

WASHING MACHINE



150150



G00002

Field of the Invention

5 The present invention relates to a washing machine provided with a door locking device for selectively locking a door which is for opening and closing the opening of a rotary drum.

10 Background of the Invention

 With regard to a conventional washing machine, for example, when a child presses an operation switch while it is running, the washing machine can stop or malfunction; a
15 safety issue still remained to be solved since the child can enter the stopped washing machine by opening its door.

 To solve the problems, the door through which laundry articles is loaded and unloaded has been disposed at the front center of a washing machine's main body while
20 selectively preventing opening of the door in accordance with user's need by means of a door locking device(see, for example, Japanese Patent Laid-Open Application No. 1993-161779). Specifically, during normal operation, if a desired operation course is selected by using operation
25 course switches prior to the start of operation and the start switch is pressed thereafter, the washing machine is

operated in accordance with the selected operation course. However, as necessary, if two operation switches, for example, the standard course switch and the start switch, are pressed simultaneously, it does not gets recognized as
5 an ordinary switch input so that the door locking device is activated to lock the door, and the operation of the washing machine is started. Once the operation is completed, the locking of the door is automatically released. Further, when the washing machine is stopped after the completion of
10 a series of operations, the door is locked by pressing, for example, two course switches simultaneously. In such a locked state, a switch input does not get registered if only one switch is pressed, while the door of the washing machine still remains locked. Further, a means to be released from
15 this condition can be accomplished by simultaneously pressing two or more of the course switches that are used to lock the door or repeatedly pressing the start switch several times.

As a result of such configuration, the washing machine
20 could be prevented from being improperly operated by a child's control, and children could not enter the washing machine when it is stopped.

However, in accordance with the conventional configuration, since the function of a subsequent operation
25 switch does not register when the door locking device is activated to lock the door by way of pressing the two

operation switches simultaneously, it had the issue of user inconvenience given that the washing machine could once again be operated only after releasing the locking of the door by pressing again two or more operation switches.

5

Summary of the Invention

It is, therefore, an object of the present invention to provide a washing machine provided with a door locking
10 device for selectively locking a door of the washing machine in a closed state by setting an input setting unit while making it possible to operate the washing machine with the door locked, thereby improving both safety and usability.

In accordance with a preferred embodiment of the
15 present invention, there is provided a washing machine including: a rotary drum having an approximately horizontal or a slanted rotational axis; a door for opening and closing an opening of the rotary drum; a door locking device for selectively locking the door closed; an input setting unit
20 for inputting an operation course; and a controller for controlling a series of operations while concurrently controlling the door locking device, wherein the controller allows the door locking device to lock the door closed depending on a set state of the input setting unit and
25 allows initiating an operation of the washing machine by setting the input setting unit while the door is locked

closed.

Brief Description of the Drawings

5 The above and other objects and features of the present invention will become apparent from the following description of preferred embodiments given in conjunction with the accompanying drawings, in which:

10 Fig. 1 is a circuit diagram of a washing machine in accordance with a first preferred embodiment of the present invention, wherein some parts thereof are represented by blocks;

15 Fig. 2 sets forth a cross sectional view of the washing machine in accordance with the first preferred embodiment of the present invention;

 Fig. 3 shows an enlarged front view of an input setting unit and a display unit of the washing machine in accordance with the first preferred embodiment of the present invention;

20 Fig. 4 provides a flowchart describing an operation of the washing machine in accordance with the first preferred embodiment of the present invention;

25 Fig. 5 depicts a time chart of a dewatering operation of a washing machine in accordance with a second preferred embodiment of the present invention;

 Fig. 6 presents a flowchart describing an operation of

the washing machine in accordance with the second preferred embodiment of the present invention; and

Fig. 7 offers a flowchart describing an operation of a washing machine in accordance with a third preferred embodiment of the present invention.

Detailed Description of the Preferred Embodiments

Hereinafter, preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings.

First Preferred Embodiment

Referring to Fig. 2, cylindrical rotary drum 1 having a bottom surface is rotatably mounted in water tub 3. Rotary drum 1 is provided with a plurality of water passing holes 2 on a peripheral surface thereof and with rotating shaft (central axis of rotation) 4 at a center of rotation thereof. Rotary drum 1 is placed in washing machine main body 7 such that the central axis of rotation thereof is declined toward a rear portion of the washing machine. Motor 5 connected to rotating shaft 4 allows rotary drum 1 to execute forward and reverse rotations. Further, a number of prominences are provided on an inner wall of rotary drum 1.

Water tub 3 is suspended in washing machine main body 7 via springs 8, and door 9 is installed to open and close an opening of rotary drum 1. Door locking device 10 serves to lock door 9 closed. Connected to a lower portion of water tub 3 is one end of water drain hose 11, and the other end of water drain hose 11 is coupled to water drain pump 12 to drain washing water from water tub 3. Water supply valve 13 is used to feed water into water tub 3. Water level detector 14 detects a water level in water tub 3, and door opening/closing detector 15 (see Fig. 1) detects an opened and closed state of door 9.

Further, though rotary drum 1 having rotating shaft 4 at the center of rotation thereof is installed such that the central axis of rotation thereof is declined toward the rear portion of the washing machine, rotary drum 1 with rotating shaft 4 may be placed such that the central axis of rotation thereof is approximately horizontal to the washing machine.

Control unit 16 may be formed of controller 17, e.g., implemented by a microcomputer for controlling a series of operations including, e.g., washing, rinsing, and dewatering processes in sequence by way of controlling the operation of motor 5, water drain pump 12, water supply valve 13, and so forth as shown in Fig. 1. Responsive to information from input setting unit 18 for setting an operation course, controller 17 informs a user of input information through display unit 19. Concurrently, if an operation is set to be

started by input setting unit 18, controller 17 controls the operation of door locking device 10, water drain pump 12 and water supply valve 13 via switching driving circuit 20 and switch unit 21 based on data inputted from water level
5 detector 14, door opening/closing detector 15, and so forth, thereby performing a washing operation. Notification unit 25, e.g., an alarm, executes a notification function, e.g., to notify the user of a malfunctioning state of the washing machine or the termination of an operation.

10 Controller unit 17 controls rotation of motor 5 by way of controlling inverter 24 via inverter driving circuit 23 based on information from position detector 22 detecting a position of a rotor of motor 5. Though not shown, motor 5 is a brushless DC motor including a stator with three-phase
15 windings; and a rotor with a bipolar permanent magnet disposed on a ring. The stator is made up of the three-phase windings including first winding 5a, second winding 5b and third winding 5c wound around an iron core provided with slots.

20 Inverter 24 includes switching devices each being made up of a parallel circuit of a power transistor (e.g., insulated gate bipolar transistor("IGBT")) and a reverse conducting diode. Specifically, inverter 24 includes a serial circuit of first and second switching devices 24a and
25 24b; a serial circuit of third and fourth switching devices 24c and 24d; and a serial circuit of fifth and sixth

switching devices 24e and 24f, wherein the serial circuits are connected to each other in parallel.

Herein, both ends of each of the serial circuits serve as input terminals and are coupled to a DC power supply. Further, respectively coupled to a junction of the two switching devices in each serial circuit are output terminals, which are in turn connected to a U terminal, a V terminal and a W terminal of the three-phase winding, respectively. The U, V and W terminals are controlled as a positive voltage, a zero voltage and floating state, respectively, by a combination of on-off operations of the two switching devices in each serial circuit.

The on-off operations of the switching devices are controlled by controller 17 based on data from three position detectors 22a to 22c, which are made up of hall IC's for example. Position detectors 22a to 22c are disposed at a stator by an interval of an electrical angle of 120 degrees to face the permanent magnet provided in the rotor.

While the rotor makes one revolution, each of three position detectors 22a to 22c outputs a pulse by the interval of the electrical angle of 120 degrees. Controller 17 monitors a change in a state of a signal from at least one of three position detectors 22a to 22c. When a change is detected, controller 17 changes the on-off states of the switching devices 24a to 24f based on the signals from

position detectors 22a to 22c, thereby setting the U, V and W terminals as the positive voltage, the zero voltage and the floating state, respectively. A magnetic field is formed by supplying thus controlled electricity to first, second and third windings 5a to 5c, thereby rotating the rotor.

Furthermore, switching devices 24a, 24c and 24e are subjected to pulse width modification (PWM), and the number of revolutions of the rotor is controlled by way of, for example, repeatedly controlling a duty ratio at a frequency of 10 kHz. Every time the state of the signal from at least one of three position detectors 22a to 22c is changed, controller 17 detects the period thereof, calculates the number of revolutions (rotational speed) of the rotor; and then performs the PWM control of switching devices 24a, 24c and 24e such that the rotor makes as many revolutions as set. At this time, switching devices 23b, 23d and 23f are not subjected to the PWM control.

Commercial power source 26 is coupled to inverter 24 via DC power converter 27 including diode bridge 27a and smoothing capacitors 27b, 27c for example. It is, however, to be appreciated that the configuration described above with respect to Fig. 1 is only an example. For instance, the configurations of brushless DC motor 5 and inverter 24 are not limited thereto. Moreover, though not shown in Figs. 1 and 2, incorporated in rotary drum 1 are a heater for

heating the air and a fan for blowing the warm air into rotary drum 1 to carry out a laundry drying function for drying laundry articles loaded in rotary drum 1.

As shown in Fig. 3, input setting unit 18 includes
5 washing time setting switch 18a for setting a washing time period, rinsing number setting switch 18b for setting a number of rinsing operation, dewatering time setting switch 18c for setting the dewatering time period, drying time setting switch 18d for setting the drying time period, a
10 course setting switch 18e, a start/pause switch 18f, power-on switch 18g, power-off switch 18h, and so forth. Display unit 19 includes washing time display unit 19a, rinsing number display unit 19b, dewatering time display unit 19c, drying time display unit 19d, course set display unit 19e,
15 and so forth.

Herein, controller 17 allows door locking device 10 to operate to thereby lock door 9 closed or to release or unlock the door locking in the closed state depending on setting of input setting unit 18 (e.g., when power-on switch
20 18g is turned on while washing time setting switch 18a is on). Moreover, even with door 9 locked, the operation of the washing machine can be initiated by pressing only the start switch.

In addition, when the operation of the washing machine
25 is temporarily stopped by setting the input setting unit, e.g., by pressing start/pause switch 18f, controller 17

allows door locking device 10 to keep locking door 9 closed. Further, even after the completion of the operation, door locking device 10 is still in operation thereby making door 9 remain locked.

5 Under such configuration, the washing machine is operated as shown in Fig. 4. First, a process is initiated (step 30), and power-on switch 18g is turned on (step 31). At this time, it is determined whether at least one of setting switches 18a to 18e, e.g., washing time setting
10 switch 18a is on (step 32) and if so, the process proceeds to step 33 in which a door lock setting is converted. That is, if door 9 is not locked when the process is initiated, it is set to be converted into a locking state, whereas if door 9 is locked at the initiation stage of the process, the
15 locking state is set to be released. If washing time setting switch 18a is not on in the step 32, however, the process proceeds to step 34.

 In the step 34, it is determined whether the current setting requires a door locking. If so, a door locking
20 (child locking) is set (step 35), and door 9 is locked closed by door locking device 10 (step 36). Then, if start/pause switch 18f is pushed (step 37), a washing/drying operation is started (step 38).

 It is determined whether start/pause switch 18f is
25 pressed or not (step 39) and if so, the operation of the washing machine is stopped (step 40) while door 9 is locked

closed. When the power is on, the washing machine is initially in a pause mode and then by pushing down the start/pause switch 18f, the washing machine switches between the start mode and the pause mode. It is determined whether
5 start/pause switch 18f is pressed again or not (step 41) and if so, the operation is resumed (step 42). Then, it is determined in step 43 whether the washing/drying operation is completed. If the washing/drying operation is not finished, the steps from 39 to 43 are repeated. If the
10 washing/drying operation is found to be ended in the step 43, however, door locking device 10 keeps locking door 9 closed (step 44), and the process is terminated (step 45).

Referring back to the step 34, if the current setting does not require a door locking, a door locking release is
15 set (step 46), and a door locking is released in order to allow door locking device 10 to release (step 47). Then, a normal washing operation is conducted (step 48), and when the normal washing operation is completed, the whole process is finished (step 45).

20 As described above, since controller 17 can lock door 9 by using door locking device 10 depending on the setting of input setting unit 18, i.e., when power-on switch 18g is turned on while washing time setting switch 18a is on and can perform the operation of the washing machine in a state
25 where door 9 is locked, a problem that infants enter rotary drum 1 can be prevented, resulting in improvement of safety.

Besides, since the operation of the washing machine can be started by using only the start switch even while door 9 is locked, it becomes possible to immediately operate the washing machine without having to release the door locking
5 by door locking device 10, thereby enhancing usability.

Furthermore, since controller 17 renders door locking device 10 to keep locking door 9 closed when the operation of the washing machine is temporarily stopped by setting the input setting unit, e.g., by pressing start/pause switch 18f,
10 door 9 cannot be opened until the door locking is released when the operation of the washing machine is temporarily stopped. Thus, even in case the period of stopping the washing machine is long, the infants can be protected from entering rotary drum 1, so that the safety can be further
15 improved.

Moreover, since door locking device 10 is still in operation even after the completion of the operation of the washing machine, an opening of door 9 needs to be preceded by a release of the door locking by door locking device 10.
20 Therefore, even though the washing machine is left temporarily stopped for a long period of time, the infants can be prevented from entering rotary drum 1, thereby further enhancing the safety.

Second Preferred Embodiment

Position detector 22 shown in Fig. 1 detects the position of the rotor of motor 5 and, at the same time, outputs three pulses during a time period when rotary drum 1 is driven to make one revolution by a rotation of the rotor (since rotary drum 1 and motor 5 rotate by one-to-one correspondence, position detector 22 also outputs the three pulses while motor 5 makes one revolution). Further, since position detector 22 can detect the rotation of motor 5 based on the output pulses, it can function as a rotation monitoring means for monitoring the rotational state of rotary drum 1 or motor 5.

As shown in Fig. 5, when rotating rotary drum 1 such that the number of rotation thereof becomes about 1000 r/min during a dewatering action during a rinsing operation or a dewatering operation, controller 17 controls control amounts of switching devices in inverter 24 such that the rotation number of rotary drum 1 becomes about 100 r/min during the time period of t_1 to t_2 . Then, controller 17 monitors a change in the rotation number of rotary drum 1 in order to detect an unbalanced distribution of the laundry articles in rotary drum 1. For example, if the change in the rotation number of rotary drum 1 is not greater than about 10 r/min, it is regarded that the laundry articles in rotary drum 1 is not distributed in an unbalanced manner, whereas if the

change in the rotation number of rotary drum 1 is more than about 10 r/min, it is determined that the laundries are densely gathered in one side of rotary drum 1. When the unbalanced distribution of the laundry articles is detected, controller 17 stops the dewatering action or the dewatering operation and, concurrently, renders door locking device 10 to release the door locking in the closed state. Likewise, controller 17 detects the unbalanced distribution of the laundry articles within rotary drum 1 while revolving rotary drum 1 with a rotation number of 200 r/min during the time period of t3 to t4. The other configurations of the washing machine in accordance with the second preferred embodiment are identical to those described in the first preferred embodiment.

Referring to Fig. 6, there is provided a flowchart describing an operation of the washing machine configured as described. Since steps 30 to 38 and 45 to 48 are identical with those described in the first preferred embodiment, explanation thereof will be omitted.

It is determined whether a dewatering operation is initiated or not (step 49) and if so, rotary drum 1 is revolved by controlling control amounts of switching devices made up of inverter 24 such that the number of revolutions of rotary drum 1 becomes about 100 r/min (step 50). At this time, an unbalanced distribution of laundry articles within rotary drum 1 is detected based on a change in the number of

revolutions of rotary drum 1. If the change in the number of revolutions of rotary drum 1 is found to be greater than about 10 r/min (step 51), it is determined there exists an imbalance of the laundry articles within rotary drum 1, so
5 that the process proceeds to step 52 in which the dewatering action is stopped and, at the same time, the door locking in the closed state is released or unlocked by door locking device 10. Then, door 9 is opened to allow correcting the imbalance of the laundry articles within rotary drum (step
10 53).

In addition, though not shown in Fig. 6, the same operation as described above is performed when an operation of the washing machine is conducted by controlling the switching devices of inverter 24 such that the number of
15 revolutions of rotary drum 1 becomes about 200 r/min.

When door 9 is closed after correcting the unbalanced distribution of the laundry articles, the closing of door 9 is detected by door opening/closing detector 15, and the process proceeds to step 54 in which the previous operation
20 is resumed and door 9 is locked closed. Then, the dewatering operation is continued (step 55) and, if the dewatering operation is completed, the whole process is terminated (step 45).

Referring back to the step 51, if the change in the
25 number of revolutions of rotary drum 1 is not greater than about 10 r/min and the laundry articles within rotary drum 1

is not unbalanced, the process directly proceeds to the step
55 to continue the dewatering operation. When the
dewatering is completed, the whole process is terminated in
the step 45. Further, if the normal washing operation is
5 finished (step 48), the process is ended (step 56).

In the second preferred embodiment described above,
controller 17 stops the dewatering action and permits door
locking device 10 to release the door locking in the closed
state when the unbalanced distribution of the laundry
10 articles within rotary drum 1 is detected based on the
change in the number of revolutions of rotary drum 1 which
is obtained from output pulses of position detector 22
during the dewatering action. Therefore, when the
dewatering is stopped due to the unbalanced distribution of
15 the laundry articles within rotary drum 1, door 9 can be
opened immediately, which makes it possible to correct the
imbalance of the laundry articles promptly, shortening the
interruption period of the dewatering action while improving
the usability.

20

Third Preferred Embodiment

Controller 17 shown in Fig. 1 stops the current
operation of the washing machine when a problem in, e.g.,
25 water level detector 14 is found and, then, notifies the
problem by using notification unit 25 while concurrently

allowing door locking device 10 to release the door locking in the closed state. The other configurations are identical to those described in the first preferred embodiment.

Hereinafter, an operation of a washing machine
5 configured as described above will be described with reference to Fig. 7. Since the steps 30 to 38 and 45 to 48 are identical with those described in the first preferred embodiment, explanation thereof will be omitted.

A washing/drying action starts (step 38), and it is
10 determined whether water level detector 14 is out of order (step 57). Then, presence of other trouble or malfunctioning is checked (step 58) and, if there is found no trouble in the steps 57 and 58, the process proceeds to step 43. In the step 43, it is determined whether the
15 washing/drying action is completed. If the washing/drying action is not finished, the process returns the step 57 and the steps 57, 58 and 43 are repeated until the washing/drying cycle is completed.

If a trouble in water level detector 24 is founded in
20 the step 57 or if other malfunction state is detected in the step 58, step 59 is conducted so that the current operation is immediately stopped and the door locking in the closed state is released by door locking device 10. Then, notification unit 25 reports the trouble and/or other
25 malfunction state (step 60), and the operation of the washing machine is stopped (step 61).

In accordance with the third preferred embodiment of the present invention described above, controller 17 stops the operation of the washing machine when there is found some trouble in, e.g., water level detector 14, and then
5 reports the trouble by using notification unit 25 while concurrently allowing door locking device 10 to release the door locking in the closed state. Therefore, since the washing machine is automatically stopped when there is found some trouble in water level detector 14 and the like, a
10 problem that might be caused by the trouble in water level detector 14 and the like can be prevented. Further, since the presence of the trouble can be reported to the user via notification unit 25 and the door locking in the closed state is automatically released by door locking device 10, a
15 repair work can be conducted immediately without having to perform an additional control to release the door locking.

As described, since the washing machine in accordance with the present invention is configured to lock its door closed depending on the setting of the input setting unit,
20 safety can be enhanced. Moreover, since the washing machine can be operated with the door in the closed state locked by the door locking device, usability can also be improved. Thus, the present invention is advantageous in case it is applied to a washing machine using a door locking device for
25 locking a door for opening and closing an opening of a rotary drum.

While the invention has been shown and described with respect to the preferred embodiments, it will be understood by those skilled in the art that various changes and modifications may be made without departing from the spirit and scope of the invention as defined in the following claims.

What is claimed is:

1. A washing machine comprising:
 - a rotary drum having an approximately horizontal or a
5 slanted rotational axis;
 - a door for opening and closing an opening of the
rotary drum;
 - a door locking device for selectively locking the door
closed;
 - 10 an input setting unit for inputting an operation
course; and
 - a controller for controlling a series of operations
while concurrently controlling the door locking device,
wherein the controller allows the door locking device
15 to lock the door closed depending on a set state of the
input setting unit and allows initiating an operation of the
washing machine by setting the input setting unit while the
door is locked closed.
- 20 2. The washing machine of claim 1, wherein the controller
renders the door locking device to keep locking the door
closed even when the operation of the washing machine is
stopped by setting the input setting unit during the
operation.
- 25 3. The washing machine of claim 1, wherein the controller

renders the door locking device to keep locking the door closed even after the completion of the operation.

4. The washing machine of claim 1, further comprising;

5 a motor for driving the rotary drum; and

a rotation detector for detecting a rotational state of the rotary drum or the motor,

wherein, when an unbalanced distribution of laundry articles within rotary drum is detected by the rotation detector during a dewatering operation, the controller stops the dewatering operation and renders the door locking device to unlock a door closed state.

5. The washing machine of claim 1, further comprising:

15 a water level detector for detecting a water level within the rotary drum; and

a notification unit for executing a notification operation,

wherein when malfunctioning of the water level detector is detected, the controller stops the operation of the washing machine, and reports the malfunctioning by using the notification unit, and concurrently renders the door locking device to unlock a door closed state.

25 6. The washing machine of claim 1, wherein when malfunctioning in the washing machine is detected, the

controller renders a notification unit to report the malfunctioning to a user and controls the door locking device to unlock a door closed state to enable the use to open the door.

5