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

(11) EP 1 477 606 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 158(3) EPC

(43) Date of publication:
17.11.2004 Bulletin 2004/47

(21) Application number: **02786147.5**

(22) Date of filing: **18.12.2002**

(51) Int Cl.[7]: **D06F 39/04**

(86) International application number:
PCT/JP2002/013271

(87) International publication number:
WO 2003/054277 (03.07.2003 Gazette 2003/27)

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

(30) Priority: **21.12.2001 JP 2001389573**

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(54) WASHING MACHINE

(57) A washing machine includes a wash tub (9) in which a predetermined amount of wash liquid is reserved, a heating unit (17) heating the wash liquid, a temperature sensor (45) detecting a temperature of the wash liquid, a drive unit (15) rotating the wash tub (9), and a control device (46) controlling the driving unit (15) so that rotation of the wash tub (9) is controlled. The control device (46) changes a rotating mode of the wash tub (9) according to one of a plurality of temperature ranges to which the temperature of the wash liquid detected by the temperature sensor (45) belongs.

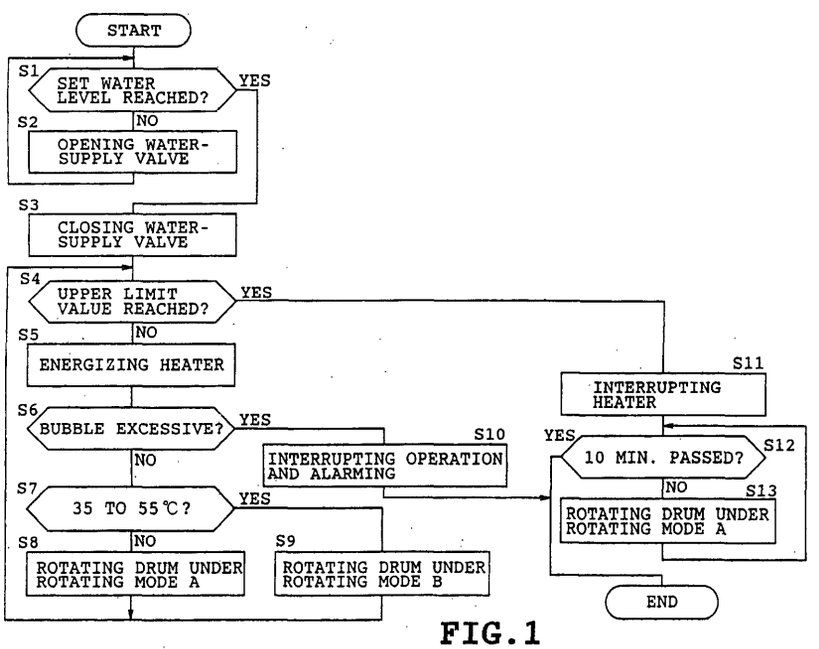

FIG.1

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Description

TECHNICAL FIELD

[0001] This invention relates to a washing machine including a heater for heating wash liquid during a washing operation.

BACKGROUND ART

[0002] There have conventionally been provided washing machines comprising a water tub, a wash tub rotatably mounted in the water tub, and a heating element provided in a bottom of the water tub for heating wash liquid in the wash tub. These washing machines are constructed so as to carry out a washing operation while washing liquid is being heated by the heating element. Enzyme contained in a detergent is activated when wash liquid is heated by the heater during the washing operation. Furthermore, vegetable and animal fats and oils contained in clothes to be washed are melted. Accordingly, laundry can efficiently be washed.

[0003] On the other hand, detergent lathers easily when a temperature of the wash liquid is high. Accordingly, a washing efficiency is reduced since an amount of bubble in the wash tub becomes excessive. Particularly in drum type washing machines, bubbles may leak out of an access opening through which laundry is put into and taken out of the wash tub. In view of the problem, the above-described washing machines, when the washing operation is carried out while the washing liquid is heated, a driving time of an agitator mounted on the bottom of the wash tub is reduced or rotational speeds of the wash tub and agitator are reduced so that an amount of bubble is reduced.

[0004] In the above-described method, however, a mechanical washing action applied to laundry is reduced. As a result, a sufficient washing performance cannot be achieved.

DISCLOSURE OF THE INVENTION

[0005] Therefore, an object of the present invention is to provide a washing machine which can improve the washing performance in a washing operation during which washing liquid is heated.

[0006] The present invention provides a washing machine comprising a wash tub in which a predetermined amount of wash liquid is reserved, a heating unit heating the wash liquid, a temperature sensor detecting a temperature of the wash liquid, a driving unit rotating the wash tub, and a control device controlling the driving unit so that rotation of the wash tub is controlled, wherein the control device changes a rotating mode of the wash tub according to one of a plurality of temperature ranges to which the temperature of the wash liquid detected by the temperature sensor belongs.

[0007] The invention also provides a washing machine comprising a wash tub in which a predetermined amount of wash liquid is reserved, a heating unit heating the wash liquid, a temperature sensor detecting a temperature of the wash liquid, an agitator rotatably mounted in the wash tub, a driving unit rotating the agitator, a control device controlling the drive unit so that rotation of the agitator is controlled, wherein the control device changes a rotating mode of the agitator according to one of a plurality of temperature ranges to which the temperature of the wash liquid detected by the temperature sensor belongs.

[0008] An amount of bubble produced with rotation of the wash tub or agitator is increased when the temperature of wash liquid is increased. However, an internal pressure of the bubble is increased when the wash liquid temperature exceeds a predetermined value, whereupon the bubble produced tend to be broken. An experiment conducted by the inventors shows that an amount of bubble is increased when a temperature of the wash liquid is in a temperature range suitable for activation of enzyme or in a range in which vegetable and animal fats and oils liquate out. Accordingly, when the wash tub or agitator is rotated in the rotating mode suitable for the temperature range to which the temperature of wash liquid belongs, a reduction in the mechanical force applied to the laundry can be restrained. Further, the wash liquid can be heated until its temperature becomes suitable for activating enzyme or liquating out fats and oils while an amount of bubble produced upon rotation of the wash tub or agitator is reduced. Consequently, the washing performance of the washing machine can be improved.

[0009] The invention further provides a washing machine comprising a wash tub in which a predetermined amount of wash liquid is reserved, a heating unit heating the wash liquid, a drain unit draining the wash liquid from the wash tub, a bubble detector detecting an amount of bubble produced in the wash tub, and a control device controlling at least the wash tub and the heating unit so that a washing operation is carried out with the heating unit heating the wash liquid, wherein when determining that an amount of bubble detected by the bubble detector exceeds a predetermined value, the control device interrupts the heating unit and operates the drain unit so that the wash liquid is drained and the cleaning operation is carried out.

[0010] The wash liquid is drained and the cleaning operation is then carried out when an amount of bubble produced in the wash tub exceeds a predetermined value. Thus, the cleaning operation is prevented from being carried out under the condition where an amount of bubble produced is excessive. In this case, even if the wash liquid is drained such that the heating unit is exposed on the surface of the wash liquid, the service life of the heating unit can be prevented from being reduced since the heating unit is turned off.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

FIG. 1 is a flowchart showing a wash step under a warm water mode executed by a drum washing machine in accordance with a first embodiment of the present invention;
FIG. 2 is a partially broken side view of the machine;
FIG. 3 is a rear view of the machine with a rear panel of an outer cabinet being eliminated;
FIG. 4 is a block diagram showing an electrical arrangement of the machine;
FIG. 5 is a graph showing a normal rotational mode of a wash tub;
FIG. 6 is also a graph showing a rotational mode restraining production of bubble in the wash tub;
FIG. 7 is a graph showing a relation between a temperature of wash liquid and an amount of bubble produced;
FIG. 8 is a flowchart showing a wash step under a warm water mode executed by the drum washing machine in accordance with a second embodiment of the present invention; and
FIG. 9 is a flowchart showing a wash step under a warm water mode executed by the drum washing machine in accordance with a third embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0012] The present invention will be described in detail with reference to the accompanying drawings. FIGS. 1 to 7 illustrate a drum washing machine in accordance with a first embodiment of the invention. Referring to FIGS. 2 and 3, the drum washing machine of the first embodiment comprises an outer cabinet 1, a stationary cylindrical water tub 7 mounted in the cabinet 1 and a drum 9 rotatably mounted in the water tub 7.

[0013] The outer cabinet 1 includes a front having a centrally formed access opening 2 closed and opened by a door 3. Laundry is put into and taken out of the drum 9 through the access opening 2. An operation panel 4 is mounted on the upper front of the cabinet 1. An operation circuit unit 5 is provided in the rear of the operation panel 4 in the interior of the cabinet 1. The operation panel 4 includes setting switches for setting various conditions for a washing operation etc. and a display section for displaying various pieces of information for the washing operation etc. although neither of them are shown. A control circuit unit 6 is provided in the lower front interior of the cabinet 1.

[0014] The water tub 7 is disposed so that a central axis thereof extends back and forth with respect to the cabinet 1. The water tub 7 is further inclined rearwardly downward. The water tub 7 is supported by a pair of elastic supporting mechanisms 8 disposed right and left. The drum 9 serves as a washing tub, dehydrating tub and drying tub and is disposed so as to be substantially coaxial with the water tub 7. The drum 9 has a circumferential side wall having a large number of small through holes 10 formed substantially in the overall wall. Both water and air are caused to flow through the holes 10. The drum 9 has an inner circumferential face formed with a plurality of baffles 11 for picking up laundry during rotation thereof.

[0015] The water tub 7 has a front formed with an access opening 12 and the drum 9 also has a front formed with an access opening 13. Laundry is put into and taken out of the drum 9 through the access openings 12 and 13. The opening 12 of the water tub 7 is connected by bellows to the access opening 2 of the cabinet 1 in a watertight manner. An electric motor 15 is mounted on a rear of the water tub 7. The motor 15 serves as a driving unit for driving the drum 9. The motor 15 comprises a brushless motor of the outer rotor type in which a rotor 15b is disposed outside a stator 15a. A bearing housing having a bearing (neither shown) is secured to the central rear of the water tub 7. The stator 15a is fixed to an outer circumference of the bearing. The rotor 15b includes a rotational shaft 15c rotatably mounted on the bearing. The rotational shaft 15c has a forward portion extending through a hole (not shown) formed in the rear wall of the water tub 7 into the water tub 7. The rear of the drum 9 is secured to the front end of the rotational shaft 15c.

[0016] A water reservoir 16 is mounted on a lower part of the water tub 7 so as to protrude downward. A heating element 17 is provided in the water reservoir 16. The heating element 17 comprises a sheath wire, for example and serves as a heating unit for heating wash liquid in the water tub 7. A drain hole (not shown) is provided in a rear of the water reservoir 16. A drain hose 19 is connected via a motor-driven drain valve 18 to the drain hole. The drain valve 18 and hose 19 serve as a draining unit.

[0017] A blower 20 is mounted over the rear top of the water tub 7. A heater 21 is disposed in front of the blower 20. The blower 20 comprises a casing 22, an impeller 23 disposed in the casing 22 and an electric motor 51 disposed outside the casing 22 for driving the impeller 23. The heater 21 comprises a case 24 and a heating element 25 disposed in the case 24 for producing warm air. The case 24 has an entrance communicating with an exit of the casing 22. The case 24 has an exit connected via the duct 26 to the water tub 7. A generally hollow heat exchanger 27 is provided on the left-hand rear of the water tub 7 as viewed in FIG. 3. The heat exchanger 27 is curved along the outer circumference of the rear of the water tub 7 so as to keep away from the motor 15. A rear panel of the water tub 7 has an air inlet 28 formed so as to correspond to a lower part of the heat exchanger 27. The air inlet 28 also serves as a water outlet. An upper part of the heat exchanger 27 communicates via a duct 29 with the casing 22 of the blower 20.

[0018] A water filling pipe 30 extends in an upper interior of the heat exchanger 27. The pipe 30 has a number of spouts 30a formed in a lower portion thereof so as to be horizontally aligned. The pipe 30 has an end serving as a coupling located outside the heat exchanger 27. The coupling 30a is connected via a Y-shaped connector 31 and a water filling tube 32 to a motor-driven water-supply valve 33. The water-supply valve 33 is mounted in an uppermost interior of the cabinet 1. The heat exchanger 27 exchanges heat between interior air and water supplied from the water filling pipe 30, thereby cooling and dehumidifying the interior air. Thus, the heat exchanger 27 is of the water cooled. The heat exchanger 27, blower 20, heater 21, etc. constitute a drying unit. An air trap 34 is mounted on a vertically middle portion of the rear of the heat exchanger 27. The rear of the heat exchanger 27 has a small hole (not shown) formed to correspond to the air trap 34. The heat exchanger 27 communicates via the small hole with the air trap 34.

[0019] A pressure sensor 36 is provided in the upper rear interior of the cabinet 1. The pressure sensor 36 is connected via an air tube 35 to the air trap 34. The pressure sensor 36 detects pressure in the air trap 34 and is of a high sensitivity type which can detect small pressure in the order of about several hundreds [Pa]. The air trap 34 and pressure sensor 36 constitute a bubble detecting device 37 serving as a bubble detecting unit. Furthermore, the air trap 34 is connected via a water filling tube 40 to a branch 31a of the connector 31. An interior of the air trap 34 is cleaned by water supplied from the water-supply valve 33 via the tubes 32 and 40 to the air trap.

[0020] A water-level sensor 38 is provided in the upper rear interior of the cabinet 1 so as to be located on the right of the pressure sensor 36 (on the left of the pressure sensor as viewed in FIG. 3). The water-level sensor 38 is connected to an air tube 39 and another air trap (not shown) to detect a water level in the water tub 7. Furthermore, a water filling case 41 is provided in an upper front interior of the cabinet 1. The case 41 is connected via a connecting hose 42 to the water-supply valve 33. The water filling case 41 has an exit connected via a water-supply pipe 43 to the interior of the water tub 7. The water filling case 41 encloses a detergent-dispensing case 44 which can be drawn by a user. When the detergent-dispensing case 44 containing detergent therein is accommodated in the water-filling case 41, the detergent is supplied into the water tub 7 together with water. Additionally, a temperature sensor 45 comprising a thermistor, for example, is mounted on a lower rear of the water tub7. The temperature sensor 45 detects a temperature of wash liquid in the water tub 7 and accordingly in the drum 9.

[0021] Referring now to FIG. 4, an electrical arrangement of the drum washing machine is shown. A control device 46 comprises a circuit mainly composed of a micro computer and stores a control program for controlling overall washing and drying functions. The control device 46 is provided in the aforesaid control circuit unit 6. The control device 46 receives an operation signal from a switch input section 47 and output signals from the respective water-level sensor 38, rotation sensor 48, temperature sensor 45 and pressure sensor 36. The switch input section 47 is provided in the operation circuit unit 5 and delivers operation signals in response to various switches of the operation panel 4 respectively. The rotation sensor 48 delivers a rotational position signal in accordance with a rotational position of the motor 15. Furthermore, the control device 46 controls an inverter circuit 49 thereby to control the motor 15. The control device 46 further controls the heating element 17, motor 51 of the blower 20, heating element 25 of the heater 21 and drain valve 18.

[0022] The operation of the drum washing machine will now be described with reference to FIGS. 1 and 5 to 7. The control device 46 stores a control program for carrying out a washing operation which includes overall processing for the washing operation, such as wash step, dehydration step, rinse step, etc. and a control program for carrying out a drying operation. The user can operate the operation panel 4 so that only the washing operation is carried out or both of the washing and drying operation are continuously carried out.

[0023] The washing machine of the embodiment is provided with a warm water mode in which wash liquid during a wash step. FIG. 1 is a flowchart showing a wash step carried out by the drum washing machine when execution of washing and drying operations or a washing operation is instructed under the warm water mode. Firstly, the control device 46 determines whether a previously set water level has been reached in the water tub 7 (drum 9), based on an output signal from the water-level sensor 38 (step S1). The set water level depends upon an amount of laundry in the drum 9. When determining that the set water level has not been reached (NO at step S1), the control device 46 energizes the water-supply valve 33 so that the exit at the connecting hose 42 side is opened (step S2). As a result, water from the water-supply valve 33 is supplied via the water filling case into the water tub 7. At this time, detergent in the case 44 is also supplied into the water tub 7 together with the water. Mixture of water and detergent will hereinafter be referred to as "wash liquid." The control device 46 drives the motor 15 during water supply to rotate the drum 9, whereupon the wash liquid permeates laundry in a sufficiently mixed state.

[0024] When determining that the set water level has been reached in the water tub 7 (YES at step S1), the control device 46 closes the exit of the water-supply valve 33 (step S3), advancing to step S4. The control device 46 determines whether the temperature of wash liquid has reached an upper limit value (60°C, for example) , based on an output signal of the temperature sensor 45 at step S4. When determining that the temperature of wash liquid has not reached the upper limit value (NO at step S4), the control device 46 energizes

the heating element 17 so that heat is generated by the heating element (step S5). The control device 46 successively determines whether an amount of bubble is excessive in the drum 9, based on an output signal of the pressure sensor 36 at step S6. When determining that an amount of bubble is not excessive (NO at step S6), the control device 46 determines whether the temperature of wash liquid belongs to a temperature range from 35°C to 55°C, based on an output signal of the temperature sensor 45 at step S7. When determining that the temperature of wash liquid does not belong to the temperature range from 35°C to 55°C (NO at step S7), the control device 46 rotates the drum 9 under a normal rotating mode for execution of a cleaning operation (step S8). The normal rotating mode will be referred to as "rotating mode A." In the rotating mode A, the drum 9 is rotated at 50 rpm in the normal direction for 15 seconds, interrupted for 5 seconds and rotated at 50 rpm in the reverse direction for 15 seconds, sequentially repeatedly, as shown in FIG. 5.

[0025] On the other hand, when determining that the temperature of wash liquid belongs to the temperature range from 35°C to 55°C (YES at step S7), the control device 46 rotates the drum 9 under a rotating mode restraining production of bubble for execution of a cleaning operation (step S9). This rotating mode will be referred to as "rotating mode B." In the rotating mode B, the drum 9 is rotated at 30 rpm in the normal direction for 2 seconds, interrupted for 5 seconds and rotated at 30 rpm in the reverse direction for 2 seconds, sequentially repeatedly, as shown in FIG. 6. Thus, the rotational speed of the drum 9 is lower under the rotating mode B than under the rotating mode A and the rotating time of the drum 9 is shorter under the rotating mode B than under the rotating mode A.

[0026] The cleaning operation at step S8 or S9 is carried out until the temperature of wash liquid reaches the upper limit. More specifically, the drum 9 is rotated under the rotating mode A when the temperature of wash liquid belongs to a temperature range below 35°C, which range will be referred to as "a first temperature range." The drum 9 is rotated under the rotating mode B when the temperature of wash liquid belongs to the temperature range from 35°C to 55°C, which range will be referred to as "a second temperature range." The drum 9 is again rotated under the rotating mode A when the temperature of wash liquid belongs to a temperature range exceeding 55°C, which range will be referred to as "a third temperature range." Furthermore, when determining that an amount of bubble in the drum 9 is excessive (YES at step S6), the control device 46 interrupts energization to the heating element 17 and interrupts rotation of the drum 9 so that the cleaning operation is interrupted. Furthermore, a buzzer 50 is actuated to inform of occurrence of abnormal condition (step S10).

[0027] On the other hand, when determining that the temperature of wash liquid has reached the upper limit value (YES at step S4), the control device 46 advances to step S11 to interrupt energization to the heating element 17. The control device 46 then advances to step S12 to determine whether for example, 10 minutes have passed since the temperature of wash liquid reached the upper limit value. When determining that 10 minutes have not passed yet (NO at step S12), the control device 46 rotates the drum 9 under the normal rotating mode A for execution of a cleaning operation (step S13). In this case, the cleaning operation is executed for improvement in the cleaning effect. The control device 46 terminates the wash step when determining that 10 minutes have passed since the temperature of wash liquid reached the upper limit value (YES at step S12).

[0028] The other steps of the washing operation includes a rinse step and a dehydration step. In the rinse step, the water tub 7 is drained and thereafter, water is supplied into the water tub 7. The drum 9 is then rotated. In the dehydration step, the drum 9 is rotated at high speeds or spun while the water tub 7 is being drained. Additionally, in the drying operation, the drum 9 is rotated at low speeds alternately in the normal and reverse directions repeatedly after the water tub 7 has been drained. Furthermore, the blower 20 and heater 21 are driven. Furthermore, water from the water-supply valve 33 is supplied via the tube 32 and connector 31 into the heat exchanger 27. Air in the drum 9 is returned sequentially via the heat exchanger 27, duct 29, casing 22, case 24 and duct 26 into the drum 9. Consequently, air in the drum 9 is heated into warm air and dehumidified, whereupon laundry is dried.

[0029] The inventors conducted an experiment about a relation between an amount of bubble produced in the drum 9 and the temperature of wash liquid. FIG. 7 shows the results of the experiment. Curve LA in FIG. 7 denotes a case where the drum 9 is rotated under the rotating mode A. Curve LB denotes a case where the drum 9 is rotated under the rotating mode B. As obvious from the graph of FIG. 7, an amount of bubble produced is increased with rise of the temperature of wash liquid in each rotating mode until the temperature of wash liquid reaches about 40°C to 45°C. However, when the wash liquid temperature exceeds this range of about 40°C to 45°C, an amount of bubble produced is decreased with rise of the wash liquid temperature. The reason for this is that bubble tends to break more easily when the wash liquid temperature exceeds a predetermined value, as described above. Particularly in the rotating mode A, an amount of bubble exceeds an allowable limit shown by "L" in FIG. 7 when the wash liquid temperature belongs to the temperature range of 35°C to 55°C.

[0030] On the other hand, enzyme contained in a detergent is activated when the wash liquid temperature ranges from 35°C to 45°C. Furthermore, vegetable fats and oils constituting blot of laundry start melting at 40°C to 45°C, whereas animal fats and oils start melting at 55°C to 65°C. Accordingly, various kind of soil can efficiently be removed when the cleaning operation is car-

ried out with the wash liquid temperature being increased to the range of 55°C to 65°C. In view of this, the wash liquid is heated until the temperature thereof reaches the upper limit (60°C). Furthermore, the temperature range up to the upper limit is divided into three ranges, that is, the first temperature range below 35°C, the second temperature range from 35°C to 55°C and the third temperature range from 55°C to 60°C. The rotating mode is changed according to one of the temperature ranges to which the wash liquid temperature belongs.

[0031] The drum 9 is rotated under the rotating mode B restraining production of bubble when the wash liquid temperature belongs to the second temperature range in which bubble tends to be produced easily. Furthermore, when the wash liquid temperature belongs to the first or third temperature range in which amount of bubble is relatively smaller, the drum 9 is rotated under the normal rotating mode A. Consequently, the wash liquid can be heated until it reaches a sufficient temperature to activate enzyme and to dissolve fats and oils while an amount of bubble is restrained from becoming excessive in the drum 9. Furthermore, a reduction in the mechanical cleaning action applied to laundry can be rendered smaller.

[0032] The cleaning operation is interrupted and the buzzer 50 is actuated when an amount of bubble produced in the drum 9 becomes excessive. Consequently, an excessive amount of bubble produced in the drum 9 can reliably be prevented from overflowing the washing machine. Additionally, the user can quickly find an abnormal condition of the machine.

[0033] FIG. 8 illustrates a second embodiment of the invention. Only the differences of the second embodiment from the first one will be described. Identical or similar parts are labeled with same reference symbols in the second embodiment as in the first one. FIG. 8 is a flowchart showing the wash step under the warm water mode executed by the drum washing machine of the second embodiment. In the second embodiment, the control device 46 determines whether an amount of bubble produced in the drum 9 is excessive (step S101) after the wash liquid temperature has reached the upper limit value and heat generation by the heating element 17 has been interrupted (YES at step S4; and step S11). When determining that an amount of bubble is excessive (YES at step S101), the control device 46 advances to step S102 to open the drain valve 18 so that a predetermined amount of wash liquid in the water tub 7 and accordingly in the drum 9 (2 lit., for example) is drained and thereafter, the control device 46 advances to step S12.

[0034] At step S12, the control device 46 determines whether for example, 10 minutes have passed since the wash liquid temperature reached the upper limit value. When determining that 10 minutes have not passed yet, the control device 46 executes the cleaning operation under the normal rotating mode A (step S13). Thereafter, the control device 46 returns to step S101 to repeat the processing from step S101 to step S13 until determining in the affirmative at step S12.

[0035] In the embodiment, the wash liquid is drained in the wash tub 7 when an amount of bubble has become excessive during the cleaning operation executed for enhancement of the cleaning effect. Consequently, a level of the bubble in the drum 9 can be reduced and an amount of bubble produced upon the cleaning operation can be reduced. Furthermore, laundry contains wash liquid necessary for the cleaning operation although the wash liquid is drained. Consequently, the cleaning effect can be prevented from being reduced.

[0036] The heating element 17 is sometimes exposed on the liquid surface of the wash liquid after the wash liquid has been drained. The heating element 17 is provided for heating the wash liquid. When energized in the aforesaid exposed state, the heating element 17 heats itself such that the service life thereof is reduced. In the second embodiment, however, the wash liquid is drained after energization to the heating element has been interrupted. Consequently, there is no problem if the heating element 17 is exposed on the wash liquid surface.

[0037] FIG. 9 illustrates a third embodiment of the invention. Only the differences of the third embodiment from the second one will be described. Identical or similar parts are labeled with same reference symbols in the third embodiment as in the second one. In the third embodiment, the user can set a time required for execution of the wash step. More specifically, the user operates the operation panel 4 to set a wash time T. In this case, wash times of 30, 60, 120 min. etc. are previously set in consideration of a time required for the heating element 17 to heat the wash liquid. The user selects one of the wash times. When the wash time T has been set by the user, the control device 46 stores data of the set wash time T (step S201).

[0038] The control device 46 carries out the water supply to the water tub 7 (steps S1 to S3) and thereafter, starts counting the set wash time T (step S202). The control device 46 then determines whether the counted time has reached a time (T-10) (step S203). The control device 46 repeatedly executes the processing from step S4 to step S9 until the counted time has reached the time (T-10). When determining that an amount of bubble produced in the drum 9 is excessive (YES at step S6), the control device 46 advances to step S11. When determining that the counted time has reached a time (T-10) (YES at step S203), the control device 46 advances to step S11. The control device 46 interrupts energization to the heating element 17 at step S11 and thereafter, carries out the processing from step S101 to step S13. In the third embodiment, the control device 46 carries out the processing at step S204, instead of step S12 in the second embodiment. At step S204, the control device 46 determines whether the set time T has expired. The control device 46 repeatedly carries out the

processing from step S101 to S13 until the set time T expires. The control device 46 finishes the wash step upon expiration of the set time T.

[0039] The wash step is not discontinued even when an amount of bubble has become excessive during the cleaning operation. Consequently, the cleaning operation can be executed exactly for the wash time T set by the user.

[0040] The invention should not be limited to the embodiments described with reference to the accompanying drawings. The following modification can be made. The invention may be applied to washing machines of the vertical axis type comprising a wash tub rotated about a vertical axis and an agitator mounted on the bottom of the wash tub. In this case, the control device preferably changes a rotating mode of the agitator according to the wash liquid temperature.

[0041] Furthermore, the control device 46 may change either one of a rotational speed and rotating time of the drum 9 according to the temperature range to which the wash liquid temperature belongs.

[0042] Additionally, a boundary between the first and second temperature ranges should not be limited to 35°C but may be ranged from 35°C. In the same way, a boundary between the second and third temperature ranges should not be limited to 55°C but may be ranged from 55°C to 65°C.

INDUSTRIAL APPLICABILITY

[0043] As obvious from the foregoing, the present invention is useful when applied to a domestic washing machine in which wash liquid is heated for execution of a cleaning operation.

Claims

1. A washing machine comprising:

a wash tub in which a predetermined amount of wash liquid is reserved;
a heating unit heating the wash liquid;
a temperature sensor detecting a temperature of the wash liquid;
a driving unit rotating the wash tub; and
a control device controlling the driving unit so that rotation of the wash tub is controlled,

wherein the control device changes a rotating mode of the wash tub according to one of a plurality of temperature ranges to which the temperature of the wash liquid detected by the temperature sensor belongs.

2. A washing machine comprising:

a wash tub in which a predetermined amount of wash liquid is reserved;
a heating unit heating the wash liquid;
a temperature sensor detecting a temperature of the wash liquid;
an agitator rotatably mounted in the wash tub;
a driving unit rotating the agitator;
a control device controlling the driving unit so that rotation of the agitator is controlled,

wherein the control device changes a rotating mode of the agitator according to one of a plurality of temperature ranges to which the temperature of the wash liquid detected by the temperature sensor belongs.

3. A washing machine according to claim 1, wherein the temperature ranges include a first temperature range and a second temperature range higher than the first temperature range, and the control device renders a rotating time of the wash tub shorter and/or a rotational speed of the wash tub lower when the temperature of the wash liquid detected by the temperature sensor belongs to the second temperature range than when the temperature of the wash liquid detected by the temperature sensor belongs to the first temperature range.

4. A washing machine according to claim 2, wherein the temperature ranges include a first temperature range and a second temperature range higher than the first temperature range, and the control device renders a rotating time of the agitator shorter and/or a rotational speed of the agitator lower when the temperature of the wash liquid detected by the temperature sensor belongs to the second temperature range than when the temperature of the wash liquid detected by the temperature sensor belongs to the first temperature range.

5. A washing machine according to claim 3, wherein a boundary between the first and second temperature ranges is set to be at or above 35°C and at or below 45°C.

6. A washing machine according to claim 4, wherein a boundary between the first and second temperature ranges is set to be at or above 35°C and at or below 45°C.

7. A washing machine according to claim 1, wherein the temperature ranges include a first temperature range, a second temperature range higher than the first temperature range and a third temperature range higher than the second temperature range, and the control device renders a rotating time of the wash tub shorter and/or a rotational speed of the wash tub lower when the temperature of the wash liquid detected by the temperature sensor belongs

to the second temperature range than when the temperature of the wash liquid detected by the temperature sensor belongs to each of the other temperature ranges.

8. A washing machine according to claim 2, wherein the temperature ranges include a first temperature range, a second temperature range higher than the first temperature range and a third temperature range higher than the second temperature range, and the control device renders a rotating time of the agitator shorter and/or a rotational speed of the agitator lower when the temperature of the wash liquid detected by the temperature sensor belongs to the second temperature range than when the temperature of the wash liquid detected by the temperature sensor belongs to each of the other temperature ranges.

9. A washing machine according to claim 7, wherein a boundary between the second and third temperature ranges is set to be at or above 55°C and at or below 65°C.

10. A washing machine according to claim 8, wherein a boundary between the second and third temperature ranges is set to be at or above 55°C and at or below 65°C.

11. A washing machine comprising:

a wash tub in which a predetermined amount of wash liquid is reserved;
a heating unit heating the wash liquid;
a draining unit draining the wash liquid from the wash tub;
a bubble detector detecting an amount of bubble produced in the wash tub; and
a control device controlling at least the wash tub and the heating unit so that a washing operation is carried out with the heating unit heating the wash liquid,

wherein when determining that an amount of bubble detected by the bubble detector exceeds a predetermined value, the control device interrupts the heating unit and operates the draining unit so that the wash liquid is drained and the washing operation is carried out.

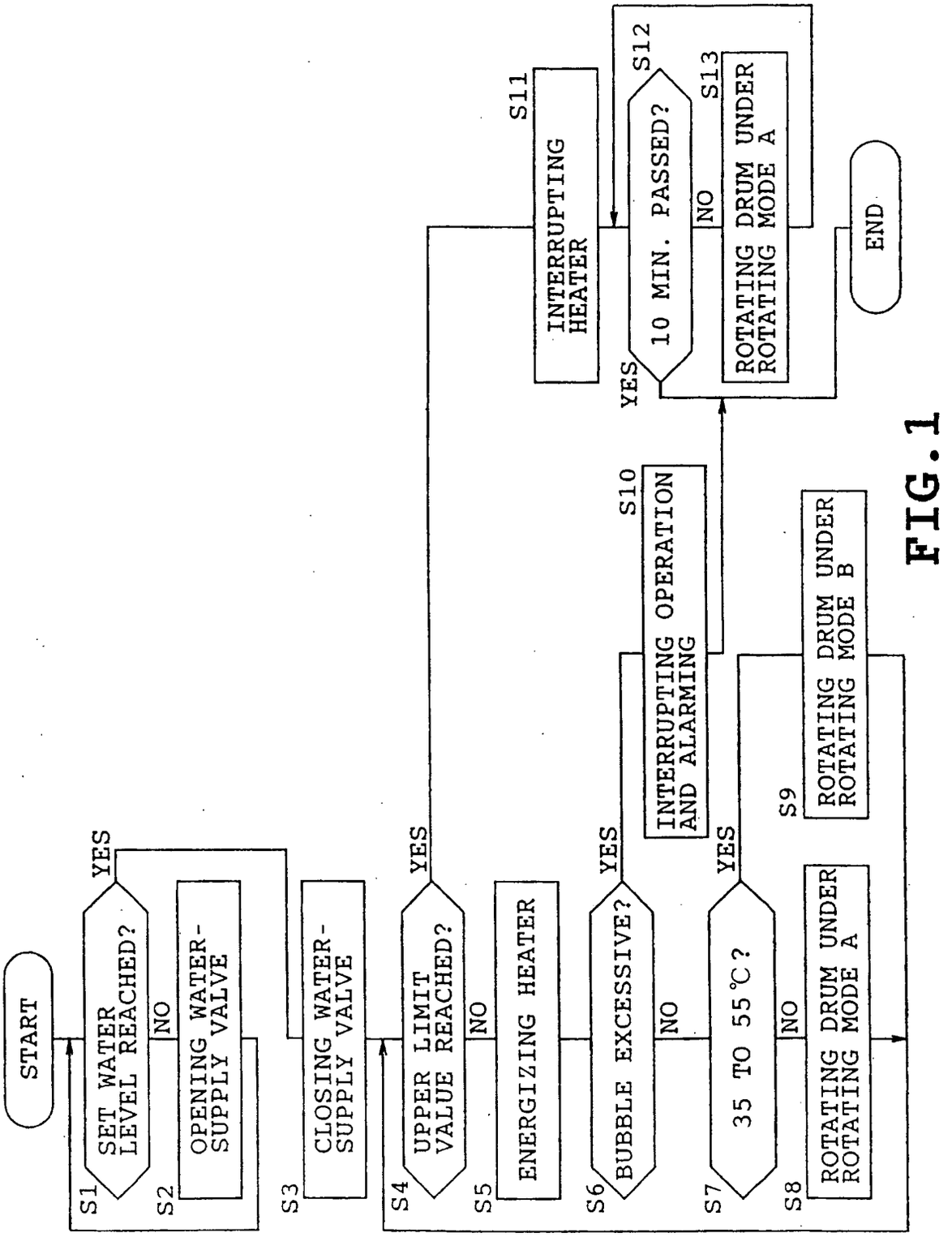
START
S1
SET WATER LEVEL REACHED?
YES
NO
S2
OPENING WATER-SUPPLY VALVE
S3
CLOSING WATER-SUPPLY VALVE
S4
UPPER LIMIT VALUE REACHED?
YES
NO
S5
ENERGIZING HEATER
S6
BUBBLE EXCESSIVE?
YES
NO
S7
35 TO 55 ℃ ?
YES
NO
S8
ROTATING DRUM UNDER ROTATING MODE A
S9
ROTATING DRUM UNDER ROTATING MODE B
S10
INTERRUPTING OPERATION AND ALARMING
S11
INTERRUPTING HEATER
S12
10 MIN. PASSED?
YES
NO
S13
ROTATING DRUM UNDER ROTATING MODE A
END

FIG.1

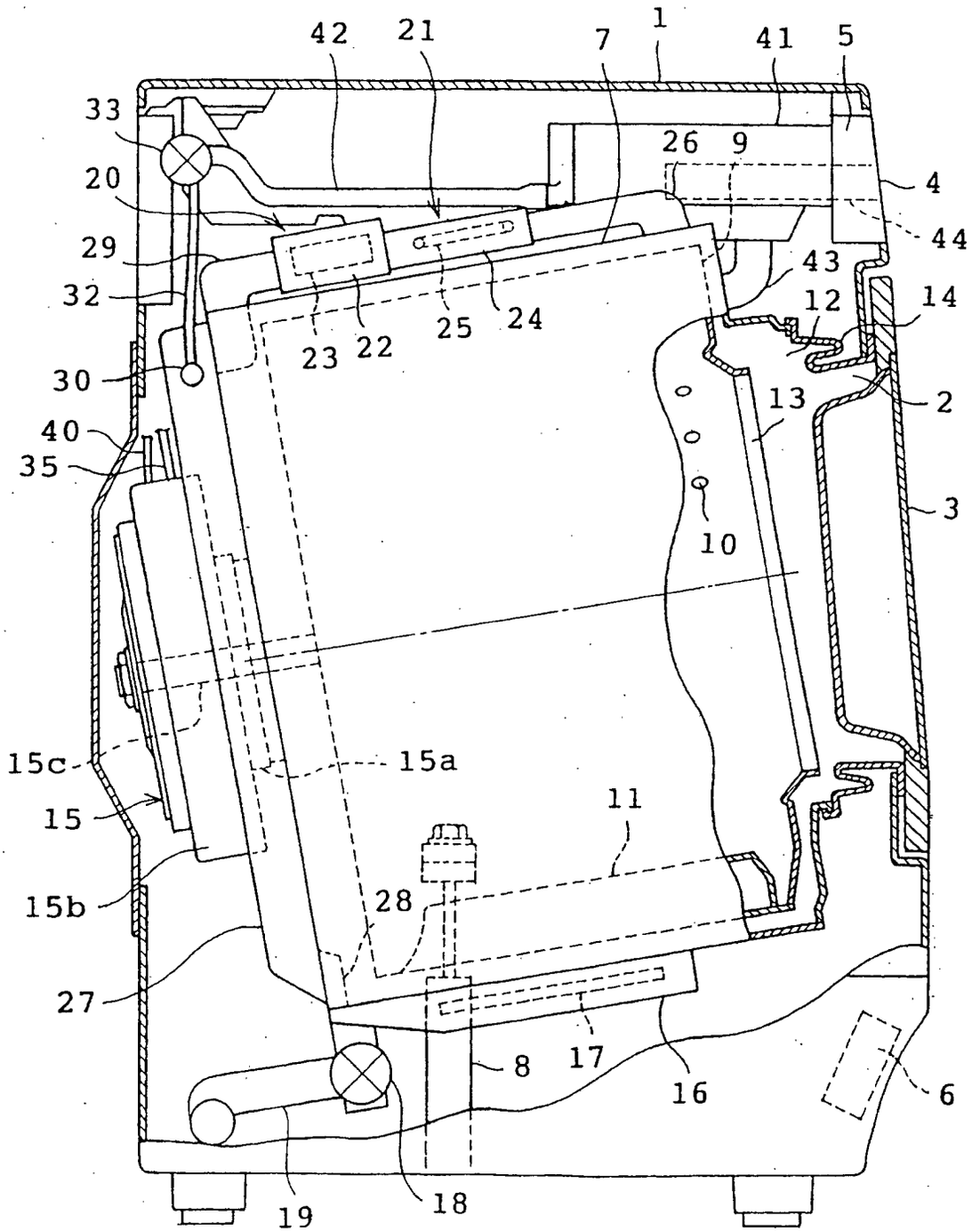
42
21
7
1
41
5
33
26
9
20
4
44
29
43
32
12
14
23
22
25
24
30
13
2
40
35
10
3
15c
15a
11
15
28
15b
27
8
17
16
6
19
18

FIG. 2

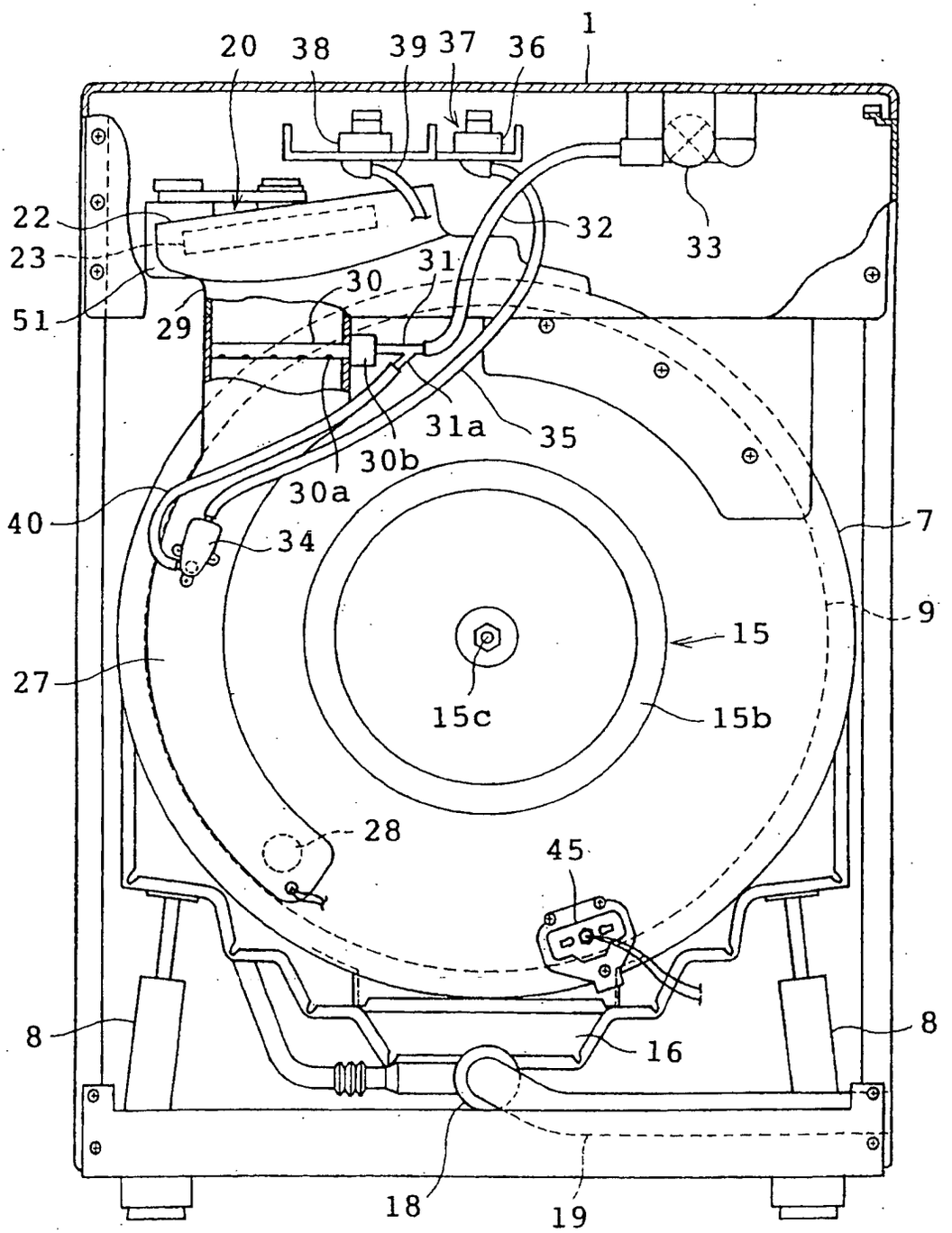
1
20
38
39
37
36
22
23
51
29
30
31
32
33
31a
35
30b
30a
40
34
7
9
15
27
15c
15b
28
45
8
16
8
18
19

FIG.3

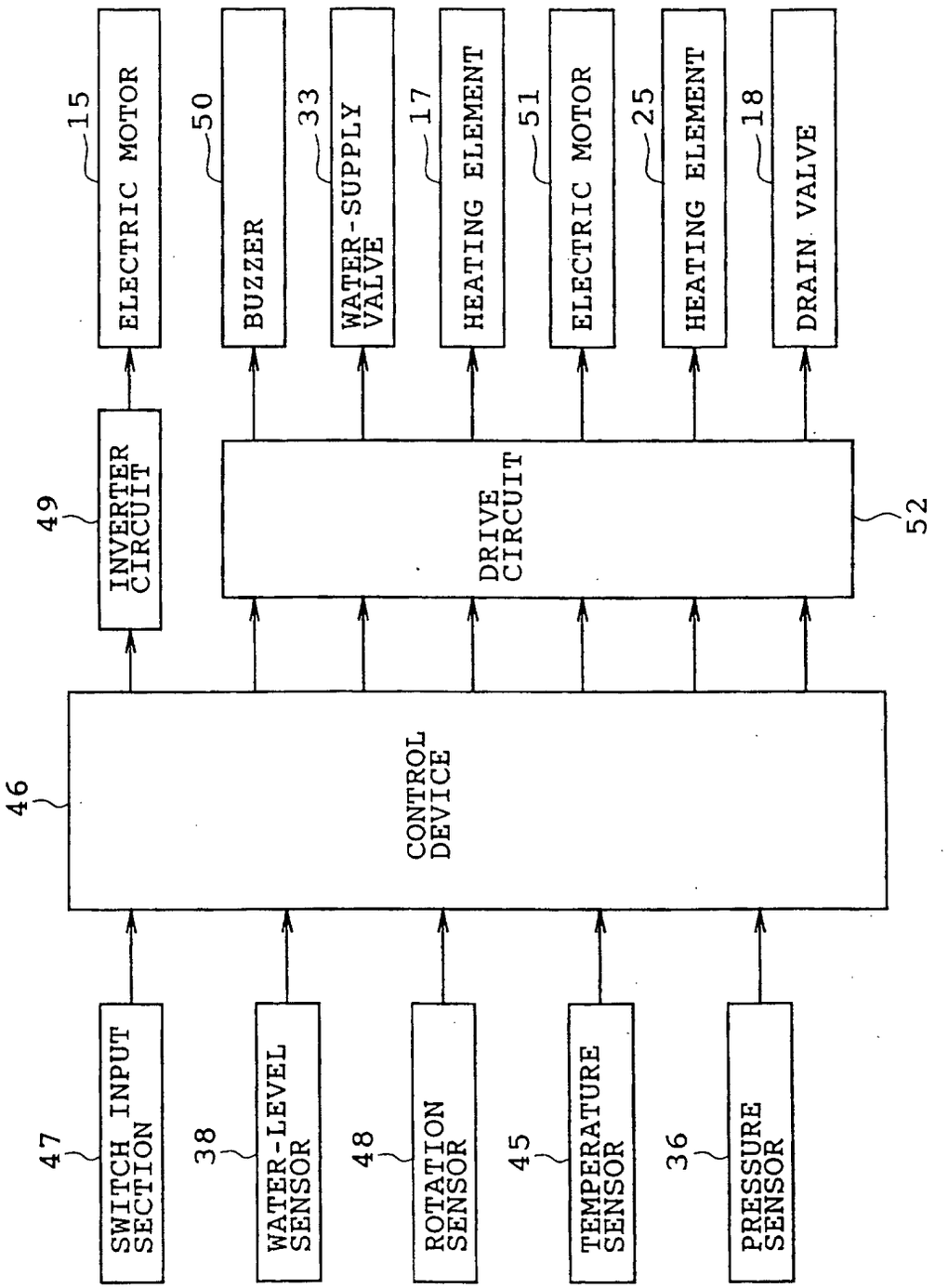
ELECTRIC MOTOR
15
BUZZER
50
WATER-SUPPLY VALVE
33
HEATING ELEMENT
17
ELECTRIC MOTOR
51
HEATING ELEMENT
25
DRAIN VALVE
18
INVERTER CIRCUIT
49
DRIVE CIRCUIT
52
CONTROL DEVICE
46
SWITCH INPUT SECTION
47
WATER-LEVEL SENSOR
38
ROTATION SENSOR
48
TEMPERATURE SENSOR
45
PRESSURE SENSOR
36

FIG. 4

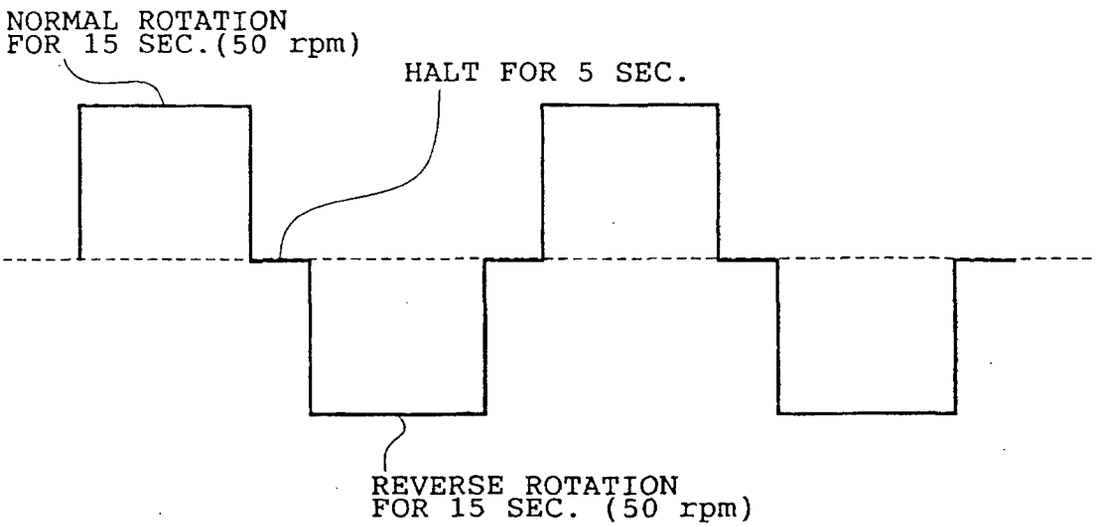
NORMAL ROTATION
FOR 15 SEC.(50 rpm)
HALT FOR 5 SEC.
REVERSE ROTATION
FOR 15 SEC. (50 rpm)

FIG.5

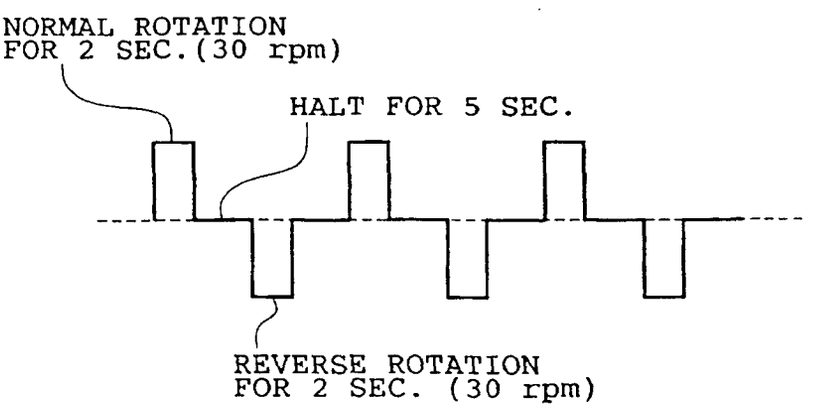
NORMAL ROTATION
FOR 2 SEC.(30 rpm)
HALT FOR 5 SEC.
REVERSE ROTATION
FOR 2 SEC. (30 rpm)

FIG.6

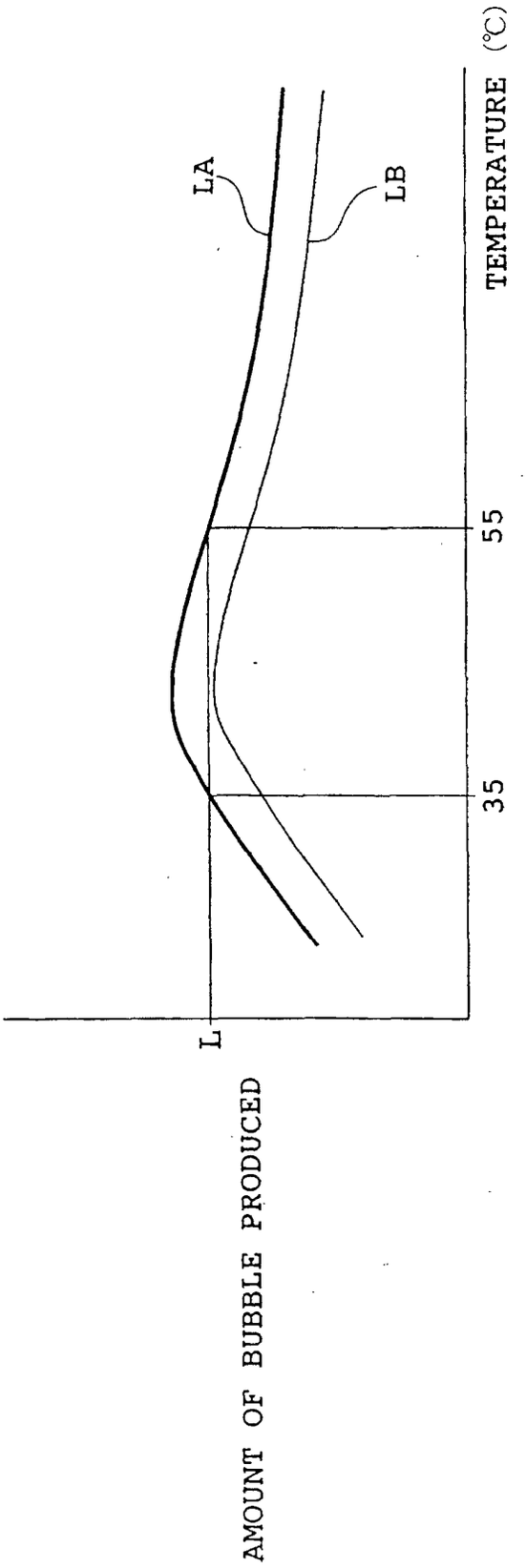

FIG. 7

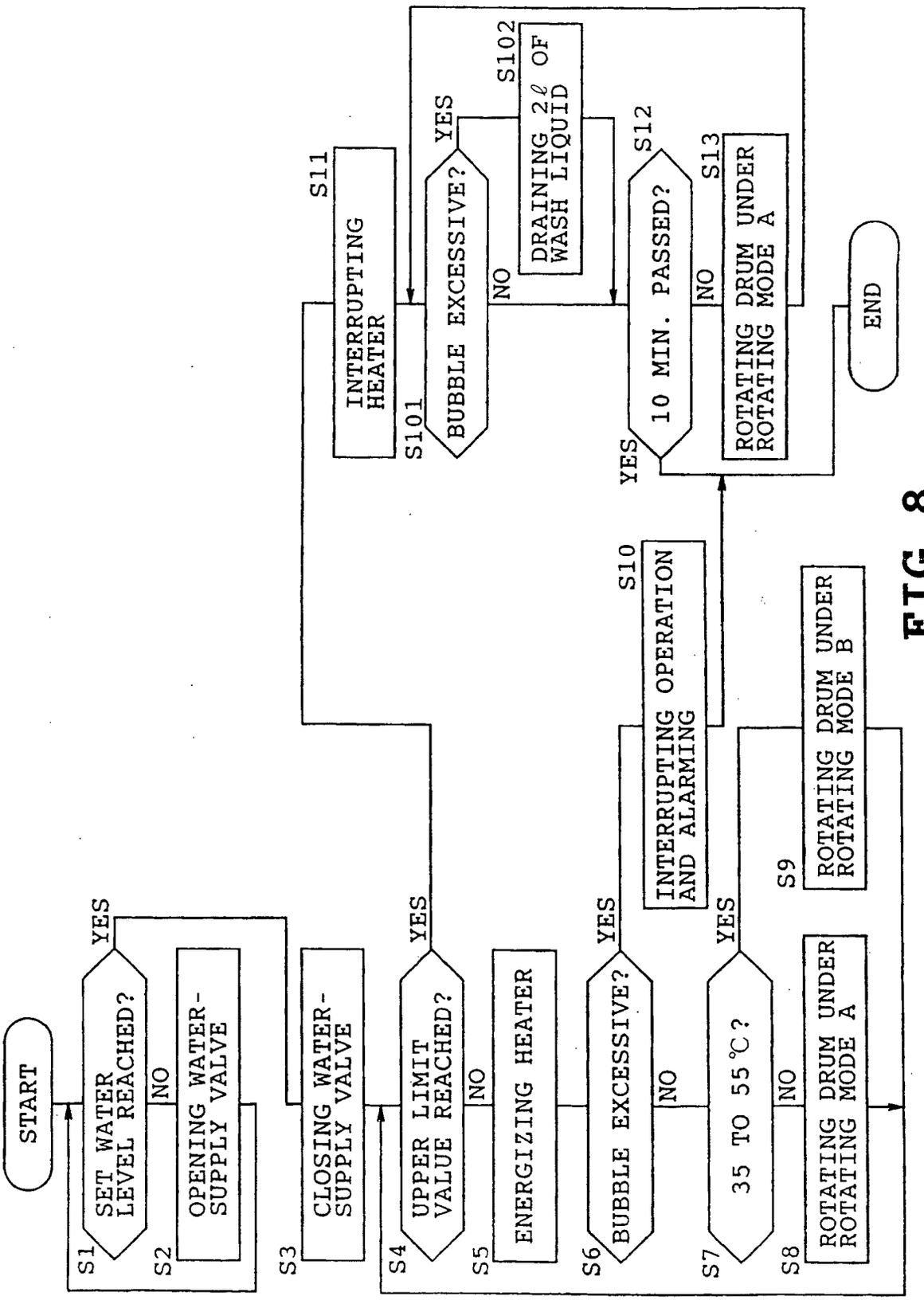
START
S1
SET WATER LEVEL REACHED?
YES
NO
S2
OPENING WATER-SUPPLY VALVE
S3
CLOSING WATER-SUPPLY VALVE
S4
UPPER LIMIT VALUE REACHED?
YES
NO
S5
ENERGIZING HEATER
S6
BUBBLE EXCESSIVE?
YES
NO
S7
35 TO 55 ℃?
YES
NO
S8
ROTATING DRUM UNDER ROTATING MODE A
S9
ROTATING DRUM UNDER ROTATING MODE B
S10
INTERRUPTING OPERATION AND ALARMING
S11
INTERRUPTING HEATER
S101
BUBBLE EXCESSIVE?
YES
NO
S102
DRAINING 2ℓ OF WASH LIQUID
S12
10 MIN. PASSED?
YES
NO
S13
ROTATING DRUM UNDER ROTATING MODE A
END

FIG. 8

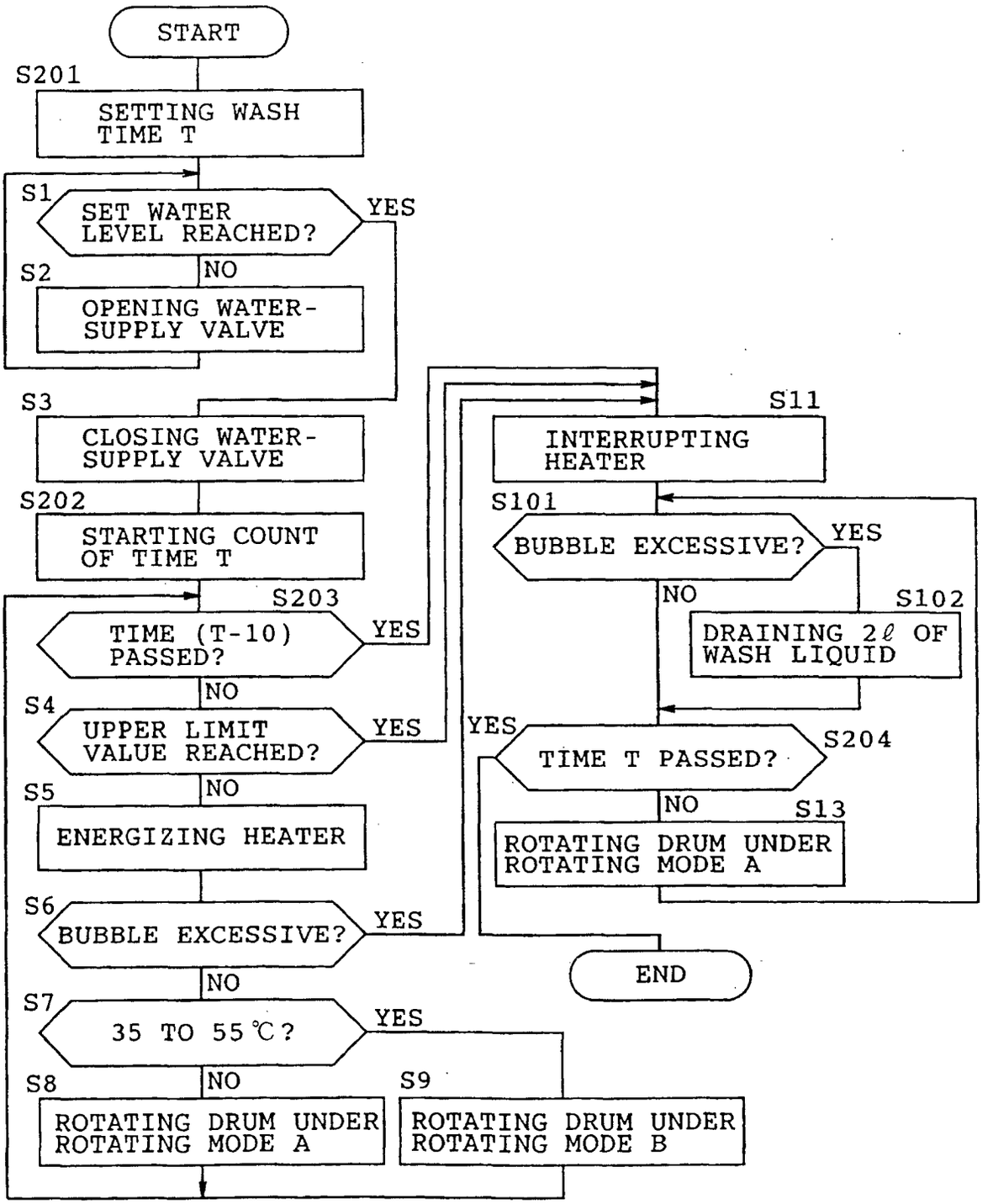
START
S201
SETTING WASH TIME T
S1
SET WATER LEVEL REACHED?
YES
NO
S2
OPENING WATER-SUPPLY VALVE
S3
CLOSING WATER-SUPPLY VALVE
S202
STARTING COUNT OF TIME T
S203
TIME (T-10) PASSED?
YES
NO
S4
UPPER LIMIT VALUE REACHED?
YES
NO
S5
ENERGIZING HEATER
S6
BUBBLE EXCESSIVE?
YES
NO
S7
35 TO 55℃?
YES
NO
S8
ROTATING DRUM UNDER ROTATING MODE A
S9
ROTATING DRUM UNDER ROTATING MODE B
S11
INTERRUPTING HEATER
S101
BUBBLE EXCESSIVE?
YES
NO
S102
DRAINING 2ℓ OF WASH LIQUID
YES
S204
TIME T PASSED?
NO
S13
ROTATING DRUM UNDER ROTATING MODE A
END

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP02/13271

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] D06F39/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] D06F39/04, D06F39/06, D06F33/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2003
Kokai Jitsuyo Shinan Koho	1971-2003	Toroku Jitsuyo Shinan Koho	1994-2003

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2001-224887 A (Toshiba Corp.), 21 August, 2001 (21.08.01), Par. Nos. [0050] to [0051], [0058]; Figs. 1, 7 (Family: none)	1,3 2,4-10
X Y	JP 9-225175 A (Matsushita Electric Industrial Co., Ltd.), 02 September, 1997 (02.09.97), Par. Nos. [0044] to [0051] (Family: none)	2,4 1,3,5,6

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
05 February, 2003 (05.02.03)	25 February, 2003 (25.02.03)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP02/13271

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 122301/1988(Laid-open No. 43986/1990) (Sharp Corp.), 27 March, 1990 (27.03.90), Page 1, lines 10 to 17; page 4, lines 3 to 4 (Family: none)	2,4 1,3,5,6
P	JP 2002-248296 A (Toshiba Corp.), 03 September, 2002 (03.09.02), Par. Nos. [0099] to [0101] (Family: none)	11

Form PCT/ISA/210 (continuation of second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP02/13271

Box I Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
Claims 1-10 relate to a washing machine adapted to detect the temperature of a washing water to inhibit excessive foaming.
Claim 11 relates to a washing machine having a device to cope with excessive foam produced.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest
☐ The additional search fees were accompanied by the applicant's protest.
☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (1)) (July 1998)