

DESCRIPTION

WASHING MACHINE

5 TECHNICAL FIELD

[0001]

The present disclosure relates to a washing machine.

BACKGROUND ART

10 [0002]

Conventionally, a washing machine that detects the temperature of the winding of the stator with a thermistor has been proposed.

[0003]

This washing machine includes a water tub, a rotary tub rotatably
15 arranged inside the water tub, a motor that rotationally drives the rotary tub,
and a control circuit that controls the motor and the like. The motor includes a
rotor having a ring-shaped permanent magnet and a stator having a
three-phase winding. A thermistor that serves as a temperature detection
means is arranged in proximity to the winding of the stator. The control
20 circuit detects the temperature of the winding of the stator with the voltage of
the thermistor (see, for example, Patent Literature (PTL) 1).

Citation List

Patent Literature

[0004]

25 [PTL 1] Japanese Unexamined Patent Application Publication No. H11-239688

SUMMARY (SUMMARY OF THE INVENTION)

[0005]

However, components such as thermistors are expensive, leading to a high manufacturing cost.

[0006]

5 The present disclosure provides a washing machine that improves the safety of the motor with an inexpensive configuration.

[0007]

10 A washing machine according to the present disclosure includes a rotary tub, a motor configured to drive the rotary tub to rotate, an inverter circuit configured to convert direct current to alternating current to drive the motor, and a current detector configured to detect current flowing through the motor. The washing machine further includes: a low-pass filter unit configured to perform low-pass filtering on the current detected by the current detector, and output the low-pass filtered value as a processed current value; an
15 overload detector configured to detect an overload state of the motor; and a controller configured to transmit a motor drive command to the inverter circuit to control the motor through the inverter circuit. The overload detector determines an overload state of the motor based on the processed current value output from the low-pass filter unit, and the controller controls rotational drive
20 of the motor based on a determination result of the overload detector.

[0008]

The washing machine according to the present disclosure improves the safety of the motor with an inexpensive configuration.

25 **BRIEF DESCRIPTION OF THE DRAWINGS**

[0009]

[FIG. 1]

FIG. 1 is a vertical cross-sectional view illustrating a schematic configuration of a washing machine according to a first embodiment.

[FIG. 2]

FIG. 2 is a block diagram illustrating a circuit configuration of the washing machine according to the first embodiment.

[FIG. 3]

FIG. 3 is a characteristic diagram of a motor winding temperature at each current value of a motor of the washing machine according to the first embodiment.

10 [FIG. 4]

FIG. 4 is a flowchart of a process of detecting an overload state of the motor of the washing machine according to the first embodiment.

[FIG. 5]

FIG. 5 is a flowchart of an inverter control process of the motor of the washing machine according to the first embodiment.

[FIG. 6]

FIG. 6 is a diagram illustrating a relationship between (low-pass filtered) motor current and motor drive command in the washing machine according to the first embodiment.

20 [FIG. 7]

FIG. 7 is a flowchart of an inverter control process of a motor of a washing machine according to a second embodiment.

DESCRIPTION OF EMBODIMENTS

25 [0010]

Hereinafter, embodiments will be described in detail with reference to the drawings. It is to be noted that the present invention is not limited by the

accompanying drawings and the following description.

[0011]

(First Embodiment)

Hereinafter, a first embodiment will be described with reference to FIG.

5 1 to FIG. 6.

[0012]

(Basic Configuration of Washing Machine)

FIG. 1 is a vertical cross-sectional view illustrating a schematic configuration of a washing machine according to the first embodiment.

10 [0013]

As illustrated in FIG. 1, inside washing machine main body 1, water tub 2 having a cylindrical shape with a closed end is elastically supported by a suspension structure (not illustrated). Water tub 2 is supported with its axial direction tilted downward from the front side (left side in FIG. 1) to the back side (right side in FIG. 1). Inside water tub 2, rotary tub 3 having a cylindrical shape with a closed end is rotatably arranged. On the inner wall surface of rotary tub 3, a plurality of water passage holes 6 for passing washing water to the inside and outside of rotary tub 3 and a plurality of agitating protrusions (not illustrated) for agitating clothes are provided.

20 [0014]

Donut-shaped fluid balancer 15 is provided on the front side of rotary tub 3. Fluid balancer 15 is divided into a plurality of storage chambers (not illustrated) by a plurality of partition plates provided in the circumferential direction, and each partition plate has a communication hole. Liquid having a large specific gravity, such as calcium chloride, is stored inside fluid balancer 15. Liquid can move from one storage chamber to the next storage chamber through the communication hole. If the laundry inside rotary tub 3 is lopsided

during the washing operation, an uneven load is generated on rotary tub 3. The liquid moves to the opposite side of the uneven load to correct the deviation of the center of gravity and reduce the vibration noise of rotary tub 3.

[0015]

5 Laundry access opening 4 leading to the open end of rotary tub 3 is provided on the front side of washing machine main body 1, and laundry access opening 4 is covered by door 5 in a manner which allows opening and closing. The user is capable of loading and unloading the laundry to and from rotary tub 3 through laundry access opening 4 with door 5 open. Operation display panel
10 10 which is input setting unit 25 (see FIG. 2) is provided on the upper part of the front surface of washing machine main body 1 which is above laundry access opening 4. The user is capable of setting a desired operation course by operating operation display panel 10.

[0016]

15 Motor 7 is arranged below water tub 2. Motor 7 is connected to rotation center shaft 17 provided at the lower bottom of rotary tub 3 via pulley 14 and belt 16. The rotational driving force of motor 7 is transmitted to rotary tub 3 via pulley 14 and belt 16 to rotate rotary tub 3 in the forward or reverse direction.

20 [0017]

Water injection pipe 8 is connected to the upper part of water tub 2, and drainage pipe 9 is connected to the lower part of water tub 2. Water supply valve 27 and drain valve 28 are respectively provided in water injection pipe 8 and drainage pipe 9 in a manner which allows opening and closing. By
25 opening water supply valve 27, water is injected to water tub 2, and by opening drain valve 28, water is drained from water tub 2.

[0018]

(Configuration of Motor Driving Device)

FIG. 2 is a block diagram illustrating a circuit configuration of the washing machine according to the first embodiment.

[0019]

5 As illustrated in FIG. 2, a circuit for driving motor 7 includes rectifier 21, choke coil 22, and smoothing capacitor 23. The alternating-current (AC) voltage of commercial power supply 20 is rectified by rectifier 21. The rectified AC power is converted into a direct-current (DC) voltage by a smoothing circuit including choke coil 22 and smoothing capacitor 23. Accordingly, the converted
10 DC voltage is applied to inverter circuit 24.

[0020]

Inverter circuit 24 includes a three-phase full-bridge inverter circuit that includes six power switching semiconductors 24a to 24f and antiparallel diodes. In the present embodiment, inverter circuit 24 is formed of an
15 intelligent power module (hereinafter, referred to as IPM) incorporating insulated gate bipolar transistors (IGBTs), antiparallel diodes, a drive circuit of the IGBTs and a protection circuit. Motor 7 is connected to the output terminal of inverter circuit 24. Inverter circuit 24 controls the operations of water supply valve 27, drain valve 28, blower fan 12, and heat pump 29 by load
20 driver 26 based on an operation command and monitoring information.

[0021]

Motor 7 is a brushless motor. Motor 7 includes a permanent magnet that forms a rotor, a stator, and a rotor position detector including three hall ICs which are hall IC 30a, hall IC 30b, and hall IC 30c. Hall IC 30a, hall IC
25 30b, and hall IC 30c detect a position output reference signal for the electrical angle at every 60 degrees from the relative position (rotor position) between the permanent magnet and the stator.

[0022]

A current detecting means according to the present embodiment includes a shunt resistor (not illustrated), and is provided in inverter circuit 24. The current detecting means detects motor current I_u , I_v , and I_w of motor 7.

5 [0023]

Controller 31 includes a microcomputer, an inverter control timer (PWM timer) built in the microcomputer, a high-speed A/D conversion circuit, memory circuits (ROM, RAM), and the like. Controller 31 detects the electrical angle from the output signals of hall IC 30a, hall IC 30b, and hall IC
 10 30c included in the rotor position detector. Controller 31 further performs three-phase to two-phase dq transformation that separates the input into current component I_d corresponding to the magnetic flux and current component I_q corresponding to the torque, and two-phase to three-phase inverse dq transformation that transforms voltage component V_d corresponding
 15 to the magnetic flux and voltage component V_q corresponding to the torque into three-phase motor drive control voltage V_u , V_v , V_w , to perform PWM control on the switching of the IGBTs of drive circuit 32 according to the three-phase motor drive control voltage V_u , V_v , V_w . Accordingly, controller 31 controls power supply to windings 7a, 7b, and 7c, which are the three-phase winding of
 20 the stator, to rotate motor 7 at a required rotation speed .

[0024]

In the present embodiment, the microcomputer of controller 31 functions as low-pass filtering processor 33 and overload detector 34. The detailed operations of low-pass filtering processor 33 and overload detector 34
 25 will be described later.

[0025]

(Basic Operation of Washing Operation)

The user opens door 5, puts laundry and detergent into rotary tub 3, and operates operation display panel 10 which is input setting unit 25 to start an operation. When the operation starts, controller 31 opens water supply valve 27 to inject water into water tub 2. When a predetermined water level is reached, controller 31 closes water supply valve 27 to start the washing operation.

[0026]

In the washing operation, controller 31 rotates rotary tub 3 by rotationally driving motor 7. The laundry accommodated in rotary tub 3 is lifted in the rotational direction by the agitating protrusions as rotary tub 3 rotates, and is dropped from an appropriate height for agitation. In such a manner, in the washing operation, dirt and the like is removed from the laundry by the beating of the laundry through lifting and dropping.

[0027]

When a predetermined time elapses in the washing operation, controller 31 opens drain valve 28 to drain the dirty washing water through drainage pipe 9. Subsequently, controller 31 removes the washing water contained in the laundry through a spinning operation in which rotary tub 3 is rotated at high speed.

[0028]

(Relationship between Motor Current Value and Motor Winding Temperature)

Excessive loading of laundry in rotary tub 3 causes a problem in that the laundry is twisted or is caught between water tub 2 and rotary tub 3 during the rotation operation of rotary tub 3, and an excessive load is applied to motor 7. In a state where motor 7 is overloaded, that is, in a motor overload state, the value of current flowing through motor 7, that is, the motor current value

becomes higher than the motor current value at the time of normal washing operation.

[0029]

FIG. 3 is a characteristic diagram of the motor winding temperature at each current value of the motor of the washing machine according to the first embodiment.

[0030]

The motor winding temperature is the temperature of windings 7a, 7b, and 7c, which are three-phase winding. In FIG. 3, the horizontal axis represents the operating time and the vertical axis represents the motor winding temperature, and changes in motor winding temperature at each current value are shown. Each current value is set to a predetermined value in the decreasing order of motor current A, motor current B, motor current C, and motor current D.

[0031]

Generally, the motor winding temperature increases in proportion to the square of the motor current value, and after a certain period of time, the motor winding temperature saturates. When the saturation temperature is higher than the heat resistant temperature of the motor winding, the motor winding may burn out. Accordingly, it is necessary to control the motor current value so that the motor winding temperature does not exceed the heat resistant temperature.

[0032]

In the present embodiment, the current value at which the winding saturation temperature may exceed the heat resistant temperature of the motor winding is experimentally measured in advance, and a predetermined threshold value is set based on the current value. When a predetermined time

elapses in a state where the motor current value is greater than the predetermined threshold value, it is defined as a motor overload state.

[0033]

(Overload State Detection Process and Inverter Control Process)

5 FIG. 4 is a flowchart of a process of detecting an overload state of the motor of the washing machine according to the first embodiment, and FIG. 5 is a flowchart of an inverter control process of the motor of the washing machine according to the first embodiment.

[0034]

10 In the washing operation, controller 31 starts the overload state detection process (step S101) and also starts the inverter control process illustrated in FIG. 5. The two processes are performed independently in parallel, and are repeatedly performed at their respective time intervals.

[0035]

15 First, the overload state detection process will be described.

[0036]

As illustrated in FIG. 4, when the overload state detection process is started (step S101), overload detector 34 performs low-pass filtering on the motor current value (step S102).

20 [0037]

In the low-pass filtering according to the present embodiment, the change between the previous motor current value and the present motor current value is calculated, and the change is reduced by a constant ratio and is added to the previously detected current. These processes are arithmetically
25 processed by low-pass filtering processor 33 which is a microcomputer. In general, it is known that the value of the current that flows through the motor when the motor is started instantaneously becomes large and gradually

converges to a constant value. By performing the low-pass filtering, the components due to the input current can be removed from the measured motor current value, so that false detection of the overload state due to the instantaneous flow of large current can be prevented. The time constant of the
 5 low-pass filter is set to a time (for example, 10 seconds) that is approximately equivalent to the ON time of the driving of the motor.

[0038]

Next, overload detector 34 compares the low-pass filtered motor current value with threshold value α to determine whether or not the motor is in an
 10 overload state (step S103). In S103, when the motor current value is less than α (No in step S103), or when predetermined time $t1$ has not elapsed in the state where the motor current value is greater than or equal to α (No in step S103), the overload state detection process ends (Step S107). Accordingly, it is possible to prevent a motor overload state from being erroneously detected
 15 when the motor current value instantaneously becomes greater than or equal to α .

[0039]

In step S103, when predetermined time $t1$ has elapsed in the state where the motor current value is greater than or equal to α (Yes in step S103),
 20 overload detector 34 sets the motor overload state, that is, sets that the motor is in the overload state (step S104).

[0040]

As mentioned above, in the motor overload state, the motor winding temperature may exceed the heat resistant temperature. Accordingly, the
 25 motor winding has to be cooled until the low-pass filtered motor current value becomes less than or equal to a predetermined value. In the present embodiment, threshold value β , which is one-third of threshold value α , is

provided, and when the motor current value becomes less than or equal to threshold value β , it is determined that the motor is not in the overload state.

[0041]

Overload detector 34 compares the low-pass filtered motor current value with threshold value β (step S105). In step S105, when the motor current value is greater than threshold value β (No in step S105), the overload state detection process ends (step S107).

[0042]

In step S105, when the motor current value is less than or equal to threshold value β (Yes in step S105), overload detector 34 clears the motor overload state, that is, cancels the determination that the motor is in the overloaded state (step S106). Subsequently, the overload state detection process ends (step S107).

[0043]

Next, the inverter control process will be described.

[0044]

As illustrated in FIG. 5, controller 31 starts the inverter control process (step S201). Controller 31 causes drive circuit 32 to perform PWM control on the switching of the IGBTs by issuing a motor drive command (step S202). Accordingly, motor 7 rotationally drives rotary tub 3 based on the motor drive command.

[0045]

When the motor overload state is set in step S203 (Yes in step S203), controller 31 causes drive circuit 32 to stop the PWM output (step S204). After that, the inverter control process ends (step S205). When the motor overload state is not set (No in step S203), the inverter control process ends (step S205).

[0046]

Next, the characteristics of the (low-pass filtered) motor current value and the motor drive command according to the present embodiment will be described.

[0047]

5 FIG. 6 is a diagram illustrating a relationship between the (low-pass filtered) motor current and the motor drive command in the washing machine according to the first embodiment. The horizontal axis represents the operating time, the left vertical axis represents the low-pass filtered motor current value, and the right vertical axis represents the motor drive command.

10 [0048]

The agitating period during washing is set such that one cycle includes ten seconds of the motor driving ON state and one second of the motor driving OFF state. Rotary tub 3 performs the agitating operation while rotating to the left and right in each cycle. At this time, the low-pass filtered motor current value increases while fluctuating up and down at the agitation ON time, and gradually decreases at the agitation OFF time. When the motor overload state is set in the overload state detection process illustrated in FIG. 4 (step S104), the PWM output is stopped in the inverter control process illustrated in FIG. 5 (step S204). Since the motor current does not flow during the period in which the PWM output is stopped, the low-pass filtered motor current value gradually decreases.

15 value increases while fluctuating up and down at the agitation ON time, and gradually decreases at the agitation OFF time. When the motor overload state is set in the overload state detection process illustrated in FIG. 4 (step S104), the PWM output is stopped in the inverter control process illustrated in FIG. 5 (step S204). Since the motor current does not flow during the period in which

20 the PWM output is stopped, the low-pass filtered motor current value gradually decreases.

[0049]

It is known that the low-pass filtered motor current value takes longer to decrease as the motor current value increases. Accordingly, when the motor current value is large, the time taken for the motor current value to become threshold value β or less increases, leading to a longer period during which driving of the motor is stopped. As a result, even when the motor current

25 current value is large, the time taken for the motor current value to become threshold value β or less increases, leading to a longer period during which driving of the motor is stopped. As a result, even when the motor current

value rapidly increases before predetermined time t_1 elapses in the state where the motor current value is greater than or equal to threshold value α , the cooling time becomes longer according to the motor current value, so that the motor winding temperature can be lowered more reliably.

5 [0050]

When the low-pass filtered motor current value falls below threshold value β , the motor overload state is cleared in the overload state detection process illustrated in FIG. 4 (step S106). Then, the PMW output is restarted in the inverter control process illustrated in FIG. 5 (step S202).

10 [0051]

As described above, the safety function of the motor can be realized at a lower cost than conventional techniques by detecting the motor overload state based on the low-pass filtered motor current and keeping the motor winding temperature within the heat resistant temperature.

15 [0052]

(Effects, etc.)

A front-loading washing machine according to the present embodiment includes rotary tub 3, motor 7 configured to drive rotary tub 3 to rotate, inverter circuit 24 configured to convert direct current into alternating current to drive
20 motor 7, and a current detector configured to detect current flowing through motor 7. The front-loading washing machine further includes low-pass filtering processor 33 configured to perform low-pass filtering on the current detected by the current detector and output the low-pass filtered value as a processed current value, overload detector 34 configured to detect the overload
25 state of motor 7, and controller 31 configured to transmit a motor drive command to inverter circuit 24 and controls motor 7 through inverter circuit 24.

[0053]

Moreover, overload detector 34 further determines whether motor 7 is in an overload state based on the processed current value output by low-pass filtering processor 33, and controller 31 controls the rotational drive of motor 7 based on the determination result of overload detector 34.

5 [0054]

With this configuration, it is possible to detect an increase in motor winding temperature from changes in motor current value without providing separate components such as a thermal fuse and thermistor. Accordingly, it is possible to prevent the motor winding temperature from excessively increasing and to realize the safety of the motor at low cost.

10 [0055]

In addition, as in the present embodiment, when a predetermined time elapses in the state where the processed current value is greater than or equal to α which is a first value, overload detector 34 may determine that motor 7 is in an overload state, and when the processed current value is β which is a second value less than α which is the first value, overload detector 34 may cancel the motor overload state.

15 [0056]

With this configuration, the time taken from when driving of motor 7 is stopped due to the determination that motor 7 is in the overload state till when the motor current value falls below β increases as the motor current value increases. Accordingly, when the winding temperature is likely to increase, the heat dissipation time can be set long, so that the safety of the motor can be realized at low cost.

20 [0057]

(Second Embodiment)

A washing machine according to a second embodiment is different from

washing machine 100 according to the first embodiment in the inverter control process during a spinning operation. Hereinafter, the second embodiment will be described with the same reference numerals for the same configurations as those of the first embodiment.

5 [0058]

FIG. 7 is a flowchart of an inverter control process of a motor of the washing machine according to the second embodiment.

[0059]

Controller 31 starts an inverter control process (step S301). Controller
10 31 determines whether or not the PWM output stop history has been set, that is, whether or not the history of stopping due to the motor overload state in the previous inverter control process has been set (step S302). When the PWM output stop history has been set (Yes in step S302), a motor drive command is transmitted to reduce the rotation speed of motor 7 (step S303). For example,
15 when an overload state is detected when the spinning rotation speed is 1400 rpm, the spinning rotation speed is reduced to 1300 rpm in the next inverter control process.

[0060]

In step S304, controller 31 clears the PWM output stop history, that is,
20 cancels the history of stopping due to the motor overload state in the previous inverter control process (step S304).

[0061]

In step S305, drive circuit 32 performs PWM output according to the motor drive command received from controller 31 (step S305).

25 [0062]

In step 306, controller 31 refers to the motor overload state (S306). When the motor overload state has been set (Yes in step S306), controller 31

causes drive circuit 32 to stop the PWM output (step S307), and sets the PWM output stop history (step S308). After that, the inverter control process ends (step S309). When a predetermined time elapses, the next inverter control process is started (step S301).

5 [0063]

By repeating the above inverter control process (steps S301 to S309), the rotation speed of motor 7 is adjusted such that the motor current value becomes less than or equal to the overload current value.

[0064]

10 In particular, in the spinning operation, a flux weakening operation is performed according to an increase in motor-induced voltage, so that the motor current increases as the rotation speed increases. Accordingly, by adjusting the rotation speed of motor 7, it is possible to effectively prevent the motor winding temperature from excessively increasing.

15 [0065]

(Effects, etc.)

The front-loading washing machine according to the present embodiment includes rotary tub 3, motor 7 configured to drive rotary tub 3 to rotate, inverter circuit 24 configured to convert direct current into alternating
20 current to drive motor 7, and a current detector configured to detect current flowing through motor 7. The front-loading washing machine further includes low-pass filtering processor 33 configured to perform low-pass filtering on the current detected by the current detector and output the low-pass filtered value as a processed current value, overload detector 34 configured to detect the
25 overload state of motor 7, and controller 31 configured to transmit a motor drive command to inverter circuit 24 to control motor 7 through inverter circuit 24. Moreover, overload detector 34 determines whether motor 7 is in the overload

state based on the processed current value output by low-pass filtering processor 33, and controller 31 reduces the rotation speed of motor 7 when the motor is in the overload state in the spinning operation.

[0066]

5 With this configuration, in the spinning operation in which the motor current increases as the rotation speed increases, it is possible to effectively prevent the motor winding temperature from excessively increasing by adjusting the rotation speed of motor 7.

[0067]

10 (Other Embodiments)

As examples of the technique disclosed in the present application, the first embodiment and the second embodiment have been described above. However, the technique according to the present disclosure is not limited to the above examples.

15 [0068]

As such, other embodiments will be described below as examples.

[0069]

In the first embodiment and the second embodiment, the front-loading washing machine has been described as an example of the washing machine.
20 However, the washing machine may be any type in which the rotary tub is rotationally driven by a motor. Accordingly, the washing machine is not limited to the front-loading washing machine, but may be a vertical type (top-loading) washing machine or a twin-tub washing machine.

[0070]

25 In the first embodiment and the second embodiment, the IGBT has been described as an example of the power switching semiconductor. The power switching semiconductor may be formed of a metal oxide film

semiconductor field effect transistor (MOSFET) or the like.

[0071]

In the first embodiment and the second embodiment, the shunt resistor has been described as an example of the current detector. However, the current detector may use a method of measuring a DC transformer or AC transformer from low frequencies including direct current. In the case of a three-phase motor, a method of obtaining two-phase current and obtaining the remaining one phase from Kirchhoff's law ($I_u + I_v + I_w = 0$) may be used.

[0072]

In the first embodiment and the second embodiment, as an example of the rotor position detector, rotor position detector 30 that detects the position of the rotor based on output reference signals H1 to H3 of the Hall ICs has been described. However, the rotor position detector is not limited to the one with the Hall ICs. The rotor position detector may detect the rotor position by calculation from the phase current of the motor and the three-phase motor drive control voltage.

[0073]

In the first embodiment and the second embodiment, the arithmetic processing in the microcomputer has been described as an example of a low-pass filter unit, but the low-pass filter unit is not limited to such an example. As the low-pass filter unit, low-pass filter configuration may be realized on a circuit by using a resistor and a capacitor. In addition, in the first embodiment and the second embodiment, as an example of the low-pass filtering, the configuration has been described in which a change between the previous motor current value and the present motor current value is calculated, and the change is reduced by a constant ratio and is added to the previously detected current. However, the low-pass filtering is not limited to such an

example. For example, a simple moving average value may be used.

[0074]

In the first embodiment and the second embodiment, the low-pass filtering (S102) performed as part of the overload state detection process has
5 been described as an example of the low-pass filtering. The timing when the low-pass filtering is performed is not limited to step 102, but may be performed independently of the overload state detection process.

[0075]

In the first embodiment and the second embodiment, threshold value β ,
10 which is one-third of threshold value α , has been described as a reference value for determining that the motor is not in an overload state. However, the reference value is not limited to one-third of threshold value α as long as it can be determined that the motor is not in the overload state.

[0076]

15 In the first embodiment, as an example of controlling the rotational drive of the motor in the motor overload state, an example in which driving of motor 7 is stopped in the motor overload state has been described. However, the control of the rotational drive of the motor in the motor overload state is not limited to the stopping of the driving. For example, it may be that the
20 agitating period during washing may be changed such that the ON state is reduced, and the OFF state is increased.

[0077]

In the first embodiment, as a method of controlling the rotational drive of the motor based on the determination result of the overload detector, an
25 example of stopping the driving of motor 7 in the motor overload state has been described. However, the method of controlling the rotational drive of the motor is not limited to stopping of the driving of motor 7 in the motor overload

state, and may be stopping of the washing operation. For example, when it is determined that the motor is in an overload state a predetermined number of times or more, it may be determined that motor 7 has a malfunction. When it is determined that motor 7 has a malfunction, the washing operation may be
 5 stopped to notify of the malfunction.

INDUSTRIAL APPLICABILITY

[0078]

The present disclosure is applicable to a device that rotationally drives
 10 a rotary tub with a motor. Specifically, the present disclosure is applicable to top-loading washing machines, front-loading washing machines, twin-tub washing machines, and the like.

REFERENCE MARKS IN THE DRAWINGS

15 [0079]

- | | | |
|----|------------|-------------------------|
| | 1 | washing machine body |
| | 2 | water tub |
| | 3 | rotary tub |
| | 4 | laundry access opening |
| 20 | 5 | door |
| | 6 | water passage hole |
| | 7 | motor |
| | 7a, 7b, 7c | winding |
| | 8 | water injection pipe |
| 25 | 9 | drainage pipe |
| | 10 | operation display panel |
| | 12 | blower fan |

	14	pulley
	15	fluid balancer
	16	belt
	17	rotation center shaft
5	20	commercial power supply
	21	rectifier
	22	choke coil
	23	smoothing capacitor
	24	inverter circuit
10	24a to 24f	power switching semiconductor
	25	input setting unit
	26	load driver
	27	water supply valve
	28	drain valve
15	29	heat pump
	30	rotor position detector
	30a, 30b, 30c	hall IC
	31	controller
	32	drive circuit
20	33	low-pass filtering processor
	34	overload detector

CLAIMS

1. A washing machine, comprising:
 - a rotary tub;
 - 5 a motor configured to drive the rotary tub to rotate;
 - an inverter circuit configured to convert direct current to alternating current to drive the motor;
 - a current detector configured to detect current flowing through the motor;
 - 10 a low-pass filter unit configured to perform low-pass filtering on the current detected by the current detector, and output a low-pass filtered value as a processed current value;
 - an overload detector configured to detect an overload state of the motor;
 - and
 - 15 a controller configured to transmit a motor drive command to the inverter circuit to control the motor through the inverter circuit,
 - wherein the overload detector determines whether the motor is in an overload state based on the processed current value output from the low-pass filter unit, and
 - 20 the controller controls rotational drive of the motor based on a determination result of the overload detector.

2. The washing machine according to claim 1,
 - wherein the overload detector determines that the motor is in the
 - 25 overload state when a predetermined time elapses in a state where the processed current value is greater than or equal to a first value, and
 - the overload detector cancels the overload state when the processed

current value is a second value that is less than the first value.

3. The washing machine according to any one of claims 1 and 2,
wherein the controller reduces a rotation speed of the motor when the
5 motor is in the overload state in a spinning operation.