

DESCRIPTION

WASHING MACHINE

5 TECHNICAL FIELD

The present disclosure relates to a washing machine that agitates clothes and washing water.

BACKGROUND ART

10 PTL 1 discloses a washing machine that suppresses generation of detergent bubbles generated during laundry.

A drum-type washing machine in PTL 1 has an outer tub, a rotary drum rotatably disposed in the outer tub, a drain part that drains washing water in the outer tub, and a bubble detector including a pair of electrodes.

15 When the bubble detector detects bubbles, a controller moves an operation to a gentle washing sequence and prevents the drain part from operating within a predetermined time. After a lapse of the predetermined time, the controller returns to a normal washing sequence when the bubble detector has not detected bubbles, and the controller operates the drain part to drain the water
20 in the outer tub when the bubble detector has detected bubbles.

Citation List

Patent Literature

PTL 1: Unexamined Japanese Patent Publication No. 2007-117139

25 SUMMARY

However, there is a problem that the conventional washing machine cannot determine the generation of detergent bubbles when a short circuit

occurs in the bubble detector.

The present disclosure provides a washing machine that includes a bubble detector that detects generation of detergent bubbles generated during washing and that can appropriately deal with a short circuit of the bubble
5 detector.

In an aspect, the present disclosure provides a washing comprising: a housing, an outer tub elastically supported inside or within the housing, an inner tub provided in the outer tub and rotatably disposed, a water supply part that supplies water into the outer tub, a water level detector that detects a
10 water level in the outer tub, a drain part that drains water in the outer tub, a bubble detector including a pair of electrodes configured by a first electrode and a second electrode, and a controller that controls a laundry operation including at least one of washing, rinsing, and spin-drying, wherein the controller determines that the pair of electrodes is short-circuited when a
15 resistance between the pair of electrodes falls below a predetermined value before the water level reaches a predetermined water level.

The washing machine according to the present disclosure includes the bubble detector that detects the generation of detergent bubbles generated during washing, and can appropriately deal with a short circuit of the bubble
20 detector.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a side sectional view of a drum-type washing machine according to a first exemplary embodiment.

25 FIG. 2 is an operation flowchart of a controller of the drum-type washing machine.

FIG. 3 is a schematic diagram when abnormal foaming occurs in a

bubble detector of the drum-type washing machine or when a short circuit due to deposits occurs.

FIG. 4 is a schematic diagram showing temporal changes in a resistance value of the bubble detector of the drum-type washing machine and
5 a water level in a water tub.

DESCRIPTION OF EMBODIMENTS

Hereinafter, exemplary embodiments will be described in detail with reference to the drawings as appropriate.

10 (First exemplary embodiment)

FIG. 1 is a side sectional view of a drum-type washing machine according to a first exemplary embodiment of the present disclosure.

As shown in FIG. 1, water tub 33 is swingably supported by, for example, vibration-isolating member 41 disposed at a downside of washing
15 machine body 39. Rotary drum 31 is rotatably provided in water tub 33, and is disposed such that a central axis of rotation is inclined downward from a front surface toward a rear surface. Rotary drum 31 has a bottomed cylindrical shape, and is provided with multiple water passage holes 32 on its entire outer peripheral surface. A plurality of protruding plates 36 for
20 agitating clothes is provided on an inner wall surface of rotary drum 31. Opening 38 is provided on a front side of water tub 33 and rotary drum 31, and opening 38 is openably and closably covered by lid 37. By opening lid 37, a user can put laundry in and out of rotary drum 31 through opening 38.

Water supply valve (water supply part) 44 supplies water into water
25 tub 33 through water supply passage 45. Controller 57 is disposed at a downside of the body. One end of drain path 42 is connected to a lower part of water tub 33, and drain valve (drain part) 43 is connected to the other end of

drain path 42 for draining washing water in water tub 33.

Rotation shaft 34 is provided on the rear surface of rotary drum 31. Motor 35 attached to the rear surface of water tub 33 is connected to rotation shaft 34. Motor 35 is configured by a DC brushless motor or the like, and is
5 controlled by controller 57, a drive circuit (not shown), and the like so as to rotate in forward and reverse directions and to change rotation speed. A load applied to motor 35, that is, an amount of laundry is detected by a signal from a current detection circuit (not shown).

The drum-type washing machine has heater 47, blower fan 48, and
10 warm air blowing path 49 as a configuration for implementing a drying function. Further, a warm air inlet port (not shown) that takes in air in water tub 33 is provided at a rear part of an upper surface of water tub 33. Warm air blowing port 51 is provided at an upside of the rear surface of water tub 33. Warm air flows into water tub 33 and rotary drum 31 in a direction of arrow a,
15 the air inside or within rotary drum 31 and water tub 33 is heated and circulates, and the laundry is dried.

Information from input setting part 58 for setting a driving course and the like is input to controller 57. Controller 57 displays the set content on display 59 on the basis of the input information to notify the user. Further,
20 when an operation start is set by input setting part 58, data from water level detector 46 or the like that detects the water level in water tub 33 is input to controller 57. Then, controller 57 controls operations of drain valve 43, water supply part 44, blower fan 48, heater 47, and the like via a load drive part (not shown). Further, controller 57 controls motor 35 via the drive circuit (not
25 shown). Controller 57 operates a laundry process configured by at least one of washing, rinsing, spin-drying, or drying.

Bubble detector 70 is configured by a pair of lower electrode 70a and

upper electrode 70b, lower electrode 70a being disposed at a downside of water tub 33, upper electrode 70b being disposed at the upside of water tub 33 or within a predetermined area from warm air blowing port 51 in warm air blowing path 49. Here, the predetermined area refers to an area where
5 detergent bubbles generated in water tub 33 can reach upper electrode 70b. This is because the generation of detergent bubbles is detected when the detergent bubbles reach upper electrode 70b. Upper electrode 70b is disposed at a position higher than lower electrode 70a.

Next, the positions where lower electrode 70a and upper electrode 70b
10 are disposed will be further described with reference to FIG. 1. Water levels h1, h2, h3 all indicate water levels of the washing water in water tub 33 with the lower end of water tub 33 as a reference. Water level h1 is a water level when a normal washing sequence described below is performed. Water level h2 is a water level corresponding to a height position of a lower end of rotary
15 drum 31. Water level h3 is a water level corresponding to a height position of lower electrode 70a. As shown in FIG. 1, the height of the water level has a relationship in which $h1 > h2 > h3$ is satisfied. As an example, water level h1 is about 100 mm higher than water level h2.

Lower electrode 70a is disposed at a height position corresponding to
20 water level h3 lower than water level h2. That is, lower electrode 70a is disposed at the downside of water tub 33 and at a position lower than rotary drum 31. This makes it possible to distinguish between a short circuit and abnormal foaming in bubble detector 70. Upper electrode 70b is disposed at a position higher than water level h1.

25 Note that, in FIG. 1, lower electrode 70a and upper electrode 70b are disposed at a rear part of water tub 33, but the configuration is not limited to this. Lower electrode 70a and upper electrode 70b may be disposed at a front

part of water tub 33.

Bubble detector 70 is connected to a resistance value determination circuit (not shown). A resistance between lower electrode 70a and upper electrode 70b is detected by comparison with a reference resistance in the resistance value determination circuit. When the resistance value between lower electrode 70a and upper electrode 70b is greater than or equal to a threshold value, controller 57 determines that bubbles have not entered between the pair of electrodes. When bubbles enter between the pair of electrodes, an energization path is formed by the bubbles between lower electrode 70a that is soaked and upper electrode 70b, and a resistance value lower than the threshold value is detected. The resistance value for determination of the resistance value determination circuit is set to be less than the threshold value (for example, 500 k Ω) when bubbles are present, and greater than or equal to the threshold value (for example, 500 k Ω) when bubbles are not present.

With respect to the drum-type washing machine configured as described above, the operation and action when the bubble detector detects bubbles during laundry will be described with reference to FIGS. 2 to 4.

FIG. 2 is an operation flowchart of the controller of the drum-type washing machine according to the first exemplary embodiment of the present invention. Part (a) of FIG. 3 is a schematic diagram when abnormal foaming occurs in the bubble detector of the drum-type washing machine. Part (b) of FIG. 3 is a schematic view when a short circuit due to deposits occurs in the bubble detector of the drum-type washing machine. FIG. 4 is a schematic diagram showing temporal changes in the resistance value of the bubble detector of the drum-type washing machine and the water level in the water tub.

When the washing process starts, bubble detector 70 starts detecting the resistance value. When the resistance value detected by bubble detector 70 does not fall below the threshold value (for example, 500 k Ω) (No in S102) before the water level in water tub 33 reaches water level h2 corresponding to the height at which the lower end of rotary drum 31 is located (S101), controller 57 determines that a short circuit has not occurred between the pair of electrodes and performs the normal washing sequence (S103). Here, the normal washing sequence (S103) refers to, for example, operating at a rotation speed of 45 r/min in an agitating time period in which water is supplied to water level h1, and rotary drum 31 is operated for 12 seconds and suspended for 1 second. Here, the normal washing sequence is also referred to as a first washing sequence.

As shown by broken line B in FIG. 4, in the normal washing sequence (S103), it is determined whether the resistance value of bubble detector 70 is below the threshold value after reaching water level h2 (S104). When the resistance value is less than the threshold value, controller 57 determines that abnormal foaming has occurred (S105). The abnormal foaming occurs when the washing water including the detergent component is agitated by the rotation of rotary drum 31, and the pair of electrodes is energized as shown in part (a) of FIG. 3. Upon determination that abnormal foaming has occurred, controller 57 performs a defoaming sequence of draining the water in water tub 33 by drain part 43 and the like (S106).

Then, when the normal washing sequence for a first predetermined time, for example, 15 minutes is finished (S107), controller 57 finishes the washing process (S108) and moves the process to the next process.

On the other hand, when the resistance value of bubble detector 70 becomes less than the threshold value before the water level reaches h2 (Yes in

S102) as shown by solid line A in FIG. 4, controller 57 can determine that abnormal foaming has not occurred. This is because the washing water including detergent component is not agitated by the rotation of rotary drum 31 and abnormal foaming does not occur until the water level in water tub 33 reaches h2. When the resistance value is less than the threshold value, controller 57 can determine that a short circuit between the electrodes has occurred. Thus, when the resistance value is less than the threshold value before the water level reaches h2 (Yes in S102), controller 57 determines that a short circuit has occurred (S109).

The short circuit between the electrodes is caused by deposits accumulated between the electrodes. The deposits are residue of detergent components (detergent slags) and lint from laundry. When these are accumulated between the electrodes of bubble detector 70, as shown in part (b) of FIG. 3, the washing water forms a thin membrane with the detergent component residue or thread waste as a medium due to a surface tension, and causes a short-circuit between the electrodes.

After S109, no matter what value the resistance value detected by bubble detector 70 is, the water in water tub 33 is not drained by drain part 43 until the washing ends (S108) and the process moves to the next step. This is because, as described above, something other than bubbles adheres between the pair of electrodes, and controller 57 cannot accurately determine whether abnormal foaming has occurred in water tub 33 on the basis of the resistance value between the pair of electrodes. When it is determined that there is a short circuit (S109), bubble detector 70 is not normally functioning. Thus, when the drain operation is performed on the basis of the determination of bubble detector 70, there is a possibility that abnormal foaming is erroneously detected although abnormal foaming has not actually occurred. False

detection not only causes unnecessary drainage, but also causes drainage of the detergent component included in the washing water in water tub 33 together, and significantly deteriorates cleaning performance.

However, after S109, until the washing process ends (S108), abnormal
5 foaming may possibly occur. Thus, when a short circuit determination is made (S109), controller 57 performs a first gentle washing sequence to suppress abnormal foaming (S110). The first gentle washing sequence refers to, for example, operating at a rotation speed of 35 r/min in a weak agitating time period in which rotary drum 31 is rotated for ten seconds and suspended
10 for five seconds. In the first gentle washing sequence, the agitation is gentler than in the normal washing sequence (S103), and foaming can be suppressed. Further, “the agitation is gentler than in the normal washing sequence” means that at least one of the rotation speed and rotation time of rotary drum 31 is less than that of the normal washing sequence. Here, the first gentle washing
15 sequence is also referred to as a second washing sequence.

After that, when the washing process is continued and the washing sequence is continued for the second predetermined time (S111), for example, 15 minutes, controller 57 ends the washing process (S108) and moves the process to the next process.

20 After that, a series of laundry operations such as rinsing, spin-drying, and drying is sequentially performed. When the operations end, controller 57 causes display 59 to display that the short circuit determination is made to inform the user. Accordingly, the user recognizes that bubble detector 70 is not normally functioning, and can operate a course of cleaning water tub 33 or
25 rotary drum 31 itself (for example, a tub cleaning course). As a result, the detergent slags and the like accumulated between the pair of electrodes of bubble detector 70 are removed, and this can prevent the washing machine

from being continuously used with the pair of electrodes being short-circuited.

As described above, the drum-type washing machine of the present disclosure includes washing machine body 39, water tub 33 elastically supported inside or within washing machine body 39, rotary drum 31 provided
5 in water tub 33 and rotatably disposed, water supply valve 44 that supplies water into water tub 33, water level detector 46 that detects the water level in water tub 33, drain valve 43 that drains the water in water tub 33, bubble detector 70 configured by the pair of electrodes, that is, lower electrode 70a and upper electrode 70b, and controller 57 that controls the laundry operation
10 including at least one of washing, rinsing, and spin-drying. Controller 57 determines that electrodes 70a, 70b are short-circuited when the resistance between electrodes 70a, 70b falls below a predetermined value before the water level of the water supplied to water tub 33 by water supply part 44 reaches a predetermined water level.

15 Thus, an increase of bubbles due to abnormal foaming can be suppressed and unnecessary drainage can be prevented even when a short circuit occurs between lower electrode 70a and upper electrode 70b. The drum-type washing machine according to the present exemplary embodiment can therefore appropriately deal with the short circuit of bubble detector 70.

20 The predetermined water level may correspond to the height at which the lower end of rotary drum 31 is located.

Lower electrode 70a may be disposed at a position lower than the predetermined water level.

25 Lower electrode 70a may be provided at the downside of water tub 33, and upper electrode 70b may be provided at the upside of water tub 33.

The drum-type washing machine may further include warm air blowing path 49 that circulates warm air for drying the laundry, and warm air

blowing port 51 that is formed at the upside of the rear surface of water tub 33 and introduces the warm air into water tub 33. Lower electrode 70a may be provided at the downside of water tub 33, and upper electrode 70b may be provided within the predetermined area from warm air blowing port 51 in
5 warm air blowing path 49.

Controller 57 may be configured such that when the resistance between electrodes 70a, 70b does not fall below the predetermined value until the water level supplied to water tub 33 by water supply part 44 reaches the predetermined water level, and the resistance between the electrodes falls
10 below the predetermined value after the water level reaches the predetermined water level, drain valve 43 performs the drain operation.

As a result, controller 57 can perform the washing sequence after determining that abnormal foaming has occurred and once draining the washing water abnormally foamed. The drum-type washing machine
15 according to the present exemplary embodiment can therefore distinguish between the short circuit of bubble detector 70 and the abnormal foaming, and can appropriately deal with the abnormal foaming.

Controller 57 performs the first washing sequence when the resistance between the electrodes does not fall below the predetermined value until the
20 water level supplied to water tub 33 by water supply part 44 reaches the predetermined water level. Upon determination that electrodes 70a, 70b are short-circuited before the water level supplied to water tub 33 by water supply part 44 reaches the predetermined water level, controller 57 may perform the second washing sequence in which at least one of the rotation speed and
25 rotation time of rotary drum 31 is set less than that of the first washing sequence instead of performing the drain operation by drain valve 43.

This can suppress foaming due to agitation of rotary drum 31 as

compared with the normal washing sequence. The drum-type washing machine according to the present exemplary embodiment can therefore appropriately deal with abnormal foaming even when the bubble detector is short-circuited.

5 Further, display 59 that notifies a state of the laundry operation may be further provided, and controller 57 may issue an abnormality notification by display 59 after the laundry process ends upon determination that electrodes 70a, 70b are short-circuited.

This allows the user to recognize that bubble detector 70 is not
10 functioning normally. It is therefore possible to appropriately deal with the short circuit of the bubble detector by performing the course of cleaning water tub 33 or rotary drum 31 itself to remove the deposits accumulated between the electrodes of bubble detector 70.

(Other exemplary embodiments)

15 As described above, the first exemplary embodiment has been described as an example of a technique disclosed in the present application, but the technique in the present disclosure is not limited to this.

Thus, other exemplary embodiments will be exemplified below.

In the first exemplary embodiment, the drum-type washing machine
20 has been described as an example of a washing machine. The washing machine is not limited to the drum-type washing machine as long as the washing machine can wash clothes with water. The washing machine may be a top-loading-type washing machine or a two-tub washing machine. Further, although the drum-type washing machine having the drying function has been
25 described in the first exemplary embodiment, a similar effect can be obtained in a drum-type washing machine having no drying function. Further, if by any chance a short circuit occurs between the electrodes due to secular change,

it is possible to prevent bubbles from increasing and at the same time prevent the cleaning performance from significantly deteriorating. The present invention is also useful for a washing machine or the like that requires a protector capable of protecting electric parts from bubbles and the like.

5 In the first exemplary embodiment, as an example of the inner tub, rotary drum 31 disposed such that an axial direction is inclined downward from the front side toward the rear side has been described. The inner tub may be disposed in a horizontal direction as long as the inner tub is provided in the outer tub and rotatably disposed.

10 In the first exemplary embodiment, the short circuit determination is made on the basis of the changes in the resistance value until the water level reaches h2 (S102). However, if the water level in water tub 33 is already at or above h2 before the operation is started, the short circuit determination (S102) may not be made. This is because S101 and 102 cannot be performed in order,
15 and therefore the short circuit determination itself lacks accuracy. In this case, there is a possibility that abnormal foaming has occurred. Thus, when the resistance value of bubble detector 70 is less than the threshold value, drainage (defoaming sequence) (S106) may be started immediately.

 In the first exemplary embodiment, the abnormal foaming is dealt with
20 by draining the water in water tub 33 after it is determined that the abnormal foaming has occurred in S105. The way of dealing with abnormal foaming is not limited to draining the water in water tub 33, but the abnormal foaming may be dealt with by the washing sequence. For example, if the resistance value detected by bubble detector 70 after a lapse of a predetermined time (for
25 example, one minute) is equal to or greater than the threshold value after the first gentle washing sequence is performed, controller 57 may determine that bubbles between the electrodes are not present, that is, have disappeared.

Furthermore, back in the normal washing sequence (S103), if the resistance value detected by bubble detector 70 is still less than the threshold value, the water in water tub 33 may be drained by drain part 43.

In the first exemplary embodiment, the first gentle washing sequence
5 is performed in S110. In S110, the second gentle washing sequence, which is gentler than the first gentle washing sequence, may be entered. Here, the second gentle washing sequence is, for example, operating at a rotation speed of 30 r/min in a further gentler agitating time period in which rotary drum 31 is rotated for five seconds and suspended for ten seconds. Because the
10 agitation is even gentler in the second gentle washing sequence than in the first gentle washing sequence, foaming can be further suppressed. When the second gentle washing sequence is entered, the second predetermined time (S111) may be longer than the first predetermined time (S107) (for example, 20 minutes) in order to secure the cleaning performance. Further, the first
15 gentle washing sequence may be performed in S103, and the second gentle washing sequence may be performed in S110. Here, the second gentle washing sequence is also referred to as a third washing sequence.

Further, in the first exemplary embodiment, a determination value of the abnormal foaming determination (S105) in the normal washing sequence
20 (S103) and a determination value of the short circuit determination (S109) are both the same threshold value (for example, 500 k Ω), but is not limited thereto. The abnormal foaming determination value may be a first threshold value (for example, 500 k Ω) and the short circuit determination value may be a second threshold value (for example, 250 k Ω). The accuracy of the short circuit
25 determination can be improved by using a resistance value that is lower than a normal degree of decrease in the resistance value due to foaming of the detergent as a short circuit determination standard.

Further, in the first exemplary embodiment, water level h2 is the water level corresponding to the height position of the lower end of rotary drum 31, but is not limited to this. Water level h2 only has to be a water level lower than water level h1 such that the washing water including the detergent
5 component does not generate foaming by being agitated by the rotation of rotary drum 31.

Further, in the first exemplary embodiment, circulation pump 80 that communicates with drain path 42 is provided, and circulation path 81 that communicates with circulation pump 80 is communicated with circulation port
10 82 at a lower front part of water tub 33 to circulate the washing water during the laundry process as shown by arrow b. Although driving of circulation pump 80 has not been described in the first exemplary embodiment, the following may be adopted. During the normal washing sequence (S103), the rotation speed and operating rate of circulation pump 80 may be increased (for
15 example, 3,500 r/min, 30 seconds on and 30 seconds off), and during the short circuit determination (S109), the rotation speed and operating rate of circulation pump 80 may be reduced (for example, 2,500 r/min, 20 seconds on and 40 seconds off) or stopped to suppress foaming. This can suppress further promotion of abnormal foaming due to the drive of circulation pump 80.

20 Note that, since the above exemplary embodiments are for exemplifying the technique in the present disclosure, various changes, replacements, additions, omissions, and the like can be made within the scope of the claims or equivalents thereof.

The present disclosure is applicable to a washing machine that washes
25 clothes. Specifically, the present disclosure is applicable to a top-loading-type washing machine, a drum-type washing machine, a two-tub washing machine, and the like.

REFERENCE MARKS IN THE DRAWINGS

	31	rotary drum (inner tub)
	33	water tub (outer tub)
5	43	drain valve (drain part)
	44	water supply valve (water supply part)
	46	water level detector
	57	controller
	59	display
10	70	bubble detector
	70a	lower electrode (first electrode)
	70b	upper electrode (second electrode)

CLAIMS

1. A washing machine comprising:
 - a housing;
 - 5 an outer tub elastically supported inside or within the housing;
 - an inner tub provided in the outer tub and rotatably disposed;
 - a water supply part that supplies water into the outer tub,
 - a water level detector that detects a water level in the outer tub;
 - a drain part that drains water in the outer tub;
 - 10 a bubble detector including a pair of electrodes configured by a first electrode and a second electrode; and
 - a controller that controls a laundry operation including at least one of washing, rinsing, and spin-drying, wherein the controller determines that the pair of electrodes is short-circuited when a resistance between the pair of
 - 15 electrodes falls below a predetermined value before the water level reaches a predetermined water level.
2. The washing machine according to claim 1, wherein the predetermined water level corresponds to a height at which a lower end of the
- 20 inner tub is located.
3. The washing machine according to claim 1 or 2, wherein the first electrode is disposed at a position lower than the predetermined water level.
- 25 4. The washing machine according to any one of claims 1 to 3, wherein
 - the first electrode is provided at a downside of the outer tub, and

the second electrode is provided at an upside of the outer tub.

5. The washing machine according to any one of claims 1 to 3, further comprising:

5 a warm air blowing path that circulates warm air for drying laundry;
and

a warm air blowing port disposed at an upside of a rear surface of the outer tub and introducing the warm air into the outer tub,

wherein

10 the first electrode is provided at a downside of the outer tub, and

the second electrode is provided in a predetermined area from the warm air blowing port in the warm air blowing path.

6. The washing machine according to any one of claims 1 to 5,
15 wherein when the resistance between the pair of electrodes does not fall below the predetermined value until the water level in the outer tub reaches the predetermined water level, and when the resistance between the electrodes falls below the predetermined value after the water level in the outer tub reaches the predetermined water level, the controller performs the drain
20 operation by the drain part.

7. The washing machine according to any one of claims 1 to 6,
wherein

when the resistance between the pair of electrodes does not fall below
25 the predetermined value until the water level in the outer tub reaches the predetermined water level, the controller performs a first washing sequence,
and

when the controller determines that the pair of electrodes is short-circuited before the water level in the outer tub reaches the predetermined water level, the controller does not perform the drain operation by the drain part, and the controller performs a second washing sequence in which at least
5 one of a rotation speed and a rotation time of the inner tub is set smaller than in the first washing sequence.

8. The washing machine according to any one of claims 1 to 7, further comprising a display that notifies a state of the laundry operation, wherein
10 when the controller determines that the pair of electrodes is short-circuited, the controller issues an abnormality notification by the display after the washing operation ends.