

## DESCRIPTION

### WASHING MACHINE

#### 5 TECHNICAL FIELD

[0001] The present disclosure relates to a washing machine.

#### BACKGROUND ART

[0002] PTL 1 discloses a drum type washing machine that supplies steam into a drum.

10 [0003] A drum type washing machine according to PTL 1 feeds washing water into a tub at a water level lower than a drum bottom surface, heats the washing water by a washing heater provided in the tub to generate steam, and rotates the drum to supply the steam into the drum from a small hole on a drum side wall.

#### Citation List

#### 15 Patent Literature

[0004] PTL 1: Unexamined Japanese Patent Publication No. 2014-151187

### SUMMARY OF THE INVENTION

[0005] The present disclosure provides a washing machine capable of efficiently  
20 supplying steam into an accommodation tank.

[0006] A washing machine according to the present disclosure includes a tub, an accommodation tank provided in the tub, a steam generator that is provided to the tub and generates steam, and an air blower that supplies the steam generated by the steam generator into the accommodation tank.

25 [0007] A washing machine according to the present disclosure includes a tub, an accommodation tank provided in the tub, a water feeder that supplies water to the tub, an air supply unit that supplies air to the tub, a steam generator that is provided in the tub and generates steam, and a controller. Then, the controller drives the water feeder to feed water into the tub, drives the steam generator to generate steam with the fed water, and drives the  
30 air supply unit to blow the steam into the accommodation tank.

[0008] The washing machine according to the present disclosure can efficiently supply steam into the accommodation tank.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0009]** Fig. 1 is a schematic longitudinal sectional view illustrating a configuration of a washing machine according to a first exemplary embodiment.

Fig. 2 is a schematic front sectional view illustrating a configuration of the washing machine according to the first exemplary embodiment.

Fig. 3 is a flowchart illustrating steam supply control of the washing machine according to the first exemplary embodiment.

Fig. 4 is a schematic front view illustrating a flow of steam in a steam process of a conventional washing machine.

Fig. 5 is a schematic side view illustrating a flow of steam in a steam process of a conventional washing machine.

Fig. 6 is a schematic view illustrating a flow of steam in a steam process of the washing machine according to the first exemplary embodiment.

Fig. 7 is a schematic side view illustrating a flow of steam in a steam process of the washing machine according to the first exemplary embodiment.

Fig. 8 is a schematic front sectional view illustrating a configuration of a washing machine according to a fourth exemplary embodiment.

## DESCRIPTION OF EMBODIMENT

**[0010]** Exemplary embodiments will be described below in detail with reference to the drawings. Note that the present disclosure is not limited by the accompanying drawings and the following description.

**[0011]** (First exemplary embodiment)

Hereinafter, washing machine 100 according to the first exemplary embodiment of the present disclosure will be described with reference to Figs. 1 to 7.

**[0012]** [Configuration of washing machine]

Fig. 1 is a schematic longitudinal sectional view illustrating the configuration of washing machine 100 according to the first exemplary embodiment, and Fig. 2 is a schematic front sectional view illustrating the configuration of washing machine 100 according to the first exemplary embodiment. First, the configuration of washing machine 100 will be described with reference to Figs. 1 and 2. Hereinafter, there is a case where a vertical direction in a state where washing machine 100 is installed as illustrated in Fig. 1 (corresponding to an installation state according to the present disclosure) is described as

an up-down direction. This also applies to washing machines according to other exemplary embodiments.

**[0013]** As illustrated in Fig. 1, washing machine 100 is a drum type washing machine, and includes housing 110 and tank unit 200 that accommodates a treatment object in housing 110. Tank unit 200 includes drum 210, which is an example of the accommodation tank according to the present disclosure and has peripheral wall 211 having a substantially cylindrical shape surrounding axis of rotation RX, and tub 220 that accommodate drum 210. Drum 210 is configured to be able to accommodate a treatment object, and tub 220 is configured to be able to store water (hereinafter, also referred to as "washing water"). That is, washing machine 100 includes tub 220 and drum 210 provided in tub 220. Examples of the treatment object include clothes, hats, shoes, and toys. A plurality of holes 214 for communicating the inside and the outside of drum 210 are formed in peripheral wall 211, and the plurality of holes 214 allow the water stored in tub 220 to pass through the inside of drum 210. Three baffles (not illustrated) are provided inside drum 210 at predetermined intervals, and the baffles lift and drop the treatment object downward as drum 210 rotates.

**[0014]** Washing machine 100 according to the present exemplary embodiment includes steam generator 160, which is provided on tub 220 and generates steam. Steam generator 160 includes hot water heater 163, which is an example of a heater according to the present disclosure and heats washing water stored in tub 220. Hot water heater 163 is provided with a temperature fuse (not illustrated) described later. It is desirable that steam generator 160 according to the present exemplary embodiment is at a position lower than the bottom surface of drum 210. This is because an updraft is generated by steam, so that the steam generated in tub 220 can be efficiently supplied into drum 210. Hot water heater 163 according to the present exemplary embodiment is disposed in a lower part of tub 220. That is, steam generator 160 and hot water heater 163 are disposed below drum 210 in the installation state of washing machine 100.

**[0015]** Hot water heater 163 is disposed such that the long direction becomes substantially parallel to a horizontal plane in the installation state of washing machine 100. That is, hot water heater 163 is disposed below drum 210 so as to be horizontal in the installation state of washing machine 100. Due to this, washing machine 100 can submerge hot water heater 163 with less washing water, compared to a case where hot water heater 163 is provided such that the long direction becomes substantially parallel to the bottom surface of drum 210. By a configuration of reducing the amount of washing water required

for steam, washing machine 100 can improve thermal efficiency and generate steam in a short time. Washing machine 100 can increase a distance between an inner lowermost end of drum 210 and a set water level required for steam and suppress the treatment object accommodated in drum 210 from being immersed due to erroneous detection of the water level. Note that hot water heater 163 may be provided such that the long direction is inclined downward. In this case, the heat generation part of hot water heater 163 is desirably below the temperature fuse. Due to this, even if hot water heater 163 is heated without being submerged, when the temperature reaches higher than or equal to a predetermined temperature, the electric power is cut off by the temperature fuse, and the heating is stopped. Therefore, safety is secured even if the set water level required for steam is provided in the vicinity of hot water heater 163.

**[0016]** The temperature fuse is incorporated in hot water heater 163. Since hot water heater 163 automatically stops heating by the temperature fuse when the temperature becomes higher than or equal to the predetermined temperature, even when water level sensor 321 erroneously detects the water level, heating without water in a state where hot water heater 163 is not submerged is suppressed. The temperature fuse may be provided on the outer wall of tub 220 instead of being incorporated in hot water heater 163.

Furthermore, when water temperature T detected by water temperature detection sensor 161 exceeds a predetermined abnormal temperature higher than an upper limit temperature control temperature, hot water heater 163 may be stopped and an error indication may be displayed on operation unit 123.

**[0017]** Housing 110 includes front wall 111 where throw-in slot 119 for throwing a treatment object into tank unit 200 is formed, and rear wall 112 positioned on an opposite side to front wall 111. Housing 110 includes housing top wall 113 extending substantially horizontally between front wall 111 and rear wall 112, and housing bottom wall 114 positioned on the opposite side to housing top wall 113. Opening 213 communicating with throw-in slot 119 formed on front wall 111 is formed in each of drum 210 and tub 220.

**[0018]** Washing machine 100 further includes door body 120 attached to front wall 111. Door body 120 turns between a closed position where throw-in slot 119 formed on front wall 111 is closed and an open position where throw-in slot 119 is opened. By turning door body 120 to the open position, the user can throw the treatment object into drum 210 through throw-in slot 119 of front wall 111. Thereafter, by moving door body 120 to the closed position, the user can cause washing machine 100 to wash the treatment object.

Note that door body 120 illustrated in Fig. 1 is present at the closed position.

[0019] Drum 210 rotates about axis of rotation RX extending between front wall 111 and rear wall 112. The treatment object thrown into drum 210 moves inside drum 210 along with the rotation of drum 210, and undergoes treatment corresponding to a course selected  
5 by the user from among washing, rinsing, and dewatering.

[0020] Drum 210 includes peripheral wall 211 and bottom wall 212 opposing door body 120 in the closed position. Tub 220 includes bottom 221 surrounding bottom wall 212 and a part of peripheral wall 211 of drum 210, and front 222 surrounding the other part of peripheral wall 211 of drum 210 between bottom 221 and door body 120.

10 [0021] Tank unit 200 includes rotating shaft 230 attached to bottom wall 212 of drum 210. Rotating shaft 230 extends toward rear wall 112 along axis of rotation RX. Rotating shaft 230 passes through bottom 221 of tub 220 and emerges between tub 220 and rear wall 112.

[0022] Washing machine 100 further includes motor 231 installed below tub 220, pulley  
15 232 attached to rotating shaft 230 exposed to the outside of tub 220, and belt 233 for transmitting the power of motor 231 to pulley 232. When motor 231 operates, the power of motor 231 is transmitted to belt 233, pulley 232, and rotating shaft 230. As a result, drum 210 rotates in tub 220.

[0023] Washing machine 100 further includes packing structure 116 disposed between  
20 front 222 of tub 220 and door body 120. Door body 120 turned to the closed position compresses packing structure 116. As a result, packing structure 116 forms a watertight seal structure between door body 120 and front 222.

[0024] Washing machine 100 performs cloth amount sensing for measuring an amount of the treatment object. Cloth amount sensing is measured from a current value of motor 231  
25 at the time when, for example, drum 210 is accelerated to a prescribed rotation speed.

[0025] Washing machine 100 further includes drying unit 700, which is an example of the air supply unit according to the present disclosure. Drying unit 700 supplies tub 220 with air. Drying unit 700 includes air filter 711, drying duct 710, heat exchanger 712, which is an example of the air heater according to the present disclosure, blower fan 730,  
30 which is an example of the air blower according to the present disclosure, air suction pipe 750, and air feed pipe 760. Air suction pipe 750 and air feed pipe 760 are provided with blower fan 730 and constitute a part of an air passage as an example of an air passage according to the present disclosure connected to tub 220.

[0026] Here, air filter 711 removes lint from air sent from drum 210. Heat exchanger 712 includes a heat pump or a drying heater, and, by exchanging heat with air passing through air filter 711, heats air to be supplied. Drying duct 710 accommodates air filter 711 and heat exchanger 712. Blower fan 730 is joined to drying duct 710 to generate wind. That is, blower fan 730 supplies the steam generated by steam generator 160 into drum 210. Air suction pipe 750 defines a flow path of air from tank unit 200 to blower fan 730. Air feed pipe 760 defines a flow of air sent from blower fan 730 to tank unit 200.

[0027] Drying unit 700 constitutes a circulation air passage including tank unit 200 by taking in the air of tank unit 200 from air suction pipe 750 and sending air to tank unit 200 through air feed pipe 760.

[0028] When blower fan 730 rotates, a negative pressure environment is created in air suction pipe 750, while a positive pressure environment is created in air feed pipe 760, and air is supplied into drum 210. Therefore, washing machine 100 is a circulation type washing and drying machine including the circulation air passage configured by drying unit 700 and tank unit 200.

[0029] A joint surface between air suction pipe 750 and tank unit 200 is provided with air suction port 751, and a joint surface between air feed pipe 760 and tank unit 200 is provided with air feed port 761. Drying unit 700 includes air suction port 751 and air feed port 761. Air suction port 751 is an opening for connecting tub 220 and air suction pipe 750 at a position above steam generator 160 in the installation state of washing machine 100 on an upstream side of blower fan 730 and for sucking air in tub 220. Air feed port 761 is an opening for connecting tub 220 and air feed pipe 760 on a downstream side of heat exchanger 712 and blower fan 730 and for blowing air (steam) into drum 210. It is desirable to provide air suction port 751 at a position higher than hot water heater 163 included in steam generator 160 according to the present exemplary embodiment because an updraft is generated by steam. It is desirable to provide air suction port 751 particularly at an upper part of tub 220 where heated air including steam is easily stored. Furthermore, it is desirable to provide air suction port 751 at a position higher than air feed port 761.

[0030] Drying unit 700 is provided with a drying temperature sensor that detects the temperature of the air in drying unit 700. Note that as in the present exemplary embodiment, as the drying temperature sensor, suction temperature sensor 162a that detects the temperature of air sucked from air suction port 751 and blowing temperature sensor 162b that detects the temperature of air heated by heat exchanger 712 may be

provided. That is, blowing temperature sensor 162b is an example of a blowing temperature detector according to the present disclosure, and detects the temperature of steam in the vicinity of air feed port 761.

**[0031]** As illustrated in Fig. 2, washing machine 100 includes water feed unit 139 that supplies water to tub 220 as an example of the water feeder according to the present disclosure. Water feed unit 139 includes water feed port 140 connected to a faucet (not illustrated), water feed valve 141, detergent container 150 that accommodates detergent, and water feed pipe 151 that connects detergent container 150 and tank unit 200.

**[0032]** Washing water to be fed is preferably fed inside tub 220 so as not to hit the treatment object accommodated in drum 210. Therefore, water feed pipe 151 is disposed at the upper part on the rear side of tub 220, and the flow passage constituted by water feed pipe 151 may be formed along the rear surface of tub 220. In order to prevent inside drum 210 from getting water, water feed valve 141 may be intermittently opened to reduce the amount of water to be fed, and the fed water may flow down along the inner surface of tub 220. Note that a first water feed flow passage for feeding water so that the washing water hits the treatment object accommodated in drum 210 and a second water feed flow passage for feeding water so that the washing water does not hit the treatment object accommodated in drum 210 are provided, and the first water feed flow passage and the second water feed flow passage may be selectively used according to the application.

**[0033]** As illustrated in Fig. 1, washing machine 100 includes upstream circulation pipe 640, downstream circulation pipe 650, drainpipe 660, drain valve 690, and lint filter 152. Here, upstream circulation pipe 640 defines a path of water flowing from tub 220 to circulation pump 610. Downstream circulation pipe 650 defines a path of water from circulation pump 610 back to tub 220. Drainpipe 660 defines a drain path to the outside of housing 110. Lint filter 152 collects foreign substances such as lint. Drain valve 690 is attached to drainpipe 660. A drain unit according to the present exemplary embodiment for draining water stored in tub 220 includes drain valve 690 and is defined by a flow passage from drum 210 to drainpipe 660. Upstream circulation pipe 640 branches near a connection part with tub 220 to form air trap 630, and is connected to air pipe 631 at an upper part of air trap 630. The upper part of air pipe 631 is provided with water level sensor 321, which is an example of a water level detector according to the present disclosure and detects a water level in tub 220.

**[0034]** Washing machine 100 includes water level sensor 321, which is an example of the

water level detector according to the present disclosure. Water level sensor 321 is configured by a MEMS type pressure sensor. Since water level sensor 321 can accurately detect the water level by adopting the MEMS type pressure sensor, it is possible to suppress water immersion into drum 210 or exposure of hot water heater 163. Therefore, it is no longer necessary to increase the distance from the lower end of drum 210 to hot water heater 163 in order to cope with erroneous detection of the water level, so that the degree of freedom in design is improved.

**[0035]** Note that as an example of the water level detector according to the present disclosure, instead of water level sensor 321 configured by the MEMS type pressure sensor, a sensor that performs electrode detection to detect the water level by reading a potential change between electrodes or a sensor that performs water level detection by a float sensor may be used. Since these water level detectors sharply reflect a decrease in the water level, it is possible to effectively suppress heating without water in the state where hot water heater 163 is not submerged.

**[0036]** Lint filter 152 may have a configuration where attachment/detachment is locked when the washing water has a high temperature. This can suppress high-temperature washing water from flowing out due to removal of lint filter 152 during steam supply control described later.

**[0037]** Washing machine 100 includes water temperature detection sensor 161, which is an example of the water temperature detector according to the present disclosure. Water temperature detection sensor 161 is attached to an outer wall surface of tub 220, and detects the temperature of washing water in tub 220. The attachment location of water temperature detection sensor 161 is not limited to the outer wall surface of tub 220, is only required to be able to detect water temperature T in tub 220, and may be inside tub 220, for example.

**[0038]** Washing machine 100 includes operation unit 123. Operation unit 123 includes a button for receiving an operation of the user and a display. The user can select various courses with the button of operation unit 123, and information regarding the selected course is displayed on the display. Note that operation unit 123 may include a touchscreen. The various courses include a washing course, a drying course, a washing and drying course performed as a series from washing to drying, a refresh course for treating the treatment object with only steam without washing, and a tub cleaning course for treating a washing tub without putting the treatment object. Steam supply control described later is

performed as a part of these courses. Note that the various courses may include a course only including steam supply control.

5 [0039] Washing machine 100 includes controller 170. Controller 170 controls entire washing machine 100, and particularly executes steam supply control. Although described in detail later, controller 170 drives water feed unit 139 to feed water into tub 220, drives steam generator 160 to generate steam from the fed water, and drives drying unit 700 to blow steam into drum 210. Note that the position of controller 170 illustrated in Fig. 1 is an example, and may be arranged at another position. Controller 170 includes a computer system having a processor and a memory. Then, when the processor executes a program stored in the memory, the computer system functions as controller 170. Here, the program executed by the processor is assumed to be recorded in advance in the memory of the computer system, but the program may be provided by being recorded in a non-temporary recording medium such as a memory card, or may be provided through a telecommunication line such as the Internet.

15 [0040] [Steam supply control]

The steam supply control exerts effects such as wrinkle removal on clothes, sterile filtration, deodorization, and allergen removal or deactivation by causing steam to act on the treatment object. The steam supply control includes, for example, a water feed process of feeding water to steam generator 160, a steam process of generating steam, a drying process of drying a wet treatment object, and a cooling process of cooling washing water in tub 220. The process time related to the steam supply control, the rotation time limit of drum 210, and the like are decided based on the amount of the treatment object or the temperature of washing water.

25 [0041] Hereinafter, as an example of the steam supply control, a refresh course including the steam process and the drying process will be described. Hereinafter, as illustrated in Fig. 2, a water level higher than the inner bottom surface of drum 210 is water level A, a water level lower than the bottom surface of drum 210 and being a set water level of the steam process is water level B, and a water level lower than water level B and having a possibility that hot water heater 163 is exposed is water level C.

30 [0042] Fig. 3 is a flowchart illustrating the steam supply control (refresh course) of washing machine 100 according to the first exemplary embodiment.

[0043] As illustrated in Fig. 3, when the refresh course is started (step S101), controller 170 executes the water feed process (step S102). Specifically, controller 170 opens water

feed valve 141 to supply water to detergent container 150, and the supplied water is fed inside tub 220 so as not to hit the treatment object accommodated in drum 210 (step S102). Controller 170 determines whether or not the water level detected by water level sensor 321 is higher than or equal to water level B (step S103). Controller 170 continues (step 5 S102) water feed until water level B reaches (step S103, No). When water level sensor 321 detects that water level B has been reached (step S103, Yes), controller 170 closes water feed valve 141 and proceeds to the steam process. That is, controller 170 executes the steam process of blowing steam into tub 220.

**[0044]** When the steam process is started, controller 170 starts energization of hot water 10 heater 163 (step S104). In this way, by starting the steam process in a state where water feed is completed, it is possible to heat hot water heater 163 in a state where hot water heater 163 is completely immersed in washing water. Therefore, it is possible to suppress hot water heater 163 from heating without water. Note that when hot water heater 163 is in a state of being completely immersed in the washing water, energization of hot water 15 heater 163 may be started during the water feed process.

**[0045]** Controller 170 causes hot water heater 163 to heat the washing water until the temperature of the washing water detected by water temperature detection sensor 161 reaches an upper limit temperature control temperature, which is a predetermined temperature. The upper limit temperature control temperature is set to, for example, 60 °C. 20 The washing water stored in steam generator 160 subcooled boils in the vicinity of hot water heater 163 to generate steam. The washing water stored in steam generator 160 may generate steam by normal boiling.

**[0046]** When the washing water reaches the upper limit temperature control temperature, controller 170 stops hot water heater 163. When the washing water drops to a lower limit 25 temperature control temperature, which is lower than the upper limit temperature control temperature, controller 170 starts energization of hot water heater 163 again. The lower limit temperature control temperature is set to, for example, 55 °C.

**[0047]** In the present exemplary embodiment, after elapse of 2 minutes from the start of energization of hot water heater 163, controller 170 drives blower fan 730 (step S105). 30 That is, in the steam process of generating steam, when the water in tub 220 reaches a predetermined water temperature, controller 170 starts blowing air by drying unit 700.

**[0048]** In a state where driving of drying unit 700 is stopped, controller 170 drives water feed unit 139 to feed water into tub 220, and drives steam generator 160 to generate steam

from the fed water. Controller 170 then drives drying unit 700 to blow steam into drum 210. Thus, by starting the steam process in a state where the water feed is completed so as to be higher than or equal to water level B, it is possible to suppress water level sensor 321 from erroneously detecting the water level due to the change in the wind pressure caused by the driving of blower fan 730. Note that drive of blower fan 730 in the steam process may be intermittently operated. By detecting the water level by water level sensor 321 when blower fan 730 is stopped, it is possible to suppress erroneous detection due to the change in wind pressure.

**[0049]** In the steam process, controller 170 continuously or intermittently operates motor 231 that rotates drum 210. The rotation speed of drum 210 is set to, for example, about 50 r/min to 60 r/min at which the treatment object accommodated in drum 210 tumbles. When drum 210 is rotating at about 50 r/min to 60 r/min, the treatment object in drum 210 is lifted upward in drum 210 by the baffle and dropped from above. In the present exemplary embodiment, since air feed port 761 is provided on the back surface of drum 210, the treatment object passes in front of air feed port 761 and is blown with steam when dropping from above. This allows the treatment object to efficiently obtain the effect of steam. In a case where the treatment object is clothes, the clothes are spread by the air blown when dropping from above, so that the wrinkle of the clothes can be efficiently smoothed out.

**[0050]** Controller 170 determines whether or not the water level detected by water level sensor 321 is lower than water level C (step S106). When the water level is higher than or equal to water level C (step S106, No), controller 170 proceeds to the processing of step S108. When the water level becomes lower than water level C (step S106, Yes), controller 170 stops energization of hot water heater 163 and proceeds to the processing of step S108 (step S107). Controller 170 determines whether or not steam process time  $t_s$  has elapsed from the start of energization of hot water heater 163 (step S108). Until steam process time  $t_s$  elapses (step S108, No), controller 170 repeats the processing from step S104. When steam process time  $t_s$  elapses (step S108, Yes), controller 170 ends the steam process and transitions to the drying process (step S109). Steam process time  $t_s$  is set to, for example, about 5 minutes.

**[0051]** The treatment object after the steam process is wet with steam and is in a state of being not able to be immediately used or worn. Therefore, as in the drying process of a general washing machine, it is necessary to dry the wet treatment object by driving only

blower fan 730 or heat exchanger 712 and blower fan 730 simultaneously while rotating drum 210. That is, controller 170 executes the drying process of drying the treatment object accommodated in tub 220.

**[0052]** In the present exemplary embodiment, when the drying process is started,  
5 controller 170 stops hot water heater 163, and starts driving of a drying function, that is, driving of blower fan 730 and heat exchanger 712 (step S109). Note that controller 170 determines the degree of dryness of the treatment object from a difference between the suction temperature detected by suction temperature sensor 162a and the blowing temperature detected by blowing temperature sensor 162b. Since the amount of heat used  
10 to evaporate moisture of the treatment object decreases as the treatment object dries, controller 170 determines that the degree of drying increases as the difference between the suction temperature and the blowing temperature decreases.

**[0053]** Next, the cooling process of cooling the washing water in tub 220 will be described. An object of the cooling process is to cool the washing water to lower than or  
15 equal to a predetermined temperature and drain the washing water, thereby suppressing the user from burning. When water temperature T of the washing water after the steam process is lower than or equal to the predetermined temperature, the cooling process needs not be executed. In the present exemplary embodiment, since the heat radiation amount of the washing water is larger than the amount of heat obtained from the dry air, a part of the  
20 drying process also serves as the cooling process, but the cooling process and the drying process may be separately executed.

**[0054]** In the present exemplary embodiment, the washing water is left to cool down until the temperature of the washing water detected by water temperature detection sensor 161 falls below a predetermined temperature. Controller 170 determines whether or not water  
25 temperature T detected by water temperature detection sensor 161 is lower than 50 °C (step S110). When water temperature T detected by water temperature detection sensor 161 is higher than or equal to 50 °C (step S110, No), controller 170 causes blower fan 730 in a driven state to cool the washing water. Note that as described above, since the heat radiation amount of the washing water is larger than the amount of heat obtained from the  
30 dry air, the washing water is cooled even in a state where heat exchanger 712 is driven.

**[0055]** Controller 170 adds time t' to be left to cool down, which is the time when cooling is performed, to t2 described later (step S111). Water temperature T is determined every time time t' to be left to cool down, which is a predetermined time, elapses.

**[0056]** A drain operation is executed when the washing water is cooled to less than or equal to a predetermined water temperature after the cooling process or during the cooling process. In the present exemplary embodiment, when water temperature T falls below 50 °C (step S110, Yes), controller 170 executes the drain operation (step S112). When  
5 controller 170 opens drain valve 690, the washing water in tub 220 is discharged to the outside of washing machine 100 through drainpipe 660. Water flow generated by the drainage washes away a scale precipitated on the surface of hot water heater 163 at the time of the steam process. Due to this, deposition of scale is suppressed, and thus it is possible to suppress reduction in steam generation ability of hot water heater 163 due to  
10 deposition of impurities. Thus, when the steam process of blowing steam into tub 220 is completed, controller 170 stops the driving of steam generator 160 and then starts the driving of drying unit 700 (blower fan 730). Then, when the water in tub 220 reaches a predetermined water temperature (50 °C in this example), controller 170 drains the water in tub 220.

**[0057]** Controller 170 determines whether or not drying process time  $t_d$  has elapsed after the completion of the drain operation (step S113). Controller 170 continues to maintain driving of heat exchanger 712 until drying process time  $t_d$  elapses (step S113, No). Drying process time  $t_d$  is set as the sum of  $t_2$ , which is a predetermined time, and time  $t'$  to be left to cool down. For example,  $t_2$  is set to about 5 minutes. Note that in a case of being left to  
20 cool down a plurality of times, time  $t'$  to be left to cool down for the plurality of times may be added to  $t_2$ . When drying process time  $t_d$  has elapsed (step S113, Yes), the drying process is completed, and the refresh course is completed (step S114).

**[0058]** [Action of steam process]

Fig. 4 is a schematic front view illustrating the flow of steam in the steam process  
25 of conventional washing machine 1000, and Fig. 5 is a schematic side view illustrating the flow of steam in the steam process of washing machine 1000.

**[0059]** As illustrated in Figs. 4 and 5, conventional washing machine 1000 includes water feed unit 1139, steam generator 1160, drum 1210, tub 1220, motor 1231, circulation pump 1610, and drying unit 1700. Water feed unit 1139 includes water feed port 1140, water  
30 feed valve 1141, detergent container 1150, and water feed pipe 1151. Steam generator 1160 includes hot water heater 1163. Opening 1213 formed in each of drum 1210 and tub 1220. A plurality of holes 1214 for communicating the inside and the outside of drum 1210 are formed in drum 1210. Drying unit 1700 includes air suction pipe 1750, blower fan

1730, and air feed pipe 1760. Conventional washing machine 1000 heats washing water stored in steam generator 1160 to generate steam, and rotates drum 1210 to supply steam into drum 1210 from hole 1214 on a side wall of drum 1210. Thus, conventional washing machine 1000 uses natural convection generated by rotation of drum 1210 as a means for supplying steam into drum 1210. Therefore, conventional washing machine 1000 has a problem that the amount of steam supplied to the treatment object in drum 1210 is too small to sufficiently exert the effect of steam.

[0060] Fig. 6 is a schematic view illustrating the flow of steam in the steam process of washing machine 100 according to the first exemplary embodiment, and Fig. 7 is a schematic side view illustrating the flow of steam in the steam process of washing machine 100.

[0061] As illustrated in Figs. 6 and 7, in the steam process of the present exemplary embodiment, the water stored in steam generator 160 is heated by hot water heater 163, and blower fan 730 is driven. As illustrated in Figs. 6 and 7, the steam generated by steam generator 160 (a) rises to the upper part of tank unit 200, and (b) is introduced into drying unit 700 from air suction port 751 via air feed pipe 760. Then, the steam (c) is supplied from drying unit 700 to the treatment object in drum 210 from air feed port 761 via air suction pipe 750. This enables a large amount of steam to be supplied to the treatment object in drum 210, and the water content of the treatment object to increase.

[0062] In the steam process, washing machine 100 may be modified so as to drive heat exchanger 712, which is an example of the air heater according to the present disclosure. The washing machine according to the first modification can send high-temperature steam to drum 210 by operating heat exchanger 712 in the steam process, and therefore treatment object wrinkle smoothing performance, sterile filtration/deodorization performance, and the like are improved. Furthermore, by keeping the steam at a high temperature, the washing machine according to the first modification can suppress a decrease in the amount of steam blown into tub 220 due to condensation of the steam.

[0063] In the steam process, washing machine 100 may be modified such that motor 231 is driven to rotate drum 210. The washing machine according to the second modification can uniformly apply steam to the treatment object by rotating drum 210 to stir the treatment object.

[0064] When the treatment object is clothes, the clothes are loosened by rotating drum 210, so that steam effectively acts in the washing machine according to the second

modification. In the washing machine according to the second modification, by operating blower fan 730, a pulling force by the circulating air acts on the clothes, so that the ability to smooth out wrinkles of the clothes is improved. When the treatment object is shoes, stuffed toys, or the like, steam is preferably blown in a state where drum 210 is stationary.

5   **[0065]** In the case of a drum type washing machine such as washing machine 100, the temperature of steam is desirably set to lower than or equal to 70 °C. That is, when the temperature of steam detected by blowing temperature sensor 162b is higher than or equal to 70 °C, controller 170 desirably stops heating by heat exchanger 712. This is because when the treatment object is a polyester fiber in particular, at higher than or equal to 70 °C  
10 at which the polyester easily plastically deforms, there is a possibility that clothes in a state of being folded have secondary wrinkles. On the other hand, in a case where the present disclosure is applied to a cloth treatment device of the refresher type in which the treatment object is suspended from above, the temperature of steam is desirably set to higher than or equal to 70 °C. This is because when the treatment object is a polyester fiber in particular,  
15 clothes in a suspended state are efficiently dewrinkled by being treated with steam at higher than or equal to 70 °C. A sterile filtration effect can also be expected by treating at a high temperature.

**[0066]** [Effects and the like]

Washing machine 100 according to the present exemplary embodiment includes  
20 tub 220, drum 210 provided in tub 220, hot water heater 163, and blower fan 730. Hot water heater 163 is a part of steam generator 160 that is provided in tub 220 and generates steam. Blower fan 730 supplies steam generated by hot water heater 163 to drum 210.

**[0067]** Due to this, the steam generated in tub 220 is supplied to drum 210 by blower fan 730. Therefore, washing machine 100 can increase the amount of steam supplied into drum  
25 210 as compared with a conventional washing machine. That is, washing machine 100 can efficiently supply steam into the drum.

**[0068]** Washing machine 100 according to the present exemplary embodiment includes tub 220, drum 210 provided in tub 220, water feed unit 139, drying unit 700, hot water heater 163, and controller 170. Water feed unit 139 supplies tub 220 with water. Drying  
30 unit 700 supplies tub 220 with air. Hot water heater 163 is a part of the steam generator that is provided in tub 220 and generates steam. Controller 170 drives water feed unit 139 to feed water into tub 220, drives hot water heater 163 to generate steam from the fed water, and drives blower fan 730 to blow steam into drum 210.

**[0069]** Due to this, the steam generated in tub 220 is supplied to drum 210 by blower fan 730. Therefore, washing machine 100 can increase the amount of steam supplied into drum 210 as compared with a conventional washing machine. That is, washing machine 100 can efficiently supply steam into the drum.

5 **[0070]** Steam generator 160 of washing machine 100 according to the present exemplary embodiment may include hot water heater 163, which heats water stored in tub 220, and hot water heater 163 may be disposed below drum 210 in the installation state of washing machine 100.

**[0071]** This enables washing machine 100 to store water in tub 220 so as to prevent the  
10 treatment object such as clothes accommodated in drum 210 from getting wet, and generate steam in a lower part of tub 220. Since heated steam rises, washing machine 100 can efficiently supply the steam into drum 210.

**[0072]** Drying unit 700 of washing machine 100 according to the present exemplary embodiment may include blower fan 730, air suction pipe 750 and air feed pipe 760, and  
15 air suction port 751. Blower fan 730 generates wind. Air suction pipe 750 and air feed pipe 760 are provided with blower fan 730 and constitute a part of an air passage connected to tub 220. Air suction port 751 connects tub 220 and air suction pipe 750 at a position above hot water heater 163 in the installation state of washing machine 100 on the upstream side of blower fan 730 and sucks air in tub 220.

20 **[0073]** Due to this, when generated, steam lighter than air rises to the upper part of tub 220 and is sucked from air suction port 751.

**[0074]** Therefore, washing machine 100 can efficiently suck generated steam and supply the steam to drum 210.

**[0075]** Drying unit 700 of washing machine 100 according to the present exemplary  
25 embodiment may include air feed port 761 for connecting tub 220 and air feed pipe 760 and blows air into drum 210 on the downstream side of blower fan 730.

**[0076]** Due to this, the sucked steam is blown into drum 210 on the downstream side of blower fan 730, which is a positive pressure environment.

**[0077]** Therefore, washing machine 100 can efficiently send steam into drum 210.

30 **[0078]** Washing machine 100 according to the present exemplary embodiment may further include water level sensor 321 that detects a water level in tub 220, and hot water heater 163 may be disposed below drum 210. In the state where driving of drying unit 700 is stopped, controller 170 of washing machine 100 according to the present exemplary

embodiment may drive water feed unit 139 to feed water into tub 220, and drive hot water heater 163 to generate steam from the fed water. Then, controller 170 of washing machine 100 according to the present exemplary embodiment may drive drying unit 700 to blow steam into drum 210.

5   **[0079]** Due to this, washing machine 100 can execute the water feed process in a state where blowing of air by drying unit 700 is stopped, and therefore it is possible to suppress water level sensor 321 from erroneously detecting a water level due to a wind pressure.

**[0080]** Therefore, washing machine 100 can suppress the water level of the water stored in the lower part of tub 220 used for steam generation from falling below water level C.

10   **[0081]** Washing machine 100 according to the present exemplary embodiment may further include water temperature detection sensor 161 that detects water temperature T in tub 220, and controller 170 may start blowing air by drying unit 700 when water in tub 220 reaches a predetermined water temperature in the steam process.

**[0082]** Due to this, washing machine 100 can efficiently supply steam by starting  
15   blowing air after the water temperature at which steam is generated is reached.

**[0083]** Controller 170 of washing machine 100 according to the present exemplary embodiment may temporarily stop blowing air by drying unit 700 at a predetermined timing in the steam process.

**[0084]** Due to this, washing machine 100 can suppress erroneous detection of the water  
20   level due to a wind pressure when detecting change in the water level in the steam process.

**[0085]** Drying unit 700 of washing machine 100 according to the present exemplary embodiment may include heat exchanger 712 that heats air to be supplied.

**[0086]** Due to this, since washing machine 100 can send high-temperature steam to drum 210, treatment object wrinkle smoothing performance, sterile filtration/deodorization  
25   performance, and the like are improved. By heating the steam blown by drying unit 700, washing machine 100 can suppress the temperature of the steam from lowering and condensing.

**[0087]** Drying unit 700 of washing machine 100 according to the present exemplary embodiment may include air feed port 761 and blowing temperature sensor 162b. Air feed  
30   port 761 connects tub 220 and air feed pipe 760 on the downstream side of heat exchanger 712 and blows steam into drum 210. Blowing temperature sensor 162b detects the temperature of steam in the vicinity of air feed port 761. When the temperature of steam detected by blowing temperature sensor 162b is higher than or equal to 70 °C, controller

170 may stop heating by heat exchanger 712.

[0088] Due to this, in washing machine 100, by blowing high-temperature steam, it is possible to suppress clothes that are treatment objects from having secondary wrinkles.

[0089] Controller 170 of washing machine 100 according to the present exemplary

5 embodiment may execute the steam process of blowing steam into tub 220 and the drying process of drying the treatment object accommodated in tub 220.

[0090] Due to this, after treating the treatment object with a large amount of steam, washing machine 100 dries the treatment object in a wet state, so that the user can immediately use or wear the treated treatment object after the end of the operation.

10 [0091] Upon ending the steam process, Controller 170 of washing machine 100 according to the present exemplary embodiment may start driving of drying unit 700 after stopping driving of hot water heater 163, and may drain water in tub 220 when the water in tub 220 reaches a predetermined water temperature.

[0092] Due to this, by leaving the water in tub 220 to cool down by the air blow, washing  
15 machine 100 can lower water temperature T in tub 220 without additionally feeding water into tub 220.

[0093] Steam generator 160 of washing machine 100 according to the present exemplary embodiment may include hot water heater 163, which heats water stored in tub 220, and hot water heater 163 may be horizontally disposed below drum 210 in the installation state  
20 of washing machine 100.

[0094] Due to this, in a drum type washing machine such as washing machine 100 in which drum 210 is provided in an inclined manner, the water surface and hot water heater 163 are substantially parallel to each other, and thus hot water heater 163 can be completely immersed in water with a minimum amount of water.

25 [0095] (Second exemplary embodiment)

A washing machine according to a second exemplary embodiment is different from that in the first exemplary embodiment in that steam supply control is performed in the washing course. That is, the controller of the washing machine according to the second exemplary embodiment is different from controller 170 of washing machine 100 according  
30 to the first exemplary embodiment in the control content. Other configurations of the washing machine according to the second exemplary embodiment are similar to those of washing machine 100 according to the first exemplary embodiment, and therefore, the controller of the washing machine according to the second exemplary embodiment will

mainly be described here.

**[0096]** The washing course includes a washing process, a rinsing process, and a dewatering process. The steam process is performed in at least one of the washing process, the rinsing process, and the dewatering process. Hereinafter, a case where the steam process is performed in the washing process (hereinafter, also referred to as "application example 1"), a case where the steam process is performed in the rinsing process (hereinafter, also referred to as "application example 2"), and a case where the steam process is performed in the dewatering process (hereinafter, also referred to as "application example 3") will be described in order. Note that hereinafter, application examples 1 to 3 will be described assuming that the steam process is performed in one process of the washing process, the rinsing process, and the dewatering process, but the steam process may be performed in a plurality of processes among the washing process, the rinsing process, and the dewatering process.

**[0097]** [Application example 1: Steam process in washing process]

Hereinafter, a case where the controller according to application example 1 performs the steam process at the end of the washing process will be described.

**[0098]** Immediately after the start of operation, the controller according to application example 1 feeds washing water to water level A higher than the inner bottom surface of drum 210. At the time of water feed, detergent accommodated in detergent container 150 is supplied into tub 220 together with washing water, and the washing process is started.

**[0099]** In the washing process, the controller according to application example 1 operates motor 231 that rotates drum 210 to execute a washing operation in combination of beat washing, push washing, hand washing, and the like, thereby removing dirt adhering to the treatment object. Here, the beat washing is a washing method of striking the treatment object onto drum 210. The push washing is a washing method in which drum 210 is rotated at a high speed to wash the treatment object in a state of being stuck to drum 210. The hand washing is a washing method in which the rotation direction of drum 210 is reversed in a short time. At the same time, the treatment object gets washing water by driving of circulation pump 610, and the cleaning effect of the treatment object is further enhanced.

**[0100]** At the end of the washing process, the controller according to application example 1 performs the steam process by draining water to water level B. This is because the treatment object such as clothes is prevented from being damaged by heating the washing water by hot water heater 163 in a state where the treatment object is immersed in the

washing water. Of course, the steam process may be performed with keeping water level A.

[0101] The controller according to application example 1 performs the cooling process of cooling the washing water in tub 220 after the steam process. The controller according to application example 1 lowers the temperature of the washing water to a predetermined temperature by supplying water into tub 220, then drains the washing water, and transitions to the rinsing process. When the rinsing process and the dewatering process are completed, the washing course is completed.

[0102] Thus, performing the steam process during the washing process gives the treatment object effects such as sterile filtration, deodorization, allergen removal or deactivation, and a loosening effect of the entangled treatment object.

[0103] Here, the case where the steam process is executed in the latter half of the washing process has been described, but the steam process may be modified to be executed in the early stage of the washing process. In a case where the steam process is performed at the early stage of the washing process, the controller according to the modification of application example 1 first feeds washing water to water level B, and executes the steam process. After the steam process, the controller according to the modification of application example 1 further feeds washing water to water level A and executes the washing operation. Note that as a further modification, the controller according to the further modification of application example 1 may perform the steam process after feeding water to water level A from the beginning.

[0104] [Application example 2: Steam process in rinsing process]

Hereinafter, a case where the controller according to application example 2 performs the steam process during the rinsing process will be described.

[0105] In the rinsing process, one time or a plurality of times of rinsing processes are provided, and in application example 2, a case where the steam process is provided in the final rinsing process immediately before the dewatering process will be described as an example.

[0106] In order to obtain an effect of loosening an entangled treatment object by steam, it is preferable to perform the steam process at the end of the final rinsing process. In the early stage of the rinsing process, the controller according to application example 2 executes rinsing at a water level higher than or equal to water level A as in a general washing machine, drains water to water level B at the end of the rinsing process, and

performs the steam process.

[0107] The controller according to application example 2 performs the cooling process after the steam process. In the cooling process, the controller according to application example 2 lowers the temperature of washing water to a predetermined temperature by feeding water into tub 220, and then drains the washing water, and transitions to the dewatering process. Note that the cooling means may be a method of providing a cooling time until water temperature T spontaneously cools to a predetermined temperature.

[0108] Thus, in application example 2, performing the steam process in the rinsing process gives effects such as sterile filtration, deodorization, inactivation of allergen, and loosening effect of an entangled treatment object.

[0109] [Application example 3: Steam process in dewatering process]

Hereinafter, a case where the controller according to application example 3 performs the steam process during the dewatering process will be described.

[0110] The steam process during the dewatering process may be performed by either a method of feeding water to water level B at the early stage of the dewatering process and executing the steam process while rotating drum 210 at a high speed or a method of after finishing high-speed rotation of drum 210, feeding water to water level B, and executing the steam process. After the steam process is executed, the process transitions to the cooling process, and the controller according to application example 3 cools the washing water and then drains the washing water to the outside of washing machine 100.

[0111] Thus, performing the steam process in the dewatering process gives effects such as sterile filtration, deodorization, allergen removal or deactivation, and reduction of wrinkles due to loosening of an entangled treatment object.

[0112] (Third exemplary embodiment)

A washing machine according to a third exemplary embodiment is different from that in the first exemplary embodiment in that steam supply control is performed after a series of operations from washing to drying is performed. That is, the controller of the washing machine according to the third exemplary embodiment is different from controller 170 of washing machine 100 according to the first exemplary embodiment in the control content. Other configurations of the washing machine according to the third exemplary embodiment are similar to those of washing machine 100 according to the first exemplary embodiment, and therefore, the controller of the washing machine according to the third exemplary embodiment will mainly be described here.

**[0113]** [Steam supply control after first drying process]

Hereinafter, a case where the steam process is performed after the drying process will be described.

**[0114]** When a series of operations of the washing process, the rinsing process, and the dewatering process is completed, a first drying process is performed. In the drying process, the controller according to the third exemplary embodiment drives blower fan 730 and heat exchanger 712 while rotating drum 210, and dries the treatment object wet by washing. At this time, the controller according to the third exemplary embodiment drives drain valve 690 to be continuously or intermittently opened. When the treatment object dries, energy is no longer used to evaporate water contained in the treatment object, and therefore the temperature of the air circulating through drum 210 gradually increases.

**[0115]** When the drying temperature sensor (suction temperature sensor 162a and blowing temperature sensor 162b) detects that the air reaches a predetermined temperature, the controller according to the third exemplary embodiment brings drain valve 690 into the closed state, opens water feed valve 141, and feeds the washing water to water level B. Blower fan 730 and heat exchanger 712 may be stopped at the time of feeding water in order to suppress water splashing to the treatment object in drum 210. The predetermined temperature refers to a temperature in the latter half of the decreasing drying period in which the hot air temperature approaches temperature equilibrium. At this stage, the treatment object is in a state of being dry enough to be used or worn.

**[0116]** Upon completing the water feeding, the steam process is performed. Upon completing the steam process, the drying course proceeds in the order of the second drying process of drying the treatment object that is wet after the steam process, the cooling process, and the drain operation.

**[0117]** In the drying course in the present exemplary embodiment, since the steam process is performed after the first drying process, the steam process can be started in a state where tank unit 200 is warmed, and therefore the effect by steam is easily obtained.

**[0118]** Executing the steam process after the drying process as in the present exemplary embodiment gives effects such as sterile filtration and deodorization of the treatment object, inactivation of allergic substances adhered to the treatment object, and reduction of drying wrinkles of the treatment object by steam.

**[0119]** (Fourth exemplary embodiment)

[Configuration of washing machine including second water feed pipe]

Washing machine 100a in the fourth exemplary embodiment is different from washing machine 100 according to the first exemplary embodiment in that washing machine 100a includes second water feed pipe 153 connecting water feed valve 141 and upstream circulation pipe 640 as an example of a second water feeder according to the present disclosure. Controller 170a of washing machine 100a according to the fourth exemplary embodiment is different from controller 170 of washing machine 100 according to the first exemplary embodiment in the control content. Other configurations of washing machine 100a according to the fourth exemplary embodiment are similar to those of washing machine 100 according to the first exemplary embodiment, and therefore, differences will be mainly described here.

**[0120]** Fig. 8 is a schematic front sectional view illustrating the configuration of washing machine 100a according to the fourth exemplary embodiment of the present disclosure.

**[0121]** Note that the position of controller 170a illustrated in Fig. 8 is an example, and may be arranged at another position. Controller 170a includes a computer system having a processor and a memory. Then, when the processor executes a program stored in the memory, the computer system functions as controller 170a. Here, the program executed by the processor is assumed to be recorded in advance in the memory of the computer system, but the program may be provided by being recorded in a non-temporary recording medium such as a memory card, or may be provided through a telecommunication line such as the Internet.

**[0122]** Hereinafter, a drain operation different from that of the first exemplary embodiment will be described with reference to Fig. 8.

**[0123]** After the steam process is completed, when the temperature in tub 220 is higher than or equal to a predetermined water temperature, controller 170a simultaneously opens water feed valve 141 and drain valve 690. Water supplied from water feed valve 141 is directly supplied to upstream circulation pipe 640 through second water feed pipe 153, and merges with washing water drained from tub 220. Due to this, the washing water is cooled in upstream circulation pipe 640 before being drained from washing machine 100.

Therefore, since it is not necessary to separately provide time for the cooling process, washing machine 100a according to the fourth exemplary embodiment can complete the steam supply control in a shorter time than washing machine 100 according to the first exemplary embodiment does.

**[0124]** [Actions and others]

Washing machine 100a according to the present exemplary embodiment may further include drain valve 690 constituting a part of a drain unit for draining water stored in tub 220, and second water feed pipe 153 for feeding water so as to merge with drained water. When the steam process of blowing steam into tub 220 is finished, controller 170a  
5 may stop the driving of hot water heater 163 and cause drain valve 690 to drain water and second water feed pipe 153 to feed water.

**[0125]** Due to this, since the temperature of the washing water to be drained can be rapidly cooled, washing machine 100a can complete the steam supply control in a short time.

10 **[0126]** (Other exemplary embodiments)

In the first to fourth exemplary embodiments, a drum type washing machine has been described as an example of the washing machine according to the present disclosure. The washing machine according to the present disclosure is not limited to a drum type washing machine, and may be a vertical washing machine or a refresher.

15 **[0127]** In the first to fourth exemplary embodiments, steam generator 160 integrally formed with tub 220 has been described as an example of the steam generator according to the present disclosure. Since the steam generator according to the present disclosure only needs to be provided in communication with the tub according to the present disclosure, the steam generator may be a steam water tank as a separate component provided in a  
20 lower part of the tub according to the present disclosure.

**[0128]** In the first to fourth exemplary embodiments, a configuration in which water feed unit 139 executes water feed in a state where blowing is stopped has been described as an example of water feed by the water feeder according to the present disclosure. Since the water feed can be executed as long as the water level can be detected by excluding the  
25 influence of the wind pressure, it is not limited to the configuration in which water feed is executed in a state where blowing is stopped. For example, the water feed may be performed in a state where blower fan 730 is driven at a constant rotation speed. The wind pressure generated when blower fan 730 is rotated at a constant rotation speed is substantially constant. Therefore, since the differential pressure before and after water feed  
30 corresponds to a change in water pressure, it is possible to suppress water level sensor 321 from erroneously detecting the water level. The washing machine according to the present disclosure may adopt a configuration of calculating the water level by providing a wind pressure detector in the air supply unit according to the present disclosure, and taking a

difference in wind pressure from the pressure detected by the water level detector according to the present disclosure. The washing machine according to the present modification can execute water feed while blowing air.

**[0129]** In the first to fourth exemplary embodiments, the configuration in which the driving of blower fan 730 is started after heating by hot water heater 163 has been described as an example of the timing for starting the driving of the steam generator according to the present disclosure and the air supply unit according to the present disclosure. The timing for starting the driving of the steam generator according to the present disclosure and the air supply unit according to the present disclosure is not limited to this. In the steam process, hot water heater 163 and blower fan 730 may be started to be driven at the same time, or blower fan 730 may be started to be driven first. The driving of blower fan 730 may be configured to be started when the temperature of the washing water detected by water temperature detection sensor 161 reaches a predetermined temperature. Due to this, the washing machine according to the present modification can suppress the washing water from dissipating heat due to circulation of air, and can efficiently raise water temperature T.

**[0130]** In the first to fourth exemplary embodiments, two configurations have been described as an example of the configuration of controlling the water level so as not to become a water level at which the heater is possibly be exposed in the steam process. That is, the configuration in which hot water heater 163 is stopped when the water level becomes lower than water level C and the configuration in which blower fan 730 is intermittently operated and the water level is detected when blower fan 730 is stopped have been described. The configuration of controlling the water level so as not to become a water level at which the heater is possibly be exposed is not limited to this. For example, in the steam process, when the water level in tub 220 becomes lower than a preset re-water feed water level (not illustrated), water feed valve 141 may be opened to re-feed water to a predetermined water level. By setting the re-water feed water level higher than water level C, it is possible to suppress a part of hot water heater 163 from being above the water surface. In the steam process, when water level sensor 321 detects a sudden pressure drop, hot water heater 163 may be stopped. This is because there is a high possibility that the rapid pressure drop is not caused by air blowing by blower fan 730 but caused by a water level change due to water leakage.

**[0131]** In the first to third exemplary embodiments, as an example of the configuration

for cooling washing water before draining, the cooling process of leaving the cooling water to cool down when water temperature T is higher than or equal to 50 °C has been described. The cooling process is not limited to this because it is sufficient that the washing water can be cooled before draining. Heat dissipation of the washing water may be  
5 facilitated by driving blower fan 730 to circulate air in tub 220 with drain valve 690 in the closed state, for example. When the distance between water level B and the lowermost end inside drum 210 is sufficient, the temperature of the washing water may be lowered by further feeding water in the cooling process.

**[0132]** In the first exemplary embodiment, as a means for cooling washing water in tub  
10 220, the method for leaving the cooling water to cool down over time has been described. The means for cooling the washing water in tub 220 may be, for example, a method of further feeding washing water into tub 220 to lower water temperature T in tub 220, or a method of performing drainage while feeding water to lower the drain temperature. For example, in the course where the steam supply control is executed at water level A, the  
15 temperature of the washing water may be lowered by further feeding washing water in order to quickly cool the washing water. On the other hand, in the course where the steam supply control is executed at water level B, the temperature of the washing water may be lowered by further feeding washing water only when the distance between water level B and the bottom surface of drum 210 is sufficient.

20

#### INDUSTRIAL APPLICABILITY

**[0133]** The present disclosure is applicable to a washing machine that supplies steam into an accommodation tank. Specifically, the present disclosure is applicable to a vertical washing machine, a drum type washing machine, a twin-tub washing machine, and the  
25 like.

#### REFERENCE MARKS IN THE DRAWINGS

**[0134]** 100 washing machine  
100a washing machine  
30 110 housing  
111 front wall  
112 rear wall  
113 housing top wall

|    |      |                                                                 |
|----|------|-----------------------------------------------------------------|
|    | 114  | housing bottom wall                                             |
|    | 116  | packing structure                                               |
|    | 119  | throw-in slot                                                   |
|    | 120  | door body                                                       |
| 5  | 123  | operation unit                                                  |
|    | 139  | water feed unit (water feeder)                                  |
|    | 140  | water feed port                                                 |
|    | 141  | water feed valve                                                |
|    | 150  | detergent container                                             |
| 10 | 151  | water feed pipe                                                 |
|    | 152  | lint filter                                                     |
|    | 153  | second water feed pipe (second water feeder)                    |
|    | 160  | steam generator                                                 |
|    | 161  | water temperature detection sensor (water temperature detector) |
| 15 | 162a | suction temperature sensor                                      |
|    | 162b | blowing temperature sensor (blowing temperature detector)       |
|    | 163  | hot water heater (heater)                                       |
|    | 170  | controller                                                      |
|    | 170a | controller                                                      |
| 20 | 200  | tank unit                                                       |
|    | 210  | drum (accommodation tank)                                       |
|    | 211  | peripheral wall                                                 |
|    | 212  | bottom wall                                                     |
|    | 213  | opening                                                         |
| 25 | 214  | hole                                                            |
|    | 220  | tub                                                             |
|    | 221  | bottom                                                          |
|    | 222  | front                                                           |
|    | 230  | rotating shaft                                                  |
| 30 | 231  | motor                                                           |
|    | 232  | pulley                                                          |
|    | 233  | belt                                                            |
|    | 321  | water level sensor (water level detector)                       |

|    |      |                               |
|----|------|-------------------------------|
|    | 610  | circulation pump              |
|    | 630  | air trap                      |
|    | 631  | air pipe                      |
|    | 640  | upstream circulation pipe     |
| 5  | 650  | downstream circulation pipe   |
|    | 660  | drainpipe                     |
|    | 690  | drain valve                   |
|    | 700  | drying unit (air supply unit) |
|    | 710  | drying duct                   |
| 10 | 711  | air filter                    |
|    | 712  | heat exchanger (air heater)   |
|    | 730  | blower fan (air blower)       |
|    | 750  | air suction pipe              |
|    | 751  | air suction port              |
| 15 | 760  | air feed pipe                 |
|    | 761  | air feed port                 |
|    | 1000 | washing machine               |
|    | 1139 | water feed unit               |
|    | 1140 | water feed port               |
| 20 | 1141 | water feed valve              |
|    | 1150 | detergent container           |
|    | 1151 | water feed pipe               |
|    | 1160 | steam generator               |
|    | 1163 | hot water heater              |
| 25 | 1210 | drum                          |
|    | 1213 | opening                       |
|    | 1214 | hole                          |
|    | 1220 | tub                           |
|    | 1231 | motor                         |
| 30 | 1610 | circulation pump              |
|    | 1700 | drying unit                   |
|    | 1730 | blower fan                    |
|    | 1750 | air suction pipe              |

|   |      |                              |
|---|------|------------------------------|
|   | 1760 | air feed pipe                |
|   | RX   | axis of rotation             |
|   | T    | water temperature            |
|   | td   | drying process time          |
| 5 | ts   | steam process time           |
|   | t'   | time to be left to cool down |

## CLAIMS

1. A washing machine comprising:  
a tub;  
5 an accommodation tank that is provided in the tub;  
a steam generator that is provided to the tub and generates steam; and  
an air blower that supplies the steam generated by the steam generator into the  
accommodation tank.
- 10 2. A washing machine comprising:  
a tub;  
an accommodation tank that is provided in the tub;  
a water feeder that supplies water to the tub;  
an air supply unit that supplies air to the tub;  
15 a steam generator that is provided in the tub and generates steam; and  
a controller,  
wherein the controller  
drives the water feeder to feed water into the tub,  
drives the steam generator to generate steam with the water fed, and  
20 drives the air supply unit to blow the steam into the accommodation tank.
3. The washing machine according to Claim 2, wherein  
the steam generator includes a heater that heats water stored in the tub, and  
the heater is disposed below the accommodation tank in an installation state of the  
25 washing machine.
4. The washing machine according to any one of Claims 2 and 3, wherein  
the air supply unit includes  
an air blower that generates wind,  
30 an air passage that is provided with the air blower and connected to the tub, and  
an air suction port for connecting the tub to the air passage at a position above the  
steam generator in an installation state of the washing machine on an upstream side of the  
air blower, the air suction port sucking air in the tub.

5. The washing machine according to Claim 4, wherein the air supply unit includes an air feed port for connecting the tub and the air passage on a downstream side of the air blower, the air feed port blowing air into the accommodation tank.

5

6. The washing machine according to any one of Claims 2 to 5, further comprising a water level detector that detects a water level in the tub, wherein

the steam generator is disposed below the accommodation tank, and  
10 the controller

drives the water feeder to feed water into the tub in a state where driving of the air supply unit is stopped,

drives the steam generator to generate steam with the fed water, and  
drives the air supply unit to blow the steam into the accommodation tank.

15

7. The washing machine according to any one of Claims 2 to 6, further comprising a water temperature detector that detects a water temperature in the tub, wherein the controller, in a steam process of generating steam, starts blowing air by the air supply unit when water in the tub reaches a predetermined water temperature.

20

8. The washing machine according to any one of Claims 2 to 6, wherein the controller, in a steam process of generating steam, temporarily stops blowing air by the air supply unit at a predetermined timing.

25

9. The washing machine according to Claim 4, wherein the air supply unit includes an air heater that heats air to be supplied.

10. The washing machine according to Claim 9, wherein the air supply unit includes

30 an air feed port for connecting the tub and the air passage on a downstream side of the air heater and blowing steam into the accommodation tank, and a blowing temperature detector that detects temperature of steam in a vicinity of the air feed port, and

the controller stops heating by the air heater when temperature of steam detected by the blowing temperature detector is higher than or equal to 70°C.

5           11. The washing machine according to any one of Claims 2 to 10, wherein the controller executes  
a steam process of blowing steam into the tub, and  
a drying process of drying a treatment object accommodated in the tub.

10           12. The washing machine according to any one of Claims 2 to 11, wherein the controller, after stopping driving of the steam generator, starts driving of the air supply unit when a steam process of blowing steam into the tub is finished, and drains water in the tub when water in the tub reaches a predetermined water temperature.

15           13. The washing machine according to any one of Claims 2 to 11, further comprising:  
a drain unit that drains water stored in the tub; and  
a second water feeder that feeds water to merge with drained water,  
wherein the controller, when a steam process of blowing steam into the tub is finished, stops driving of the steam generator, and causes the drain unit to drain and the  
20           second water feeder to feed water.

            14. The washing machine according to Claim 1 or 2, wherein  
the steam generator includes a heater that heats water stored in the tub, and  
the heater is disposed to become horizontal below the accommodation tank in an  
25           installation state of the washing machine.