

DESCRIPTION

WASHING MACHINE

5 TECHNICAL FIELD

The present invention relates to a washing machine including a hot water generating device that heats washing water.

BACKGROUND ART

10 PTL 1 discloses overheating preventing means of a washing machine including a hot water generating device that heats washing water. This washing machine includes a first thermistor for sensing a heating temperature of a heater, a heater temperature sensor for outputting a first temperature sensing signal corresponding to the sensed temperature of the heater, a second
15 thermistor for sensing a temperature of washing water, and a water temperature sensor for outputting a second temperature sensing signal corresponding to the sensed temperature of the washing water. Further, the first temperature sensing signal is input, and a temperature incremental value of the heater to a predetermined time value is calculated. The washing
20 machine includes a power source supply switching part for switching a power source supplied to the heater according to a power source supply switching signal.

The temperature incremental value of the heater to the predetermined time value is calculated from the first temperature sensing signal. When the
25 temperature incremental value of the heater is larger than a predetermined reference value, the power source supply switching part switches the power source supplied to the heater. Accordingly, overheating of the heater can be

prevented.

Citation List

Patent Literature

PTL 1: Unexamined Japanese Patent Publication No. H06-79089

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SUMMARY

However, in the conventional configuration, it is necessary to have two temperature detectors, that is, a temperature detector mainly including a thermistor for detecting a heating temperature of a heater and a temperature
10 detector mainly including a thermistor for detecting a water temperature within a water tub.

Embodiments of the present disclosure provide a low cost and highly reliable washing machine capable of preventing overheating of a heater by detecting a temperature of the heater and a water temperature within a water
15 tub by one temperature detector.

A washing machine according to a first aspect of the present disclosure includes a washing machine body, a water tub supported in an inside of the washing machine body and having a drain port at a bottom, and a drain cock unit coupled with the drain port of the water tub. Further, the washing
20 machine includes a heater unit coupled with the drain cock unit and communicating with an inner bottom of the water tub, a heater incorporated in the heater unit and heating washing water, and a temperature detector for detecting a water temperature within the heater unit. Furthermore, it is configured that energization to the heater is stopped after a first
25 predetermined period of time elapses from a start of the energization, and that the temperature detector detects a water temperature within the heater unit after a second predetermined period of time elapses from an end of the

energization to the

heater, and a water temperature within the water tub is estimated based on the detected water temperature.

With this configuration, by using the temperature detector for detecting a water temperature within a heater container, the temperature of the heater can be detected, and the water temperature within the water tub can be estimated. Accordingly, there is no need to provide a temperature detector on the water tub side. As a result, the low cost and highly reliable washing machine capable of preventing overheating of the heater can be provided.

Further, a washing machine according to an aspect of the present disclosure includes a washing machine body, a water tub supported in an inside of the washing machine body and having a drain port at a bottom, and a drain cock unit coupled with the drain port of the water tub. Further, the washing machine includes a heater unit coupled with the drain cock unit and communicating with an inner bottom of the water tub, a heater incorporated in the heater unit and heating washing water, a temperature detector for detecting a water temperature within the heater unit, and a controller for controlling energization of the heater so that washing water within the water tub reaches a predetermined set target water temperature. Further, the controller estimates a water temperature within the water tub from the temperature detected by the temperature detector, and determines first energizing time of the heater from at least a water temperature of water supplied into the water tub and an amount of the water supply. Furthermore, it is configured that the controller calculates a temperature rising speed within the water tub in the first energizing time based on the temperature detected by the temperature detector, and calculates, from the temperature rising speed and the water temperature within the water tub after the first energizing time,

second energizing time of the heater until the washing water within the water tub reaches the set target water temperature.

With this configuration, detection of overheating of the heater and temperature control of the water temperature within the water tub can be performed by using the one temperature detector. Accordingly, the low cost and highly reliable washing machine can be provided.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a longitudinal sectional view of a washing machine according to a first exemplary embodiment of the present invention.

FIG. 2 is a combined perspective view of a perspective view of a bottom surface of a water tub and an exploded perspective view of a heater unit of the washing machine according to the first exemplary embodiment of the present invention.

FIG. 3 is a perspective view of the heater unit of the washing machine according to the first exemplary embodiment of the present invention.

FIG. 4A is a top view of the heater unit of the washing machine according to the first exemplary embodiment of the present invention.

FIG. 4B is a sectional view taken along line 4B-4B in FIG. 4A.

FIG. 5 is a sectional view of the heater unit of the washing machine according to the first exemplary embodiment of the present invention.

FIG. 6 is a sectional view of the bottom surface of the water tub and the heater unit of the washing machine according to the first exemplary embodiment of the present invention.

FIG. 7 is an enlarged sectional view of a main portion of the heater unit of the washing machine according to the first exemplary embodiment of the present invention.

FIG. 8 is a combined sectional view of a sectional view of the bottom surface of the water tub and a sectional view taken along line 8-8 in FIG. 4A of the washing machine according to the first exemplary embodiment of the present invention.

5 FIG. 9 is an enlarged sectional view of a main portion of the heater unit of the washing machine according to the first exemplary embodiment of the present invention.

FIG. 10 is a partial sectional perspective view showing flow of washing water within the heater unit of the washing machine according to the first
10 exemplary embodiment of the present invention.

FIG. 11 is a graph of a water temperature within a heater container and a water temperature within the water tub of the washing machine according to the first exemplary embodiment of the present invention.

FIG. 12 is an exploded perspective view of a heater unit of a washing
15 machine according to a third exemplary embodiment of the present invention.

FIG. 13 is a sectional view of a bottom surface of a water tub, a drain cock unit, and the heater unit of the washing machine according to the third exemplary embodiment of the present invention.

FIG. 14 is a perspective view of the heater unit of the washing machine
20 according to the third exemplary embodiment of the present invention.

FIG. 15 is a perspective view of the heater unit of the washing machine according to the third exemplary embodiment of the present invention.

FIG. 16 is a sectional view showing flow of washing water within the heater unit of the washing machine according to the third exemplary
25 embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

Hereinafter, exemplary embodiments will be described in detail with reference to the drawings as appropriate. However, descriptions in more detail than necessary may be omitted. For example, the detailed description of already well-known matters and the overlap description of substantially identical configurations may be omitted. This is intended to prevent the following description from becoming unnecessarily redundant and to facilitate understanding by those skilled in the art.

Note that the attached drawings and the following description are provided for those skilled in the art to fully understand the present disclosure, and are not intended to limit the subject matter as described in the appended claims.

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[1. First exemplary embodiment]

Hereinafter, a first exemplary embodiment will be described with reference to FIGS. 1 to 11.

[1-1. Configuration]

[1-1-1. Configuration of washing machine]

5 FIG. 1 is a longitudinal sectional view of a washing machine according to the first exemplary embodiment.

 In FIG. 1, water tub 13 is suspended, vibration-controlled, and supported by suspension 12 inside washing machine body 11. Washing and spin-drying tub 15 serving both as a washing tub and a spin-drying tub is
10 rotatably provided inside water tub 13. Pulsator 18 is rotatably disposed at a bottom of washing and spin-drying tub 15.

 An outer bottom of water tub 13 is provided with transmission mechanism 20. Transmission mechanism 20 incorporates a gear (not shown) to reduce speed during washing, a changeover clutch (not shown) of
15 washing/spin-drying shaft 14, and a brake (not shown) to stop washing and spin-drying tub 15.

 Motor 21 is mounted on the outer bottom of water tub 13, and motor-side pulley 22 is mounted on motor 21. Mechanism-side pulley 23 is coupled to washing/spin-drying shaft 14, and motor-side pulley 22 and mechanism-side
20 pulley 23 are coupled to each other by belt 24. With this configuration, power of motor 21 is transmitted to washing/spin-drying shaft 14 via belt 24. Further, by controlling the changeover clutch, a state of rotating only pulsator 18 and a state of simultaneously rotating pulsator 18 and washing and spin-drying tub 15 can be realized by using motor 21.

25 Upper frame body 25 is disposed on an upper part of washing machine body 11. A substantially central part of upper frame body 25 is formed with laundry loading/unloading port 26 for communicating washing and spin-drying

tub 15 and an outside, and door body 27 openably covers laundry loading/unloading port 26. A rear side of upper frame body 25 is disposed with operation display 29 in which various input settings are made and which displays the set contents. Water supply valve 30 that can be opened by electromagnetic force and water pouring case 31 are disposed inside the rear side of upper frame body 25.

A controller (not shown) that controls motor 21 or the like to sequentially control a series of washing, rinsing, and spin-drying processes or to control a water temperature of washing water is disposed inside washing machine body 11.

Fluid balancer 16 is disposed at an upper part of washing and spin-drying tub 15. Backboard 17 is detachably disposed on a back surface of washing machine body 11 so as to cover back surface opening (inspection opening) 11a.

FIG. 2 is a perspective view of a bottom surface of the water tub and an exploded perspective view of a heater unit of the washing machine according to the present exemplary embodiment. As shown in FIG. 2, a bottom of water tub 13 has first drain port 33a and second drain port 33b.

[1-1-2. Configuration of heater unit]

FIG. 3 is a perspective view of the heater unit of the washing machine according to the present exemplary embodiment. FIG. 4A is a top view of the heater unit of the washing machine according to the present exemplary embodiment. FIG. 4B is a sectional view taken along line 4B-4B in FIG. 4A. FIG. 5 is a sectional view of the heater unit of the washing machine according to the present exemplary embodiment. FIG. 6 is a sectional view of the bottom surface of the water tub and the heater unit of the washing machine according to the present exemplary embodiment. FIG. 7 is an enlarged sectional view of

a main portion of the heater unit in FIG. 6. FIG. 8 is a sectional view of the bottom surface of the water tub of the washing machine according to the present exemplary embodiment and taken along line 8-8 in FIG. 4A. FIG. 9 is an enlarged sectional view of a main portion of the heater unit in FIG. 8.

5 Heater unit 32 of the washing machine according to the present exemplary embodiment will be described below.

As shown in FIG. 1, heater unit 32 is fixed to the outer bottom on the back surface side of water tub 13 at a position where maintenance can be performed by detaching backboard 17.

10 As shown in FIG. 2, heater unit 32 includes substantially rectangular parallelepiped heater container 37 with both ends in a longitudinal direction opened, heater 38 inserted through a first opening of heater container 37, sheet metal member 36 inserted through a second opening of heater container 37 and covering heater 38, and lid body 51 covering the second opening,
15 through which sheet metal member 36 is inserted.

The parts will be described below.

[A. Heater container 37]

Heater container 37 is formed of heat-resistant resin, and has the substantially rectangular parallelepiped shape with both the ends in the
20 longitudinal direction opened. Of the openings in the longitudinal direction of heater container 37, the first opening is heater inserting opening 37b for inserting heater 38, and the second opening is sheet metal inserting opening 37c for inserting sheet metal member 36 and covered with lid body 51.

On an upper surface of heater container 37 and near heater inserting
25 opening 37b, tubular outflow passage 37g communicating with second drain port 33b at the bottom of water tub 13 is formed.

On a side surface adjacent to a surface having outflow passage 37g and

near sheet metal member inserting opening 37c, drain cock connecting opening 37a communicating with drain cock unit 34 is formed. Drain cock unit 34 and heater container 37 are detachably mounted by screw fastening (not shown) or the like.

5 As shown in FIG. 2, drain cock unit 34 is welded and fixed by welding bosses 45 at a position where inflow port 34a and first drain port 33a at the bottom of water tub 13 communicate. Water tub 13 and heater container 37 are communicated and connected via drain cock unit 34. As shown in FIGS. 2, 3, and 4B, drain cock unit 34 has drain passage side opening 34c. Drain
10 passage side opening 34c is connected and communicated with drain passage 41 (see FIG. 1). By opening a drain valve (not shown) of drain cock unit 34, washing water within water tub 13 and heater container 37 is drained to the outside of washing machine body 11 through drain passage 41.

 Note that in the present exemplary embodiment, water tub 13 and
15 drain cock unit 34 are welded and fixed, but the present invention is not limited to this. Drain cock unit 34 and water tub 13 may be detachably mounted by screw fastening or the like.

[B. Sheet metal member 36]

 As shown in FIG. 2, sheet metal member 36 surrounding heater 38 has
20 a substantially rectangular parallelepiped shape with both ends in the longitudinal direction opened. Sheet metal member 36 is inserted forward into heater container 37 through sheet metal member inserting opening 37c.

 Since radiant heat generated from heater 38 is conducted to sheet metal member 36 and diffused, a risk of melting a part of heater container 37
25 by heat concentration and causing perforation can be reduced.

 Sheet metal member 36 includes two sheet metal parts. As shown in FIGS. 2 and 6, one end of sheet metal member 36 is spot-welded along spot

welding part 42 in the longitudinal direction. As shown in FIGS. 6 and 7, another end of sheet metal member 36 has separation part 36a that is not welded and has a fixed gap. As a result, sheet metal member 36 is substantially U-shaped. Sheet metal member 36 is formed with support piece 40 recessed inward by bending. This support piece 40 fixes heater 38 housed in heater container 37 so that heater 38 is not moved.

With reference to FIGS. 5, 6, and 7, a method for fixing sheet metal member 36 and heater container 37 will be described.

As shown in FIG. 5, on an inner wall of heater container 37, belt-shaped rib 37d is extended so as to correspond to a position of separation part 36a in a state in which sheet metal member 36 is inserted into heater container 37. When sheet metal member 36 is inserted forward into heater container 37 through sheet metal member inserting opening 37c, belt-shaped rib 37d is located at separation part 36a.

As shown in FIGS. 6 and 7, in the state in which sheet metal member 36 is inserted into heater container 37, width dimension W of belt-shaped rib 37d at a position abutting on sheet metal member 36 is made larger from a rear side to a front side.

Width dimension W1 of an end on sheet metal member inserting opening 37c side (rear side) of belt-shaped rib 37d in FIG. 7 is formed smaller than a separation width of separation part 36a in a state in which sheet metal member 36 is housed within heater container 37. Width dimension W2 of an end on heater inserting opening 37b side (front side) of belt-shaped rib 37d in FIG. 7 is formed larger than the separation width of separation part 36a in the state in which sheet metal member 36 is housed within heater container 37. Further, as shown in FIG. 8, inner wall lower surface 39a of heater container 37 is gradually inclined upward and inner wall upper surface 39b is gradually

inclined downward from sheet metal member inserting opening 37c side (rear side) to heater inserting opening 37b side (front side). As a result, as sheet metal member 36 is inserted from sheet metal member inserting opening 37c side (rear side) to heater inserting opening 37b side (front side), the separation width of separation part 36a becomes smaller.

With this configuration, when sheet metal member 36 is inserted into heater container 37 from sheet metal member inserting opening 37c side (rear side) to heater inserting opening 37b side (front side), width W of belt-shaped rib 37d is larger than the separation width of separation part 36a of sheet metal member 36 from the middle of insertion. Accordingly, when sheet metal member 36 is press-fitted into heater container 37 by pushing, an end of separation part 36a of sheet metal member 36 is sunk into belt-shaped rib 37d. Thus, sheet metal member 36 can be supported and fixed within heater container 37, and looseness of sheet metal member 36 can be prevented during spin-drying rotation of washing and spin-drying tub 15.

In the present exemplary embodiment, sheet metal member 36 is formed by spot-welding two sheet metals. However, sheet metal member 36 may be configured by molding one sheet metal, for example.

[C. Heater 38]

Heater 38 will be described with reference to FIG. 2.

Heater 38 is inserted through heater inserting opening 37b of heater container 37.

Heater 38 includes heating part 38a, terminal 38b, and connecting part 38c.

Heating part 38a is located inside heater container 37, and generates heat for heating washing water within heater container 37. Further, as shown in FIG. 2, heating part 38a is folded many times on an identical plane. With

this configuration, since a surface area of heating part 38a is increased, the washing water can be heated efficiently.

Terminal 38b is electrically connected with heating part 38a. Further, terminal 38b is electrically connected with an external power source (not shown) located on the outside of heater container 37 and a control device (not shown). Power from the external power source is supplied to heating part 38a via terminal 38b.

Connecting part 38c is interposed between heating part 38a and terminal 38b. Connecting part 38c is provided with flexible member 38d with a size corresponding to a size of heater inserting opening 37b of heater container 37. In FIG. 8, by tightening nut 43 in a state in which heating part 38a is inserted through heater inserting opening 37b, heater 38 can be fixed within heater container 37. In other words, forward force is applied to bolt 44 and pressure welding plate 47 welded by bolt 44 by tightening nut 43, and flexible member 38d is expanded in a circumferential direction by being compressed in a front and rear direction, thereby enabling sealing of heater inserting opening 37b. With this configuration, the washing water within heater container 37 can be prevented from being leaked from heater inserting opening 37b. Flexible member 38d is formed of packing which is elastically deformed, such as rubber.

Further, as shown in FIG. 2, connecting part 38c is disposed with temperature detector 56 for detecting a water temperature within heater container 37. Temperature detector 56 includes a thermistor or the like.

[D. Lid body 51]

As shown in FIGS. 8 and 9, lid body 51 detachably covers sheet metal member inserting opening 37c of heater container 37 by screw fastening (not shown).

In order to detach lid body 51 to confirm the inside of heater container 37 and to perform maintenance of heater unit 32, sheet metal member inserting opening 37c covered with lid body 51 is provided on the back surface side, in which back surface opening 11a of washing machine body 11 is disposed.

Sheet metal member inserting opening 37c covered with lid body 51 is mounted to a position facing heater 38 inserted into heater container 37. With this configuration, a state of heater 38 can be easily visually recognized by detaching lid body 51 from heater container 37.

Lid body 51 is formed with inclined rib 51a, which is a projected rib, for pressing sheet metal member 36 inserted into heater container 37 against an inner wall surface side of heater container 37. Inclined rib 51a has an inclined surface facing sheet metal member 36 housed in heater container 37, and the inclined surface is inclined so as to approach the inner wall surface of heater container 37 from the “front” side to the “rear” side shown by arrows in FIG. 8. With this configuration, the end on sheet metal member inserting opening 37c side of sheet metal member 36 inserted into heater container 37 is expanded toward inner wall lower surface 39a and inner wall upper surface 39b by inclined rib 51a. The end on sheet metal member inserting opening 37c side (rear side) of sheet metal member 36 inserted into heater container 37 is expanded toward inner wall lower surface 39a and inner wall upper surface 39b by inclined rib 51a.

Further, in a state in which heater container 37 is mounted on the bottom of water tub 13, rib 37e (see FIG. 6) for supporting sheet metal member 36 is extended on inner wall lower surface 39a and inner wall upper surface 39b of heater container 37. Rib 37e suppresses direct transmission of heat of sheet metal member 36 heated by heater 38 to inner wall lower surface 39a

and inner wall upper surface 39b.

With this configuration, by covering sheet metal member inserting opening 37c with lid body 51 in a state in which sheet metal member 36 is inserted into heater container 37, sheet metal member 36 is supported and
5 fixed by inclined rib 51a and rib 37e. As a result, oscillation of sheet metal member 36 within heater container 37 is suppressed.

In this way, heater unit 32 is configured.

[1-2. Operational motion of washing machine]

Next, operational motion of the washing machine in the present
10 exemplary embodiment will be described.

A user opens door body 27, loads clothes into washing and spin-drying tub 15 through laundry loading/unloading port 26, closes door body 27, and starts a hot water washing course by operating operation display 29.

When a washing process is started, water supply valve 30 is opened,
15 and water is poured into water tub 13 from water pouring case 31. The poured water flows into heater container 37 through first drain port 33a and second drain port 33b at the bottom of water tub 13.

Here, in the hot water washing course, after the washing process in water heated by heater 38 is completed, rinsing and spin-drying processes are
20 performed.

In the hot water washing course, when the water in water tub 13 reaches a predetermined water level by pouring water into water tub 13, heater 38 of heater unit 32 is turned ON. Based on a water temperature of the washing water within the water tub, the control device performs ON-OFF
25 control of heater 38 to control the temperature of the washing water. A method for detecting the water temperature within the water tub will be described in [1-5. Method for detecting water temperature within water tub].

When the water temperature within water tub 13 reaches predetermined temperature M1 (for example, 55°C), heater 38 is turned OFF. Further, when the detected water temperature within water tub 13 is lowered to less than or equal to predetermined temperature M2 (for example, less than
5 or equal to 53°C), heater 38 is turned ON. According to this method, the washing water within water tub 13 can be controlled to have a predetermined water temperature.

Note that predetermined temperatures M1, M2 may be set for each operation course (for example, a sterile filtration course or a mud stain
10 washing course). When predetermined temperatures M1, M2 are changed according to the operation course, the washing water can be controlled to have water temperature suitable for a purpose of each operation course.

Further, after the hot water washing, motion in which water is added into washing and spin-drying tub 15 and agitated by pulsator 18 may be
15 repeated until the water temperature within water tub 13 is less than or equal to a predetermined temperature (for example, less than or equal to 50°C). When the water temperature within water tub 13 is less than or equal to 50°C, the drain valve of drain cock unit 34 is opened, and the washing water is discharged to the outside of washing machine body 11. When the water
20 temperature within water tub 13 is more than or equal to a predetermined temperature (for example, more than or equal to 50°C) and the water level of water tub 13 reaches a limited level, temporary drainage is performed for a predetermined time.

With this configuration, even in an environment where drainage water
25 is drained to a road surface, the washing water can be drained in a state in which the water temperature is lowered. Accordingly, safety is improved.

On the other hand, when outflow passage 37g of heater container 37 is

blocked by yarn waste of clothes or the like, there is a possibility that water flow between heater container 37 and water tub 13 is disturbed. When the water flow between heater container 37 and water tub 13 is disturbed, even though the water temperature within the water tub is less than or equal to predetermined temperature M1, it is assumed that the inside of heater unit 32 is overheated. In this case, when detected water temperature of temperature detector 56 for detecting the water temperature within heater container 37 reaches heater overheating set temperature (for example, 95°C), control is performed so as to turn OFF heater 38. Accordingly, overheating within heater unit 32 can be prevented, and occurrence of scale or degradation of heater container 37 can be suppressed.

[1-3. Flow of washing water within heater unit]

FIG. 10 is a partial sectional perspective view showing flow of washing water within the heater unit of the washing machine according to the present exemplary embodiment.

With reference to FIG. 10, flow of washing water within heater unit 32 when heater 38 is turned ON in the hot water washing course will be described.

Outflow passage 37g communicating with an inner bottom of water tub 13 is formed on a root side of heating part 38a on the upper surface of heater container 37, and drain cock unit 34 communicating with the inner bottom of water tub 13 is coupled to a tip lateral side of heating part 38a on the side surface of heater container 37.

The washing water heated within heater container 37 and raised in water temperature moves up within heater container 37.

Herein, since a distance from heater 38 to outflow passage 37g is shorter than a distance from heater 38 to drain cock connecting opening 37a, in a state in which a power source of heater 38 is turned on, the water

temperature in outflow passage 37g is higher than the water temperature in drain cock connecting opening 37a within heater container 37. As a result, as shown in arrow D in FIG. 10, the washing water moved up within heater container 37 is discharged to water tub 13 through outflow passage 37g.

5 In order to supplement the high temperature washing water discharged from heater container 37 to water tub 13, as shown in arrow C in FIG. 10, washing water having a low temperature and a heavy specific gravity within water tub 13 flows from inflow port 34a into the inner bottom of heater container 37 through drain cock front passage 34b on an upstream side of the
10 drain cock of drain cock unit 34. The washing water flowed into heater container 37 is heated by effectively utilizing the radiant heat of heater 38, while flowing from the vicinity of the tip to the vicinity of the root of heating part 38a of heater 38. Accordingly, the washing water can be heated efficiently.

 Thus, since two passages (inflow port 34a, outflow passage 37g)
15 coupling water tub 13 and heater container 37 are provided at the positions having different distances from heater 38, the washing water within water tub 13 and the washing water within heater container 37 can be circulated by natural convection, utilizing the difference in water temperature of the washing water within the passages. As a result, a number of parts can be
20 reduced without requiring an external force, such as a pump, and cost can be cut.

 Further, since a capacity of heater container 37 is smaller than a capacity of water tub 13, a temperature rising speed by heater 38 and a water temperature of the washing water within heater container 37 are higher than
25 the temperature rising speed and the water temperature of the washing water within water tub 13. As a result, bacteria included in the washing water flowing into heater container 37 can be effectively sterilized.

Furthermore, by rotating pulsator 18 every fixed time, the washing water within water tub 13 can be agitated, and the water temperature within water tub 13 can be made uniform.

In the present exemplary embodiment, when first drain port 33a and second drain port 33b have larger opening areas, circulation of the washing water in heater unit 32 and water tub 13 can be activated. However, when the opening areas of first drain port 33a and second drain port 33b are increased in perfect circular shapes, first drain port 33a and second drain port 33b interfere with welding boss 45, female screw 46, and the like around first drain port 33a and second drain port 33b. Therefore, it is necessary to greatly modify the bottom of water tub 13.

Therefore, by forming first drain port 33a in a substantially elliptical shape as shown in FIG. 2, the opening area of first drain port 33a can be increased without changing positions of welding boss 45 and female screw 46. Hence, the washing water within water tub 13 and heater container 37 can be efficiently circulated at low cost without making large investment on mold.

Further, as shown in FIG. 8, inner wall lower surface 39a on the bottom side of heater container 37 is gradually inclined downward from heater inserting opening 37b to drain cock connecting opening 37a. With this configuration, during drainage, the washing water within heater container 37 flows toward drain cock connecting opening 37a and flows out to the outside of washing machine body 11 through drain cock unit 34, drain passage 41 (see FIG. 1). Hence, accumulation of the washing water within heater container 37 or foreign matter during drainage can be prevented.

[1-4. State confirmation of heater unit, and maintenance method]

Since relatively large foreign matter, such as yarn waste, generated from clothes is attached to heater 38 or blocks outflow passage 37g, there is a

possibility that the hot water within heater container 37 cannot flow out to water tub 13. Further, malfunction may occur to a part of heater unit 32. As a result, it is necessary to confirm a state of the inside of heater unit 32 or repair heater unit 32, as needed.

5 State confirmation of the inside of heater unit 32 and a maintenance method will be described below.

 In order to confirm the state of heater unit 32, backboard 17 covering back surface opening 11a on a rear side of washing machine body 11 is detached, and lid body 51 of heater container 37 mounted on the bottom
10 surface of water tub 13 is detached from back surface opening 11a. Since heater container 37 and lid body 51 are fixed by screw fastening, lid body 51 can be detached by removing the screw.

 According to this method, the state of heater 38 within heater container 37 can be confirmed by back surface opening 11a of washing machine
15 body 11, and yarn waste attached to a surface of heater 38 can be removed as needed. Accordingly, since detachment of a lead wire connector connected to heater 38 is not required, confirmation and maintenance of heater 38 can be easily performed.

 Further, when sheet metal member 36 is desired to be repaired or
20 replaced, sheet metal member 36 can be detached by pulling out sheet metal member 36 from heater container 37, thereby enabling repair or replacement.

 Further, heater unit 32 and water tub 13, and heater unit 32 and drain cock unit 34 are fastened by a screw or the like (not shown) and detachably mounted. With this configuration, when removal of foreign matter entered
25 into heater unit 32 is required, or when replacement of heater unit 32 is required, washing machine body 11 can be laid on a side, and at the bottom of washing machine body 11, heater unit 32 can be detached from water tub 13

and drain cock unit 34, thereby enabling maintenance of heater unit 32 alone. Further, since only a broken part of heater unit 32 can be maintained, time and cost required for the repair can be reduced.

[1-5. Method for detecting water temperature within water tub]

FIG. 11 is a graph of a water temperature within heater container 37 and a water temperature within water tub 13 of the washing machine according to the present exemplary embodiment.

When heater 38 is turned ON at time Ta0, water within heater container 37 is heated by heater 38. Since a volume of heater container 37 is smaller than a volume of the water tub, the water temperature within heater container 37 is normally 10°C to 40°C higher than the water temperature within water tub 13. When a predetermined period of time elapses after heater 38 is turned OFF at time Ta1, the water temperature within water tub 13 and the water temperature within heater container 37 are gradually equalized and become substantially equal at time Ta2.

A method for estimating the water temperature within water tub 13 using temperature detector 56 disposed in heater 38 will be described below.

In the hot water washing course, when the water in water tub 13 reaches a predetermined water level by pouring water into water tub 13, heater unit 32 is turned ON. Time at this point is set to time Ta0. Next, after a predetermined period of time elapses after heater 38 is turned ON (time at this point is set to time Ta1), heater 38 is turned OFF. After a predetermined period of time elapses after heater 38 is turned OFF and the water temperature within heater container 37 and the water temperature within water tub 13 become substantially equal (time at this point is set to time Ta2), temperature detector 56 detects the water temperature within heater container 37. Accordingly, the water temperature within water tub 13 can be

estimated.

It is desirable that ON time (a period from time Ta0 to time Ta1) of heater 38 be calculated from an output of heater 38, an amount of water within water tub 13, an amount of clothes, and the like. For example, when
5 the output of the heater is 1500 W, the amount of water within water tub 13 is 66 L, the amount of clothes is 5 kg, and heating is performed from an initial water temperature of 20°C to a predetermined temperature of 55°C, the ON time is about 130 minutes.

It is desirable that a predetermined period of time (a period from time
10 Ta1 to time Ta2) during which heater 38 is turned OFF be 1 to 5 minutes, for example.

After heater 38 is turned OFF for the predetermined period of time, by rotating pulsator 18 for a predetermined period of time, the washing water within water tub 13 is agitated, and a difference in water temperature
15 between water tub 13 and heater container 37 can be balanced. As a result, the difference in water temperature between heater container 37 and water tub 13 can be reduced in a short time, and the water temperature within water tub 13 can be accurately detected.

According to this method, temperature control of the washing water
20 within water tub 13 can be performed by using temperature detector 56 that detects the water temperature within heater container 37. As a result, the low cost and highly reliable washing machine which does not require arrangement of the water temperature detector within the water tub can be provided.

[2. Second exemplary embodiment]

25 Next, a washing machine according to a second exemplary embodiment of the present invention will be described.

Note that since components of the washing machine according to the

present exemplary embodiment are identical to the components of the washing machine according to the first exemplary embodiment, identical reference marks are assigned to identical components, and descriptions thereof are omitted.

5 [2-1. Method for controlling water temperature within water tub]

Herein, in the washing machine according to the present exemplary embodiment, a control method for controlling washing water within water tub 13 to have a predetermined set target water temperature (for example, 53°C) by using temperature detector 56 will be described.

10 The washing machine according to the present exemplary embodiment includes washing machine body 11, water tub 13 supported in an inside of washing machine body 11 and having a drain port at a bottom, and drain cock unit 34 coupled with the drain port of water tub 13. Further, the washing machine includes heater unit 32 coupled with drain cock unit 34 and
15 communicating with an inner bottom of water tub 13, heater 38 incorporated in heater unit 32 and heating washing water, and temperature detector 56 for detecting a water temperature within heater unit 32. Furthermore, the washing machine includes a controller (not shown) for controlling energization of heater 38 so that the washing water within water tub 13 reaches the
20 predetermined set target water temperature. After completion of water supply into water tub 13, the controller calculates to determine first energizing time of heater 38 from at least a water temperature of water supplied into water tub 13 and an amount of the water supply, and energizes heater 38 during the first energizing time. Herein, heater 38 may be energized continuously during
25 the first energizing time or may be energized intermittently during the first energizing time.

Further, in the first energizing time, the controller calculates

temperature rising speed V_t of the washing water within water tub 13 based on the temperature detected by temperature detector 56. Furthermore, from temperature rising speed V_t and a water temperature within water tub 13 after an end of the first energizing time, the controller calculates second energizing time of heater 38 until the washing water within water tub 13 reaches the set target water temperature. Then, the controller energizes heater 38 during the calculated second energizing time. Herein, heater 38 may be energized continuously during the second energizing time or may be energized intermittently during the second energizing time.

After heater 38 is energized continuously during the second energizing time, the water temperature within water tub 13 is estimated by temperature detector 56 and compared with the set target water temperature. When the water temperature is lower than the set target water temperature, heater 38 is energized for a predetermined period of time, and the water temperature within water tub 13 is estimated again based on the temperature detected by temperature detector 56. When the water temperature is higher than the set target water temperature, heater 38 is not energized for a predetermined period of time, and the water temperature within water tub 13 is estimated again based on the temperature detected by temperature detector 56.

According to this method, only by temperature detector 56 provided within heater container 37, detection of overheating of heater 38 and temperature control of the washing water within water tub 13 can be performed. As a result, the low cost and highly reliable washing machine can be provided.

[3. Third exemplary embodiment]

In the washing machine according to the first exemplary embodiment, heater container 37 and the inner bottom surface of water tub 13 are coupled

by the two passages, and the washing water heated within heater container 37 and the washing water within water tub 13 are circulated. However, in the first exemplary embodiment, it is necessary to provide the plurality of drain ports in water tub 13. Therefore, in a washing machine according to a third
5 exemplary embodiment, a heater container and an inner bottom surface of a water tub are coupled by one passage.

Hereinafter, the third exemplary embodiment will be described with reference to FIGS. 12 to 16. Note that regarding a longitudinal sectional view of the washing machine, see FIG. 1.

10 The bottom of water tub 13 of the washing machine according to the first exemplary embodiment has first drain port 33a and second drain port 33b. A bottom of water tub 113 of the washing machine according to the present exemplary embodiment has drain port 133. Since the other configuration of the washing machine according to the present exemplary embodiment is
15 identical to the configuration of the washing machine according to the first exemplary embodiment, description thereof is omitted.

[3-1. Configuration of heater unit]

FIG. 12 is an exploded perspective view of a heater unit of the washing machine according to the present exemplary embodiment. FIG. 13 is a
20 sectional view of a bottom surface of the water tub, a drain cock unit, and the heater unit of the washing machine according to the present exemplary embodiment. FIGS. 14 and 15 are perspective views of the heater unit of the washing machine according to the present exemplary embodiment.

Heater unit 132 of the washing machine according to the present
25 exemplary embodiment will be described below.

As shown in FIG. 13, heater unit 132 is fixed to a position, of an outer bottom on a back surface side of water tub 113, where maintenance can be

performed by detaching backboard 17 (see FIG. 1).

As shown in FIG. 12, heater unit 132 includes substantially rectangular parallelepiped heater container 137 with both ends in a longitudinal direction opened, heater 138 inserted through one opening of
5 heater container 137, sheet metal member 136 inserted through another opening of heater container 137 and covering heater 138, and lid body 151 covering the opening of heater container 137, through which sheet metal member 136 is inserted.

The parts will be described below. Note that since heater 138 of the
10 washing machine according to the present exemplary embodiment has a configuration identical to the configuration of heater 38 according to the first exemplary embodiment, description thereof is omitted.

[A. Heater container 137]

As shown in FIG. 12, heater container 137 is formed of heat-resistant
15 resin, and has the substantially rectangular parallelepiped shape with both the ends in the longitudinal direction opened.

On a side surface on the longitudinal direction side of heater container 137 and near sheet metal member inserting opening 137c, drain cock connecting opening 137a communicating with drain cock unit 134 is formed.
20 In the washing machine according to the first exemplary embodiment, tubular outflow passage 37g communicating with second drain port 33b at the bottom of water tub 13 is formed on the upper surface of heater container 37. However, such a passage is not formed in heater container 137 of the washing machine according to the present exemplary embodiment. The other
25 configuration of heater container 137 is identical to the configuration of heater container 37 according to the first exemplary embodiment.

As shown in FIG. 13, drain cock unit 134 is detachably mounted to

drain port 133 at the bottom of water tub 113 by a screw or the like. As shown in FIG. 13, a part of drain cock unit 134 is formed in an L shape that extends toward heater container 137, and water tub 113 and heater container 137 are connected in communication via drain cock unit 134. As shown in FIG. 13, drain cock unit 134 is provided with partition wall 146 for separating a passage that communicates water tub 113 and heater container 137 within drain cock unit 134. Partition wall 146 includes vertical part 146a and horizontal part 146b extending from a lower end of vertical part 146a toward heater 138, and is formed in an L shape in a cross section. By partition wall 146, a water passage within drain cock unit 134 is separated into inflow passage 135a located on a left side of vertical part 146a and below horizontal part 146b, and outflow passage 135b located above horizontal part 146b and on a right side of vertical part 146a in FIG. 13.

In the present exemplary embodiment, as shown in FIG. 13, inner wall upper surface 139b and inner wall lower surface 139a of heater container 137 are formed so that an inclination angle of inner wall upper surface 139b and an inclination angle of inner wall lower surface 139a of heater container 137 are substantially identical. With this configuration, as shown in FIGS. 14 and 15, even when heater container 137 is turned upside down, heater container 137 can be inserted into the bottom of water tub 113 via drain cock unit 134 and used. As a result, heater unit 132 can be disposed considering a gravity center of vibration, arrangement of parts, and the like for each type of the washing machine.

[B. Sheet metal member 136]

As shown in FIG. 12, sheet metal member 136 surrounding heater 138 has a substantially rectangular parallelepiped shape with one end in the longitudinal direction opened. Sheet metal member 136 is configured by

molding one sheet metal part into a rectangular parallelepiped shape. As shown in FIG. 13, the one end in the longitudinal direction of sheet metal member 136 has separation part 136a that is not welded and has a fixed gap. Support piece 140 for supporting and fixing heater 138 is welded to an inner
5 surface of sheet metal member 136. Support piece 140 fixes heater 138 housed in heater container 137 so that heater 138 is not moved.

Note that sheet metal member 136 may be configured by welding two sheet metals by spot welding or the like, for example.

A method for fixing sheet metal member 136 and heater container 137
10 is identical to the method in the first exemplary embodiment.

[C. Lid body 151]

As shown in FIG. 13, lid body 151 detachably covers sheet metal member inserting opening 137c of heater container 137 by fastening with a screw (not shown) or the like.

Lid body 51 of the washing machine according to the first exemplary embodiment is formed with inclined rib 51a, which is a projected rib (see FIG. 6). However, lid body 151 of the washing machine according to the present exemplary embodiment is not formed with such a rib. The other configuration of lid body 151 according to the second exemplary embodiment is identical to
20 the configuration of lid body 51 according to the first exemplary embodiment.

In this way, heater unit 132 is configured.

[3-2. Flow of washing water within heater unit]

FIG. 16 is a sectional view showing flow of washing water within the heater unit of the washing machine according to the present exemplary
25 embodiment. With reference to FIG. 16, flow of washing water within heater unit 132 in a state in which heater 138 is turned ON in a hot water washing course will be described.

As shown in FIG. 12, drain cock unit 134 communicating with an inner bottom of water tub 113 is coupled to a side surface in the longitudinal direction of heater container 137. As shown in FIG. 13, partition wall 146 is provided inside drain cock unit 134. Partition wall 146 is formed substantially in the L shape extending downward toward heater 138. Partition wall 146 prevents low temperature washing water within inflow passage 135a flowing from water tub 113 to heater container 137 and high temperature washing water within outflow passage 135b flowing from heater container 137 to water tub 113 from being mixed within drain cock unit 134, and the washing water can be efficiently circulated.

When heater 138 is turned ON in a state in which the washing water is filled within heater container 137, the washing water within heater container 137 is heated by heater 138, moves up within heater container 137, and is discharged from outflow passage 135b to water tub 113 as shown in arrow B in FIG. 16.

On the other hand, in order to supplement the high temperature washing water discharged from heater container 137 to water tub 113, washing water having a low temperature and a heavy specific gravity within water tub 113 flows into heater container 137 through inflow passage 135a as shown in arrow A in FIG. 16. Since the washing water heated within heater container 137 moves upward, the low temperature washing water within water tub 113 easily flows into the bottom side of heater container 137 from inflow passage 135a.

The washing water flowed into heater container 137 is heated by heater 138, moves up within heater container 137, and is discharged from outflow passage 135b to water tub 113.

Thus, by communicating heater container 137 and the inner bottom of

water tub 113 by the one passage and circulating the washing water by natural convection caused by a difference in temperature of the washing water, a common metal mold for water tub 113 can be used for a type of washing machine having heater unit 132 and a type of washing machine having no heater unit 132. As a result, manufacturing cost when a washing machine is developed to realize a hot water specification function can be suppressed low. Furthermore, heater unit 132 can be externally provided as needed.

Further, as shown in FIGS. 13 and 16, an upper end of vertical part 146a of partition wall 146 is located above inflow port 134a. With this configuration, entering of the high temperature washing water discharged from outflow passage 135b to water tub 113 into inflow passage 135a can be suppressed. Accordingly, the washing water within the water tub can be heated efficiently.

Furthermore, by rotating pulsator 18 every fixed time, the washing water within water tub 113 can be agitated, and the water temperature within water tub 113 and the water temperature within the heater container can be made uniform in a short time.

Further, as shown in FIG. 16, inner wall upper surface 139b on water tub 113 side (upper side) of heater container 137 is gradually inclined to the water tub side (upper side) from heater inserting opening 137b (see FIG. 12) toward drain cock connecting opening 137a. With this configuration, when the washing water is supplied into heater container 137, air accumulated within heater container 137 is easily discharged from heater container 137 toward water tub 113. As a result, air accumulation within heater container 137 can be prevented, and a risk of no-water burning can be reduced.

[4. Other exemplary embodiments]

The first to the third exemplary embodiments have been described

above as an example of the technique disclosed in the present application. The technique in the present disclosure, however, can be applied to any exemplary embodiment to which modification, replacement, addition, omission, or the like are made, other than the foregoing exemplary embodiments. In addition, new
5 exemplary embodiments can be made by combining components described in the first to the third exemplary embodiments.

Therefore, other exemplary embodiments will be described below.

In the first exemplary embodiment, the coupling passage between water tub 13 and heater container 37 is configured by drain cock unit 34 and
10 outflow passage 37g formed in heater container 37. However, the present invention is not limited to this configuration. For example, an inflow passage and an outflow passage may be formed in heater container 37, and water tub 13 and heater container 37 may be directly communicated without passing
15 through drain cock unit 34. At this time, drain cock unit 34 may be connected to the bottom surface or the side surface of heater container 37 in a state in which heater container 37 is mounted on the bottom of water tub 13. Further, three or more coupling passages may be provided between water tub 13 and heater container 37.

In the first exemplary embodiment, first drain port 33a is formed in
20 the substantially elliptical shape. However, second drain port 33b may be formed in the substantially elliptical shape, or first drain port 33a and second drain port 33b may be formed in the substantially elliptical shapes.

In the third exemplary embodiment, the coupling passage is configured by drain cock unit 134 between water tub 113 and heater container 137.
25 However, the present invention is not limited to this configuration. For example, by forming a passage communicating with the drain port at the inner bottom of water tub 113 in heater container 137, water tub 113 and heater

container 137 may be directly communicated without passing through drain
cock unit 134. At this time, a partition wall may be disposed inside the
passage. Further, by forming the passage of heater container 137 in a
substantially L shape and communicating the side surface of heater container
5 137 and the inner bottom surface of water tub 113, the low temperature
washing water within water tub 113 easily flows into the bottom side of heater
container 137 through inflow passage 135a. Further, drain cock unit 134 may
be connected to the bottom surface or the side surface of heater container 137
in a state in which heater container 137 is mounted on the bottom of water tub
10 113.

In the third exemplary embodiment, the configuration in which the
upper end of vertical part 146a of partition wall 146 is located above inflow
port 134a has been described. However, the present invention is not limited to
this configuration. The upper end of vertical part 146a may be located below
15 inflow port 134a.

In the first and the third exemplary embodiments, the configuration in
which lid body 51, 151 is provided in heater container 37, 137 at back surface
opening 11a of washing machine body 11 in the state in which heater unit 32,
132 is attached to the outer bottom surface of water tub 13, 113 has been
20 described. Lid body 51 may be provided in heater container 37 in a direction
in which the openable opening of washing machine body 11 is located.
Therefore, the opening of heater container 37, 137 opened and closed by lid
body 51, 151 may be formed on the front surface side of washing machine body
11, or may be formed on the side surface side of washing machine body 11.

25 In the first to the third exemplary embodiments, the top-loading-type
washing machine has been described as an example of washing machine.
However, the present invention is not limited to this type of washing machine,

and may be applied to a drum type washing machine.

The above exemplary embodiment is an illustration of the technique of the present disclosure. Therefore, various changes, replacements, additions, or omissions may be made to the exemplary embodiment within the scope of
5 claims or their equivalents.

As described above, a first disclosure includes a washing machine body, a water tub supported in an inside of the washing machine body and having a drain port at a bottom, and a drain cock unit coupled with the drain port of the water tub. Further, the washing machine includes a heater unit coupled with
10 the drain cock unit and communicating with an inner bottom of the water tub, a heater incorporated in the heater unit and heating washing water, and a temperature detector for detecting a water temperature within the heater unit. Furthermore, energization to the heater is stopped after a first predetermined period of time elapses from a start of the energization. The temperature
15 detector detects a water temperature within the heater unit after a second predetermined period of time elapses from an end of the energization to the heater, and a water temperature within the water tub is estimated based on the detected water temperature.

With this configuration, a water temperature within a heater container
20 and the water temperature within the water tub can be detected by using the one temperature detector. Accordingly, the low cost and highly reliable washing machine that requires no temperature detector on the water tub side can be provided.

A second disclosure particularly according to the first disclosure
25 includes a washing and spin-drying tub disposed rotatably inside the water tub and a pulsator disposed rotatably in a center of an inner bottom of the washing and spin-drying tub, and the pulsator is rotated at a predetermined

time interval.

With this configuration, by agitating washing water within the water tub and washing water within the heater container, the washing water within the water tub is agitated, and a difference in water temperature between the washing water within the water tub and the washing water within the heater container can be balanced.

A third disclosure includes a washing machine body, a water tub supported in an inside of the washing machine body and having a drain port at a bottom, and a drain cock unit coupled with the drain port of the water tub. Further, the washing machine includes a heater unit coupled with the drain cock unit and communicating with an inner bottom of the water tub, a heater incorporated in the heater unit and heating washing water, a temperature detector for detecting a water temperature within the heater unit, and a controller for controlling energization of the heater so that washing water within the water tub reaches a predetermined set target water temperature. Further, the controller estimates a water temperature within the water tub from the temperature detected by the temperature detector, and determines first energizing time of the heater from at least a water temperature of water supplied into the water tub and an amount of the water supply. Furthermore, the controller calculates a temperature rising speed within the water tub in the first energizing time based on the temperature detected by the temperature detector, and calculates, from the temperature rising speed and the water temperature within the water tub after the first energizing time, second energizing time of the heater until the washing water within the water tub reaches the set target water temperature.

With this configuration, detection of overheating of the heater and temperature control of the water temperature within the water tub can be

performed by using the one temperature detector.

In a fourth disclosure particularly according to the third disclosure, the controller estimates the water temperature within the water tub based on the temperature detected by the temperature detector after a predetermined
5 period of time elapses from an end of the energization to the heater.

With this configuration, detection of overheating of the heater and detection of the water temperature within the water tub can be performed by using the one temperature detector.

A fifth disclosure particularly according to the third or fourth
10 disclosure includes a washing and spin-drying tub disposed rotatably inside the water tub and a pulsator disposed rotatably in a center of an inner bottom of the washing and spin-drying tub, and the pulsator is rotated at a predetermined time interval.

With this configuration, by agitating the washing water within the
15 water tub and washing water within the heater unit, the washing water within the water tub is agitated, and a difference in water temperature between the washing water within the water tub and washing water within a heater container can be balanced.

20 INDUSTRIAL APPLICABILITY

As described above, a washing machine according to the present invention is applicable not only to a washing machine for home use but also to a washing machine for business use.

25 REFERENCE MARKS IN THE DRAWINGS

11: washing machine body

11a: back surface opening (inspection opening)

	12: suspension
	13, 113: water tub
	14: washing/spin-drying shaft
	15: washing and spin-drying tub
5	17: backboard
	16: fluid balancer
	18: pulsator
	20: transmission mechanism
	21: motor
10	22: motor-side pulley
	23: mechanism-side pulley
	24: belt
	25: upper frame body
	26: laundry loading/unloading port
15	27: door body
	29: operation display
	30: water supply valve
	31: water pouring case
	32, 132: heater unit
20	33a: first drain port
	33b: second drain port
	34, 134: drain cock unit
	34a, 134a: inflow port
	34b: drain cock front passage
25	34c, 134c: drain passage side opening
	36, 136: sheet metal member
	36a, 136a: separation part

	37, 137: heater container
	37a, 137a: drain cock connecting opening
	37b, 137b: heater inserting opening
	37c, 137c: sheet metal member inserting opening
5	37d, 137d: belt-shaped rib
	37e, 137e: rib
	37g: outflow passage
	38, 138: heater
	38a, 138a: heating part
10	38b, 138b: terminal
	38c, 138c: connecting part
	38d, 138d: flexible member
	39a, 139a: inner wall lower surface
	39b, 139b: inner wall upper surface
15	40, 140: support piece
	41: drain passage
	42: spot welding part
	43: nut
	44: bolt
20	51, 151: lid body
	51a: inclined rib
	56, 156: temperature detector
	133: drain port