(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 502 981 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
02.02.2005 Bulletin 2005/05

(51) Int Cl.[7]: **D06F 35/00**

(21) Application number: **04252394.4**

(22) Date of filing: **23.04.2004**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL HR LT LV MK

(30) Priority: **31.07.2003 KR 2003053156**

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(54) Washing machine

(57) A drum washing machine and a method of controlling the drum washing machine including spin-drying laundry by rotating a rotary tub after a washing and/or rinsing operation, wherein the spin-drying of the laundry comprises spraying and feeding water into the rotary tub during a time period wherein the rotary tub is inertially rotated.

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Description

[0001] The present invention relates, in general, to a drum washing machine comprising a rotary tub and a motor connected to a power supply to rotate the rotary tub, and a method of controlling the drum washing machine.

[0002] In a conventional drum washing machine, a set amount of water is fed into a fixed water tub to rinse laundry. The water gradually fills the water tub, and then flows into a rotary tub. Laundry is contained in the rotary tub and is soaked with the water. When the water rises to a certain level, a rinsing process is executed while the rotary tub is alternately rotated in opposite directions. Therefore, the laundry in contact with the inner wall of the rotary tub is initially soaked with the water and then remaining laundry is soaked as the water gradually disperses.

[0003] Therefore, the conventional drum washing machine is problematic in that it takes a long time for all of the laundry to be soaked with water.

[0004] Furthermore, in the conventional drum washing machine, the laundry that is in contact with the inner wall of the rotary tub becomes sufficiently soaked with water. However, the laundry at the centre of the drum can remain relatively insufficiently soaked with the water, meaning that the entire laundry load is not uniformly soaked with water. Consequently, if rinsing is performed in this state, the rinsing performance is deteriorated.

[0005] The present invention seeks to provide a drum washing machine that substantially alleviates or overcomes the problems mentioned above.

[0006] Accordingly, the method of controlling a drum washing machine of the present invention is characterised by the step of spraying water into said rotary tub after supply of power to the motor is cut but before the rotary tub has stopped rotating.

[0007] A preferred embodiment includes the step of stopping the spray of water when a predetermined period of time has elapsed after supply of power to the motor is cut and before the rotary tub comes to rest.

[0008] The washing machine preferably includes a drain pump to drain water from the rotary tub and the method preferably includes the step of activating the drain pump, determining when a predetermined time period for the tub to come to rest has elapsed and, deactivating the drain pump.

[0009] Conveniently, water is sprayed into the rotatable tub whilst power is being supplied to the motor.

[0010] The method preferably includes the step of initiating the spray of water when the rotational speed of the tub reaches a pre-set value and advantageously includes the step of terminating spray of water when a predetermined period of time has elapsed.

[0011] In a preferred embodiment, the rotary tub is mounted in a water tub and the method preferably includes the step of feeding the water into the water tub at the same time as spraying it into the rotary tub.

[0012] The time period of the spraying of the water may be shorter than a time required for termination of the inertial rotation of the rotary tub.

[0013] The spin-drying of the laundry may be an intermittent spin-drying operation in which the laundry is intermittently spin-dried after the washing and/or rinsing operation.

[0014] The drum washing machine of the present invention is characterised by a water supply unit operable to spray water into the rotary tub after supply of power to the motor is cut but before the rotary tub has stopped rotating.

[0015] In a preferred embodiment, the rotary tub is mounted in a water tub and the water supply unit comprises a main feed pipe for supplying water into the water tub and, an auxiliary feed pipe through which water is sprayed into the rotary tub.

[0016] A control unit is preferably provided for controlling the supply of water through the main feed pipe and auxiliary feed pipe.

[0017] The present invention also provides a drum washing machine including a rotary tub, a spray feed unit to spray and feed water into the rotary tub, and a control unit to control the spray feed unit, wherein the control unit controls the spray feed unit to spray and feed water into the rotary tub during a time period wherein the rotary tub is inertially rotated at a time of spin-drying.

[0018] The control unit may control the spray feed unit at a time of intermittent spin-drying in which laundry is intermittently spin-dried after a washing and/or a rinsing operation.

[0019] The control unit may also control the spray feed unit to spray and feed the water during a time period wherein a rotation speed of the rotary tub rises.

[0020] The spray feed unit may include a main water feed pipe to feed water to the drum washing machine, an auxiliary water feed pipe having a first end connected to the main water feed pipe, and a second end disposed at an inlet of the rotary tub, an auxiliary water feed valve mounted at the auxiliary water feed pipe, and a spray nozzle mounted at the second end of the auxiliary water feed pipe.

[0021] The control unit may control the spray feed unit so that a time required for the spraying and feeding of the water is shorter than a time required for termination of the inertial rotation of the rotary tub.

[0022] The drum washing machine may further include a pump to drain water in the rotary tub to outside of the rotary tub.

[0023] A preferred embodiment of the invention will now be described, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view showing an internal structure of a drum washing machine, according to an embodiment of the present invention;

Figure 2 is a control flowchart of a method of controlling the drum washing machine, according to the

embodiment of the present invention shown in Figure 1;

Figure 3 is a control flowchart showing an intermittent spin-drying operation performed after a washing operation in the method of Figure 2;

Figure 4 is a graph showing a start and a termination of a spray rinsing operation of Figure 3;

Figure 5 is a control flowchart showing an intermittent spin-drying operation performed after a rinsing operation in the method of Figure 2, and

Figure 6 is a graph showing a start and a termination of a spray rinsing operation of Figure 5.

[0024] Referring now to Figure 1, main and auxiliary water feed pipes 12 and 13 are mounted to allow water flowing from an external water supply pipe to selectively flow into a water tub 10 or a rotary tub 11.

[0025] The main water feed pipe 12 is connected to the water tub 10. The auxiliary water feed pipe 13, which is branched from the main water feed pipe 12, has one end connected to the main water feed pipe 12, and a remaining end disposed at an inlet of the rotary tub 11. Main and auxiliary water feed valves 14 and 15 are mounted in the main and auxiliary water feed pipes 12 and 13, respectively, so as to allow water to selectively flow into the water tub 10 or the rotary tub 11. A detergent container 16 is disposed in the main water feed pipe 12, between the main water feed valve 14 and the water tub 10, to allow detergent to be supplied together with the water into the water tub 10.

[0026] A spray nozzle 13a is mounted at an end of the auxiliary water feed pipe 13 to spray water into the rotary tub 11. Therefore, the drum washing machine is constructed so that water and detergent are fed together into the water tub 10 through the main water feed pipe 12, and only water is fed by spraying into the rotary tub 11 through the auxiliary water feed pipe 13, the auxiliary water feed valve 15, and the spray nozzle 13a forming a spray feed unit.

[0027] Water and detergent flows through the main water feed pipe 12 and collects in a lower portion of the water tub 10. A drain pipe 17 is provided at a bottom of the water tub 10 and is connected to a drain pump 18 and a drain valve 19 to pump water and detergent out of the lower portion of the water tub 10.

[0028] A reversible motor 20 is coupled to the rotary tub 11 to rotate the rotary tub 11 in both forward and reverse directions.

[0029] The main water feed valve 14, the auxiliary water feed valve 15, the drain pump 18, the drain valve 19, and the motor 20 are all electrically connected to a control unit (not shown) that controls operation of the drum washing machine.

[0030] A method of controlling the drum washing machine of this embodiment of the present invention will now be described.

[0031] Figure 2 shows a control flowchart of a method of controlling the drum washing machine of Figure 1. Referring to Figure 2, detergent together with a set amount of water is fed into the water tub 10 in operation 100. Thereafter, the motor 20 is driven to rotate the rotary tub 11 in opposite directions, thus washing laundry in operation 101.

[0032] After the washing operation has been completed, waste water contained in the rotary tub 11 is drained in operation 102.

[0033] Thereafter, the motor 20 rotates the rotary tub 11 at high speed to remove excess water from the laundry, indicated as operation 103 in Figure 2. The rotational speed of the motor 20 in this operation is less than that of the final spin-drying operation. The auxiliary water feed valve 15 is opened to directly spray clean water into the rotary tub 11 once the intermittent spin-drying operation is terminated by cutting the power supply to the motor but while the rotary tub 11 is still rotating due to rotational inertia. Therefore, as clean water is sprayed directly onto the laundry, the entire laundry is rinsed and uniformly soaked with the clean water within a short space of time.

[0034] After the washing operation and the intermittent spin-drying operation are performed, clean water is fed again into the water tub 10 through the main water feed pipe 12 in operation 104. The motor 20 is then alternately rotated in forward and reverse directions at a preset rotation speed to rotate the rotary tub 11 in opposite directions, thereby performing a rinsing operation 105.

[0035] After the rinsing operation is performed, waste water contained in the rotary tub 11 is drained in operation 106.

[0036] After the rinsing and draining operations 105,106, the motor 20 is operated to rotate the rotary tub 11 at high speed, thereby performing intermittent spin-drying operation 107. During this operation, water is sprayed into the rotary tub 11 in a similar manner to the intermittent spin-drying operation 103 that is performed after the washing operation 101. However, in the intermittent spin-drying operation 107 performed after the rinsing operation, water is sprayed whilst the rotational speed of the rotary tub 11 is increasing by being driven by the motor 20, as well as whilst water is being sprayed during the interval when the rotary tub 11 is rotating by rotational inertia alone.

[0037] After the rinsing operation 103 and the intermittent spin-drying operation 107 have terminated, a final spin-drying operation 108 may be immediately performed. Alternatively, although not shown in detail in Figure 2, the final spin-drying operation may be performed after the water feeding operation 104, the rinsing operation 105, the draining operation 106, and the intermittent spin-drying operation 107 have all been performed a predetermined number of times. After the final spin-drying operation has been completed, the above control method terminates.

[0038] Figure 3 is a control flowchart showing the intermittent spin-drying operation 103 performed after the

washing operation 101 in the method of Figure 2. The motor 20 and the drain pump 18 are turned on in operation 110, and the rotational speed of the rotary tub 11 gradually rises, until it is rotating at a sufficiently high speed, for the waste water to be forced out of the laundry. The waste water is pumped out of the washing machine by the drain pump 18.

[0039] In operation 111, it is determined whether a preset intermittent spin-drying time has elapsed. If the preset intermittent spin-drying time has not elapsed, the control unit continues to perform operation 110. However, if the preset intermittent spin-drying time has elapsed, a signal is sent to the control unit which turns off the motor 20 to stop the rotary tub 11, in operation 112. After the moment the motor 20 is turned off, the rotary tub 11 continues to rotate for a period of time due to rotational inertia until it is brought to a stop by friction.

[0040] During the period of time that the rotary tub 11 is still rotating due to rotational inertia, the auxiliary water feed valve 15 is turned on in operation 113. Accordingly, water flows from the water supply pipe through the auxiliary water feed pipe 13 and is directly sprayed from the spray nozzle 13a onto the laundry contained in the rotary tub 11. Therefore, the sprayed water rinses the waste water from the laundry as it passes therethrough and is then drained. In operation 114, it is then determined whether the auxiliary water feed valve 15 has been turned on for a predetermined time period, for example, approximately 20 seconds.

[0041] If the auxiliary water feed valve 15 has been turned on for longer than the predetermined period, the auxiliary water feed valve 15 is turned off in operation 115 to stop the above spray rinsing operation.

[0042] It is then determined in operation 116 whether the time required for the rotary tub 11 to stop rotating under rotational inertia has elapsed. If this inertial rotation stop-time has elapsed, the drain pump 18 is turned off to terminate the intermittent spin-drying operation and the control unit then executes a next control routine.

[0043] Figure 4 is a graph showing a start and a termination of the spray rinsing operation of Figure 3. When performing the intermittent spin-drying operation 103 after the washing operation 101, the rotary tub 11 is rotated at a high speed, and, the water spraying operation is performed for a certain period just before the intermittent spin-drying operation terminates after the motor 20 is turned off. For reference, during the period when the rotation speed of the rotary tub 11 gradually increases, the water spraying operation is not performed. This is because if cool water is sprayed on the laundry while it contains hot water from heated washing, any soil in the laundry would not be sufficiently removed.

[0044] Figure 5 is a control flowchart showing the intermittent spin-drying operation performed after the rinsing operation in the method of Figure 2, and Figure 6 is a graph showing a start and a termination of a spray rinsing operation of Figure 5. These Figures show a second control operation of spraying water into the rotary tub 11 while it is rotating under inertia after the motor 10 is turned off, similar to that of Figure 3. However, in the case of the intermittent spin-drying operation in Figures 5 and 6, the water spraying operation is also performed during a time period when the rotary tub 11 is speeding up under power from the motor 20 (100 to 400 rpm). That is, when the speed of the motor 20 reaches a preset value, the auxiliary water feed valve 15 is opened to spray water thereby improving the rinsing performance.

[0045] As is apparent from the above description, the present invention provides a drum washing machine, and a method of controlling the drum washing machine, which directly sprays water into a rotary tub just before termination of an intermittent spin-drying operation which is performed after a washing or rinsing operation, thus enabling laundry to be uniformly soaked with the water within a short period of time and improving rinsing performance.

[0046] Although embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made to these embodiments without departing from the invention, the scope of which is defined in the claims and their equivalents hereafter.

Claims

1. A method of controlling a drum washing machine including a rotary tub and a motor connected to a power supply to rotate the rotary tub, the method being **characterised by** the step of spraying water into said rotary tub after supply of power to the motor is cut but before the rotary tub has stopped rotating.

2. A method according to claim 1 comprising the step of stopping the spray of water when a predetermined period of time has elapsed after supply of power to the motor is cut and before the rotary tub comes to rest.

3. A method according to claim 2 wherein the washing machine includes a drain pump to drain water from the rotary tub and the method includes the step of activating the drain pump, determining when a predetermined time period for the tub to come to rest has elapsed and, deactivating the drain pump.

4. A method according to any preceding claim, further comprising a step of spraying water into the rotatable tub whilst power is being supplied to the motor.

5. A method according to claim 4 comprising the step of initiating the spray of water when the rotational speed of the tub reaches a pre-set value.

6. A method according to claim 5 comprising the step

of terminating spray of water when a predetermined period of time has elapsed.

7. A method according to any preceding claim, wherein the rotary tub is mounted in a water tub and the method includes the step of feeding the water into the water tub at the same time as spraying it into the rotary tub.

8. A washing machine comprising a rotary tub and a motor connected to a power supply to rotate the rotary tub, **characterised by** a water supply unit operable to spray water into the rotary tub after supply of power to the motor is cut but before the rotary tub has stopped rotating.

9. A washing machine according to claim 8, wherein the rotary tub is mounted in a water tub and the water supply unit comprises a main feed pipe for supplying water into the water tub and, an auxiliary feed pipe through which water is sprayed into the rotary tub.

10. A washing machine according to claim 9, comprising a control unit for controlling the supply of water through the main feed pipe and auxiliary feed pipe.

11. A method of controlling a drum washing machine comprising spin-drying laundry by rotating a rotary tub after a washing and/or rinsing operation, wherein the spin-drying of the laundry comprises spraying and feeding water into the rotary tub during a time period wherein the rotary tub is inertially rotated.

12. The drum washing machine control method according to claim 11 wherein the time period of the spraying and feeding of the water is shorter than a time required for termination of the inertial rotation of the rotary tub.

13. The drum washing machine control method according to claim 11 further comprising pumping water in the rotary tub to outside of the rotary tub until the inertial rotation of the rotary tub terminates.

14. The drum washing machine control method according to claim 11 wherein the spin-drying of the laundry is an intermittent spin-drying operation in which the laundry is intermittently spin-dried after the washing and/or rinsing operation.

15. The drum washing machine control method according to claim 11 wherein the spraying and feeding of the water is also executed during a time period wherein a rotation speed of the rotary tub rises.

16. The drum washing machine control method according to claim 15 wherein the spraying and feeding of the water is executed for a first preset time during the time period wherein the rotary tub is inertially rotated, and for a second preset time during the time period wherein a rotation speed of the rotary tub rises.

17. The drum washing machine control method according to claim 16 wherein the second preset time begins in response to the rotation speed of the rotary tub reaching a preset level.

18. The drum washing machine control method according to claim 11 wherein spraying and feeding of the water is executed for a preset time.

19. The drum washing machine control method according to claim 11 further comprising spin-drying a final time without spraying and feeding the water, wherein the final spin-drying is performed after the washing and/or rinsing operation and a draining operation have been performed a predetermined number of times.

20. A drum washing machine comprising a rotary tub, a spray feed unit to spray and feed water into the rotary tub and a control unit to control the spray feed unit, wherein the control unit controls the spray feed unit to spray and feed water into the rotary tub during a time period wherein the rotary tub is inertially rotated at a time of spin-drying.

21. The drum washing machine according to claim 20 wherein the control unit controls the spray feed unit at a time of intermittent spin-drying in which laundry is intermittently spin-dried after a washing and/or a rinsing operation.

22. The drum washing machine according to claim 20 wherein the control unit also controls the spray feed unit to spray and feed water during a time period wherein a rotation speed of the rotary tub rises.

23. The drum washing machine according to claim 22 wherein the control unit controls the spray feed unit to spray and feed water for a first preset time during the time period wherein the rotary tub is inertially rotated, and for a second preset time during the time period wherein a rotation speed of the rotary tub rises.

24. The drum washing machine according to claim 23 wherein the second preset time begins in response to the rotation speed of the rotary tub reaching a preset level.

25. The drum washing machine according to claim 20 wherein the spray feed unit comprises a main water feed pipe to feed water to the drum washing ma-

chine, an auxiliary water feed pipe having a first end connected to the main water feed pipe, and a second end disposed at an inlet of the rotary tub, an auxiliary water feed valve mounted at the auxiliary water feed pipe, and a spray nozzle mounted at the second end of the auxiliary water feed pipe.

26. The drum washing machine according to claim 25 wherein the control unit controls the auxiliary water feed valve to open and close to respectively begin and end the spraying and feeding of the water into the rotary tub.

27. The drum washing machine according to claim 20 wherein the control unit controls the spray feed unit so that a time required for the spraying and feeding of the water is shorter than a time required for termination of the inertial rotation of the rotary tub.

28. The drum washing machine according to claim 20 further comprising a pump to drain water in the rotary tub to outside of the rotary tub.

29. The drum washing machine according to claim 28 wherein the control unit controls the pump to drain the water in the rotary tub until the inertial rotation of the rotary tub terminates.

30. A drum washing machine comprising a rotary tub, and a control unit to control adding water to the rotary tub during a time period wherein the rotary tub is inertially rotated.

31. A drum washing machine comprising a rotary tub wherein the drum washing machine adds water to the rotary tub during a time period after stopping driving the rotary tub in a spin-drying movement, but before the spin-drying movement ends.

32. A method of controlling a drum washing machine comprising adding water to a rotary tub as the rotary tub is inertially rotated.

FIG. 1

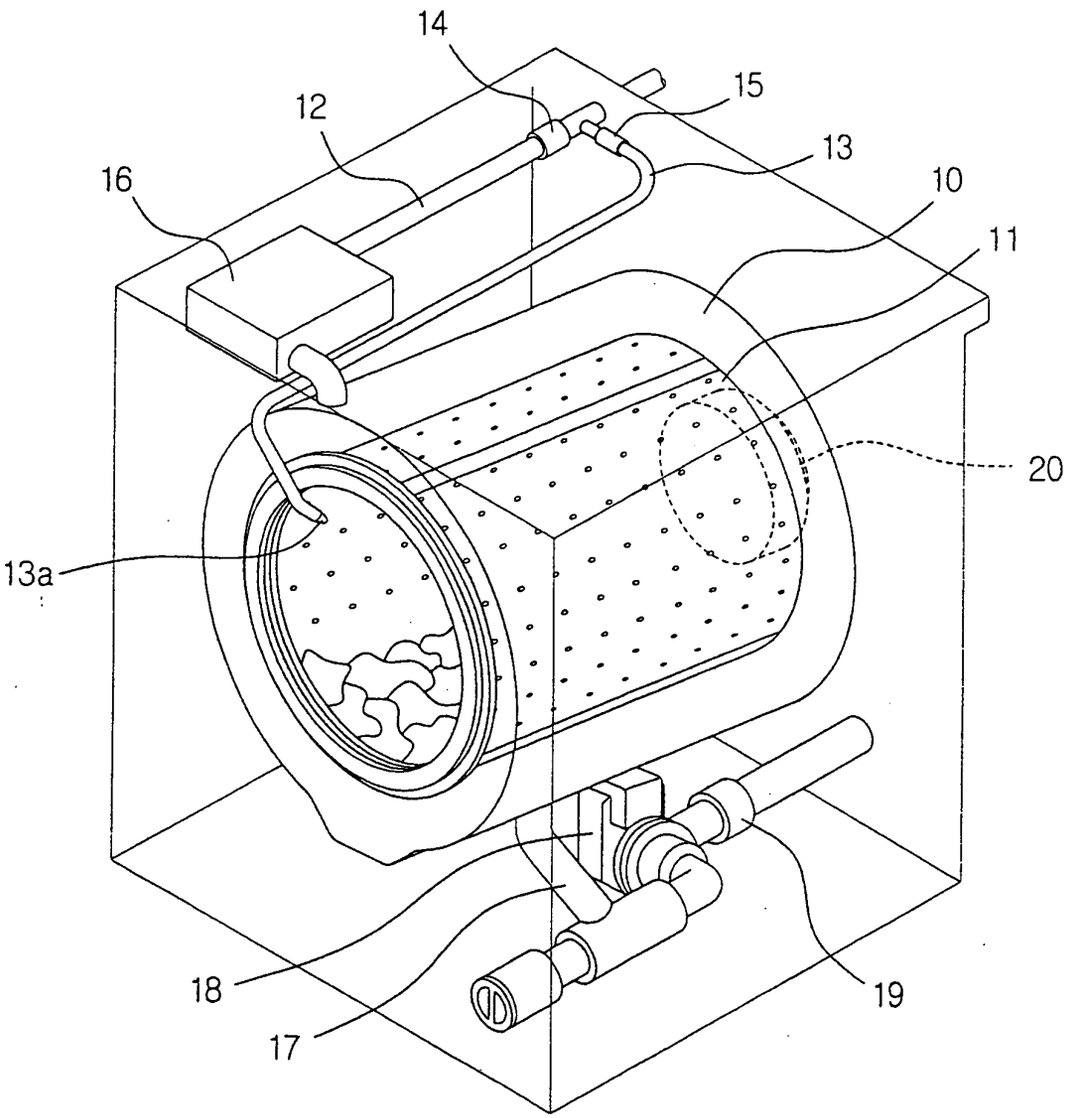


FIG. 2

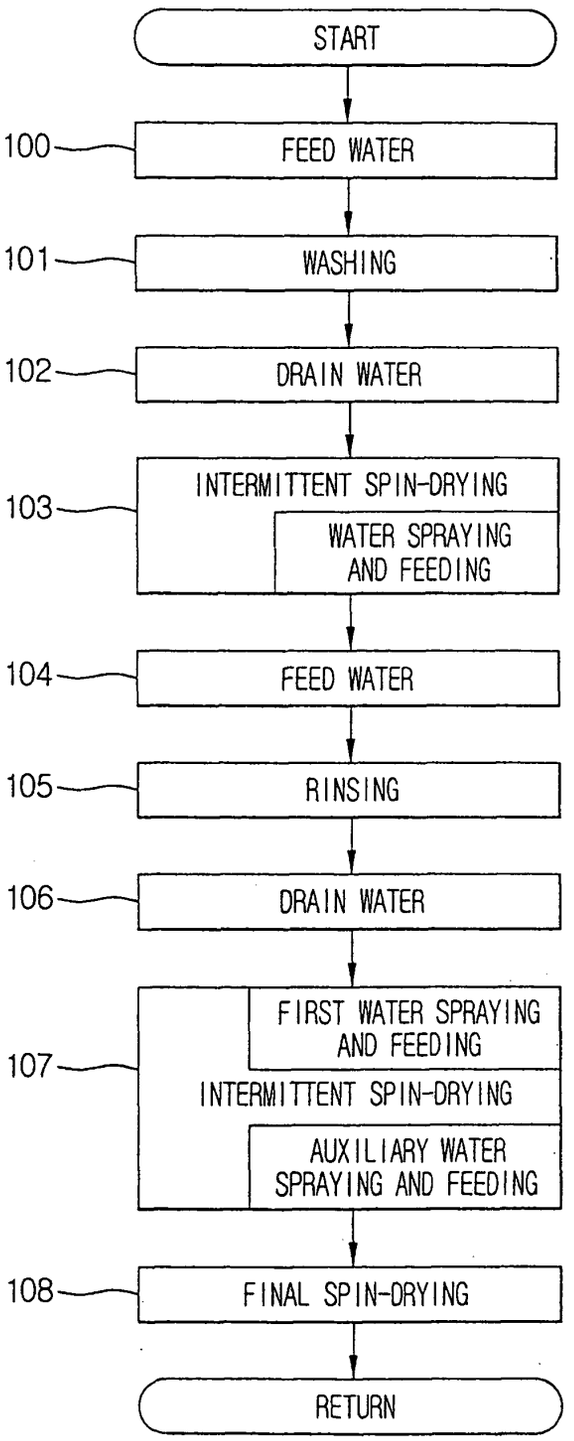

START
100
FEED WATER
101
WASHING
102
DRAIN WATER
103
INTERMITTENT SPIN-DRYING
WATER SPRAYING AND FEEDING
104
FEED WATER
105
RINSING
106
DRAIN WATER
107
FIRST WATER SPRAYING AND FEEDING
INTERMITTENT SPIN-DRYING
AUXILIARY WATER SPRAYING AND FEEDING
108
FINAL SPIN-DRYING
RETURN

FIG. 3

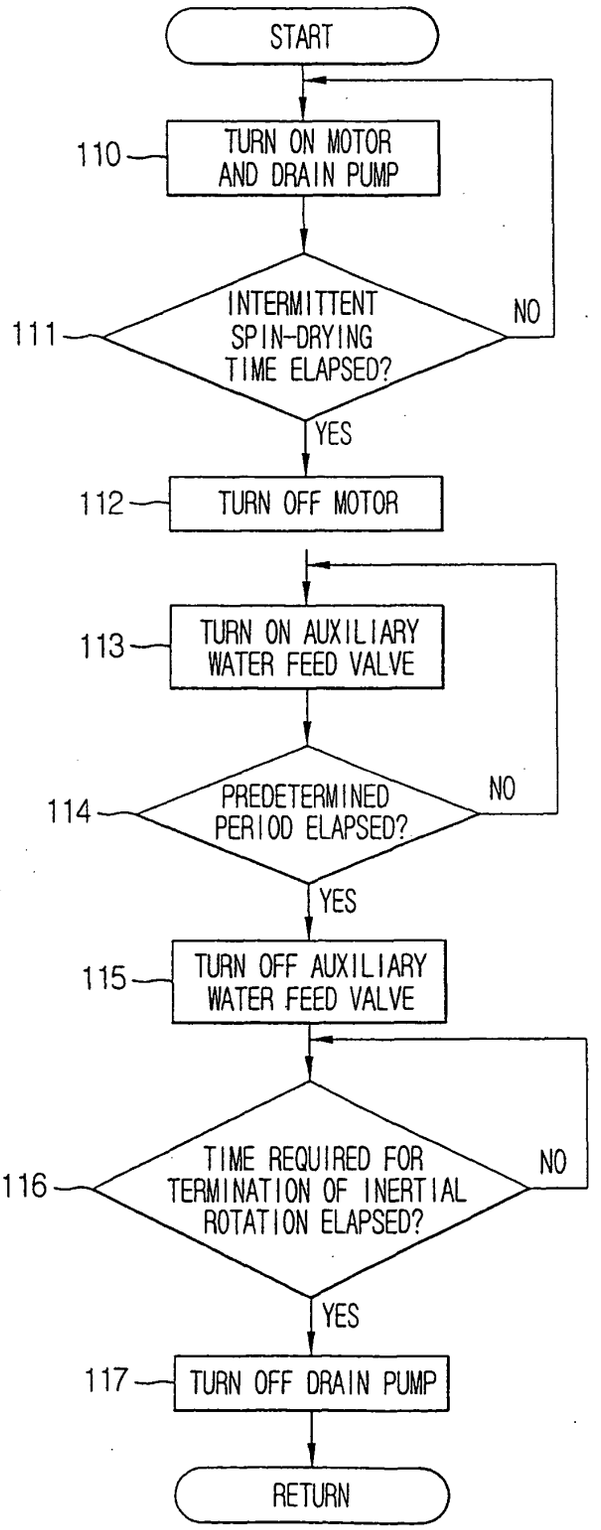

START
110
TURN ON MOTOR AND DRAIN PUMP
111
INTERMITTENT SPIN-DRYING TIME ELAPSED?
NO
YES
112
TURN OFF MOTOR
113
TURN ON AUXILIARY WATER FEED VALVE
114
PREDETERMINED PERIOD ELAPSED?
NO
YES
115
TURN OFF AUXILIARY WATER FEED VALVE
116
TIME REQUIRED FOR TERMINATION OF INERTIAL ROTATION ELAPSED?
NO
YES
117
TURN OFF DRAIN PUMP
RETURN

FIG. 4

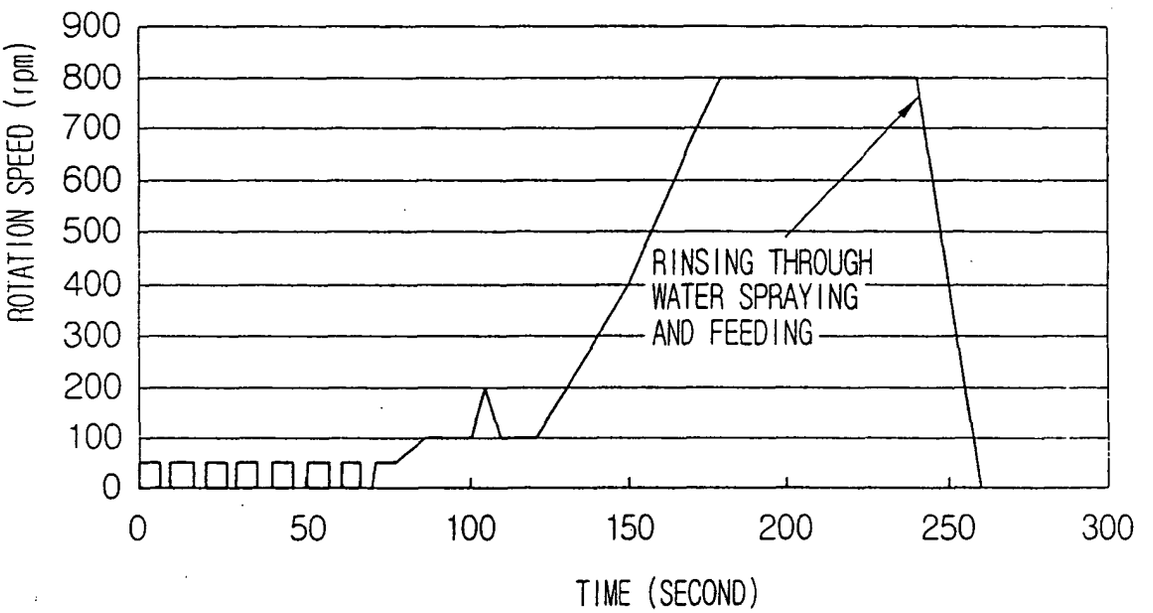

ROTATION SPEED (rpm)
900
800
700
600
500
400
300
200
100
0
0
50
100
150
200
250
300
TIME (SECOND)
RINSING THROUGH
WATER SPRAYING
AND FEEDING

FIG. 5

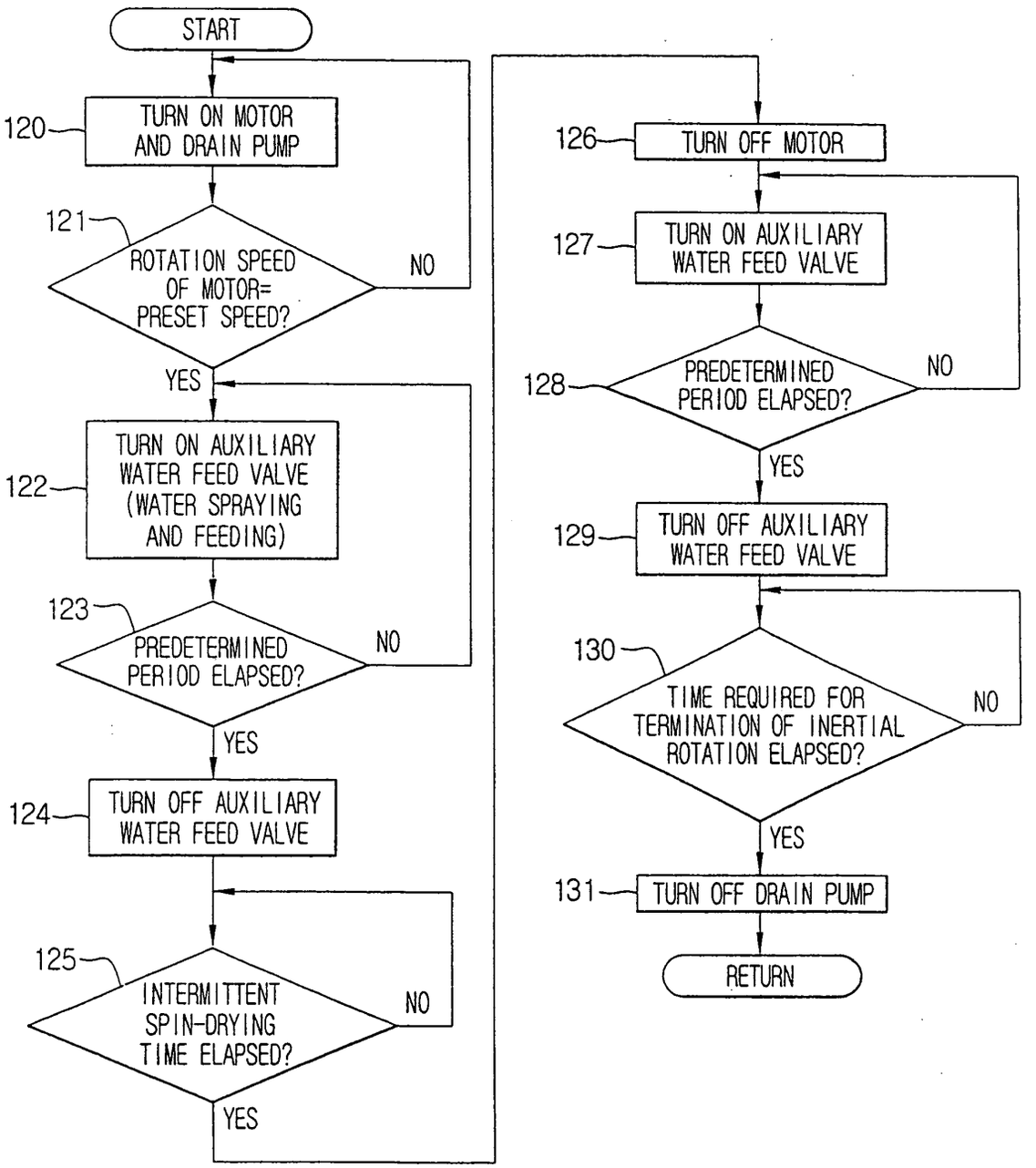
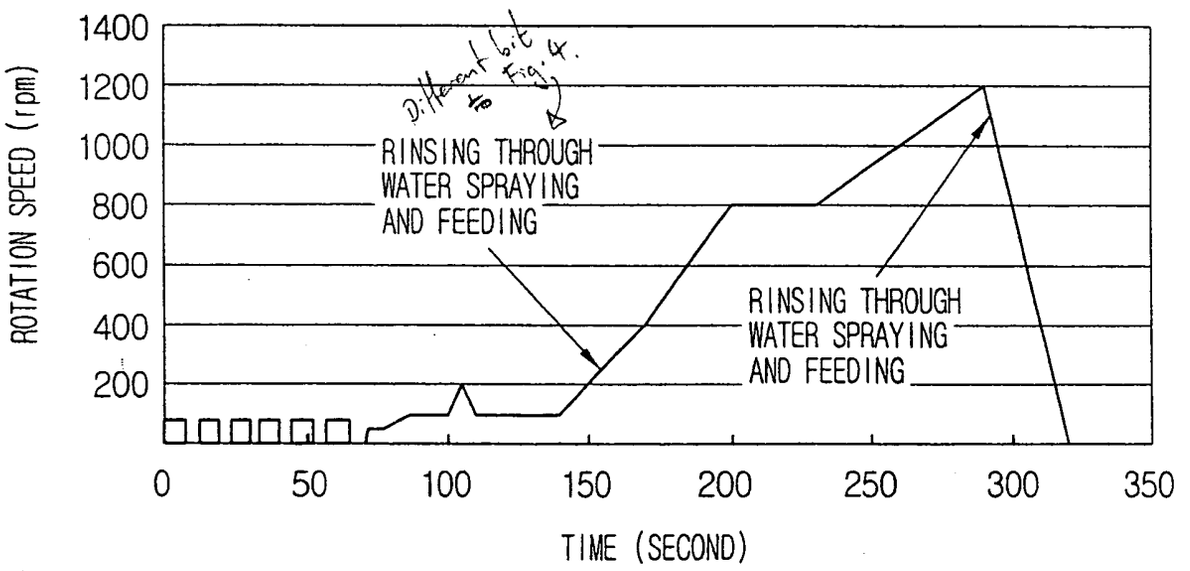

START
120
TURN ON MOTOR AND DRAIN PUMP
121
ROTATION SPEED OF MOTOR= PRESET SPEED?
NO
YES
122
TURN ON AUXILIARY WATER FEED VALVE (WATER SPRAYING AND FEEDING)
123
PREDETERMINED PERIOD ELAPSED?
NO
YES
124
TURN OFF AUXILIARY WATER FEED VALVE
125
INTERMITTENT SPIN-DRYING TIME ELAPSED?
NO
YES
126
TURN OFF MOTOR
127
TURN ON AUXILIARY WATER FEED VALVE
128
PREDETERMINED PERIOD ELAPSED?
NO
YES
129
TURN OFF AUXILIARY WATER FEED VALVE
130
TIME REQUIRED FOR TERMINATION OF INERTIAL ROTATION ELAPSED?
NO
YES
131
TURN OFF DRAIN PUMP
RETURN

FIG. 6


1400
1200
1000
800
600
400
200
ROTATION SPEED (rpm)
0
50
100
150
200
250
300
350
TIME (SECOND)
RINSING THROUGH WATER SPRAYING AND FEEDING
RINSING THROUGH WATER SPRAYING AND FEEDING