from washing water without decreasing the performance of surfactant, and the dirt is thus prevented from reattaching to laundry, thereby increasing the washing effect.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

FIG. 1 is a schematic configuration diagram of a washing machine in a first exemplary embodiment of the present disclosure.

FIG. 2 is a block configuration diagram of the washing machine in the present exemplary embodiment.

FIG. 3 is a time chart showing a main part of an operation of the washing machine in the present exemplary embodiment.

FIG. 4 is a graph showing a change in hardness of washing water in the washing machine in the present exemplary embodiment.

FIG. 5 is a diagram for describing an operation of a

washing step of the washing machine in the present exemplary embodiment.

FIG. 6 is a time chart showing an operation of another example of the washing machine in the present exemplary embodiment.

FIG. 7 is a block configuration diagram of a washing machine in a second exemplary embodiment of the present disclosure.

FIG. 8 is a schematic configuration diagram of a washing machine in a third exemplary embodiment of the present disclosure.

FIG. 9 is a block configuration diagram of the washing machine in the present exemplary embodiment.

FIG. 10 is a schematic configuration diagram of a washing machine in a fourth exemplary embodiment of the present disclosure.

FIG. 11 is a configuration diagram of a main part of the washing machine in the present exemplary embodiment.

FIG. 12 is a time chart showing a main part of an operation of the washing machine in the present exemplary embodiment.

FIG. 13 is a schematic configuration diagram of a washing machine in a fifth exemplary embodiment of the present disclosure.

FIG. 14 is a configuration diagram of a main part of the washing machine in the present exemplary embodiment.

FIG. 15 is a block configuration diagram of the washing machine in the present exemplary embodiment.

FIG. 16 is a time chart showing a main part of an operation of the washing machine in the present exemplary embodiment.

FIG. 17 is a schematic configuration diagram of a washing machine in a sixth exemplary embodiment of the present disclosure.

FIG. 18 is a configuration diagram of a main part of the washing machine in the present exemplary embodiment.

FIG. 19 is a time chart showing a main part of an operation of the washing machine in the present exemplary embodiment.

FIG. 20 is a time chart showing an operation of another example of the washing machine in the present exemplary embodiment.

FIG. 21 is a schematic configuration diagram of a conventional washing machine.

DESCRIPTION OF EMBODIMENTS

[0013] A washing machine according to a first aspect includes: an outer tank elastically supported in a chassis; a washing tub rotatably provided in the outer tank; a motor that rotationally drives the washing tub; a centrifugal separator that centrifugally separates foreign substances contained in washing water in the outer tank; a water supply passage that returns the washing water in the outer tank into the outer tank through the centrifugal separator; a pump that circulates the washing water in the outer tank through the centrifugal separator provided on the water supply passage; and a controller that performs a washing operation by sequentially controlling each of a washing step, a rinsing step, a spin-drying step, and the like. In the washing step, the controller causes the centrifugal separator to start centrifugal separation after hardness of washing water in the outer tank has decreased. With this configuration, after a water softening agent contained in a detergent traps metal ions such as calcium and magnesium contained in the washing water and the hardness of the washing water is decreased, the washing water is supplied to the centrifugal separator to start centrifugal separation. With this arrangement, dirt substances can be separated from the washing water without decreasing the performance of surfactant, and the dirt is thus prevented from reattaching to laundry, thereby increasing a washing effect.

[0014] Further, since the washing water is supplied to the centrifugal separator at a timing at an early stage of the washing step, it is possible to secure enough time for the dirt from laundry to be centrifugally separated. Further, for some time after the washing step is started, an amount of the dirt falling off the laundry is a relatively small. Therefore, an effect caused by stopping removing the dirt from the washing water because the centrifugal separator does not operate is small. Further, the centrifugal separator can remove both of the dirt from the laundry and the water softening agent, which will be unnecessary after the metal ions are removed. As described above, the water softening agent is removed from the washing water, and accordingly, it is possible to reduce progress of deposition of the water softening agent where the deposition will gradually attach to the outer tank and the washing tub.

[0015] In a second aspect, the controller causes, particularly in the first aspect, the centrifugal separator to start centrifugal separation after elapse of a predetermined time in which the hardness of the washing water in the outer tank is decreased to a predetermined value by a water softening agent contained in a laundry detergent. With this arrangement, the washing water is supplied to the centrifugal separator after the hardness of the washing water is decreased to the predetermined value. Therefore, the dirt substances can be separated from the washing water without decreasing the performance of the surfactant, and the dirt is thus prevented from reattaching to laundry, thereby increasing the washing effect.

[0016] In a third aspect, the predetermined time is, particularly in the second aspect, a time in which the hardness of the washing water is expected to decrease to be equal to or smaller than the predetermined value on the basis of a hardness decreasing characteristic with which the hardness of the washing water decreases due to the water softening agent contained in the laundry detergent. With this arrangement, the washing water whose hardness is sufficiently decreased is supplied to the centrifu-

gal separator. Therefore, the dirt substances can be separated from the washing water without decreasing the performance of the surfactant, and the dirt is thus prevented from reattaching to laundry, thereby increasing the washing effect.

[0017] A fourth aspect further includes, particularly in the second or third aspect, a hardness setting unit that sets the hardness of the washing water, and the predetermined time is set depending on the hardness set by the hardness setting unit. This arrangement enables the predetermined time to be set in conformity with the hardness of the used washing water. In general, there is a difference in hardness of tap water to be used for washing among places. For this reason, when the hardness is appropriately set in conformity with the place at the time of installing a washing machine or at other times, the predetermined time is appropriately set.

[0018] A fifth aspect includes, particularly in the second aspect, a hardness detector that detects the hardness of the washing water, and the controller causes the centrifugal separator to start the centrifugal separation when the hardness of the washing water detected by the hardness detector becomes smaller than the predetermined value. This arrangement enables the controller to accurately determine a timing when the hardness of the washing water decreases to a predetermined hardness. Therefore, it is possible to prevent the centrifugal separator from removing the water softening agent from the washing water before the hardness of the washing water decreases to the predetermined hardness. Then, the washing effect can be increased without decreasing the performance of the surfactant.

[0019] In a sixth aspect, the centrifugal separator centrifugally separates, particularly in any one of the first to fifth aspects, the foreign substances by applying a centrifugal force to the washing water by a water supply pressure of the pump. With this arrangement, the foreign substances can be easily separated from the washing water by a flow of the washing water flowing into the centrifugal separator from the water supply passage.

[0020] In a seventh aspect, the controller causes, particularly in any one of the first to sixth aspects, the centrifugal separator to start centrifugal separation by driving the pump in a stopped state to supply water to the centrifugal separator. This arrangement can cause the washing water to flow into the centrifugal separator by driving of the pump, and the foreign substances can be easily separated from the washing water.

[0021] In an eighth aspect, the controller causes, particularly in any one of the first to sixth aspects, centrifugal separation to start by shifting the pump from a low-speed drive state to a high-speed drive state. This arrangement can circulate, before the pump is shifted to the high-speed drive state where the foreign substances such as dirt contained in the washing water are separated by the centrifugal separator, the washing water in the outer tank through the water supply passage by driving the pump at a low speed at which the foreign substances is not separated. As a result, dissolution of detergent put in the washing water and trap of the metal ions contained in the washing water by the water softening agent are facilitated, and the hardness of the washing water can be thus quickly decreased.

[0022] In a ninth aspect, the water supply passage is further provided, particularly in any one of the first to sixth aspects, with a bypass passage that communicates between an inlet side and an outlet side of the centrifugal separator without passing through the centrifugal separator, and the controller performs switching between a first state where the washing water in the outer tank flows through the bypass passage and a second state where the washing water in the outer tank flows through the centrifugal separator. This arrangement enables the washing water in the outer tank to be circulated through the bypass passage without passing through the centrifugal separator until the hardness of the washing water is decreased; thus, the dissolution of the detergent put in the washing water and the trap of the metal ions contained in the washing water by the water softening agent are facilitated, which quickly decreases the hardness of the washing water.

[0023] In a tenth aspect, the controller switches, particularly in the ninth aspect, a flow of the washing water by reversing rotation of the pump. This arrangement makes it easy to perform switching from a state where the washing water in the outer tank flows through the bypass passage to a state where the washing water in the outer tank flows through the centrifugal separator.

[0024] In an eleventh aspect, the water supply passage is further provided, particularly in the ninth aspect, with a selector valve that switches the flow of the washing water, and the controller performs, by controlling the selector valve, switching between the state where the washing water flows through the bypass passage and the state where the washing water flows through the centrifugal separator. This arrangement makes it easy to perform switching from a state where the washing water in the outer tank flows through the bypass passage to a state where the washing water in the outer tank flows through the centrifugal separator.

[0025] In a twelfth aspect, the centrifugal separator is further provided, particularly in any one of the first to fifth aspects, with a rotary member that is rotated by an electric motor, and the controller applies a centrifugal force to the washing water in the centrifugal separator to centrifugally separate the foreign substances, by driving the electric motor to rotate the rotary member. With this arrangement, the foreign substances contained in the washing water in the centrifugal separator can be surely separated by control of rotation of the electric motor.

[0026] In a thirteenth aspect, the controller causes, particularly in the twelfth aspect, centrifugal separation to start by shifting the rotary member from the stopped state or the low-speed drive state to the high-speed drive state. With this arrangement, the foreign substances can be easily separated from the washing water by a centrif-

ugal force being applied to the washing water flowing into the centrifugal separator by causing the rotary member to rotate at a high speed from the stopped state. Alternatively, by causing the rotary member to rotate at a high speed from a low speed, the washing water in the outer tank can be circulated before the foreign substances contained in the washing water are separated from the washing water. As a result, dissolution of detergent put in the washing water and trap of the metal ions contained in the washing water by the water softening agent are facilitated, and the hardness of the washing water can be thus quickly decreased.

[0027] Hereinafter, exemplary embodiments of the present disclosure will be described with reference to the drawings. Note that these exemplary embodiments do not limit the present disclosure.

(First exemplary embodiment)

[0028] FIG. 1 is a schematic configuration diagram of a washing machine in a first exemplary embodiment of the present disclosure.

As shown in FIG. 1, outer tank 1 is formed to have a shape of a bottomed cylinder and is elastically supported, by a plurality of suspension mechanisms 3, inside chassis 2 constituting an outer frame of the washing machine. Washing tub 4 formed to have a shape of a bottomed cylinder is provided inside outer tank 1. Outer tank 1 and washing tub 4 are provided on the front surface side (on the left side in FIG. 1) with opening 6 through which laundry 5 such as clothes are put in and taken out.

[0029] Washing tub 4 is rotatably provided centering on rotation shaft 7. Peripheral wall surface 4a of washing tub 4 is provided with a plurality of baffles 8 (for example, three baffles) each of which protrudes inwardly. Further, peripheral wall surface 4a is provided with many small holes 9. In outer tank 1, the inside and outside of washing tub 4 are communicated with each other through small holes 9. Outer tank 1, washing tub 4, and rotation shaft 7 are provided to be inclined up in front at an angle θ (for example, 20°) to a horizontal direction.

[0030] Washing tub 4 can be rotated forward and backward by motor 10 provided on a rear part of outer tank 1. Motor 10 is, for example, a brushless DC motor, and a rotation speed of motor 10 can be arbitrarily changed by inverter control by controller 22 to be described later.

[0031] Opening 1a of outer tank 1 and opening 2a of chassis 2 are formed to face opening 6 of washing tub 4. Opening 1a of outer tank 1 and opening 2a of chassis 2 are connected to each other with packing 12 that has a bellows shape and is stretchable, and an air-tight structure is thus secured. Door 11 to open and close opening 2a is provided on a front surface of chassis 2.

[0032] Water supply port 13 through which washing water is supplied is provided on an upper part of a rear surface of chassis 2. Water supply port 13 is connected to tap water faucet 13a. Washing water is tap water supplied from water supply port 13. Water supply valve 14 and detergent case 15 are provided in the rear of water supply port 13. Water supply valve 14 is driven to be opened and closed by controller 22 to supply and stop water. Detergent case 15 is configured such that detergent inlet 15a can be pulled out to the closer side from detergent case 15 as indicated by arrow A. Thus, a user can easily put detergent in detergent case 15.

[0033] The washing water supplied from water supply port 13 flows into detergent case 15 as indicated by arrow B. The washing water having flown into detergent case 15 further flows into outer tank 1 while dissolving the detergent put in detergent case 15.

[0034] A bottom of outer tank 1 is provided with drain outlet 16 through which the washing water is discharged. Drain passage 17 is connected to drain outlet 16. Drain passage 17 is provided with drain valve 18. Drain valve 18 is driven to be opened and closed by controller 22 to discharge the washing water in outer tank 1 and store the washing water in outer tank 1.

[0035] Water supply passage 19 constitutes a circulation passage, with one end of water supply passage 19 connected to drain passage 17 and with the other end connected to a lower part of a front surface of outer tank 1. Pump 20 to circulate the washing water in outer tank 1 and centrifugal separator 21 are connected to water supply passage 19. Centrifugal separator 21 is provided on a downstream side of pump 20.

[0036] Centrifugal separator 21 has cone part 21a whose diameter is smaller toward the bottom. On an upper side surface of cone part 21a, inlet 21b through which the washing water from water supply passage 19 flows in is provided in a tangential line direction. Discharge part 21c through which the foreign substances separated from the washing water are discharged is provided on a lower end of cone part 21a. Further, collection unit 21e that collects the foreign substances is provided below discharge part 21c. In an upper part of cone part 21a, there is provided outlet 21d through which the washing water from which the foreign substances have been separated flows out to water supply passage 19.

[0037] The washing water in outer tank 1 is circulated by pump 20 from drain passage 17 through water supply passage 19 as indicated by arrow C, and passes through centrifugal separator 21. When the washing water passes through centrifugal separator 21, the foreign substances contained in the washing water are separated. The foreign substances include dirt and lint released from the laundry, and a water softening agent contained in the detergent dissolved in the washing water, and the like.

[0038] Controller 22 is provided on a lower part of chassis 2. FIG. 2 is a block configuration diagram of the washing machine in the present exemplary embodiment. Controller 22 is fed with the following outputs: an output of cloth amount detector 23 that detects an amount of laundry 5 put in washing tub 4; an output of water amount detector 24 that detects an amount of the washing water supplied into outer tank 1; an output of rotation detector 25 that detects rotational driving of washing tub 4; and

the like. Controller 22 performs a washing operation by controlling driving of motor 10, water supply valve 14, drain valve 18, pump 20, and the like on the basis of a washing course set by a user on operation display unit 26. The washing operation includes steps such as a washing step, a rinsing step, and a spin-drying step.

[0039] Operation and functions of the washing machine configured as described above will be described with reference to FIG. 1 to FIG. 3. FIG. 3 is a time chart showing a main part of an operation of the washing machine in the present exemplary embodiment. In the washing operation, in the washing step, the washing water in which the detergent is dissolved is supplied into outer tank 1, and dirt is released from laundry 5 while beat washing is being performed by the rotation of washing tub 4. Subsequently to the washing step, the rinsing step is performed. In the rinsing step, for example, a first intermediate spin-drying step, a first rinsing step, a second intermediate spin-drying step, and a second rinsing are performed. Then, a spin-drying step is performed at the end.

[0040] First, a user opens door 11 provided on a front surface of chassis 2 and put laundry 5 through opening 6 into washing tub 4. Next, the user turns on a power switch (not shown) on operation display unit 26 provided on an upper part of the front surface of chassis 2, and operates a start switch (not shown) to start the washing operation.

[0041] When the washing operation is started, controller 22 first detects an amount of laundry 5 put in washing tub 4 by cloth amount detector 23. The amount of laundry 5 is detected on the basis of a magnitude of torque on motor 10, a current value of the motor 10, or the like when washing tub 4 is rotated at a low speed.

[0042] On the basis of the detected amount of laundry 5, controller 22 sets a time of each of the washing step, the rinsing step, and the spin-drying step and an amount of the washing water. In addition, controller 22 causes operation display unit 26 to display an amount of detergent previously set depending on the amount of laundry 5. The user pulls out detergent inlet 15a from detergent case 15, puts in detergent following a rough indication of the amount of detergent displayed on operation display unit 26, and then moves detergent inlet 15a into detergent case 15.

[0043] Controller 22 causes water supply valve 14 to be opened while anticipating when the detergent is put in. When water supply valve 14 is opened, the washing water flows into detergent case 15 from water supply port 13. The washing water having flown into detergent case 15 is supplied to outer tank 1 as indicated by arrow B, while dissolving the detergent having been put in. The washing water stored in a bottom part of outer tank 1 flows into washing tub 4 through small holes 9. The washing water stored in outer tank 1 is detected by water amount detector 24. When a predetermined amount of washing water previously set depending on the amount of laundry 5 is supplied, controller 22 causes water supply valve 14 to be closed.

[0044] When the water supply is completed, controller 22 drives motor 10 to rotate washing tub 4. When washing tub 4 has started to rotate, laundry 5 in washing tub 4 is lifted up by baffle 8 in a rotational direction, then falls from above, and is slammed into a bottom surface of washing tub 4 or laundry 5 gathering on a bottom of washing tub 4. In this manner, the beat washing is performed by a mechanical force of the washing, in addition to the chemical power of the detergent. The rotation speed of washing tub 4 at which laundry 5 is beat-washed is, for example, 45 rpm, and the rotation is reversed every predetermined time so that forward and backward rotation drive is performed.

[0045] When the washing step is performed for a predetermined time, controller 22 causes drain valve 18 to be opened to discharge the washing water in outer tank 1 to outside of the machine. After the discharge of the water is completed, the operation goes on to the rinsing step, and the first intermediate spin-drying is performed followed by the first rinsing. Also in the rinsing step, as is the case with the washing step, a predetermined amount of washing water is supplied into outer tank 1, and washing tub 4 is rotated to perform rinsing of laundry 5.

[0046] In the spin-drying step, which is performed at the end, after drain valve 18 is opened and the washing water in outer tank 1 is discharged to outside of the machine, washing tub 4 containing laundry 5 is rotated at a high speed by motor 10 to perform the spin-drying of the laundry. When the spin-drying step is completed, controller 22 finishes the washing operation.

[0047] Next, a description will be given to a function by which the washing water is cleaned in centrifugal separator 21.

[0048] Controller 22 drives pump 20 in the washing step to circulate the washing water in outer tank 1 to centrifugal separator 21. Pump 20 is driven after a predetermined time from completion of the supply of water in the washing step, and pump 20 thus supplies the washing water in outer tank 1 to centrifugal separator 21 through water supply passage 19. Specifically, when a predetermined time T elapses after a predetermined amount of washing water is supplied and water supply valve 14 is closed, pump 20 in a stopped state is driven at a rated speed, and the water is supplied to centrifugal separator 21.

[0049] The predetermined time T is a time in which water softening agent (for example, zeolite or the like) contained in almost all powdery detergents traps the metal ions such as calcium and magnesium dissolved in the washing water and thus decreases the hardness of the washing water.

[0050] When pump 20 is driven, the washing water in outer tank 1 passes from drain outlet 16 through water supply passage 19 and flows into cone part 21a from inlet 21b in a circumferential direction. At this time, the washing water is rotated in cone part 21a at a high speed

by a water supply pressure of pump 20, and a centrifugal force is thus applied to the washing water, whereby the foreign substances are centrifugally separated. The foreign substances contained in the washing water such as the dirt released from laundry 5, the lint, and the water softening agent having trapped the metal ions, which are hardness substances, are separated from the washing water and are collected in collection unit 21e provided below discharge part 21c. The washing water from which the foreign substances are removed flows out to water supply passage 19 from outlet 21d provided on an upper part of a center in cone part 21a, passes through water supply passage 19, and flows into outer tank 1 from the front surface.

[0051] In this way, the washing water in outer tank 1 is cleaned while being circulated between outer tank 1 and centrifugal separator 21. Further, the foreign substances collected in collection unit 21e are discharged to the outside via drain valve 18.

[0052] When the detergent is dissolved in the washing water, the water softening agent (for example, zeolite or the like) contained in the detergent acts on the metal ions such as calcium and magnesium dissolved in the washing water and traps these hardness components, thereby decreasing the hardness of the washing water. The hardness of the washing water is detected by measuring conductivity of the washing water.

[0053] FIG. 4 is a graph showing a change in hardness of the washing water in the washing machine of the present exemplary embodiment. The predetermined time T is a time in which the hardness of tap water having common hardness is expected to decrease to a predetermined hardness D (for example, relatively low level hardness even for soft water, hardness that is about one-tenth of the original hardness, or the like) when detergent is put in the washing water. Such a hardness decreasing characteristic can be grasped by experiments or the like. That is, the predetermined time T is a time in which the hardness of the washing water is expected to decrease to be equal to or smaller than the predetermined value on the basis of a hardness decreasing characteristic with which the hardness of the washing water decreases due to the water softening agent contained in the detergent.

[0054] FIG. 5 is a diagram for illustrating an operation of the washing step of the washing machine in the present exemplary embodiment. In the present exemplary embodiment, as indicated by reference mark a of FIG. 5, controller 22 pressure-feeds the washing water in outer tank 1 to centrifugal separator 21 to start centrifugal separation by driving pump 20 after the predetermined time T from completion of the supply of washing water in the washing step. The predetermined time T may be set depending on the amount of the laundry or the amount of the supplied water, on the basis of experimental results or the like.

[0055] Note that, regarding the predetermined time, other than the predetermined time T as indicated by reference mark a of FIG. 5, the predetermined time t1 may be set from the middle of the water supply as indicated by reference mark b of FIG. 5. Alternatively, as indicated by reference mark c of FIG. 5, a predetermined time t2 may be set from the time of start of the water supply. Further, as indicated by reference mark d of FIG. 5, a predetermined time t3 may be set from the time of start of washing.

[0056] That is, a timing at which count of the predetermined time is started is not specifically limited, and basically, the timing only has to be such a timing that the hardness of the washing water is expected to decrease to the predetermined hardness D by the water softening agent, contained in the detergent, acting on the metal ions dissolved in the washing water and thus trapping hardness components.

[0057] Note that the separation of the foreign substances contained in the washing water can be performed in the rinsing step in addition to the washing step. By separating, in centrifugal separator 21, the foreign substances released into the washing water from the laundry in the rinsing step, an effect of the rinsing can be increased.

[0058] FIG. 6 is a time chart showing an operation of another example of the present exemplary embodiment. This example is different from the above-described configuration in that, when controller 22 causes the centrifugal separation to start, controller 22 shifts pump 20 from a low-speed drive state (Lo) to a high-speed drive state (Hi) instead of causing pump 20 to drive from the stopped state. With this configuration, until controller 22 causes centrifugal separation to start, controller 22 can circulate the washing water in outer tank 1 through water supply passage 19 by causing pump 20 to operate at a low speed at which centrifugal separator 21 does not separate the foreign substances. As a result, dissolution of detergent put in the washing water and trap of the metal ions contained in the washing water by the water softening agent are facilitated, and the hardness of the washing water can be thus quickly decreased.

[0059] As described above, a washing machine according to the present exemplary embodiment includes: centrifugal separator 21 that separates foreign substances contained in washing water in outer tank 1; water supply passage 19 that returns the washing water in outer tank 1 into outer tank 1 through centrifugal separator 21; pump 20 that circulates the washing water in outer tank 1 through centrifugal separator 21 provided on water supply passage 19; and controller 22 that performs a washing operation. In the washing step, controller 22 causes centrifugal separator 21 to start centrifugal separation after hardness of washing water in outer tank 1 has decreased. With this configuration, after the water softening agent contained in the detergent traps the metal ions such as calcium and magnesium contained in the washing water and after the hardness of the washing water is decreased, the washing water is supplied to centrifugal separator 21 to start centrifugal separation.

With this arrangement, dirt substances can be separated from the washing water without decreasing the perform-

ance of surfactant, and the dirt is thus prevented from reattaching to laundry, thereby increasing a washing effect.

[0060] Further, since the washing water is supplied to centrifugal separator 21 at a timing on an early stage of the washing step, it is possible to secure enough time for the dirt released from the laundry to be centrifugally separated. Further, an amount of dirt falling off the laundry is relatively small for some time after the washing step is started; therefore, even though removing of the dirt from the washing water is stopped because of non-operation of centrifugal separator 21, it does not affect much. Further, centrifugal separator 21 can remove both of the dirt from the laundry and the water softening agent, where the water softening agent will be unnecessary after the metal ions are trapped. As described above, since the water softening agent is removed from the washing water, it is possible to prevent or reduce progress of deposition of the water softening agent that is gradually attaching to outer tank 1 and washing tub 4.

(Second exemplary embodiment)

[0061] FIG. 7 is a block configuration diagram of a washing machine in a second exemplary embodiment of the present disclosure. A feature of the second exemplary embodiment is that the washing machine has hardness setting unit 27 that sets the hardness of the washing water. Controller 22 sets the above-described predetermined time T, depending on the hardness set by hardness setting unit 27. Since the other components are the same as in the first exemplary embodiment, the same components are assigned the same reference numerals, and the detailed description of the first exemplary embodiment is used.

[0062] The washing water used for washing is generally tap water, and the tap water is different in hardness among places. In the present exemplary embodiment, when a washing machine is installed, a person who installs the washing machine sets the hardness depending on the place by hardness setting unit 27. If the place of the installation is a place where the hardness is higher than the standard hardness, the water softening agent contained in the detergent takes a longer time to decrease the hardness of the washing water, and the predetermined time T is set relatively long. Note that it is not necessary to operate hardness setting unit 27 after the washing machine is installed, and hardness setting unit 27 is preferably provided in a place where a user does not touch hardness setting unit 27 by mistake.

[0063] As described above, in the present exemplary embodiment, the washing machine further includes hardness setting unit 27 that sets the hardness of the washing water, and the predetermined time is set depending on the hardness set by hardness setting unit 27. With this configuration, when the washing machine is installed, the hardness depending on the place is set, and a predetermined time in which the hardness of the washing water in outer tank 1 is expected to decrease to a predetermined hardness by the water softening agent contained in the detergent is appropriately set. The hardness only has to be set in association with the hardness of washing water such as a name of a place, a reference code of a place, or the like. With this arrangement, the operation of separating foreign substances from washing water can start at an appropriate timing, and the arrangement is effective particularly in a place or a country where the hardness of tap water is high.

(Third exemplary embodiment)

[0064] FIG. 8 is a schematic configuration diagram of a washing machine in a third exemplary embodiment of the present disclosure.

FIG. 9 is a block configuration diagram of the washing machine in the present exemplary embodiment.

[0065] As shown in FIG. 8, a feature of the third exemplary embodiment is that the washing machine includes hardness detector 28 that detects the hardness of the washing water, and controller 22 causes centrifugal separator 21 to start centrifugal separation when the hardness of the washing water detected by hardness detector 28 becomes smaller than the predetermined value. Since the other components are the same as in the first exemplary embodiment, the same components are assigned the same reference numerals, and the detailed description of the first exemplary embodiment is used.

[0066] When the detergent is put in the washing water, the water softening agent contained in the detergent acts on the metal ions dissolved in the washing water and traps the hardness components, thereby decreasing the hardness of the washing water. The hardness of the washing water is detected by measuring conductivity of the washing water.

[0067] Hardness detector 28 is provided on a bottom part of outer tank 1 (see FIG. 8) that is in the supplied washing water, on water supply passage 19, or on another component, and hardness detector 28 detects the hardness of the washing water on the basis of conductivity of the washing water. The conductivity may be electric resistance of the washing water detected by a conductivity sensor (not shown) having a pair of electrodes, and the conductivity is detected between the electrodes. Controller 22 detects the hardness of the washing water by hardness detector 28, and when the hardness becomes smaller than a predetermined value, controller 22 causes centrifugal separator 21 to start centrifugal separation by driving pump 20 to supply the washing water in outer tank 1 to centrifugal separator 21.

[0068] As described above, in the present exemplary embodiment, the washing machine further includes hardness detector 28 that detects the hardness of the washing water, and controller 22 causes centrifugal separator 21 to start the centrifugal separation when the hardness of the washing water detected by hardness detector 28 becomes smaller than the predetermined value. This ar-

rangement enables controller 22 to accurately determine a timing when the hardness of the washing water is decreased to a predetermined hardness with the water softening agent, and therefore, it is possible to prevent centrifugal separator 21 from removing the water softening agent from the washing water before the hardness of the washing water decreases to the predetermined hardness. Therefore, the washing effect can be increased without decreasing the performance of the surfactant.

(Fourth exemplary embodiment)

[0069] FIG. 10 is a schematic configuration diagram of a washing machine in a fourth exemplary embodiment of the present disclosure. FIG. 11 is a configuration diagram of a main part of the washing machine in the present exemplary embodiment. FIG. 12 is a time chart showing a main part of an operation of the washing machine in the present exemplary embodiment.

[0070] As shown in FIG. 10, a feature of the fourth exemplary embodiment is that water supply passage 19 is provided with bypass passage 29 that communicates between an inlet 21b side and an outlet 21d side of centrifugal separator 21 without passing through centrifugal separator 21. Further, switching can be performed between a first state where the washing water in outer tank 1 flows through bypass passage 29 and a second state where the washing water in outer tank 1 flows through centrifugal separator 21. Since the other components are the same as in the first exemplary embodiment, the same components are assigned the same reference numerals, and the detailed description of the first exemplary embodiment is used.

[0071] As shown in FIG. 11, water supply passage 19 is provided with bypass passage 29 communicating between inlet side 21f and outlet side 21g of centrifugal separator 21 without passing through centrifugal separator 21. Controller 22 causes switching to be performed between the state where the washing water in outer tank 1 flows though bypass passage 29 and the state where the washing water in outer tank 1 flows through centrifugal separator 21. Further, a rotational direction of pump 20 is reversed to switch the flow of the washing water.

[0072] As shown in FIG. 11 and FIG. 12, when a predetermined amount of washing water is stored in outer tank 1 and water supply is thus completed, controller 22 causes pump 20 to perform positive rotation in an arrow E direction. This operation causes the washing water to flow through bypass passage 29 and to flow into outer tank 1 without passing through centrifugal separator 21. That is to say, the washing water having passed through water supply passage 19 and reached to pump 20 flows through bypass passage 29 from inlet side 21f, which is an upstream side of centrifugal separator 21, as indicated by arrow F (see FIG. 10), and flows into water supply passage 19 on outlet side 21g, which is a downstream side of centrifugal separator 21. Then, the washing water flows into outer tank 1 and circulates.

[0073] After the predetermined time T from completion of supply of a predetermined amount of water, controller 22 causes pump 20 to reversely rotate from the arrow E direction to an arrow G direction. This operation performs switching to the state where the washing water flows through centrifugal separator 21. Then, the foreign substances contained in the washing water is separated by centrifugal separator 21, and the washing water is thus cleaned.

[0074] Note that if an enough amount of washing water to supply is stored in outer tank 1, controller 22 may cause pump 20 to operate before the predetermined amount of water is completely supplied. In this case, a time can be lengthen in which the washing water is made to circulate through bypass passage 29 before the washing water flows through centrifugal separator 21, and it is therefore possible to facilitate dissolution of the detergent put in the washing water and trap of the metal ions contained in the washing water by the water softening agent.

[0075] As described above, in the present exemplary embodiment, water supply passage 19 is further provided with bypass passage 29 communicating between inlet side 21f and outlet side 21g of centrifugal separator 21 without passing through centrifugal separator 21. Further, controller 22 causes switching to be performed between the first state where the washing water in outer tank 1 flows though bypass passage 29 and the second state where the washing water in outer tank 1 flows through centrifugal separator 21. With this arrangement, the washing water in outer tank 1 can be circulated through bypass passage 29 without passing through centrifugal separator 21 until the hardness of the washing water decreases. As a result, dissolution of detergent put in the washing water and trap of the metal ions contained in the washing water by the water softening agent are facilitated, and the hardness of the washing water can be thus quickly decreased. Further, controller 22 switches the flow of the washing water by reversing the rotation of pump 20. This arrangement makes it easy to perform switching from the state where the washing water in outer tank 1 flows through bypass passage 29 to the state where the washing water in outer tank 1 flows through centrifugal separator 21.

(Fifth exemplary embodiment)

[0076] FIG. 13 is a schematic configuration diagram of a washing machine in a fifth exemplary embodiment of the present disclosure. FIG. 14 is a configuration diagram of a main part of the washing machine in the present exemplary embodiment. FIG. 15 is a block configuration diagram of the washing machine in the present exemplary embodiment. FIG. 16 is a time chart showing a main part of an operation of the washing machine in the present exemplary embodiment.

[0077] As shown in FIG. 13, a feature of the fifth exemplary embodiment is that water supply passage 19 is provided with bypass passage 29 that communicates be-

tween an inlet 21b side and an outlet 21d side of centrifugal separator 21 without passing through centrifugal separator 21, and water supply passage 19 is provided with selector valve 30 that switches the flow of the washing water in outer tank 1. Then, switching is performed by selector valve 30 between a state where the washing water flows through bypass passage 29 and a state where the washing water flows through centrifugal separator 21. Since the other components are the same as in the first exemplary embodiment, the same components are assigned the same reference numerals, and the detailed description of the first exemplary embodiment is used.

[0078] As shown in FIG. 14, water supply passage 19 is provided with selector valve 30 that switches the flow of the washing water in outer tank 1. By controlling selector valve 30, controller 22 performs switching between a first state where the washing water flows though bypass passage 29 and a second state where the washing water flows through centrifugal separator 21.

[0079] As shown in FIG. 14 and FIG. 16, when the washing operation is started, selector valve 30 is set to an arrow H side, and water supply passage 19 on an inlet side 21f, which is an upstream side of centrifugal separator 21, is thus closed. When a predetermined amount of washing water is stored in outer tank 1 and water supply is thus completed, controller 22 drives pump 20. This operation causes the washing water to flow through bypass passage 29 and flow into outer tank 1 without passing through centrifugal separator 21. That is to say, the washing water having passed through water supply passage 19 and reached to pump 20 flows through bypass passage 29 from inlet side 21f, which is an upstream side of centrifugal separator 21, and flows into water supply passage 19 at outlet side 21g, which is a downstream side of centrifugal separator 21. Then, the washing water flows into outer tank 1 and circulates.

[0080] When the predetermined time T elapses after the supply of a predetermined amount of water is completed and controller 22 drives pump 20, controller 22 changes the setting of selector valve 30 from an arrow H side to an arrow I side to close bypass passage 29. By this operation, inlet side 21f of centrifugal separator 21 is opened, and switching is performed to the state where the washing water flows through centrifugal separator 21. Then, the foreign substances contained in the washing water is separated by centrifugal separator 21, and the washing water is thus cleaned.

[0081] Note that if an enough amount of washing water to supply is stored in outer tank 1, controller 22 may cause pump 20 to operate before the predetermined amount of water is completely supplied. In this case, a time can be lengthen in which the washing water is made to circulate through bypass passage 29 before the washing water flows through centrifugal separator 21, and it is therefore possible to facilitate dissolution of the detergent put in the washing water and trap of the metal ions contained in the washing water by the water softening agent.

[0082] As described above, in the present exemplary embodiment, water supply passage 19 is further provided with bypass passage 29 communicating between inlet side 21f and outlet side 21g of centrifugal separator 21 without passing through centrifugal separator 21, and is further provided with selector valve 30 that switches the flow of the washing water in outer tank 1. Further, by controlling selector valve 30, controller 22 performs switching between the first state where the washing water flows though bypass passage 29 and the second state where the washing water flows through centrifugal separator 21. This arrangement makes it easy to perform switching from the first state where the washing water in outer tank 1 flows through bypass passage 29 to the second state where the washing water in outer tank 1 flows through centrifugal separator 21.

(Sixth exemplary embodiment)

[0083] FIG. 17 is a schematic configuration diagram of a washing machine in a sixth exemplary embodiment of the present disclosure. FIG. 18 is a configuration diagram of a main part of the washing machine in the present exemplary embodiment. FIG. 19 is a time chart showing a main part of an operation of the washing machine in the present exemplary embodiment.

[0084] A feature of the sixth exemplary embodiment is that the configuration of centrifugal separator is different from the configuration of centrifugal separator 21. Specifically, as shown in FIG. 17, by applying a centrifugal force to the washing water by rotation of rotary member 33 provided on centrifugal separator 31, foreign substances are centrifugally separated. Since the other components are the same as in the first exemplary embodiment, the same components are assigned the same reference numerals, and the detailed description of the first exemplary embodiment is used.

[0085] As shown in FIG. 18, centrifugal separator 31 is rotatably provided with rotary member 33 having a cylindrical shape in a case 32 having a cylindrical shape. Case 32 has inlet 32a provided on a lower part of a peripheral side surface and has outlet 32b provided on an upper part of the peripheral side surface, and inlet 32a and outlet 32b each are communicated to water supply passage 19. By a water supply pressure of pump 20 provided on water supply passage 19, the washing water flows into case 32 from inlet 32a and flows out to water supply passage 19 from outlet 32b. In this manner, the washing water circulates into outer tank 1 through centrifugal separator 31.

[0086] Rotary member 33 is connected via rotation shaft 34 to electric motor 35 provided below case 32 and is rotationally driven. A bottom surface of rotary member 33 is provided with a plurality of openings 33a (for example, four openings) which are circularly arranged to surround rotation shaft 34 and each of which has an elongated arc shape. Further, an upper surface of rotary member 33 is provided with opening 33b to face outlet

32b. The washing water having flown into case 32 from inlet 32a flows into rotary member 33 from openings 33a and then passes through opening 33b and outlet 32b. In this manner, the washing water passes through centrifugal separator 31.

[0087] When a predetermined time T elapses after a predetermined amount of washing water is stored and water supply is completed, controller 22 causes pump 20 in the stopped state to operate at a rated speed and causes electric motor 35 to operate. The predetermined time T is a time in which water softening agent (for example, zeolite or the like) contained in almost all powdery detergents traps the metal ions such as calcium and magnesium dissolved in the washing water and thus decreases the hardness of the washing water.

[0088] At this time, in the washing water that is supplied by pump 20 to pass through inside rotary member 33, a high-speed swirl flow is generated by rotary member 33 that is rotating at a high speed by being driven by electric motor 35. Then, foreign substances contained in the washing water such as the dirt released from laundry 5, the lint, and water softening agent having trapped the metal ions are separated from the washing water by an effect of a centrifugal force of the swirl flow and are trapped on an inner periphery wall of rotary member 33. The washing water from which the foreign substances are thus removed flows out to water supply passage 19 from outlet 32b. As described above, washing water is cleaned while circulating between centrifugal separator 31 and outer tank 1.

[0089] FIG. 20 is a time chart showing an operation of another example of the present exemplary embodiment. Controller 22 starts centrifugal separation by shifting electric motor 35 from a low-speed drive state (Lo) to a high-speed drive state (Hi). When a predetermined amount of washing water is supplied and water supply valve 14 is closed, controller 22 causes pump 20 to operate at a rated speed and causes electric motor 35 to rotate at a low speed. Then, when a predetermined time T elapses after causing pump 20 to start to operate, controller 22 shifts electric motor 35 in the low-speed drive state (Lo) to the high-speed drive state (Hi).

[0090] With this configuration, by causing rotary member 33 to operate, until centrifugal separation is started, at a low speed at which centrifugal separator 31 does not separate the foreign substances, controller 22 can circulate the washing water in outer tank 1 through water supply passage 19 by pump 20 being driven.

As a result, dissolution of detergent put in the washing water and trap of the metal ions contained in the washing water by the water softening agent are facilitated, and the hardness of the washing water can be thus quickly decreased.

[0091] As described above, in the present exemplary embodiment, centrifugal separator 31 is further provided with rotary member 33 that is rotated by electric motor 35, and controller 22 applies a centrifugal force to the washing water in centrifugal separator 31 to centrifugally separate the foreign substances, by driving electric motor 35 to rotate rotary member 33. With this arrangement, the foreign substances contained in the washing water in centrifugal separator 31 can be surely separated by control of the rotation of electric motor 35.

[0092] Further, controller 22 starts centrifugal separation by shifting rotary member 33 from the stopped state or the low-speed drive state to the high-speed drive state. With this arrangement, the foreign substances can be easily separated from the washing water by a centrifugal force being applied to the washing water flowing into centrifugal separator 31 by causing rotary member 33 to start high-speed rotation from the stopped state.

[0093] Alternatively, by causing rotary member 33 to rotate at a high speed from a low speed, the washing water in outer tank 1 can be circulated by pump 20 before the foreign substances contained in the washing water are separated from the washing water. This operation facilitates dissolution of detergent put in the washing water and trap of the metal ions contained in the washing water by the water softening agent, and the hardness of the washing water can be thus quickly decreased.

[0094] Note that the washing machines that perform only washing are described in the above exemplary embodiments; however, the similar effect can be obtained also in a washing and drying machine provided with a drying function to dry washed laundry 5. In the case of a washing and drying machine, the following function and effect can be additionally provided.

[0095] That is, it is possible to reduce an amount of water softening agent that is scattered together with water at the time of spin-drying immediately after a washing step and that reaches a drying filter (not shown) by being carried on an air flow caused by a high-speed rotation of washing tub 4 in a spin-drying step; and it is possible to reduce an amount of the water softening agent that is left in laundry 5 at the time of a drying operation and that reaches the drying filter by being carried on air for drying. Therefore, it is possible to prevent or reduce clogging of a mesh, which is configured to trap lint in the drying filter, with water softening agent. Therefore, it is possible to prevent an amount of the air for drying from decreasing due the clogging of the drying filter, a drying time from increasing, a power consumption from increasing, and the like.

[0096] Note that the washing machine of the present disclosure can be practiced also in a top-loading-type washing machine in addition to a drum type washing machine.

[0097] Note that regarding the configurations described in the above exemplary embodiments, a part of each configuration can be appropriately combined and practiced.

INDUSTRIAL APPLICABILITY

[0098] As described above, a washing machine according to the present disclosure can separate dirt sub-

stances from washing water without decreasing the performance of surfactant, and the dirt is thus prevented from reattaching to laundry, thereby increasing the washing effect; therefore, the washing machine is useful.

REFERENCE MARKS IN THE DRAWINGS

[0099]

1	outer tank
2	chassis
4	washing tub
5	laundry
10	motor
14	water supply valve
17	drain passage
18	drain valve
19	water supply passage
20	pump
21	centrifugal separator
22	controller
27	hardness setting unit
28	hardness detector
29	bypass passage
31	centrifugal separator
33	rotary member
35	electric motor

Claims

1. A washing machine comprising:

an outer tank elastically supported in a chassis;
a washing tub rotatably provided in the outer tank;
a motor that rotationally drives the washing tub;
a centrifugal separator that centrifugally separates foreign substances contained in washing water in the outer tank;
a water supply passage that returns the washing water in the outer tank into the outer tank through the centrifugal separator ;
a pump that circulates the washing water in the outer tank through the centrifugal separator provided on the water supply passage; and
a controller that performs a washing operation by sequentially controlling each of a washing step, a rinsing step, and a spin-drying step,
wherein in the washing step, the controller causes the centrifugal separator to start the centrifugal separation after hardness of the washing water in the outer tank is decreased.

2. The washing machine according to claim 1, wherein the controller causes the centrifugal separator to start the centrifugal separation after elapse of a predetermined time in which the hardness of the washing water in the outer tank is decreased to a predetermined value by a water softening agent contained in a laundry detergent.

3. The washing machine according to claim 2, wherein the predetermined time is a time in which the hardness of the washing water is expected to be decreased to be equal to or smaller than the predetermined value, based on a hardness decreasing characteristic with which the hardness of the washing water is decreased by the water softening agent contained in the laundry detergent.

4. The washing machine according to claim 2 or 3, further comprising a hardness setting unit that sets the hardness of the washing water,
wherein the predetermined time is set depending on the hardness set by the hardness setting unit.

5. The washing machine according to claim 2, further comprising a hardness detector that detects the hardness of the washing water,
wherein the controller causes the centrifugal separator to start the centrifugal separation when the hardness of the washing water detected by the hardness detector becomes smaller than the predetermined value.

6. The washing machine according to any one of claims 1 to 5, wherein the centrifugal separator centrifugally separates the foreign substances by applying a centrifugal force to the washing water by a water supply pressure of the pump.

7. The washing machine according to any one of claims 1 to 6, wherein the controller causes the centrifugal separator to start the centrifugal separation by driving the pump in a stopped state to supply water to the centrifugal separator.

8. The washing machine according to any one of claims 1 to 6, wherein the controller causes the centrifugal separation to start by shifting the pump from a low-speed drive state to a high-speed drive state.

9. The washing machine according to any one of claims 1 to 6, wherein
the water supply passage is provided with a bypass passage that communicates between an inlet side and an outlet side of the centrifugal separator without passing through the centrifugal separator,
the controller performs switching between a first state where the washing water in the outer tank flows through the bypass passage and a second state where the washing water in the outer tank flows through the centrifugal separator.

10. The washing machine according to claim 9, wherein

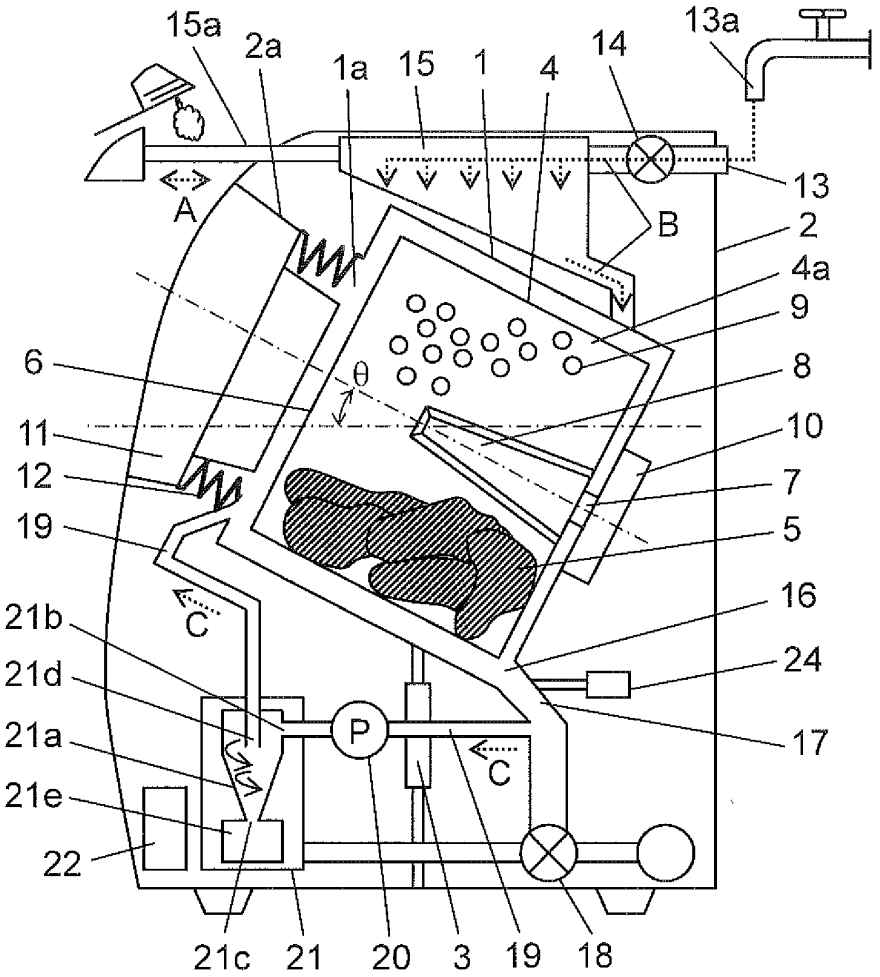
the controller switches a flow of the washing water by reversing rotation of the pump.

11. The washing machine according to claim 9, wherein the water supply passage is provided with a selector valve that switches a flow of the washing water,
the controller performs, by controlling the selector valve, switching between the first state where the washing water flows through the bypass passage and the second state where the washing water flows through the centrifugal separator.

12. The washing machine according to any one of claims 1 to 5, wherein
the centrifugal separator is provided with a rotary member that is rotated by an electric motor,
the controller applies a centrifugal force to the washing water in the centrifugal separator to centrifugally separate the foreign substances, by driving the electric motor to rotate the rotary member.

13. The washing machine according to claim 12, wherein the controller causes the centrifugal separation to start by shifting the rotary member from a stopped state or a lowspeed drive state to a high-speed drive state.

FIG. 1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12
7
19
5
C
16
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P
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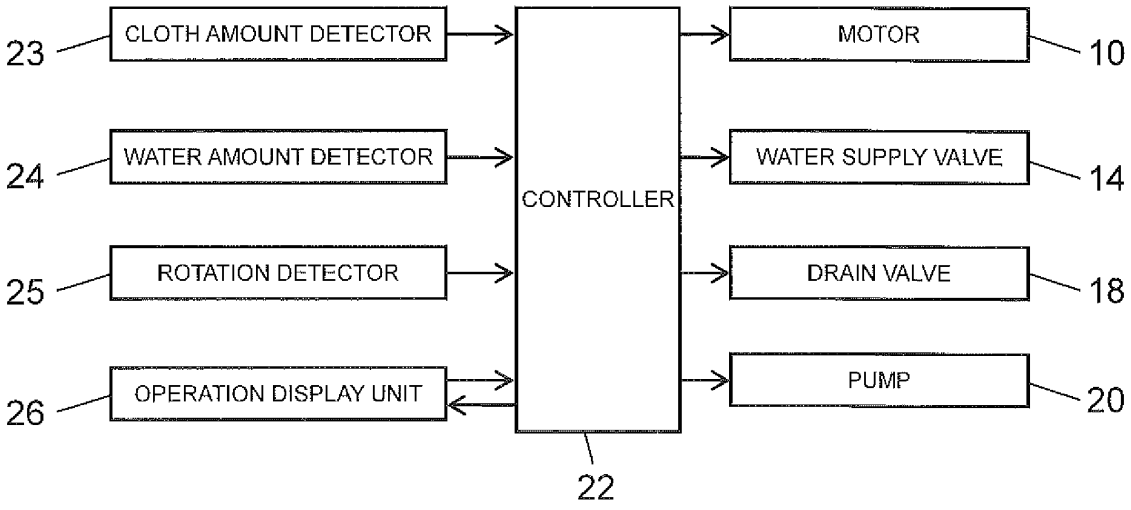
C
21e
22
21c
21
20
3
19
18

FIG. 2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CLOTH AMOUNT DETECTOR
24
WATER AMOUNT DETECTOR
25
ROTATION DETECTOR
26
OPERATION DISPLAY UNIT
CONTROLLER
22
MOTOR
10
WATER SUPPLY VALVE
14
DRAIN VALVE
18
PUMP
20

FIG. 3

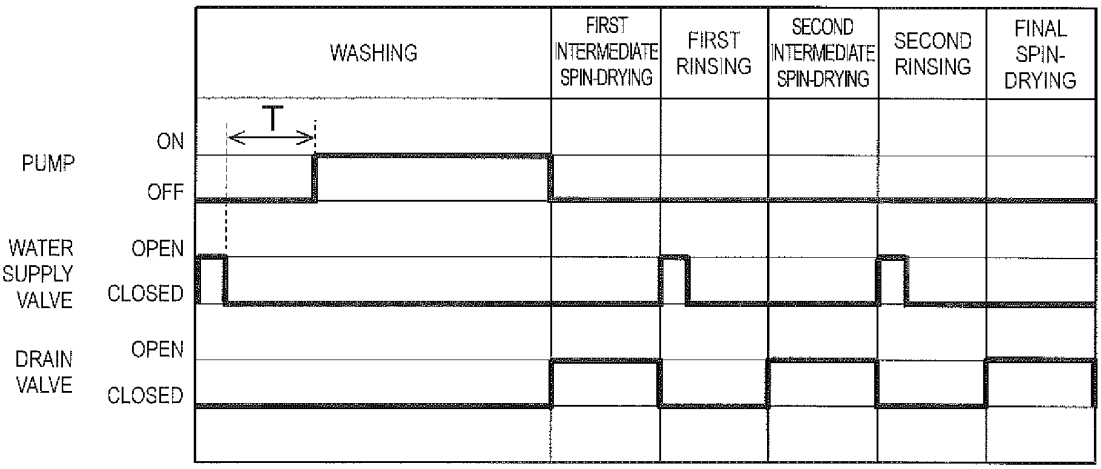


FIG. 4

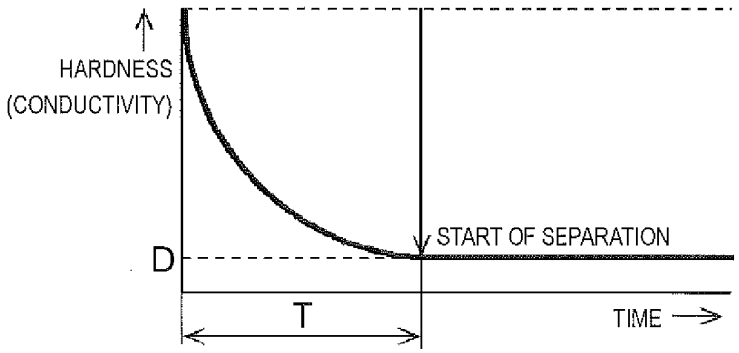


FIG. 5

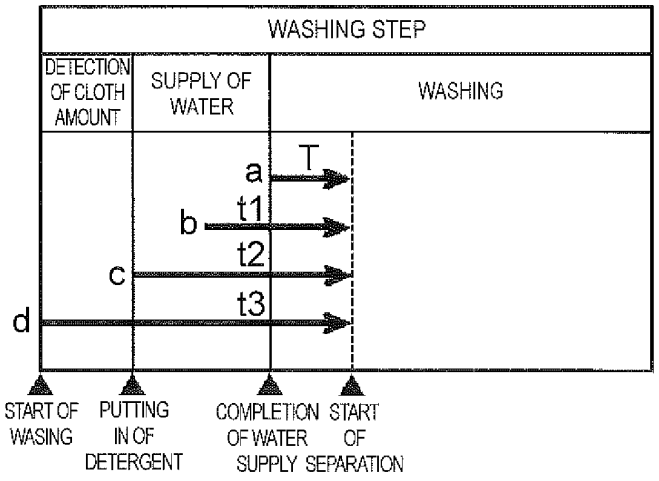


FIG. 6

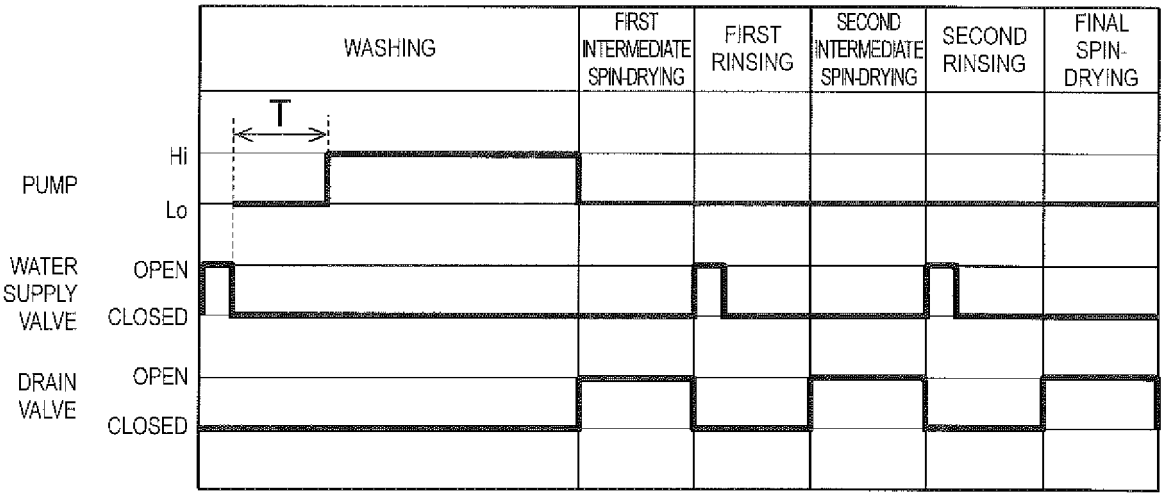
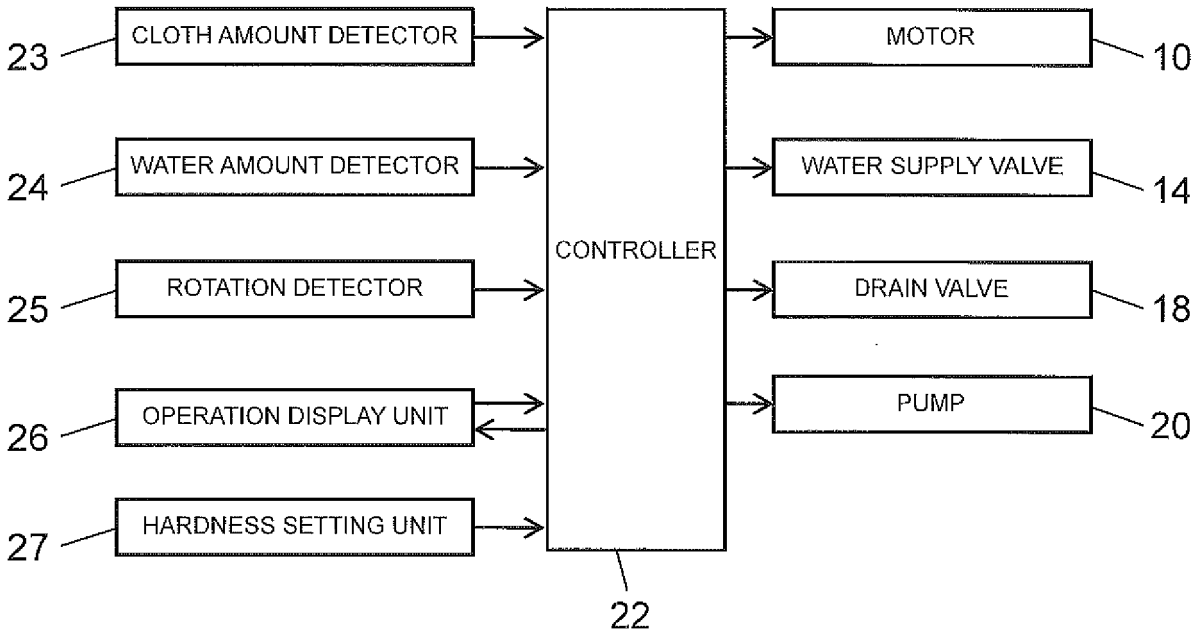

WASHING
FIRST INTERMEDIATE SPIN-DRYING
FIRST RINSING
SECOND INTERMEDIATE SPIN-DRYING
SECOND RINSING
FINAL SPIN-DRYING
T
PUMP
Hi
Lo
WATER SUPPLY VALVE
OPEN
CLOSED
DRAIN VALVE
OPEN
CLOSED

FIG. 7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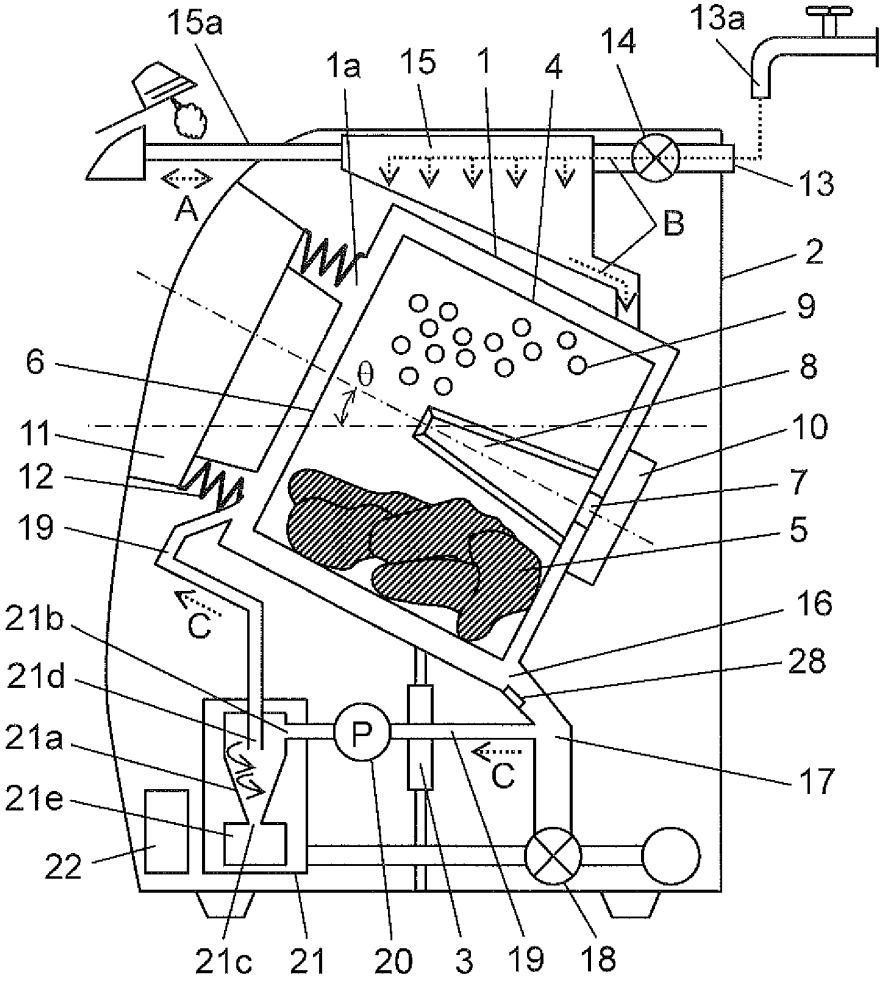
CLOTH AMOUNT DETECTOR
24
WATER AMOUNT DETECTOR
25
ROTATION DETECTOR
26
OPERATION DISPLAY UNIT
27
HARDNESS SETTING UNIT
CONTROLLER
22
MOTOR
10
WATER SUPPLY VALVE
14
DRAIN VALVE
18
PUMP
20

FIG. 8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C
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21d
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P
21a
C
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21e
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21c
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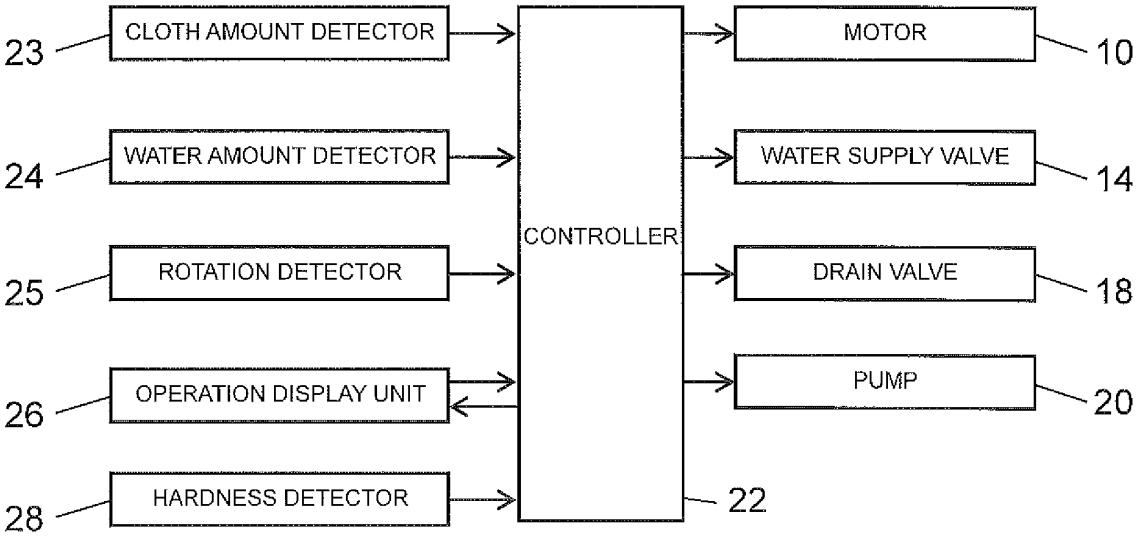
3
19
18

FIG. 9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CLOTH AMOUNT DETECTOR
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WATER AMOUNT DETECTOR
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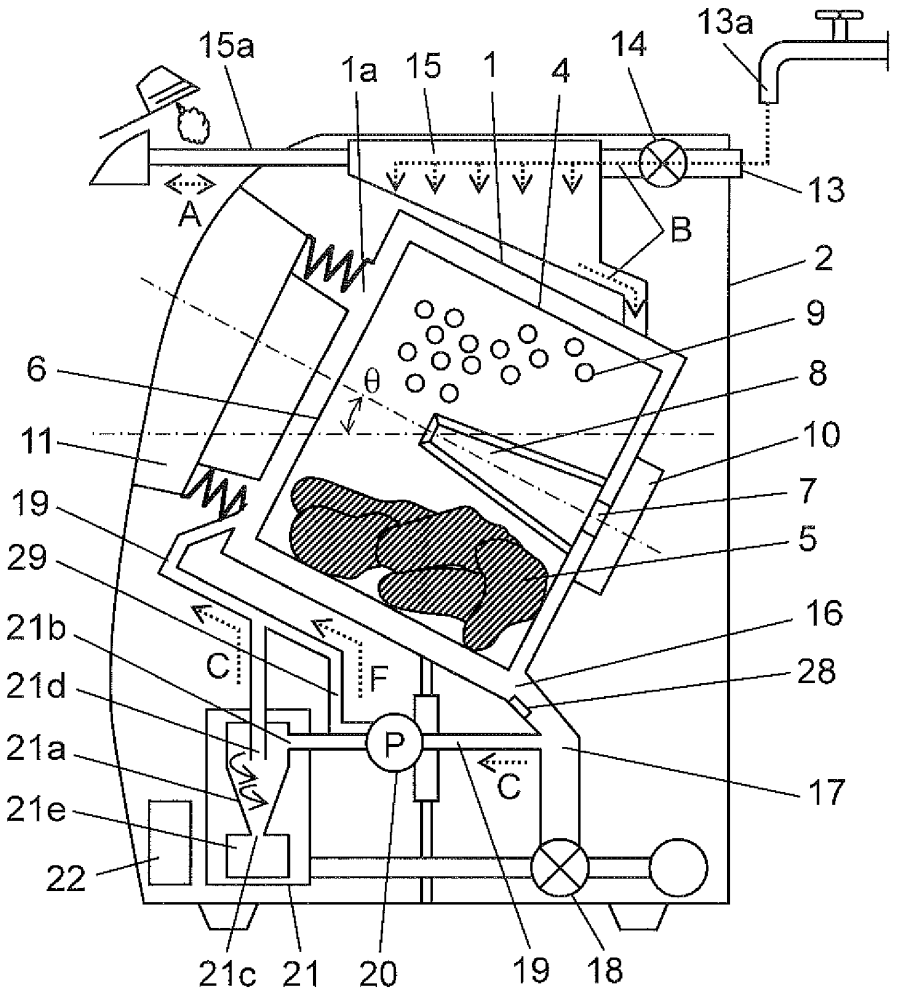
ROTATION DETECTOR
26
OPERATION DISPLAY UNIT
28
HARDNESS DETECTOR
CONTROLLER
MOTOR
10
WATER SUPPLY VALVE
14
DRAIN VALVE
18
PUMP
20
22

FIG. 10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29
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22
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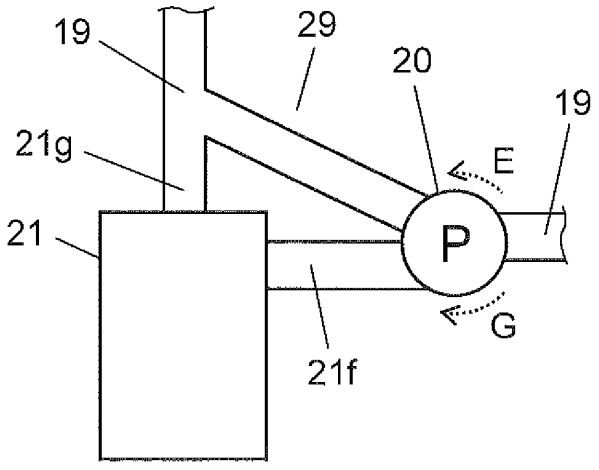
FIG. 11


19
29
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21g
E
21
P
G
21f

FIG. 12

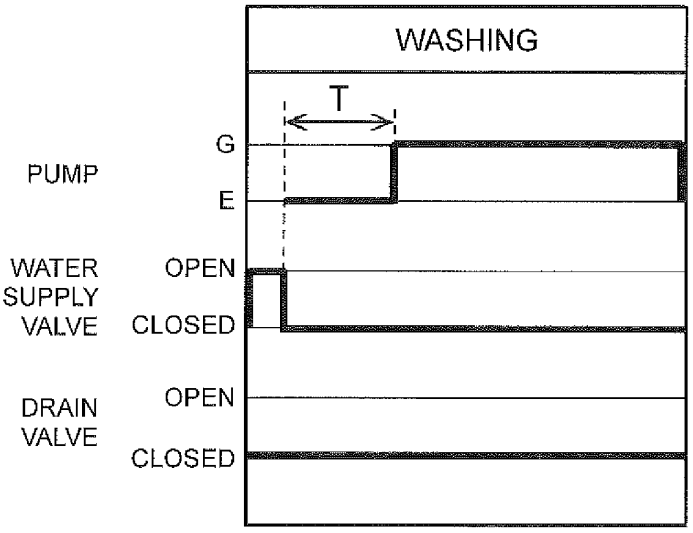
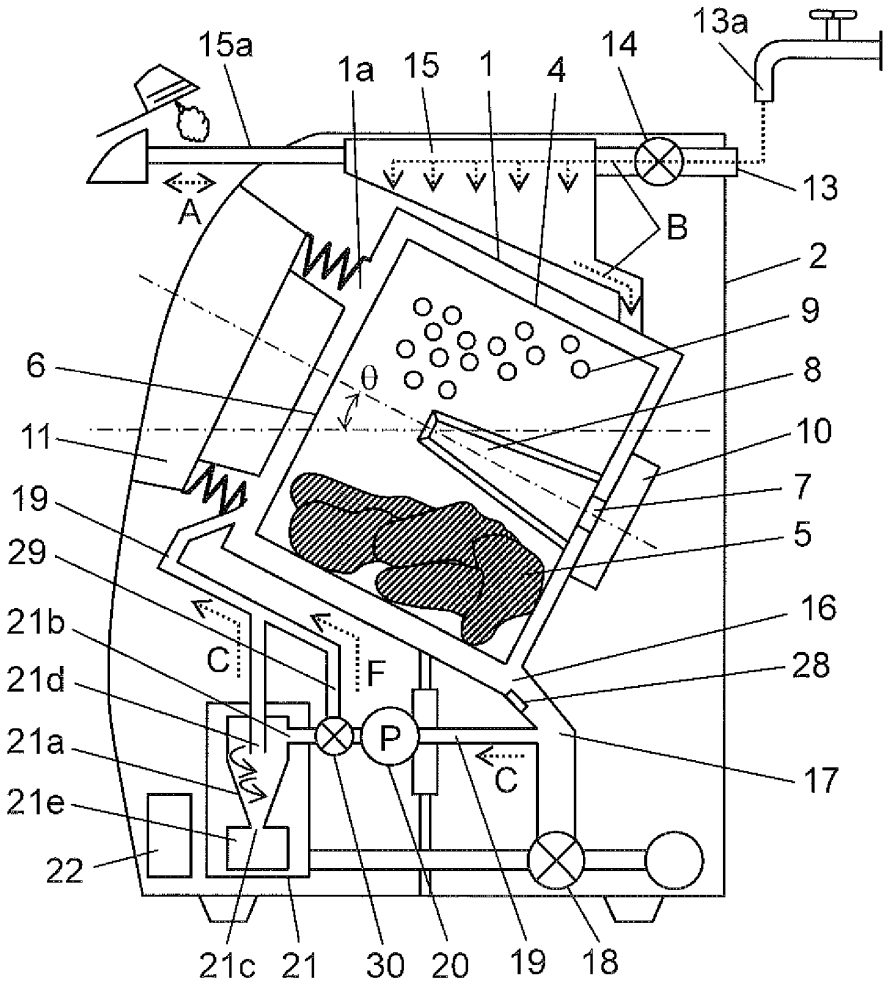

WASHING
T
PUMP
G
E
WATER SUPPLY VALVE
OPEN
CLOSED
DRAIN VALVE
OPEN
CLOSED

FIG. 13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8
10
7
5
16
28
17
6
θ
11
19
29
21b
21d
21a
21e
22
C
F
P
C
21c
21
30
20
19
18

FIG. 14

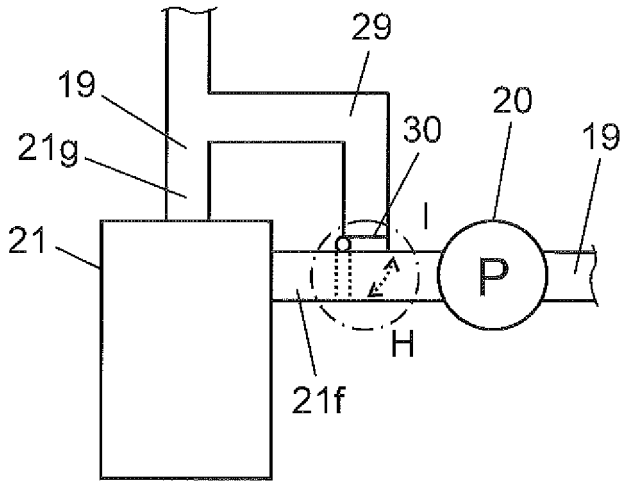

29
19
20
30
19
21g
l
21
P
H
21f

FIG. 15

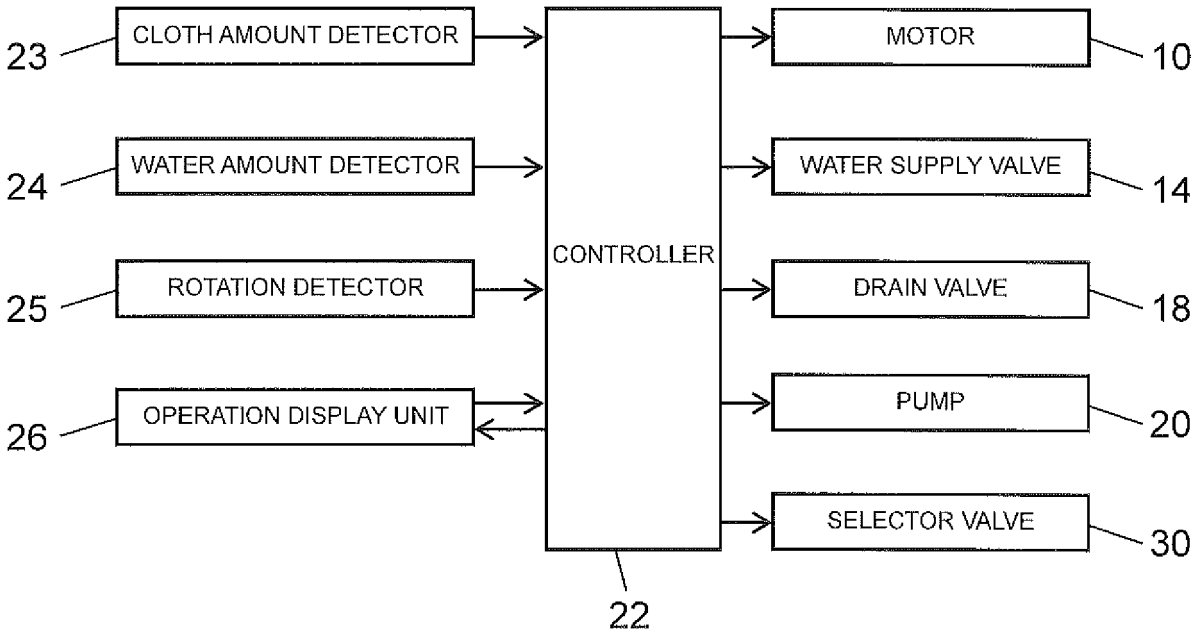

23
CLOTH AMOUNT DETECTOR
24
WATER AMOUNT DETECTOR
25
ROTATION DETECTOR
26
OPERATION DISPLAY UNIT
CONTROLLER
22
MOTOR
10
WATER SUPPLY VALVE
14
DRAIN VALVE
18
PUMP
20
SELECTOR VALVE
30

FIG. 16

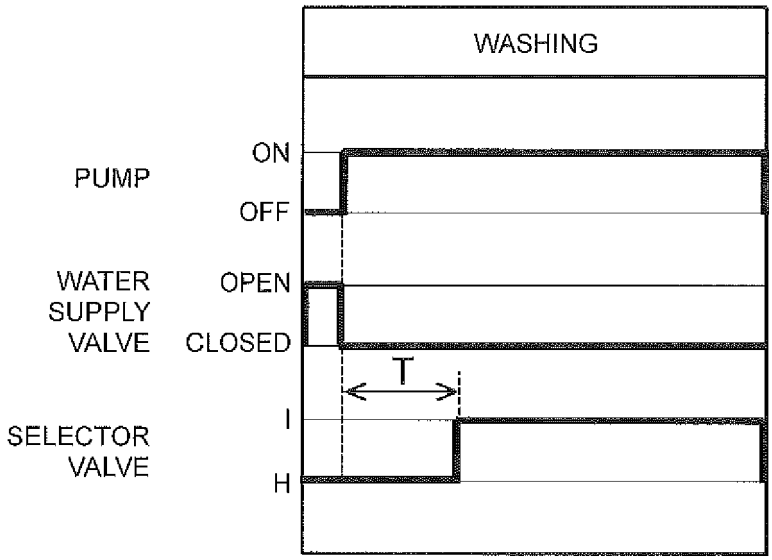

WASHING
PUMP
ON
OFF
WATER SUPPLY VALVE
OPEN
CLOSED
T
SELECTOR VALVE
I
H

FIG. 17

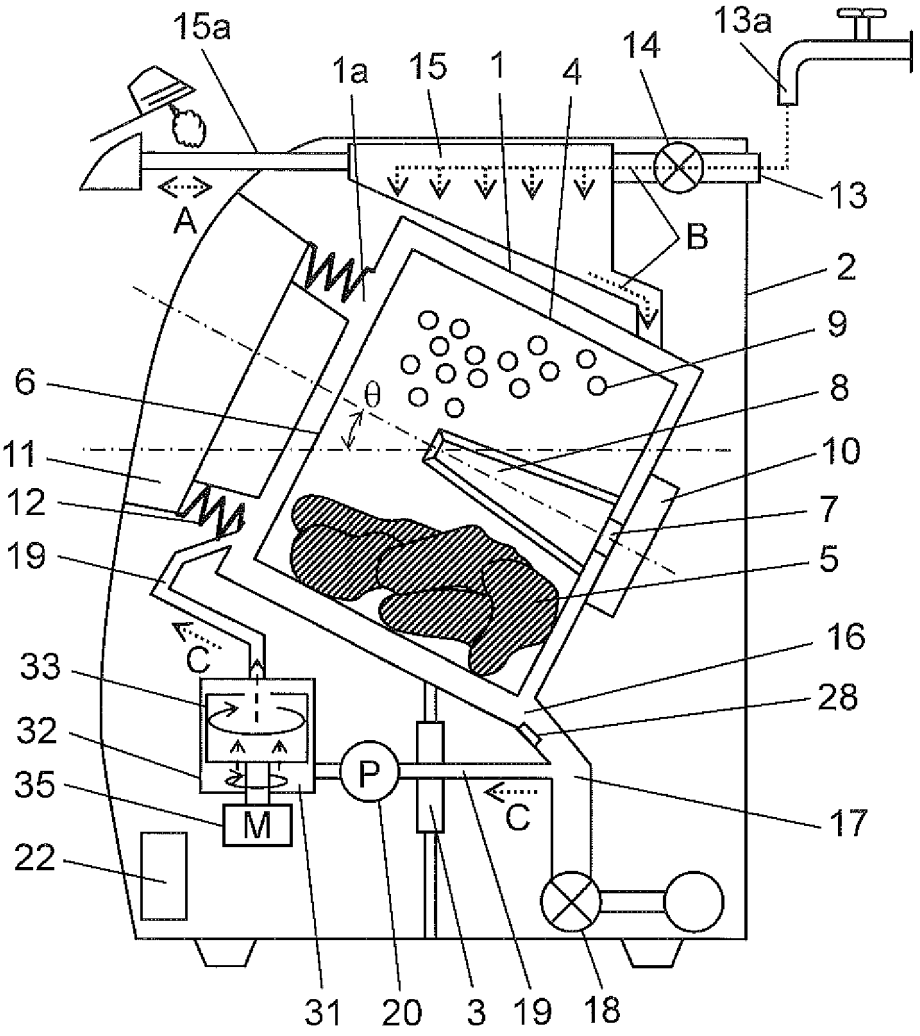

15a
1a
15
1
4
14
13a
13
A
B
2
9
8
10
7
5
6
θ
11
12
19
C
33
32
35
M
P
C
16
28
17
22
31
20
3
19
18

FIG. 18

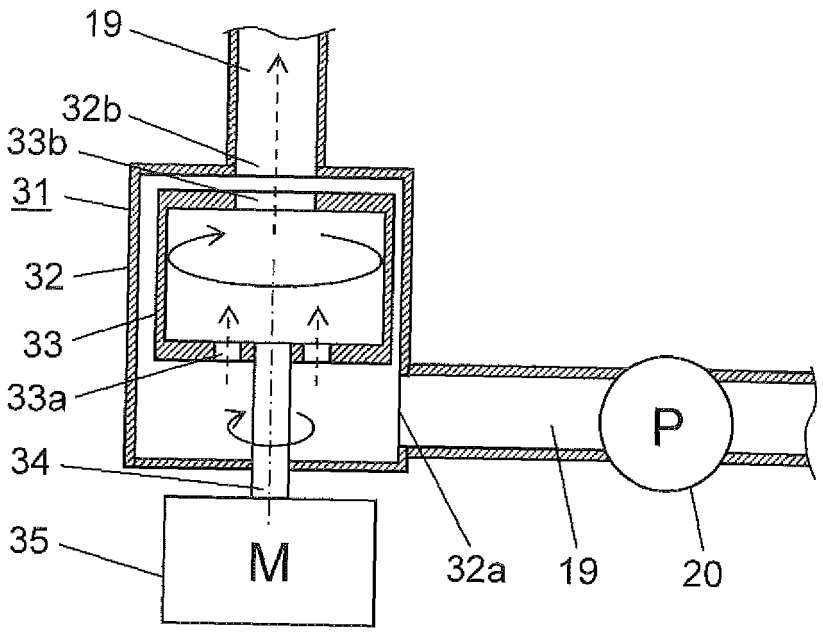

19
32b
33b
31
32
33
33a
34
35
M
P
32a
19
20

FIG. 19

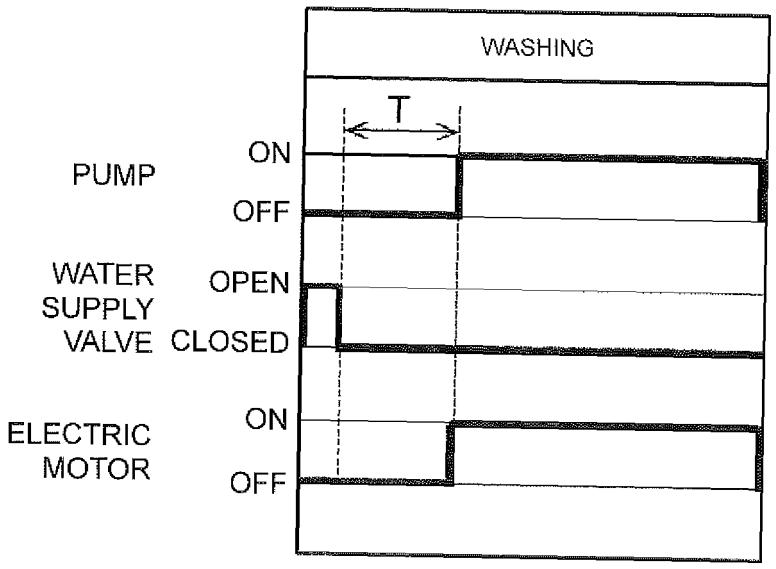

WASHING
T
PUMP
ON
OFF
WATER SUPPLY VALVE
OPEN
CLOSED
ELECTRIC MOTOR
ON
OFF

FIG. 20

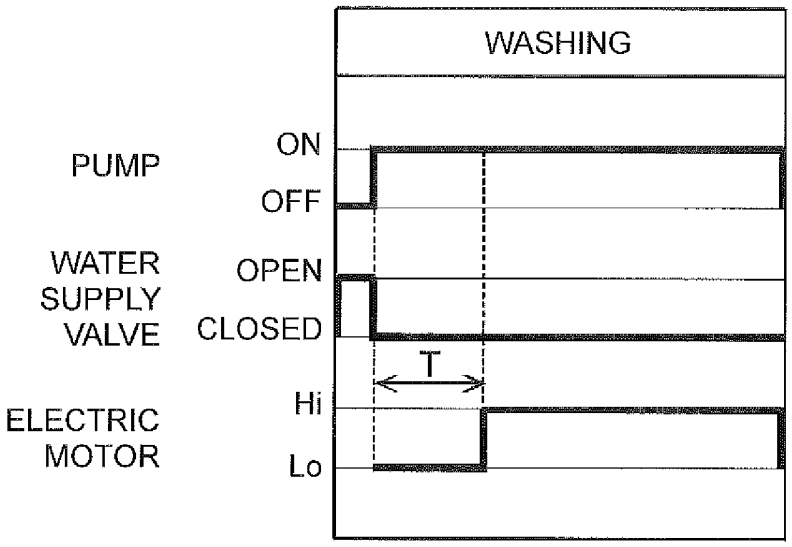
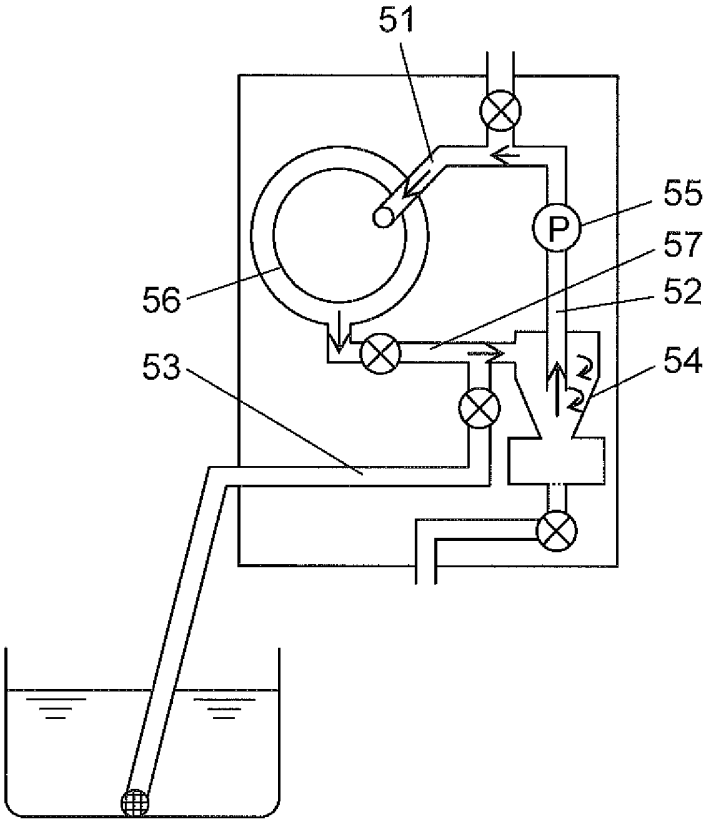

WASHING
PUMP
ON
OFF
WATER SUPPLY VALVE
OPEN
CLOSED
T
ELECTRIC MOTOR
Hi
Lo

FIG. 21


51
55
P
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52
53
54

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/004652

A. CLASSIFICATION OF SUBJECT MATTER
D06F39/10(2006.01)i, *D06F33/02*(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)
D06F39/10, D06F33/02

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 1996-2016
Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016

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.
A	JP 2005-152212 A (Toshiba Corp.), 16 June 2005 (16.06.2005), entire text; all drawings (Family: none)	1-13
A	JP 2001-70694 A (LG Electronics Inc.), 21 March 2001 (21.03.2001), entire text; all drawings & US 2003/0051514 A1 & KR 10-2001-0018296 A & CN 1285430 A	1-13
A	US 2004/0104158 A1 (LG Electronics Inc.), 03 June 2004 (03.06.2004), paragraph [0055]; fig. 2 & KR 10-2004-0046954 A	1-13

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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
07 November 2016 (07.11.16)	22 November 2016 (22.11.16)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/004652

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2013-126475 A (Panasonic Corp.), 27 June 2013 (27.06.2013), entire text; all drawings (Family: none)	1-13

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2005152212 A **[0007]**
- JP 2001070694 A **[0007]**