

Description

Title of Invention

WASHING MACHINE HAVING DRYING FUNCTION

Technical Field

[0001]

The present invention relates to a washing machine having a drying function for drying laundry.

Background Art

[0002]

A washing machine having not only a washing function for washing laundry but also a drying function for drying laundry has been widely used in recent years. Such a washing machine circulates hot and dry air (hereinafter referred to as "dry air") in the housing to dry laundry. The washing machine typically has a heat exchanger, which exchanges heat with the air circulating in the housing to generate the dry air.

[0003]

The dry air hits the laundry in a washing tub. Consequently, moisture is taken away from the laundry by the dry air. The air taking the moisture away from the laundry is then returned to the heat exchanger.

[0004]

Dust such as lint or hair may be separated from the laundry by the contact between the dry air and the laundry, and float in the air to be returned to the heat exchanger. The washing machine typically has an air filter configured to remove dust from the air going to the heat exchanger. A part of the dust may pass through the air filter and adhere to the heat exchanger although the air filter removes a lot of dust. The dust adhering to the heat exchanger may worsen heat exchanging efficiency.

[0005]

Patent Document 1 proposes technologies for sprinkling water onto a heat exchanger to remove dust. As a result of sprinkling water onto the heat exchanger, dust is less likely to excessively reduce heat exchanging efficiency.

[0006]

Sprinkling water onto the heat exchanger means additional usage of water. Accordingly, a washing machine having a function for cleaning the heat exchanger consumes more water than a machine without a function for cleaning the heat exchanger.

[0007]

Patent Document 1: JP 2005-224491 A

Summary of Invention

[0008]

An object of the present invention is to provide a washing machine configured to achieve very efficient water usage.

[0009]

The washing machine according to one aspect of the present invention has a drying function. The washing machine includes a washing tub configured to wash laundry, a heat exchanger, which exchanges heat with air passing through the washing tub to generate dry air for drying the laundry, a sprinkling mechanism including a sprinkler, which sprinkles water onto the heat exchanger to clean the heat exchanger, and a water return path configured to return to the washing tub the water, which is sprinkled from the sprinkler.

[0010]

The washing machine according to the present invention may achieve very efficient water usage.

[0011]

The object, features and advantages of the present invention will become more apparent with the ensuing detailed explanation and appended drawings.

Brief Description of Drawings

[0012]

Fig. 1 is a schematic perspective view of a washing machine according to the first embodiment.

Fig. 2 is a schematic block diagram of the washing machine shown in Fig. 1.

Fig. 3 is a schematic cross-sectional view of the washing machine shown in Fig. 1.

Fig. 4 is a schematic view of a heat pump device of the washing machine shown in Fig. 3.

Fig. 5 is a schematic block diagram of a watering mechanism of the washing machine shown in Fig. 2.

Fig. 6 is a schematic perspective view of a heat exchanging portion of the washing machine shown in Fig. 3.

Fig. 7 is a schematic bottom view of the heat exchanging portion of the washing machine shown in Fig. 3.

Fig. 8 is a schematic perspective view of the heat exchanging portion of the washing machine shown in Fig. 2.

Fig. 9 is a schematic plan view of the heat exchanging portion shown in Fig. 8.

Fig. 10 is a schematic flowchart showing operations of the washing machine depicted in Fig. 2.

Fig. 11 is a schematic block diagram of the washing machine shown in Fig. 2.

Fig. 12 is an exemplary graph showing an output from an optical sensor of the washing machine depicted in Fig. 11.

Fig. 13 is a schematic flowchart showing operations of the washing machine depicted in Fig. 11.

Fig. 14A is a schematic timing chart showing opening and closing timings of a first watering valve and a drainage valve of the washing machine depicted in Fig. 11.

Fig. 14B is a schematic timing chart showing opening and closing timings of the first watering valve and the drainage valve of the washing machine depicted in Fig. 11.

Fig. 15A is a schematic view showing a design pattern of operation courses of the washing machine depicted in Fig. 2.

Fig. 15B is a schematic view showing a design pattern of the operation courses of the washing machine depicted in Fig. 2.

Fig. 16 is a schematic view showing various design patterns of the second operation course of the washing machine depicted in Fig. 2.

Fig. 17 is a schematic graph showing an operation period under the first to third design patterns depicted in Fig. 16.

Fig. 18 is a schematic graph showing water consumption under the first to third design patterns depicted in Fig. 16.

Fig. 19 is a schematic view showing various design patterns of the fifth operation course of the washing machine depicted in Fig. 2.

Fig. 20 is a schematic graph showing water consumption under the first to third design patterns depicted in Fig. 19.

Fig. 21 is a schematic cross-sectional view of a washing machine of the second embodiment.

Description of Embodiments

[0013]

Hereinafter, an exemplary washing machine is described with reference to the drawings. Directional terms such as "up", "down", "left" and "right" used in the following explanation are merely for clarifying the description. Accordingly, these terms do not limit principles of the washing machine in any way.

[0014]

<First Embodiment>

(Washing Machine)

Fig. 1 is a schematic perspective view of a washing machine 100 of the first embodiment. The washing machine 100 is described with reference to Fig. 1.

[0015]

The washing machine 100 includes a housing 110. The washing machine 100 has not only a washing function for washing laundry but also a drying function for circulating dry air to dry the laundry in the housing 110. The housing 110 includes a front wall 111, a rear wall 112 opposite to the front wall 111, a left wall 113 standing between the front and rear walls 111, 112, and a right wall 114 opposite to the left wall 113. The housing 110 further includes a top wall 115 configured to cover a region surrounded by the upper edges of the front, rear, left and right walls 111, 112, 113, 114.

[0016]

The front wall is provided with a feed opening 116. A user may store laundry in the housing 110 through the feed opening 116.

[0017]

The washing machine 100 further has a door 120 attached to the front wall 111. A user may move the door 120 between an open position and a closed position. The door 120 shown in Fig. 1 is in the open position. The user may move the door 120 to the open position to open the feed opening 116. The user may then store laundry in the housing 110 through the feed opening 116. The user may move the door 120 to the closed position to close the feed opening 116. The laundry is then subjected to various processes such as washing, spin-drying and drying in the housing 110.

[0018]

The washing machine 100 further has a console 201. The console 201 is used as a part of the front wall 111. A user may operate the console 201 to determine various operation courses.

[0019]

Fig. 2 is a schematic block diagram of the washing machine 100. The washing machine 100 is further described with reference to Figs. 1 and 2. The dotted arrows shown in Fig. 2 schematically represent water flow in the washing machine 100. Dashed arrows shown in Fig. 2 schematically represent dry air flow in the washing machine 100.

[0020]

The user may operate the console 201 to select one of the first to fifth operation courses. The console 201 outputs course information about the operation course selected by the user's operation.

[0021]

The washing machine 100 further has a controller 200, which receives output signals (course information) from the console 201, a laundry processing mechanism 300, which carries out various processes (washing, rinsing, spin-drying and drying) for laundry under control of the controller 200, a drying processing mechanism 400, which carries out a drying process for laundry, a watering mechanism 500, which carries out water supply into the housing 110, and a drainage mechanism 600, which carries out drainage from the housing 110. The controller 200 controls the laundry processing mechanism 300, the drying processing mechanism 400, the watering mechanism 500 and the drainage mechanism 600 in response to the course information output from the console 201.

[0022]

The washing machine 100 executes a washing process, a rinsing process, a spin-drying process and/or a drying process in response to the course information output from the console 201. The laundry processing mechanism 300 includes a motor 310, which is operated under control of the controller 200, and a washing tub 320 connected to the motor 310. A user may move the door 120 to the open position to put laundry in the washing tub 320 through the feed opening 116. The washing tub 320 may use a driving force generated by the motor 310 to agitate the laundry. In this embodiment, the processing mode is exemplified by each of the washing process, the rinsing process, the spin-drying process and/or the drying process.

[0023]

When a user operates the console 201 to select one of the first to fourth operation courses, the washing machine 100 executes the washing process. Mixed liquid of detergent and tap water is supplied to the washing tub 320 in the washing process. The washing tub 320 may agitate laundry in the mixed liquid. Accordingly, the laundry may be appropriately washed. In this embodiment, the first mode is exemplified by the washing process.

[0024]

When a user operates the console 201 to select one of the first to third operation courses, the washing machine 100 executes the rinsing process after the washing process. Tap water is supplied to the washing tub 320 in the rinsing process. Accordingly, the washing tub 320 may agitate laundry in liquid, which has lower detergent concentration than that of the mixed liquid used in the washing process. Accordingly, detergent adhering to the laundry may be appropriately washed away. Optionally, the washing machine 100 may perform a spin-drying operation during the rinsing process. In this embodiment, the second mode is exemplified by the rinsing process.

[0025]

When a user operates the console 201 to select the first or second operation course, the washing machine 100 executes the spin-drying process after the rinsing process. Water inside the washing tub 320 is drained in the spin-drying process. Subsequently, the washing tub 320 applies a centrifugal force to laundry to separate water from the laundry. Accordingly, the laundry is spin-dried.

[0026]

When a user operates the console 201 to select the first operation course, the washing machine 100 executes the drying process after the spin-drying process. In the drying process, the washing tub 320 agitates laundry and makes dry air hit the laundry. Accordingly, the laundry is efficiently dried.

[0027]

The drying processing mechanism 400 includes a blower 410 and a heat pump device 420. When a user operates the console 201 to select the first operation course, the controller 200 operates the blower 410 and the heat pump device 420 in the drying process. The blower 410 sucks air from the washing tub 320. The heat pump device 420 is situated on a flow path of air, which flows from the washing tub 320 to the blower 410. The heat pump device 420 exchanges heat with the air flowing toward the blower 410 to generate dry air. The dry air is then delivered to the washing tub 320 by the blower 410.

[0028]

As described above, the washing tub 320 agitates laundry in the drying process. Accordingly, the dry air entering the washing tub 320 efficiently hits the laundry. Accordingly, the laundry is appropriately dried.

[0029]

The watering mechanism 500 includes a valve unit 510 and a sprinkler 520. The valve unit 510 includes a first watering valve 511 and a second watering valve 512. When a user selects one of the first to fourth operation courses, the controller 200 opens the second watering

valve 512 in the washing process to deliver mixed liquid of tap water and detergent to the washing tub 320. When a user selects one of the first to third operation courses, the controller 200 opens the second watering valve 512 in the rinsing process to deliver tap water to the washing tub 320. Accordingly, laundry is agitated in the water supplied into the washing tub 320 in both of the washing process and the rinsing process. In this embodiment, the submerged agitation mode is exemplified by the washing process and the rinsing process.

[0030]

In this embodiment, the controller 200 opens the first watering valve 511 to deliver tap water to the sprinkler 520 in one of the washing process and the rinsing process. The sprinkler 520 sprinkles the tap water onto the heat pump device 420.

[0031]

As described above, the heat pump device 420 is situated above the flow path of air flowing from the washing tub 320 to the blower 410. Accordingly, dust such as lint and hair separated from laundry in the washing tub 320 may adhere to the heat pump device 420. The dust adhering to the heat pump device 420 is appropriately removed by the water sprinkled from the sprinkler 520. In this embodiment, the sprinkling mechanism is exemplified by the first watering valve 511 and the sprinkler 520.

[0032]

The drainage mechanism 600 includes a circulation pump 610 and a drainage valve 620. When a user selects one of the first to fourth operation courses, the controller 200 operates the circulation pump 610 in the washing process to circulate mixed liquid of tap water and detergent between the washing tub 320 and the circulation pump 610. Meanwhile, the controller 200 closes the drainage valve 620. Accordingly, laundry is washed with a small amount of water and a small amount of detergent. The controller 200 opens the drainage valve 620 to discharge water from the housing 110 after operating the circulation pump 610 for a predetermined period or in response to physical characteristics of the liquid circulated between the washing tub 320 and the circulation pump 610.

[0033]

When a user selects one of the first to third operation courses, the controller 200 may operate the circulation pump 610 in the rinsing process to circulate liquid between the washing tub 320 and the circulation pump 610. Meanwhile, the controller 200 closes the drainage valve 620. The controller 200 opens the drainage valve 620 to discharge water from the housing 110 after operating the circulation pump 610 for a predetermined period or in response to physical characteristics of the liquid circulated between the washing tub 320 and the circulation pump 610. The circulation and drainage are repeated in the rinsing process. As described above, since tap

water is supplied to the washing tub 320 when the second watering valve 512 is opened in the rinsing process, detergent adhering to the laundry is appropriately washed away eventually.

[0034]

The first to fourth operation courses are aimed at washing laundry whereas the fifth operation course is aimed at cleaning the washing tub 320. Like the second operation course, the fifth operation course includes a washing process, a rinsing process and a spin-drying process. Operation of the laundry processing mechanism 300, the watering mechanism 500 and the drainage mechanism 600 during these processes of the fifth operation course is similar to those in the second operation course. However, since the fifth operation course is aimed at cleaning the washing tub 320 (i.e. since the fifth operation course does not have to take account of damage to laundry), there may be differences in various parameters such as an agitation period, agitation speed, water consumption and amount of detergent to be used in the washing tub 320. In this embodiment, the tub cleaning mode is exemplified by the washing process, the rinsing process and the spin-drying process of the fifth operation course.

[0035]

(Laundry Processing Mechanism)

Fig. 3 is a schematic cross-sectional view of the washing machine 100. The laundry processing mechanism 300 is described with reference to Fig. 3.

[0036]

The washing tub 320 includes a rotary drum 330, in which laundry L is stored, and a water tub 340, which surrounds the rotary drum 330. The washing tub 320 has an opening toward the front wall 111 of the housing 110 to receive the laundry L, which is fed by the user through the feed opening 116. The feed opening 116 shown in Fig. 3 is closed by the door 120.

[0037]

The motor 310 generates a driving force for agitating the laundry L inside the washing tub 320. The laundry processing mechanism 300 includes a shaft 350 which transmits the driving force from the motor 310 to the rotary drum 330. The water tub 340 includes a first bottom wall 341 adjacent to the motor 310, and a first peripheral wall 342, which extends from a periphery of the first bottom wall 341 toward the front wall 111 of the housing 110. The motor 310 is situated outside the water tub 340 (i.e. between the first bottom wall 341 and the rear wall 112 of the housing 110).

[0038]

The rotary drum 330 includes a second bottom wall 331 adjacent to the first bottom wall 341 of the water tub 340, and a second peripheral wall 332, which extends from a periphery of

the second bottom wall 331 toward the front wall 111 of the housing 110. The second bottom wall 331 and the second peripheral wall 332 of the rotary drum 330 are provided with a lot of vent holes 333. The shaft 350 extends through the first bottom wall 341 of the water tub 340, and is connected to the second bottom wall 331 of the rotary drum 330. When the motor 310 is operated, the driving force is transmitted to the rotary drum 330 through the shaft 350. Accordingly, the rotary drum 330 rotates inside the water tub 340 to agitate the laundry L.

[0039]

The washing tub 320 includes a bearing 360 mounted on the first bottom wall 341 of the water tub 340. The shaft 350 extends through the bearing 360. The bearing 360 suitably supports the shaft 350 which is rotated by the motor 310.

[0040]

(Drying Processing Mechanism)

The drying processing mechanism 400 is described with reference to Figs. 2 and 3.

[0041]

The drying processing mechanism 400 further has a circulation duct 430, in addition to the blower 410 and the heat pump device 420. The circulation duct 430 includes a first end 431, which is connected to the first peripheral wall 342 of the water tub 340, and a second end 432, which is connected to the first bottom wall 341 of the water tub 340. The circulation duct 430 includes an upstream duct 433, which extends from the first end 431 toward the rear wall 112 between the first peripheral wall 342 of the water tub 340 and the top wall 115 of the housing 110, and a downstream duct 434, which bends downward from the upstream duct 433 and extends up to the second end 432 between the first bottom wall 341 of the water tub 340 and the rear wall 112 of the housing 110.

[0042]

The blower 410 is situated at the bent portion between the upstream and downstream ducts 433, 434. The blower 410 sucks air in the upstream duct 433 whereas the blower blows the air to the downstream duct 434. Accordingly, the air flows into the water tub 340 through the second end 432 of the circulation duct 430.

[0043]

The air entering the water tub 340 flows into the rotary drum 330 through the vent holes 333 formed on the second bottom wall 331. Subsequently, the air is discharged from the rotary drum 330 through the vent holes 333 formed in the second peripheral wall 332. The air discharged from the rotary drum 330 flows into the upstream duct 433 through the first end 431

of the circulation duct 430. The air is then delivered into the washing tub 320 through the downstream duct 434 by the blower 410.

[0044]

The drying processing mechanism 400 further has an air filter portion 440 situated within the upstream duct 433. The air filter portion 440 removes dust such as lint floating in the air on the upstream side of the blower 410.

[0045]

The washing machine 100 further has a heat exchanging portion 450 configured to exchange heat in the upstream duct 433 with air passing through the washing tub 320. The heat exchanging portion 450 includes the aforementioned heat pump device 420. The heat pump device 420 includes a dehumidifier 421, which dehumidifies air, and a heater 422, which heats the air. The air passing through the air filter portion 440 goes through the dehumidifier 421. Accordingly, there is a decrease in a humidity level of the air. Subsequently, the air passes through the heater 422. Consequently, the air is heated. Therefore, the heat pump device 420 may exchange heat with the air passing through the washing tub 320 to generate dry air for drying the laundry L.

[0046]

The dry air generated by the heat exchanging portion 450 is delivered into the washing tub 320 through the downstream duct 434 by the blower 410. The laundry L hits the dry air and is dried while the dry air passes through the rotary drum 330. Accordingly, the air discharged from the washing tub 320 through the first end 431 of the circulation duct 430 becomes very humid. Dust such as lint generated from the laundry L or hair adhering to the laundry L may float in the air discharged from the washing tub 320.

[0047]

The air filter portion 440 removes the dust from the air flowing in the upstream duct 433. Subsequently, the dehumidifier 421 of the heat pump device 420 takes moisture away from the air. Accordingly, the dehumidifier 421 becomes wet.

[0048]

A part of dust may pass through the air filter portion 440 although the air filter portion 440 may capture a lot of the dust. The dust passing through the air filter portion 440 adheres to the wet dehumidifier 421. As described with reference to Fig. 2, the dust adhering to the dehumidifier 421 is removed by water sprinkled from the sprinkler 520.

[0049]

Fig. 4 is a schematic view of the heat pump device 420. The heat pump device 420 is described with reference to Figs. 3 and 4.

[0050]

The heat pump device 420 includes a compressor 423, which compresses working fluid, an expansion valve 424, which decompresses the working fluid, a first circulation tube 425, which guides the working fluid flowing from the expansion valve 424 to the compressor 423, and a second circulation tube 426, which guides the working fluid flowing from the compressor 423 to the expansion valve 424. The first and second circulation tubes 425, 426 form a closed loop, which passes through the compressor 423 and the expansion valve 424. The working fluid flowing through the first circulation tube 425 is decompressed by the expansion valve 424 and becomes a low temperature. The working fluid flowing through the second circulation tube 426 is compressed by the compressor 423 and becomes a high temperature. The first and second circulation tubes 425, 426 protrude inside the circulation duct 430 which guides the air sucked by the blower 410.

[0051]

The first circulation tube 425 defines a flow path, which is folded back several times in the circulation duct 430. The heat pump device 420 includes a lot of fins 427 mounted on the first circulation tube 425, which is folded back within the circulation duct 430. The first circulation tube 425 and the fins 427 in the circulation duct 430 are used as the aforementioned dehumidifier 421.

[0052]

The second circulation tube 426 defines a flow path, which is folded back several times in the circulation duct 430. The heat pump device 420 includes a lot of fins 428 mounted on the second circulation tube 426, which is folded back within the circulation duct 430. The second circulation tube 426 and the fins 428 in the circulation duct 430 are used as the aforementioned heater 422.

[0053]

The air flowing within the circulation duct 430 is cooled by the first circulation tube 425 and the fins 427, which are cooled by cold working fluid. Accordingly, there is dew condensation of moisture in the air on the first circulation tube 425 and the fins 427. Accordingly, the air is dehumidified.

[0054]

Subsequently, the air is heated by the second circulation tube 426 and the fins 428, which are heated by hot working fluid. Accordingly, the air becomes a temperature high enough to be dry air, which is suitable for drying the laundry L. As described above, the

dehumidifier 421 and the heater 422 exchange heat with air flowing in the circulation duct 430 to generate dry air. Accordingly, the heat exchanger is exemplified by the dehumidifier 421 and the heater 422.

[0055]

(Watering Mechanism)

Fig. 5 is a schematic block diagram of the watering mechanism 500. The watering mechanism 500 is described with reference to Figs. 1 to 3 and 5.

[0056]

The watering mechanism 500 has a watering port 530, a switching valve 540 and a detergent storage portion 550, in addition to the valve unit 510 and the sprinkler 520. As shown in Figs. 1 and 3, the watering port 530 is opened on the top wall 115 of the housing 110. The watering port 530 is connected to a water faucet with a hose (not shown). Tap water is supplied to the watering mechanism 500 through the watering port 530. In this embodiment, the watering portion is exemplified by the watering port 530.

[0057]

The tap water is supplied to the valve unit 510 through the watering port 530. When the controller 200 opens the second watering valve 512, the tap water flows toward the switching valve 540. The controller 200 controls the switching valve 540 in addition to the valve unit 510. Under control of the controller 200, the switching valve 540 switches a watering path between a path directing toward the detergent storage portion 550 and a path extending directly toward the washing tub 320.

[0058]

Detergent is stored in the detergent storage portion 550. The controller 200 controls the switching valve 540 in the washing process to set the watering path to the path along which the tap water flows toward the detergent storage portion 550. Accordingly, mixed liquid of the detergent and the tap water is supplied to the washing tub 320. The controller 200 controls the switching valve 540 in the rinsing process to set the watering path to the path along which the tap water directly flows to the washing tub 320. Accordingly, the tap water is supplied to the washing tub 320. In this embodiment, the second watering path is exemplified by the watering path which leads to the washing tub 320 through the watering port 530, the second watering valve 512 and the switching valve 540.

[0059]

As shown in Fig. 3, the watering mechanism 500 has a watering tube 560, which extends from the first watering valve 511 to the sprinkler 520. As described above, the

controller 200 opens the first watering valve 511 in at least one of the washing process and the rinsing process. When the controller 200 opens the first watering valve 511, the tap water reaches the sprinkler 520. Consequently, the sprinkler 520 sprinkles water between the air filter portion 440 and the dehumidifier 421 to clean the dehumidifier 421. When the first watering valve 511 is closed, the water supply to the sprinkler 520 is stopped. In this embodiment, the first watering path is exemplified by the watering path, which is defined by the watering port 530, the first watering valve 511 and the watering tube 560.

[0060]

When a user selects one of the first to fourth operation courses, the controller 200 may selectively open and close the first and second watering valves 511, 512 in the washing process. In other words, the controller 200 may open the first watering valve 511 whereas the controller 200 may close the second watering valve 512. Consequently, water may be sprinkled at high pressure. Accordingly, the dehumidifier 421 may be appropriately cleaned. The controller 200 may close the first watering valve 511 whereas the controller may open the second watering valve 512. Consequently, water may be efficiently supplied to the washing tub 320.

[0061]

When a user selects one of the first to third operation courses, the controller 200 may selectively open and close the first and second watering valves 511, 512 in the rinsing process. In other words, the controller 200 may open the first watering valve 511 whereas the controller 200 may close the second watering valve 512. Consequently, water may be sprinkled at high pressure. Accordingly, the dehumidifier 421 may be appropriately cleaned. The controller 200 may close the first watering valve 511 whereas the controller 200 may open the second watering valve 512. Consequently, water may be efficiently supplied to the washing tub 320.

[0062]

When a user selects the fifth operation course, the controller 200 may selectively open and close the first and second watering valves 511, 512 in the washing process and/or the rinsing process. In other words, the controller 200 may open the first watering valve 511 whereas the controller 200 may close the second watering valve 512. Consequently, water may be sprinkled at high pressure. Accordingly, the dehumidifier 421 may be appropriately cleaned. The controller 200 may close the first watering valve 511 whereas the controller 200 may open the second watering valve 512. Consequently, water may be efficiently supplied to the washing tub 320.

[0063]

Fig. 6 is a schematic perspective view of the heat exchanging portion 450. The heat exchanging portion 450 and the sprinkler 520 are described with reference to Figs. 1, 3 and 6.

[0064]

In addition to the aforementioned heat pump device 420, the heat exchanging portion 450 has an upper cover 460, which covers an upper part of the heat pump device 420. The upper cover 460 is used as a part of the circulation duct 430. The upper cover 460 includes a main body 461, which covers the heat pump device 420, a circular frame 462, to which the blower 410 is attached, and a rectangular frame 463, which protrudes above the air filter portion 440.

[0065]

A circular ventilation hole 464 is formed at the center of the circular frame 462. The blower 410 sucks air from the heat pump device 420 through the ventilation hole 464. Consequently, dry air generated by the heat pump device 420 is delivered to the washing tub 320 through the downstream duct 434 by the blower 410.

[0066]

As shown in Fig. 1, the housing 110 has a lid 117, which is detachable from the top wall 115. The rectangular frame 463 is provided with a substantially rectangular slot 465. When a user removes the lid 117 from the top wall 115, the air filter portion 440 becomes exposed through the slot 465. The user may remove the air filter portion 440 from the housing 110 through the slot 465. Subsequently, the user may clean the air filter portion 440 to remove lint. The user may set the cleaned air filter portion 440 in the housing 110 through the slot 465.

[0067]

The aforementioned sprinkler 520 is formed between the rectangular frame 463 and the dehumidifier 421 of the heat pump device 420.

[0068]

Fig. 7 is a schematic bottom view of the heat exchanging portion 450. The sprinkler 520 is described with reference to Figs. 3 and 7.

[0069]

The sprinkler 520 includes a connector 529, to which the watering tube 560 is attached, and a manifold 521 for defining a flow path through which water supplied from the watering tube 560 flows. The manifold 521 is provided with a lot of small holes 522. The many small holes 522 are aligned near the dehumidifier 421 of the heat pump device 420. The sprinkler 520 sprinkles water through the small holes 522 to clean the heat pump device 420.

[0070]

Fig. 8 is a schematic perspective view of the heat exchanging portion 450. The heat exchanging portion 450 and process for water from the sprinkler 520 are described with reference to Figs. 2 to 4, 7 and 8.

[0071]

The heat exchanging portion 450 includes a lower cover 470, in addition to the heat pump device 420 and the upper cover 460. The lower cover 470 forms a part of the circulation duct 430 together with the upper cover 460. The lower cover 470 includes a first pocket 471, in which the air filter portion 440 is stored, a second pocket 472, in which the dehumidifier 421 and the heater 422 are stored, and a third pocket 473, in which the compressor 423 is stored.

[0072]

The first pocket 471 is provided with a connection port 474 to be connected to the upstream duct 433 at the upstream side of the heat exchanging portion 450. Air flows into the air filter portion 440 through the connection port 474 under a suction force from the blower 410. The air filter portion 440 removes a lot of the dust from the air entering through the connection port 474. However, a part of the dust may pass through the air filter portion 440, and then reach the second pocket 472.

[0073]

A distribution of the many small holes 522 formed on the manifold 521 may be defined in correspondence to a design of the heat exchanging portion 450. In this embodiment, density of the small holes 522 in a region facing the connection port 474 (right half of the manifold 522 in Fig. 7) is greater than those of the other regions. There may be more dust adhering to the region of the dehumidifier 421 facing the connection port 474 but the density of the small holes 522 is high correspondingly. Consequently, dust adhering to the dehumidifier 421 may be appropriately removed.

[0074]

The dehumidifier 421 is wet since the dehumidifier 421 dehumidifies air passing through the air filter portion 440. As described with reference to Fig. 4, the dehumidifier 421 includes the many fins 427 mounted densely on the first circulation tube 425, through which cold working fluid flows. Accordingly, most of the dust passing through the air filter portion 440 is captured by the dehumidifier 421.

[0075]

As described above, the dust adhering to the dehumidifier 421 is appropriately removed by water sprinkled from the sprinkler 520. The second pocket 472 includes a bottom wall 475, which faces the sprinkler 520 and supports the dehumidifier 421 and the heater 422. The

bottom wall 475 appropriately receives water from the sprinkler 520 as well as water which drips from the dehumidifier 421. In this embodiment, the water receiver is exemplified by the second pocket 472.

[0076]

The second pocket 472 has a lot of trapping teeth 476 which protrude upward from the bottom wall 475. The many trapping teeth 476 are formed between the first pocket 471 and the dehumidifier 421. Long fibrous substances (e.g. hair) may be contained in dust which is removed by the water sprinkled from the sprinkler 520. The trapping teeth 476 may appropriately capture the long fibrous substances.

[0077]

Fig. 9 is a schematic plan view of the heat exchanging portion 450. Water flow on the bottom wall 475 is described with reference to Figs. 3, 8 and 9.

[0078]

The second pocket 472 defines a main drainage path 477, which is adjacent to the dehumidifier 421 and the heater 422, and a water storage region 478, which is recessed between the main drainage path 477 and the third pocket 473. The main drainage path 477 is inclined downward to the water storage region 478. Accordingly, water on the main drainage path 477 is urged to flow toward the water storage region 478.

[0079]

As shown in Fig. 3, the washing machine 100 has a relay tube 480, which is connected to the heat exchanging portion 450 and the washing tub 320. As shown in Fig. 9, the water storage region 478 is provided with a connector 479. The relay tube 480 is connected to the connector 479. Water temporarily stored in the water storage region 478 is urged to flow toward the washing tub 320 through the connector 479 and the relay tube 480 under the gravity action. In this embodiment, the water return path is exemplified by the water flow path, which is defined by the bottom wall 475 and the relay tube 480.

[0080]

As shown in Fig. 8, the second pocket 472 includes ribs 491 which support the dehumidifier 421 and the heater 422. The dehumidifier 421 and the heater 422 are slightly separated upward from the bottom wall 475 by the ribs 491. Accordingly, water may flow smoothly on the bottom wall 475 even below the dehumidifier 421. The bottom wall 475 below the dehumidifier 421 is inclined downward to the main drainage path 477. Consequently, water flows toward the main drainage path 477 after dripping from the dehumidifier 421.

[0081]

The rib 491, which is the closest to the first pocket 471, works as a partition between a region in which the many trapping teeth 476 are formed, and a region below the dehumidifier 421. Accordingly, little water from the sprinkler 520 directly flows into a region below the dehumidifier 421. Therefore, long fibrous substances removed from the dehumidifier 421 are likely to be captured by the trapping teeth 476.

[0082]

Since the region in which the many trapping teeth 476 are formed is inclined toward the first pocket 471, water from the sprinkler 520 flows toward the first pocket 471. Accordingly, long fibrous substances removed from the dehumidifier 421 are likely to be captured by the trapping teeth 476.

[0083]

As shown in Fig. 8, the rib 491, which is the closest to the first pocket 471, ends near the main drainage path 477, and defines an inflow port 492 configured to allow water flow from the region, in which the many trapping teeth 476 are formed, to the region below the dehumidifier 421. Water flows from the sprinkler 520 into the region below the dehumidifier 421 through the inflow port 492. Subsequently, the water flows into the relay tube 480 through the main drainage path 477 and the water storage region 478. In this embodiment, three trapping teeth 476 are formed at the boundary of the main drainage path 477 and the water storage region 478. Accordingly, the relay tube 480 is less likely to be clogged.

[0084]

(Drainage Mechanism)

The drainage mechanism 600 is described with reference to Figs. 2 and 3.

[0085]

In addition to the circulation pump 610 and the drainage valve 620, the drainage mechanism 600 has a connecting pipe 631 protruding downward from the lowermost position of the first peripheral wall 342 of the water tub 340, which is inclined upward toward the front wall 111, a reservoir box 632, which is connected to the lower end of the connecting pipe 631, and a drainage pipe 633, which extends from the reservoir box 632 toward the rear wall 112 of the housing 110. The drainage valve 620 is mounted on the drainage pipe 633. When the controller 200 opens the drainage valve 620, liquid inside the washing tub 320 is discharged from the housing 110 through the connecting pipe 631, the reservoir box 632 and the drainage pipe 633. In this embodiment, the drainage path is exemplified by the water flow path, which is defined by the connecting pipe 631, the reservoir box 632 and the drainage pipe 633.

[0086]

The drainage mechanism 600 further has a filter device 640, which is situated between the reservoir box 632 and the circulation pump 610, a first circulation duct 634, which is connected to the filter device 640 and the reservoir box 632, a suction duct 635, which is connected to the filter device 640 and the circulation pump 610, and a second circulation duct 636, which is connected to the circulation pump 610 and the water tub 340. The controller 200 operates the circulation pump 610 after closing the drainage valve 620. The liquid inside the washing tub 320 flows toward the circulation pump 610 through the connecting pipe 631, the reservoir box 632, the first circulation duct 634, the filter device 640 and the suction duct 635 due to a suction force caused by the circulation pump 610. The filter device 640 captures dust in the liquid flowing toward the circulation pump 610. Accordingly, the dust contained in the tap water used for cleaning the heat pump device 420 and dust separated from the laundry L in the washing process and the rinsing process are appropriately captured by the filter device 640. The circulation pump 610 returns the liquid cleaned by the filter device 640 to the water tub 340 through the second circulation duct 636. In this embodiment, the circulation mechanism is exemplified by the connecting pipe 631, the reservoir box 632, the first circulation duct 634, the filter device 640, the circulation pump 610, the suction duct 635 and the second circulation duct 636.

[0087]

The drainage mechanism 600 has a transmissive optical sensor 650 mounted on the first circulation duct 634. The optical sensor 650 outputs electrical signals in response to an amount of light transmission in water used for agitating the laundry L in the washing process. The amount of light transmission is used as a parameter which represents an amount of dirt in the water used for agitating the laundry L. In this embodiment, the measurement portion is exemplified by the optical sensor 650. The physical characteristics of water are exemplified by the amount of dirt detected by the optical sensor 650.

[0088]

(Operations of Washing Machine)

Fig. 10 is a schematic flowchart showing operations of the washing machine 100 in the washing process. Fig. 11 is a schematic block diagram of the washing machine 100. Fig. 12 is an exemplary graph showing an output from the optical sensor 650. Operations of the washing machine 100 in the washing process are described with reference to Figs. 2 and 10 to 12.

[0089]

(Step S105)

When a user operates the console 201 to select one of the first to fourth operation courses, step S105 is started. In step S105, the controller 200 closes the first watering valve 511 and the drainage valve 620 whereas the controller 200 opens the second watering valve 512. The controller 200 controls the switching valve 540 to set a watering path so that tap water supplied from the watering port 530 passes through the detergent storage portion 550. Consequently, the tap water containing detergent is efficiently supplied to the washing tub 320. When the water supply to the washing tub 320 is started, step S110 is executed.

[0090]

(Step S110)

In step S110, the controller 200 determines whether an amount of water stored in the washing tub 320 reaches a predetermined value. A setting value about the amount of water stored in the washing tub 320 may be set in advance by an input of the user using the console 201 or a parameter such as an amount of laundry stored in the washing tub 320. The amount of water supplied into the washing tub 320 may be detected by an elapsed time from the start time of the water supply or output signals from a liquid level sensor (not shown) mounted on the washing tub 320. Step S110 is continued until the amount of water stored in the washing tub 320 reaches a predetermined value. When the amount of water stored in the washing tub 320 reaches a predetermined value or higher, step S115 is executed.

[0091]

(Step S115)

In step S115, the controller 200 closes the second watering valve 512 to stop the water supply to the washing tub 320. Subsequently, step S120 is executed.

[0092]

(Step S120)

In step S120, the controller 200 operates the circulation pump 610 and the motor 310. Consequently, circulation of mixed liquid between the washing tub 320 and the circulation pump 610 and agitation of the laundry inside the washing tub 320 are started. Subsequently, step S125 is executed.

[0093]

(Step S125)

In step S125, the controller 200 starts clocking. Subsequently, step S130 is executed.

[0094]

(Step S130)

In step S130, the controller 200 determines whether it becomes a first measurement time on the basis of the clocking start time set in step S125. When the controller 200 determines that

it becomes the first measurement time, step S135 is executed. Otherwise, step S130 is continued.

[0095]

(Step S135)

In step S135, the controller 200 stores output values from the optical sensor 650. Subsequently, step S140 is executed.

[0096]

(Step S140)

In step S140, the controller 200 determines whether it becomes a second measurement time on the basis of the clocking start time set in step S125. When the controller 200 determines that it becomes the second measurement time, step S145 is executed. Otherwise, step S140 is continued.

[0097]

(Step S145)

In step S145, the controller 200 acquires output values from the optical sensor 650. Subsequently, the controller 200 uses the output values acquired in steps S145 and S135 to perform difference computation. Subsequently, step S150 is executed.

[0098]

(Step S150)

In step S150, the controller 200 determines control contents on the basis of results from the difference computation executed in step S145. Subsequently, step S155 is executed.

[0099]

(Step S155)

In step S155, the controller 200 opens the first watering valve 511 to clean the heat pump device 420 using the sprinkler 520. After the heat pump device 420 is cleaned for a predetermined period, the controller 200 closes the first watering valve 511. Subsequently, step S160 is executed.

[0100]

(Step S160)

In step S160, the controller 200 executes the control contents determined in step S150. For example, if the controller 200 determines in step S150 that a contamination level of liquid in the washing tub 320 is excessively high, the controller 200 may stop the circulation pump 610 and open the drainage valve 620. After the drainage valve 620 is opened for a predetermined period, the controller 200 may close the drainage valve 620 and open the second watering valve 512. Consequently, there may be a decreased contamination level in the washing tub 320.

[0101]

In this embodiment, the optical sensor 650 is used for measuring physical characteristics of water. Alternatively, another detection element may be used for measuring physical characteristics of water. For example, a conductive sensor may be suitably used for detecting detergent concentration or detergent type in the water.

[0102]

In this embodiment, physical characteristics of water are measured in the washing process. Alternatively, the physical characteristics of water may be measured in the rinsing process. For example, if a conductive sensor is used for measuring the physical characteristics of water, detergent concentration in the water may be detected in the rinsing process.

[0103]

Fig. 13 is a schematic flowchart showing operations of the washing machine 100 in the rinsing process. The operations of the washing machine 100 in the rinsing process are described with reference to Figs. 10, 11 and 13.

[0104]

(Step S205)

When a user operates the console 201 to select one of the first to third operation courses, step S205 is started after the washing process. In step S205, the controller 200 closes the second watering valve 512 and the drainage valve 620 whereas the controller 200 opens the first watering valve 511. Consequently, the heat pump device 420 is cleaned. After the heat pump device 420 is cleaned, step S210 is executed.

[0105]

(Step S210)

In step S210, the controller 200 closes the first watering valve 511 whereas the controller 200 opens the second watering valve 512. The controller 200 controls the switching valve 540 to set the watering path so that the tap water supplied from the watering port 530 bypasses the detergent storage portion 550. Accordingly, the tap water is directly supplied to the washing tub 320. When the water supply to the washing tub 320 is started, step S215 is executed.

[0106]

(Step S215)

In step S215, the controller 200 determines whether an amount of water stored in the washing tub 320 reaches a predetermined value. A setting value about the amount of water stored in the washing tub 320 may be set in advance by input of the user using the console 201 or

a parameter such as an amount of laundry stored in the washing tub 320. The amount of water supplied into the washing tub 320 may be detected by an elapsed time from the start time of the water supply or output signals from a liquid level sensor (not shown) mounted on the washing tub 320. Step S215 is continued until the amount of water stored in the washing tub 320 reaches a predetermined value. When the amount of water stored in the washing tub 320 reaches a predetermined value or higher, step S220 is executed.

[0107]

(Step S220)

In step S220, the controller 200 closes the second watering valve 512 to stop the water supply to the washing tub 320. Subsequently, step S225 is executed.

[0108]

(Step S225)

In step S225, the controller 200 operates the circulation pump 610 and the motor 310. Consequently, circulation between the washing tub 320 and the circulation pump 610 and agitation of laundry inside the washing tub 320 are started. Subsequently, step S230 is executed.

[0109]

(Step S230)

In step S230, the controller 200 starts clocking. Subsequently, step S235 is executed.

[0110]

(Step S235)

In step S235, the controller 200 determines whether a predetermined circulation period passes on the basis of the clocking start time set in step S230. When the controller 200 determines that a predetermined circulation period passes, step S240 is executed. Otherwise, step S235 is continued.

[0111]

(Step S240)

In step S240, the controller 200 opens the drainage valve 620 to drain water from the washing tub 320. After water is drained from the washing tub 320, step S245 is executed.

[0112]

(Step S245)

In step S245, the controller 200 counts how many times the water is drained (i.e. how many times that the drainage valve 620 is opened). When the drainage count reaches a predetermined value, the rinsing process is ended. Otherwise, step S210 is executed.

[0113]

As described with reference to Figs. 10 and 13, the cleaning (steps S155 and/or S205) of the heat pump device 420 is performed before the washing operation (step S160) and/or the rinsing operation (step S225). Accordingly, dust contained in the water used for cleaning the heat pump device 420 is appropriately processed in the subsequent steps S160 and/or S225. Accordingly, little dust contained in the water used for cleaning the heat pump device 420 adheres to the laundry.

[0114]

Figs. 14A and 14B are schematic timing charts showing open and close timings of the first watering valve 511 and the drainage valve 620. The open and close timings of the first watering valve 511 and the drainage valve 620 are described with reference to Figs. 10, 11, 13 to 14B.

[0115]

The controller 200 selectively opens the first watering valve 511 and the drainage valve 620. In other words, as described with reference to Figs. 11 and 13, the controller 200 opens the first watering valve 511 whereas the controller 200 closes the drainage valve 620. Otherwise, the controller 200 opens the drainage valve 620 whereas the controller 200 closes the first watering valve 511. As shown in Figs. 14A and 14B, open and close operations of the first watering valve 511 do not have to be in synchronization with the open and close operations of the drainage valve 620. As shown in Fig. 14A, the first watering valve 511 may be closed after the drainage valve 620 is opened. As shown in Fig. 14B, the first watering valve 511 may be closed before the drainage valve 620 is opened. Since the first watering valve 511 is opened while the drainage valve 620 is closed, water used for cleaning the heat pump device 420 may be effectively used in the washing process and/or the rinsing process.

[0116]

(Design of Operation Courses)

Figs. 15A and 15B are schematic views showing design patterns of the operation courses. The design patterns of the operation courses are described with reference to Figs. 2, 15A and 15B.

[0117]

As shown in Fig. 15A, when a user selects one of the first to fourth operation courses, the washing process is executed. The process for cleaning the heat pump device 420 may be incorporated into the washing process.

[0118]

As shown in Fig. 15B, when a user selects one of the first to third operation courses, the rinsing process is executed. The process for cleaning the heat pump device 420 may be incorporated into the rinsing process.

[0119]

Fig. 16 is a schematic view showing various design patterns of the second operation course. The various design patterns of the second operation course are described with reference to Figs. 2 and 16.

[0120]

A design pattern in which the process for cleaning the heat pump device 420 is incorporated into the washing process is shown as the first design pattern in Fig. 16. A design pattern in which the process for cleaning the heat pump device 420 is incorporated into the rinsing process is shown as the second design pattern. The design pattern in which the process for cleaning the heat pump device 420 is provided independently after the spin-drying process is shown as the third design pattern.

[0121]

Fig. 17 is a schematic graph showing the operation period under the first to third design patterns. Fig. 18 is a schematic graph showing water consumption under the first to third design patterns. The operation period and the water consumption under the first to third design patterns are described with reference to Figs. 2 and 16 to 18.

[0122]

With regard to first design pattern, the process for cleaning the heat pump device 420 is incorporated into the washing process. Accordingly, the water used for cleaning the heat pump device 420 is also used for cleaning laundry inside the washing tub 320. With regard to second design pattern, the process for cleaning the heat pump device 420 is incorporated into the rinsing process. Accordingly, the water used for cleaning the heat pump device 420 is used for rinsing laundry inside the washing tub 320. On the other hand, with regard to the third design pattern, the process for cleaning the heat pump device 420 is independently provided after the spin-drying process. Accordingly, water used for cleaning the heat pump device 420 is discharged without being used in other processes.

[0123]

With regard to the first design pattern, cleaning the heat pump device 420 is used as a part of the water supply process to the washing tub 320 in the washing process. Accordingly, there is a shorter operation period under the first design pattern than the third design pattern. In

addition, there is less water consumption under the first design pattern than the third design pattern.

[0124]

With regard to the second design pattern, cleaning the heat pump device 420 is used as a part of the water supply process to the washing tub 320 in the rinsing process. Accordingly, there is a shorter operation period under the second design pattern than the third design pattern. In addition, there is less water consumption under the second design pattern than the third design pattern.

[0125]

Fig. 19 is a schematic view showing various design patterns of the fifth operation course. The various design patterns of the fifth operation course are described with reference to Figs. 2 and 16.

[0126]

A design pattern in which the process for cleaning the heat pump device 420 is incorporated into the washing process is shown as the first design pattern in Fig. 19. A design pattern in which the process for cleaning the heat pump device 420 is incorporated into the rinsing process is shown as the second design pattern. A design pattern in which the process for cleaning the heat pump device 420 is independently provided after the spin-drying process is shown as the third design pattern.

[0127]

Fig. 20 is a schematic graph showing water consumption under the first to third design patterns. The water consumption under the first to third design patterns is described with reference to Figs. 2, 19 and 20.

[0128]

With regard to first design pattern, the process for cleaning the heat pump device 420 is incorporated into the washing process. Accordingly, the water used for cleaning the heat pump device 420 is also used for cleaning the washing tub 320. With regard to the second design pattern, the process for cleaning the heat pump device 420 is incorporated into the rinsing process. Accordingly, the water used for cleaning the heat pump device 420 is also used for rinsing the washing tub 320. On the other hand, with regard to the third design pattern, the process for cleaning the heat pump device 420 is provided independently after the spin-drying process. Accordingly, the water used for cleaning the heat pump device 420 is discharged without being used in other processes.

[0129]

With regard to the first design pattern, cleaning the heat pump device 420 is used as a part of the water supply process to the washing tub 320 in the washing process. Accordingly, there is less water consumption under the first design pattern than the third design pattern.

[0130]

With regard to the second design pattern, cleaning the heat pump device 420 is used as a part of the water supply process to the washing tub 320 in the rinsing process. Accordingly, there is less water consumption under the second design pattern than the third design pattern.

[0131]

<Second Embodiment>

Fig. 21 is a schematic cross-sectional view of the washing machine 100A of the second embodiment. The same reference numerals are given to components which are common with the first embodiment. The description of the first embodiment is applicable to the components that are given the same reference numerals. The washing machine 100A is described with reference to Figs. 9 and 21.

[0132]

The washing machine 100A has a relay tube 480A, which is directly connected to the reservoir box 632 from the connector 479 formed on the water storage region 478 of the heat exchanging portion 450. Accordingly, water, which is sprinkled from the sprinkler 520 and used for cleaning the heat pump device 420, is directly supplied to the reservoir box 632 through the relay tube 480A under the gravity action.

[0133]

The water supplied to the reservoir box 632 is delivered to the washing tub 320 by the circulation pump 610. The filter device 640 removes the dust from the water, which is used for cleaning the heat pump device 420. Since the relay tube 480A defines a water return path for returning the water to the washing tub after the water used for cleaning the heat pump device 420 passes through the filter device 640 unlike the first embodiment, there may be little dust flowing into the washing tub 320.

[0134]

The aforementioned embodiments primarily include the following features.

[0135]

The washing machine according to one aspect of the present invention has a drying function. The washing machine includes a washing tub configured to wash laundry, a heat

exchanger, which exchanges heat with air passing through the washing tub to generate dry air for drying the laundry, a sprinkling mechanism including a sprinkler, which sprinkles water onto the heat exchanger to clean the heat exchanger, and a water return path configured to return to the washing tub the water, which is sprinkled from the sprinkler.

[0136]

According to the aforementioned configuration, since the heat exchanger exchanges heat with air passing through the washing tub to generate dry air, the laundry washed in the washing tub may be appropriately dried. Since the sprinkling mechanism sprinkles water from the sprinkler, dust separated from the laundry may be appropriately removed from the heat exchanger. Since the water sprinkled from the sprinkler is returned to the washing tub through the water return path, the washing machine may achieve very efficient water usage.

[0137]

In the aforementioned configuration, the washing machine may further include a controller configured to control the washing tub and the sprinkling mechanism according to a processing mode for the laundry in the washing tub. The processing mode may include a submerged agitation mode for agitating the laundry in the water supplied into the washing tub. The sprinkling mechanism may sprinkle water onto the heat exchanger under control of the controller during the submerged agitation mode.

[0138]

According to the aforementioned configuration, the laundry is agitated together with water in the washing tub during the submerged agitation mode. The controller controls the sprinkling mechanism during the submerged agitation mode to sprinkle water onto the heat exchanger. The water sprinkled from the sprinkler is returned to the washing tub through the water return path, and then used for the agitation of the laundry. Accordingly, the washing machine may achieve very efficient water usage.

[0139]

In the aforementioned configuration, the washing machine may further include a watering portion to which the water is supplied. The sprinkling mechanism may include a first watering valve configured to open and close a first watering path from the watering portion to the sprinkler. The controller may open the first watering valve during the submerged agitation mode.

[0140]

According to the aforementioned configuration, since the controller opens the first watering valve during the submerged agitation mode, the water reaches the sprinkler through the watering portion and the first watering path. The water sprinkled from the sprinkler is returned

to the washing tub through the water return path, and then used for the agitation of the laundry. Accordingly, the washing machine may achieve very efficient water usage.

[0141]

In the aforementioned configuration, the washing machine may further include a measurement portion, which measures physical characteristics of the water used for agitating the laundry in the submerged agitation mode and transmits physical characteristic information about the physical characteristics to the controller. The controller may open the first watering valve after determining contents of control for the washing tub on the basis of the physical characteristic information.

[0142]

According to the aforementioned configuration, the measurement portion measures physical characteristics of the water used for the agitation of the laundry in the submerged agitation mode. The physical characteristic information about the measured physical characteristics is transmitted from the measurement portion to the controller. Since the controller determines contents of control on the basis of the physical characteristic information, appropriate control may be performed for the washing tub. Since the controller opens the first watering valve after determining the control contents for the washing tub, the water returned to the washing tub through the water return path becomes less influential in physical characteristic information. Accordingly, the controller may determine appropriate control contents.

[0143]

In the aforementioned configuration, the washing machine may further include a detergent storage portion, in which detergent is stored, and a second watering path configured to guide the water from the watering portion to the washing tub. The submerged agitation mode may include a first mode for agitating the laundry in mixed liquid, which is a mixture of the detergent and the water flowing through the second watering path, and a second mode for agitating the laundry under lower detergent concentration than that during the first mode. The controller opens the first watering valve during at least one of the first and second modes.

[0144]

According to the aforementioned configuration, the laundry during the first mode is agitated in mixed liquid, which is a mixture of the detergent stored in the detergent storage portion and the water flowing through the second watering path configured to guide the water from the watering portion to the washing tub. Accordingly, the laundry may be appropriately washed. The laundry during the second mode is agitated under lower detergent concentration than that during the first mode. Accordingly, an amount of detergent adhered to the laundry may be appropriately reduced. Since the controller opens the first watering valve during at

least one of the first and second modes, the water returned to the washing tub through the water return path is used for the agitation of the laundry in the first and/or second modes. Accordingly, the washing machine may achieve very efficient water usage.

[0145]

In the aforementioned configuration, the washing machine may further include a second watering valve configured to open and close the second watering path. The controller may open the first watering valve while the second watering valve is closed.

[0146]

According to the aforementioned configuration, when the second watering valve is closed, there may be an increase in water pressure in the watering portion in communication with the second watering path. Since the controller opens the first watering valve while the second watering valve is closed, the sprinkler may sprinkle water onto the heat exchanger under high water pressure. Accordingly, the heat exchanger may be appropriately cleaned.

[0147]

In the aforementioned configuration, the processing mode may include a tub cleaning mode for cleaning the washing tub. The controller may open the second watering valve to execute the tub cleaning mode.

[0148]

According to the aforementioned configuration, since the controller opens the second watering valve to execute the tub cleaning mode, the washing tub may be appropriately cleaned.

[0149]

In the aforementioned configuration, the controller may selectively open the first and second watering valves in the tub cleaning mode.

[0150]

According to the aforementioned configuration, since the controller opens the first watering valve in the tub cleaning mode, the water reaches the sprinkler through the watering portion and the first watering path. The water sprinkled from the sprinkler is returned to the washing tub through the water return path, and then used for cleaning the washing tub. Accordingly, the washing machine may achieve very efficient water usage. Since the controller selectively opens the first and second watering valves, the sprinkler may sprinkle water onto the heat exchanger under high water pressure. Accordingly, the heat exchanger may be appropriately cleaned.

[0151]

In the aforementioned configuration, the washing machine may further include a housing in which the washing tub is stored, a drainage path configured to discharge the water

outside the housing, and a drainage valve configured to open and close the drainage path under control of the controller. The controller may selectively open the first watering valve and the drainage valve.

[0152]

According to the aforementioned configuration, since the controller selectively opens the first watering valve and the drainage valve, the water sprinkled from the sprinkler is less likely to be directly discharged. Accordingly, the washing machine may achieve very efficient water usage.

[0153]

In the aforementioned configuration, tap water may be supplied to the watering portion.

[0154]

According to the aforementioned configuration, since tap water is used for cleaning the heat exchanger and agitating the laundry, a water distribution design in the washing machine may be simplified.

[0155]

In the aforementioned configuration, the washing machine may further include a water receiver configured to receive the water sprinkled from the sprinkler, and a relay tube connected to the water receiver and the washing tub. The relay tube may form the water return path.

[0156]

According to the aforementioned configuration, since the relay tube is connected to the washing tub and the water receiver, which receives water sprinkled from the sprinkler, the water sprinkled from the sprinkler is returned to the washing tub through the relay tube. Accordingly, the washing machine may achieve very efficient water usage.

[0157]

In the aforementioned configuration, the washing machine may further include a circulation mechanism, which makes the water discharged from the washing tub flow into the washing tub again, a water receiver, which receives the water sprinkled from the sprinkler, and a relay tube configured to relay the water from water receiver to the circulation mechanism. The relay tube may form the water return path.

[0158]

According to the aforementioned configuration, since the relay tube is connected to the water receiver, which receives water sprinkled from the sprinkler, and the washing tub, which makes the water discharged from the washing tub flow into the washing tub again, the water sprinkled from the sprinkler is returned to the washing tub through the relay tube and the

circulation mechanism. Accordingly, the washing machine may achieve very efficient water usage.

[0159]

In the aforementioned configuration, the circulation mechanism may include a filter device configured to remove dust from the water discharged from the washing tub.

[0160]

According to the aforementioned configuration, since the filter device removes dust from the water discharged from the washing tub, the dust may be appropriately removed from the water to be returned to the washing tub.

[0161]

In the aforementioned configuration, the washing machine may further include a circulation mechanism, which makes the water discharged from the washing tub flow into the washing tub again. The circulation mechanism may include a filter device configured to remove dust from the water discharged from the washing tub.

[0162]

According to the aforementioned configuration, since the circulation mechanism makes the water discharged from the washing tub flow into the washing tub again, the washing machine may achieve very efficient water usage. Since the filter device removes dust from the water discharged from the washing tub, the dust may be appropriately removed from the water to be returned to the washing tub.

Industrial Applicability

[0163]

The principle of the embodiments may be suitably applied to devices for washing and drying laundry.

Claims

1. A washing machine having a drying function, comprising:
 - a washing tub configured to wash laundry;
 - a heat exchanger which exchanges heat with air passing through the washing tub to generate dry air for drying the laundry;
 - a sprinkling mechanism including a sprinkler which sprinkles water onto the heat exchanger to clean the heat exchanger; and
 - a water return path configured to return to the washing tub the water, which is sprinkled from the sprinkler.
2. The washing machine according to claim 1, further comprising:
 - a controller configured to control the washing tub and the sprinkling mechanism according to a processing mode for the laundry in the washing tub,
 - wherein the processing mode includes a submerged agitation mode for agitating the laundry in the water supplied into the washing tub, and
 - wherein the sprinkling mechanism sprinkles the water onto the heat exchanger under control of the controller during the submerged agitation mode.
3. The washing machine according to claim 2, further comprising:
 - a watering portion to which the water is supplied,
 - wherein the sprinkling mechanism includes a first watering valve configured to open and close a first watering path from the watering portion to the sprinkler, and
 - wherein the controller opens the first watering valve during the submerged agitation mode.
4. The washing machine according to claim 3, further comprising:
 - a measurement portion which measures physical characteristics of the water used for agitating the laundry in the submerged agitation mode and transmits physical characteristic information about the physical characteristics to the controller,
 - wherein the controller opens the first watering valve after determining contents of control for the washing tub based on the physical characteristics information.
5. The washing machine according to claim 3 or 4, further comprising:
 - a detergent storage portion in which detergent is stored; and

a second watering path configured to guide the water from the watering portion to the washing tub,

wherein the submerged agitation mode includes a first mode for agitating the laundry in mixed liquid, which is a mixture of the detergent and the water flowing through the second watering path, and a second mode for agitating the laundry under lower detergent concentration than that during the first mode, and

wherein the controller opens the first watering valve during at least one of the first and second modes.

6. The washing machine according to claim 5, further comprising:
a second watering valve configured to open and close the second watering path,
wherein the controller opens the first watering valve while the second watering valve is closed.

7. The washing machine according to claim 6,
wherein the processing mode includes a tub cleaning mode for cleaning the washing tub,
and
wherein the controller opens the second watering valve to execute the tub cleaning mode.

8. The washing machine according to claim 7,
wherein the controller selectively opens the first and second watering valves in the tub cleaning mode.

9. The washing machine according to any one of claims 3 to 8, further comprising:
a housing in which the washing tub is stored;
a drainage path configured to discharge the water outside the housing; and
a drainage valve configured to open and close the drainage path under control of the controller,

wherein the controller selectively opens the first watering valve and the drainage valve.

10. The washing machine according to any one of claims 3 to 9,
wherein tap water is supplied to the watering portion.

11. The washing machine according to any one of claims 1 to 10, further comprising:

a water receiver configured to receive the water sprinkled from the sprinkler; and
a relay tube connected to the water receiver and the washing tub,
wherein the relay tube forms the water return path.

12. The washing machine according to any one of claims 1 to 10, further comprising:
a circulation mechanism which makes the water discharged from the washing tub flow
into the washing tub again;
a water receiver configured to receive the water sprinkled from the sprinkler; and
a relay tube configured to relay the water from water receiver to the circulation
mechanism,
wherein the relay tube forms the water return path.

13. The washing machine according to claim 12,
wherein the circulation mechanism includes a filter device configured to remove dust
from the water discharged from the washing tub.

14. The washing machine according to claim 11, further comprising:
a circulation mechanism which makes the water discharged from the washing tub flow
into the washing tub again,
wherein the circulation mechanism includes a filter device configured to remove dust
from the water discharged from the washing tub.