

WASHING MACHINE

BACKGROUND

1. Technical Field

5 [0001] The present disclosure relates to a washing machine including a lock device for a door.

2. Description of the Related Art

[0002] There has been provided a conventional washing machine having a door via which
10 clothes are put in or taken out of the washing machine has been proposed, in which the operation of the washing machine is controlled in accordance with a locked state of the door of the washing machine. By controlling the operation of a motor in accordance with an open or closed state of the door and a locked state of the door, the washing machine can prevent a drum from rotating with the door open, and thus prevents a user from coming
15 into contact with a rotary body (for example, see Patent Literature 1).

Citation List

[0003] Patent Literature 1: Japanese Unexamined Patent Application Publication No.
2016-158733
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SUMMARY

[0004] However, the washing machine described in Patent Literature 1 has room for improvement in control in the event that a failure occurs in a lock detection circuit during operation.

25 [0005] For example, in a common operation, when a signal of the lock detection circuit disappears during operation, a control unit determines that a locked state of a door is released, and accordingly the control unit relocks the door. However, in this case, it is difficult to distinguish a state in which the locked state cannot be correctly detected due to a failure in the lock detection circuit and a state in which lock is actually released for some
30 reason, and thus, it is difficult to perform appropriate control.

[0006] The present disclosure provides a washing machine that exercises control so that the machine operates safely for users even when a failure occurs in a lock detection circuit and even when lock is actually released, whereby safety for users is secured.

[0007] The washing machine according to the present disclosure includes: a casing; a

water tub elastically supported inside the casing; a washing-and-spin-drying tub having a cylinder shape with a bottom and rotatably contained in the water tub; a motor configured to rotate the washing-and-spin-drying tub; a door configured to cover, in a freely openable and closable manner, a loading opening through which the laundry is put in the washing-and-spin-drying tub; a door lock device configured to lock the door; and a controller including a control unit configured to control the motor and the door lock device. The door lock device includes: a lever configured to lock the door; a lock detection switch configured to detect the locking of the door; and a solenoid configured to operate the lever with an electromagnetic force. The controller further includes: a solenoid drive circuit configured to drive the solenoid; and a lock detection circuit configured to detect locking of the door. The control unit repeats an operation for relocking the door lock device an even number of times, when the lock detection circuit detects that a locked state is released during operation.

[0008] Thus, there can be provided a washing machine that is capable of preventing the door from being mistakenly opened both when a failure occurs in the lock detection circuit and when lock is actually released, and thereby is more excellent in safety.

[0009] The washing machine provided according to the present disclosure is a safe washing machine being such that, even when an abnormality occurs in the lock detection circuit, the door is never opened during operation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. 1 is a cross-sectional view of a washing machine according to a first embodiment.

FIG. 2 is a control block diagram of the washing machine according to the first embodiment.

FIG. 3 is a block circuit diagram of an opening-and-closing detection circuit of the washing machine according to the first embodiment.

FIG. 4 is a block circuit diagram of a lock detection circuit of the washing machine according to the first embodiment.

FIG. 5 is a sequence diagram illustrating the opening and closing of a door of the washing machine according to the first embodiment.

FIG. 6 is a diagram illustrating a relationship between the lock detection circuit and a state of the door of the washing machine according to the first embodiment.

DETAILED DESCRIPTIONS

[0011] Hereinafter, an embodiment will be described with reference to the drawings.

Note that the present disclosure is not limited by this embodiment.

[0012] Directional terms, such as "upper", "lower", "left", or "right", used in the

5 following description are merely for making the description clearer, and therefore the principle of the washing machine is not limited by these terms.

[0013] (First Embodiment)

FIG. 1 is a cross-sectional view of a washing machine according to a first embodiment. FIG. 2 is a control block diagram of the washing machine according to the
10 first embodiment. FIG. 3 is a block circuit diagram of an opening-and-closing detection circuit of the washing machine according to the first embodiment. FIG. 4 is a block circuit diagram of a lock detection circuit of the washing machine according to the first embodiment.

[0014] In FIG. 1, washing machine 100 includes casing 110 and accommodation tub 200
15 configured to accommodate clothes inside casing 110. Accommodation tub 200 includes: washing-and-spin-drying tub 210 having approximately-cylindrically-shaped peripheral wall 211 surrounding rotation axis RX; and water tub 220 configured to rotatably accommodate washing-and-spin-drying tub 210.

[0015] Casing 110 includes: front wall 111 including loading opening 115 through which
20 clothes are put in accommodation tub 200; and rear wall 112 opposite front wall 111. Washing-and-spin-drying tub 210 and water tub 220 are opened toward front wall 111.

[0016] Washing machine 100 further includes door 120 attached to front wall 111. Door 120 swings between a closed position at which loading opening 115 formed in front wall 111 is closed and an open position at which loading opening 115 is open. A user swings
25 door 120 to the open position, and puts clothes in accommodation tub 200 through loading opening 115 in front wall 111, and subsequently, moves door 120 to the closed position and starts washing. Note that door 120 illustrated in FIG. 1 is at the closed position.

[0017] Washing-and-spin-drying tub 210 rotates about rotation axis RX extending between front wall 111 and rear wall 112. Clothes put in accommodation tub 200 are
30 moved inside washing-and-spin-drying tub 210 with the rotation of washing-and-spin-drying tub 210 to be subjected to various types of processing, such as washing, rinsing, and spin-drying.

[0018] Washing-and-spin-drying tub 210 has bottom wall 212 facing door 120 at the closed position. Water tub 220 includes: bottom section 221 surrounding bottom wall 212

and a part of peripheral wall 211 of washing-and-spin-drying tub 210; and front section 222 surrounding another part of peripheral wall 211 of washing-and-spin-drying tub 210 between bottom section 221 and door 120.

[0019] Accommodation tub 200 includes rotation shaft 230 attached to bottom wall 212 of washing-and-spin-drying tub 210. Rotation shaft 230 extends along rotation axis RX toward rear wall 112. Rotation shaft 230 penetrates bottom section 221 of water tub 220 and appears between water tub 220 and rear wall 112.

[0020] Washing machine 100 further includes: motor 231 installed in a lower part of water tub 220; pulley 232 attached to rotation shaft 230 exposed outside water tub 220; and belt 233 configured to transmit the power of motor 231 to pulley 232. When motor 231 is driven, the power of motor 231 is transmitted to belt 233, pulley 232, and rotation shaft 230. As a result, washing-and-spin-drying tub 210 rotates about rotation axis RX inside water tub 220.

[0021] Washing machine 100 further includes packing structure 130 disposed between front section 222 of water tub 220 and door 120. Door 120 swung to the closed position compresses packing structure 130. As a result, packing structure 130 forms a watertight sealing structure between door 120 and front section 222 of water tub 220.

[0022] Casing 110 includes: casing upper wall 113 approximately horizontally extending between front wall 111 and rear wall 112; and casing lower wall 114 opposite casing upper wall 113. Washing machine 100 further includes: water supply port 140 connected to a faucet (not illustrated); and distribution unit 141 configured to distribute water introduced through water supply port 140. Water supply port 140 appears in rear wall 112.

Distribution unit 141 is disposed between casing upper wall 113 and accommodation tub 200, and water supply valve 310 is used as a part of distribution unit 141.

[0023] Washing machine 100 further includes detergent accommodation unit (not illustrated) configured to accommodate a detergent. Distribution unit 141 includes a plurality of the water supply valves for selectively supplying water to accommodation tub 200 and the detergent accommodation unit. Note that, in FIG. 1, a water supply path to the detergent accommodation unit is not illustrated. For water supply to accommodation tub 200 and the detergent accommodation unit, known techniques used for washing machines are suitably applied.

[0024] Washing machine 100 further includes operation display 85. Operation display 85 is provided, for example in front wall 111. Operation display 85 includes: a power-on switch (not illustrated) including an automatic-return push switch; a power-off switch (not

illustrated) including an automatic-return push switch serving as a power-off instruction generator; input setting unit 83 (see FIG. 2) configured to select and set modes, such as an operation course, and various functions; and display 84 (see FIG. 2) configured to display details of the setting and the likes.

5 [0025] Washing machine 100 further includes controller 80 having control unit 87 built-in. Controller 80 is provided, for example, under casing upper wall 113.

[0026] Washing machine 100 includes door lock device 121 disposed in the vicinity of door 120 and configured to lock door 120 at the closed position. Door lock device 121 locks/unlocks door 120, based on an operation signal from controller 80.

10 [0027] In a recess formed in the bottom of water tub 220, heater 56 including, for example, a sheath heater for heating washing water is horizontally provided. In the vicinity of heater 56, temperature detector 63 such as a thermistor for detecting water temperature is provided.

[0028] In a lower part of accommodation tub 200, drain pump 74 configured to drain
15 washing water contained in accommodation tub 200 to the outside of the washing machine is provided. Circulation pump 75 circulates water contained in accommodation tub 200, as necessary, to prevent a detergent from early dissolving in water or going too far to one side and to enhance functions for washing and rinsing.

[0029] In FIG. 2, control unit 87 includes a microcomputer and the like, and is configured
20 to input the output of water level detector 90 for detecting a water level in water tub 220 and the output of temperature detector 63, and, based on settings inputted by a user in input setting unit 83 of operation display 85, display the settings on display 84.

[0030] Control unit 87 controls the operation of, for example, heater 56 for heating water contained in water tub 220, water supply valve 310 for supplying water contained in water
25 tub 220, drain pump 74 for draining water contained in water tub 220, and circulating pump 75 for circulating water contained in water tub 220, via load driving unit 86 configured with a bidirectional thyristor, a relay, and the like. Furthermore, control unit 87 controls the operation of motor 231 by using motor drive circuit 251, and controls operations, that is, washing, rinsing, and spin-drying. Operation display 85 includes: input
30 setting unit 83 configured to transmit and receive a signal to and from control unit 87; and display 84.

[0031] Power supply circuit 47 is a direct-current power source obtained from commercial power supply 88, for example, by switching and is configured to supply electrical energy to control unit 87 and various loads. Electric power supplied from

commercial power supply 88 to power supply circuit 47 is converted into a direct-current voltage by using rectification circuit 252 including a diode bridge provided at a front stage and a smoothing capacitor.

[0032] Door lock device 121 (see FIG. 1) includes: lever 122 configured to lock door 120 in a closed state; lock detection switch 253 configured to be opened and closed in conjunction with the locking of door 120; solenoid 254 configured to operate lever 122 with an electromagnetic force; and opening-and-closing detection switch 258 arranged in series with solenoid 254 and configured to be opened and closed in conjunction with the opening-and-closing operation of door 120 to casing 110.

[0033] One end of solenoid 254 is connected to commercial power supply 88, meanwhile another end of solenoid 254 is connected to solenoid drive circuit 256 (for example, including an AC electronic switch such as TRIAC) configured to drive solenoid 254 in accordance with an operation command from control unit 87. Opening-and-closing detection circuit 257 of door 120 is connected in parallel with solenoid drive circuit 256, and is configured to detect the open or closed state of opening-and-closing detection switch 258 and transmits the opening-and-closing state of door 120 to control unit 87.

[0034] One end of lock detection switch 253 is connected to commercial power supply 88, meanwhile another end of lock detection switch 253 is connected to lock detection circuit 255 configured to detect the open or closed state of lock detection switch 253 and transmit the lock state of door 120 to control unit 87.

[0035] Specifically, the circuit configuration of opening-and-closing detection circuit 257 of door 120 includes resistances R101, R102, R103, and R104, diode D101, phototransistor coupler PC101, and transistor Q101, as illustrated in FIG. 3. When door 120 is closed, opening-and-closing detection switch 258 is closed, and accordingly, a pulse signal in accordance with commercial power supply 88 is transmitted to control unit 87.

[0036] As illustrated in FIG. 4, specifically, the circuit configuration of lock detection circuit 255 includes resistances R1, R2, R3, and R4, diode D1, phototransistor coupler PC1, and transistor Q1, and is configured to transmit a pulse signal in accordance with commercial power supply 88 to control unit 87.

[0037] Hereinafter, operations and actions of the washing machine configured as described above will be described.

[0038] FIG. 5 is a sequence diagram illustrating the opening and closing of the door of the washing machine according to the first embodiment. FIG. 6 is a diagram illustrating a relationship between the lock detection circuit and a state of the door of the washing

machine according to the first embodiment.

[0039] An operation under a state (for example, an initial standby state) will be described in which, as illustrated in FIG. 5, first, the washing machine is energized with commercial power supply 88 and door 120 is closed, meanwhile door 120 is not locked by door lock device 121.

[0040] In this state, lock detection switch 253 (see FIG. 2) is open and a voltage of commercial power supply 88 is not applied to lock detection circuit 255, so that lock detection circuit 255 does not operate, and accordingly, a fixed signal "L" is inputted to control unit 87. In contrast, since door 120 is closed, opening-and-closing detection switch 258 (see FIG. 2) is closed, and accordingly, commercial power supply 88 is supplied to opening-and-closing detection circuit 257 (Section (a) in FIG. 5).

[0041] Since commercial power supply 88 is an alternating-current voltage, electric current flows into an LED of phototransistor coupler PC101 in opening-and-closing detection circuit 257 via resistance R101 in a period of a positive bias direction to the LED.

During this period, a phototransistor of phototransistor coupler PC101 operates, and base current flows via resistance R102 into transistor Q101 connected to the phototransistor, so that transistor Q101 operates and a signal "H" is inputted to control unit 87.

[0042] In a reverse period, electric current flows into diode D101, and accordingly, the electric current does not flow into the LED of phototransistor coupler PC101 and transistor Q101 does not operate, so that the signal "L" is inputted to control unit 87.

[0043] Thus, as long as door 120 is closed, a square wave in synchronization with an alternating-current voltage is inputted to control unit 87.

[0044] Next, when a user opens door 120 in order to put clothes for washing in washing-and-spin-drying tub 210, opening-and-closing detection switch 258 is opened, so that commercial power supply 88 is not supplied to opening-and-closing detection circuit 257 and opening-and-closing detection circuit 257 does not operate, and as a result, the fixed signal "L" is inputted to control unit 87 (Section (b) in FIG. 5). When door 120 is closed after the clothes are put in, the same state as in Section (a) in FIG. 5 is brought about.

[0045] Next, when the user operates input setting unit 83 in order to start operating the washing machine, control unit 87 transmits an operation signal to solenoid drive circuit 256 to operate solenoid 254. This operation of solenoid 254 causes door 120 to be locked, whereby a non-safe state in which the user would accidentally open the door 120 during operation can be prevented.

[0046] In conjunction with locking of door 120, lock detection switch 253 is closed, so

that commercial power supply 88 is supplied to lock detection circuit 255.

[0047] Furthermore, as in the case where commercial power supply 88 is connected to opening-and-closing detection circuit 257, a square wave in synchronization with an alternating-current voltage is inputted to control unit 87 (Section (c) in FIG. 5). During this section, solenoid drive circuit 256 is kept operated (short-circuited state), and accordingly no voltage is supplied to opening-and-closing detection circuit 257 connected in parallel to solenoid drive circuit 256, and opening-and-closing detection circuit 257 does not operate. Therefore, regardless of the state of door 120, the fixed signal "L" is inputted to control unit 87, but, after the completion of operation of solenoid drive circuit 256, a square wave in synchronization with an alternating current voltage is inputted to control unit 87.

[0048] Next, an operation at the time of the occurrence of an abnormality will be described using FIG. 6.

[0049] As illustrated in FIG. 6, door 120 is kept locked during the operation of the washing machine, and a square wave is inputted to control unit 87 from lock detection circuit 255. Here, assuming that locking of door 120 is released due to some accidental factors such as a disturbance noise, then, the output of lock detection circuit 255 is fixed with "L" ("A" in FIG. 6).

[0050] At this time, in order to prevent a hazardous condition in which door 120 is opened during the rotation of a rotary body, control unit 87 transmits an operation signal again to solenoid drive circuit 256 to operate solenoid 254, whereby door 120 is locked. In this case, a square wave in synchronization with an alternating current period is outputted from lock detection circuit 255, and accordingly, control unit 87 determines that the state is normal, and a continues normal washing operation ("B" in FIG. 6).

[0051] Next, a case in which lock detection circuit 255 breaks down will be discussed. For example, when resistance R3 in FIG. 4 is damaged by short circuit or both ends of resistance R3 are short-circuited due to the adherence of foreign matter, control unit 87 receives the fixed signal "L" ("C" in FIG. 6). In terms of an output signal of lock detection circuit 255, the same state as in the above-described case where lock is released by the accidental factor is brought about. Therefore, control unit 87 transmits an operation signal again to solenoid drive circuit 256 so as to operate solenoid 254 and thereby lock door 120. However, in this case, lock detection circuit 255 itself is out of order, and accordingly, even when the solenoid is operated, an output signal of lock detection circuit 255 does not change. In this case, it is assumed that lock is not correctly applied due to a structurally

stuck state, and therefore, control unit 87 commonly retries operation two or more times for solenoid drive circuit 256.

[0052] At this time, the locked state of door 120 is actually such that "lock" operation and "unlock" operation are repeated every time solenoid 254 is operated. In this case, when the lock operation is retried an odd number of times (once, 3 times, 5 times ...), the operation is stopped in a lock-released state, whereby a non-safety state is possibly caused ("D" in FIG. 6).

[0053] In contrast, when the lock operation is retried an even number of times (twice, 4 times, 6 times ...), the operation can be finally stopped in a locked state as illustrated in "E" in FIG. 6, whereby a non-safety state in which door 120 is opened during operation can be prevented.

[0054] (Actions)

As described above, the washing machine according to the present embodiment includes: casing 110; water tub 220 elastically supported inside casing 110; washing-and-spin-drying tub 210 having a cylinder shape with a bottom and rotatably contained in water tub 220; motor 231 configured to rotate washing-and-spin-drying tub 210; door 120 configured to cover, in a freely openable and closable manner, loading opening 115 through which the laundry is put in washing-and-spin-drying tub 210; door lock device 121 configured to lock door 120; and controller 80 including control unit 87 configured to control motor 231 and door lock device 121. Door lock device 121 includes: lever 122 configured to lock door 120; lock detection switch 253 configured to detect locking of door 120; and solenoid 254 configured to operate lever 122 with an electromagnetic force. Controller 80 further includes: solenoid drive circuit 256 configured to drive solenoid 254; and lock detection circuit 255 configured to detect the locking of door 120. Control unit 87 repeats an operation for relocking door lock device 121 an even number of times, when lock detection circuit 255 detects that a locked state is released during operation.

[0055] With this configuration, there can be realized a washing machine that is designed to retry the relock operation for the door an even number of times and is thereby capable of safely stopping without accidentally releasing locking of door 120 even when lock detection circuit 255 breaks down.

INDUSTRIAL APPLICABILITY

[0056] As described above, the present disclosure is applied suitably for a device that operates with a door locked.

REFERENCE MARKS IN THE DRAWINGS

5	[0057] 80...controller
	87...control unit
	110...casing
	115...loading opening
	120...door
10	121...door lock device
	122...lever
	210...washing-and-spin-drying tub
	220...water tub
	231...motor
15	253...lock detection switch
	254...solenoid
	255...lock detection circuit
	256...solenoid drive circuit
	257...opening-and-closing detection circuit
	258...opening-and-closing detection switch

WHAT IS CLAIMED IS:

1. A washing machine, comprising:
 - a casing;
 - 5 a water tub elastically supported inside the casing;
 - a washing-and-spin-drying tub having a cylinder shape with a bottom and rotatably contained in the water tub;
 - a motor configured to rotate the washing-and-spin-drying tub;
 - a door configured to cover, in a freely openable and closable manner, a loading
 - 10 opening through which laundry is put in the washing-and-spin-drying tub;
 - a door lock device configured to lock the door; and
 - a controller including a control unit, the control unit being configured to control the motor and the door lock device,
 - wherein the door lock device includes:
 - 15 a lever configured to lock the door;
 - a lock detection switch configured to detect locking of the door; and
 - a solenoid configured to operate the lever with an electromagnetic force,
 - wherein the controller further includes:
 - a solenoid drive circuit configured to drive the solenoid; and
 - 20 a lock detection circuit configured to detect the locking of the door, and
 - wherein, when the lock detection circuit detects that a locked state is released during operation, the control unit repeats an operation for relocking the door lock device an even number of times.