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(54) **Washing machine**

(57) A drum washing machine including a water tub, a rotary tub rotatably provided in the water tub, a pumping unit to pump water contained in a lower portion of the water tub into the rotary tub, and a control unit to control the pumping unit wherein the control unit con-

trols the pumping unit to pump the water contained in the lower portion of the water tub into the rotary tub while determining an amount of a laundry load.

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Description

[0001] The present invention relates to a drum washing machine comprising a fixed water tub, a rotary tub rotatably mounted within the fixed tub to receive laundry to be washed and a water pump 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 water tub, and then a rotary tub within the water tub is rotated alternately in opposite directions to uniformly soak the laundry with the water. As the laundry absorbs some of the water, the water level within the water tub/rotary tub lowers relative to the water level when the water was initially fed in. Therefore, supplementary water is fed into the water tub to restore the lowered water level up to the initial water level.

[0003] A conventional drum washing machine determines the size of the laundry load according to the number of water supplement operations. That is, if there are a large number of water supplement operations, it is deduced that the laundry load is large, whereas if there are a small number of water supplement operations, it implies that the laundry load is small. The size of the laundry load is used as basic data for subsequent washing, rinsing and drying processes.

[0004] Generally, the length of time required for laundry to sufficiently absorb water differs according to the material(s) making up the laundry. In addition, the extent to which the laundry absorbs water, and the time taken to do so, also depends on how the laundry is arranged. For example, if clothes of the laundry are tightly knotted and entangled, the extent to which they absorb water and the time taken to do so will be different than if the laundry is loose and separate.

[0005] However, in conventional drum washing machines, the only way the water is caused to be absorbed into the laundry is by rotating the rotary tub alternately in opposite directions. Therefore, if the rotary tub contains laundry having a relatively low water absorptivity, or the clothes of the laundry are tight knotted and entangled, the laundry may not be sufficiently and uniformly soaked with the water within a short space of time. Consequently, there is a problem in that it is difficult to precisely determine the size of the laundry load within a short space of time.

[0006] It is therefore an object of the present invention to provide a drum washing machine, and a method of controlling the drum washing machine, which substantially alleviates or overcomes the problems mentioned above.

[0007] The washing machine of the present invention is characterised in that the water pump is operable to pump water fed into the fixed water tub from the fixed water tub and into the rotary tub.

[0008] A preferred embodiment comprises a circulation pipe having one end connected to the fixed water tub and the other end to an inlet to the rotary tub, the pump being operable to pump water through the pipe

from the fixed water tub into the rotary tub.

[0009] A control unit and a water level sensor are preferably provided to determine the level of water in the rotary tub after the pump has stopped. Conveniently, the control unit is operable to cause further water to be supplied to the fixed water tub if the water level sensor detects that the water level is below a predetermined level and to restart the pump when the predetermined water level has been reached. Advantageously, the water level sensor is operable to detect the water level in the rotary tub each time the pump is stopped, the control unit being operable to cause further water to be supplied to the fixed water tub if the water level sensor detects that the water level is below a predetermined level each time.

[0010] In a preferred embodiment, the water level sensor is operable to continue detecting the water level in the rotary tub each time the pump is stopped until a predetermined time limit is exceeded or the predetermined water level is maintained following operation of the pump.

[0011] Preferably, the control unit is operable to calculate the number of times that further water is supplied to the fixed water tub each time that the pump is stopped and, to determine the amount of laundry in the rotary drum in dependence on the calculated number of times that further water is supplied to the fixed water tub.

[0012] The drum washing machine may include a motor to rotate the rotary tub, wherein control unit may control the motor to rotate the rotary tub in opposite directions while controlling an operation of the pumping unit.

[0013] The drum washing machine control unit may determine the water level from the water level sensor when the pump and the motor are simultaneously stopped.

[0014] The drum washing machine may include a user input comprising a key input unit to receive washing courses according to materials of the laundry load, wherein the control unit operates the pump according to ON-OFF periods corresponding to the washing courses.

[0015] The key input unit may be provided with washing course buttons for one or more of cotton fabrics, mixed fabrics, woollen fabrics and synthetic fibres. The ON-OFF periods of the pump may be set according to a chosen one of the washing course buttons. Durations of OFF periods of the ON-OFF periods may increase from the cotton fabrics, to the mixed fabrics, to the woollen fabrics, to the synthetic fibres.

[0016] The method of controlling a drum washing machine of the present invention is characterised by the steps of feeding a set amount of water into the fixed water tub, operating the pump unit to circulate the water between the fixed tub and the rotary tub, and determining the size of the laundry load.

[0017] A preferred method also comprises the step of rotating the rotary tub whilst the pump unit circulates the water. Conveniently, the operation of the pump unit is variable dependent upon user input criteria.

[0018] Preferably, the method also includes the steps

of performing a number of additional water feeding operations within a preset time period to maintain the water level at a predetermined level, calculating the number of additional water feeding operations, and determining the size of the laundry load based on the number of additional water feeding operations.

[0019] The drum washing machine control method may include operating a motor to rotate the rotary tub alternately in opposite directions while controlling an operation of the pumping unit.

[0020] The drum washing machine control method may include determining the water level of the rotary tub using a water level sensor, when the pumping unit and the motor are simultaneously stopped.

[0021] The pumping unit operations may be preset according to materials of the laundry load.

[0022] The time duration of pumping operations of the pumping unit may increase from a cotton fabrics washing course, to a mixed fabrics washing course, to a woolen fabrics washing course, to a synthetic fibre washing course.

[0023] A preferred embodiment of the present 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 an embodiment of the present invention;

Figures 3A and 3B are timing diagrams showing a procedure of reading a water level value from a water level sensor so as to detect a current water level of a rotary tub in Figure 2;

Figure 4 is a control flowchart showing a method of setting an ON-OFF period of a pump according to washing course buttons which are chosen by a user based on materials of laundry; and

Figures 5A, 5B and 5C are timing diagrams showing the ON-OFF period of the pump according to buttons of Figure 4.

[0024] Referring now to Figure 1, the drum washing machine of the present invention includes a water tub 10 and a rotary tub 11 rotatably provided in the water tub 10.

[0025] A water feed pipe 12 is connected to the water tub 10 to supply water from an external water supply pipe into the water tub 10. A water feed valve 13 is mounted in the water feed pipe 12 to control the flow of water. A detergent container 14 is disposed in the water feed pipe 12.

[0026] A drain pipe 15 is disposed between the bottom of the water tub 10 and a drain outlet to enable water to be drained from the water tub 10. A drain pump 16 and a drain valve 17 are mounted in the drain pipe 15 to pump the water out of the water tub 10.

[0027] A circulating pipe 18 is branched from the drain pipe 15 between the drain pump 16 and the drain valve 17. One end of the circulating pipe 18 is connected to the water tub 10 and a remaining end thereof is provided at an inlet of the rotary tub 11 so as to circulate the water from the water tub 10 to the rotary tub 11. A spray nozzle 18a is disposed at said remaining end of the circulating pipe 18 to spray the circulated water into the rotary tub 11. A circulating valve 19 is mounted in the circulating pipe 18 to prevent water from flowing up into the circulating pipe 18 when the system is draining the water to the drain outlet. The circulating pipe 18, the drain pump 16, the spray nozzle 18a and the circulating valve 19 form a pumping unit.

[0028] A reversible motor 20 is coupled to the rotary tub 11 and is operable to rotate said rotary tub 11. A water level sensor (not shown) is mounted in the rotary tub 11 to detect the water level within the rotary tub 11.

[0029] The water feed valve 13, the motor 20, the drain pump 16, the drain valve 17, the circulating valve 19, and the water level sensor are all electrically connected to a control unit (not shown) that performs the entire control operation of the drum washing machine.

[0030] The control unit includes a user input side which is connected to washing course buttons (not shown) to receive information from a user regarding materials of the laundry, such as whether it comprises cotton fabrics, woollen fabrics, or synthetic fibres. As will be described later, the control unit controls the number of pumping operations of the drain pipe 16, varied by setting different ON-OFF periods of the drain pump 16, in response to signals received from the buttons.

[0031] Referring now to the control flowchart of Figure 2, in operation 100, the water feed valve 13 is turned on for a certain period, so that water is fed into the water tub 10 until the level of the water reaches a preset water level. Accordingly, water flows from the water feed pipe 12 through the detergent container 14, and fills a lower portion of the water tub 10.

[0032] Once the water reaches the preset water level, in operation 110, the water level sensor sends a signal to the control unit which then controls the reversible motor 20 to rotate in forward and reverse directions so as to rotate the rotary tub 11 in opposite directions, and thereby cause the laundry to be sufficiently and uniformly soaked with water. Simultaneously, also in operation 110, the control unit controls the drain pump 16 to circulate water from the lower portion of the water tub 10 to be sprayed onto the laundry in the rotary tub 11.

[0033] Even if the laundry is tangled together, the alternating opposite directional rotation of the rotary tub 11 and the water circulation and spray operation loosens and separates it. Therefore, the laundry is sufficiently and uniformly soaked with water within a short space of time.

[0034] Thereafter, in operation 120, a water current level reading is taken from the water level sensor within rotary tub 11 to determine whether supplementary feed-

ing of water is required. The water level is read during an interval when both the motor and the pump are simultaneously turned off so that the water level can be detected more accurately.

[0035] In operation 130, it is determined whether the feeding of supplementary water is required, depending on the read water level. If the read water level of the rotary tub 11 is lower than the preset water level, it is determined that the feeding of supplementary water is required. On the contrary, if the read water level of the rotary tub 11 is not lower than the preset water level, it is determined that the feeding of supplementary water is not required. If the feeding of supplementary water is required, the water feed valve 13 is turned on in operation 140.

[0036] Thereafter, the control unit repeatedly performs a series of operations for a preset period in which laundry is allowed to be soaked with water and the supplementary water is fed into the rotation tub 10 depending on the variations of the water level in the rotary tub 11.

[0037] Subsequently, the control unit determines whether the preset period has elapsed in operation 150. If the preset period has not elapsed, the control unit performs operation 110 and repeats the operations of allowing the laundry to be soaked with water and feeding the supplementary water depending on the variations of the water level. However, if the preset period has elapsed, the number of water supplement operations performed during the preset period is then determined in operation 160.

[0038] In operation 170, the size of the laundry load is determined based on the number of water supplement operations determined from operation 160. That is, if the number of water supplement operations is large, the size of the laundry load is large, whereas if the number of water supplement operations is small, the size of the laundry load is small.

[0039] Figures 3A and 3B are timing diagrams showing a procedure for reading the water level from the water level sensor in the rotary tub, as in operation 120 in Figure 2. The motor 20 and the drain pump 16 have different ON-OFF periods. However, the motor 20 and the drain pump 16 are set to have intervals T_1 during which they are both simultaneously turned off. The control unit reads the water level from the water level sensor during these intervals T_1 so as to detect the water level most precisely.

[0040] Referring now to Figures 5A-5C with Figure 4 taken into consideration, it can be seen that the ON-OFF period of the pump is set according to the washing courses classified by the materials of the laundry, such as cotton fabrics, mixed fabrics and woollen fabrics and synthetic fibres.

[0041] For example, in the case of cotton fabrics having a relatively large laundry load and high absorptivity, the OFF period of the pump is set to be shorter than those for other fabrics, so that the number of pumping

operations within the preset time period of the pump is increased thereby enabling laundry to be sufficiently soaked with water within a short time.

[0042] In the case of mixed fabrics having a similar size laundry load, but low absorptivity compared to the cotton fabrics, the OFF period of the pump is set to be longer than that for the cotton fabrics thereby reducing the number of pumping operations of the pump compared to the cotton fabrics course.

[0043] Finally, woollen fabrics have a small size load compared to the cotton fabrics and the mixed fabrics, but have very high absorptivity according to material and texture properties of the woollen fabrics. The synthetic fibres have a small size load, small volume, small thickness, and low absorptivity compared to the cotton fabrics and mixed fabrics, so that the amount of water required for washing is small. Therefore, in the case of the woollen fabrics and the synthetic fibres, the OFF period of the pump is set to be relatively longer than those for the cotton fabrics and the mixed fabrics, thus reducing the number of pumping operations of the pump compared to the cotton fabrics and mixed fabrics courses.

[0044] 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 circulates water contained in a water tub into a rotary tub to be sprayed onto laundry simultaneously with the rotation of the rotary tub in opposite directions, so that the laundry is sufficiently and uniformly soaked with water within a short space of time, and then the laundry load size is precisely and quickly determined, improving reliability of the determination.

[0045] Furthermore, the present invention is advantageous in that it controls the number of water circulation and spray operations performed by a pump according to the materials of the laundry, thus precisely determining the amount of load of laundry within a short space of time.

[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 in these embodiments without departing from the principles of the invention, the scope of which is defined in the claims and their equivalents hereafter.

Claims

1. A washing machine comprising a fixed water tub, a rotary tub rotatably mounted within the fixed tub to receive laundry to be washed and a water pump, **characterised in that** the water pump is operable to pump water fed into the fixed water tub from the fixed water tub and into the rotary tub.
2. A washing machine according to claim 1, comprising a circulation pipe having one end connected to the fixed water tub and the other end to an inlet to

the rotary tub, the pump being operable to pump water through the pipe from the fixed water tub into the rotary tub.

3. A washing machine according to claim 1 or claim 2, including a control unit and a water level sensor to determine the level of water in the rotary tub after the pump has stopped. 5
4. A washing machine according to claim 3, wherein the control unit is operable to cause further water to be supplied to the fixed water tub if the water level sensor detects that the water level is below a predetermined level and to restart the pump when the predetermined water level has been reached. 10 15
5. A washing machine according to claim 4, wherein the water level sensor is operable to detect the water level in the rotary tub each time the pump is stopped, the control unit being operable to cause further water to be supplied to the fixed water tub if the water level sensor detects that the water level is below a predetermined level each time. 20
6. A washing machine according to claim 5, wherein the water level sensor is operable to continue detecting the water level in the rotary tub each time the pump is stopped until a predetermined time limit is exceeded or the predetermined water level is maintained following operation of the pump. 25 30
7. A washing machine according to claim 6, wherein the control unit is operable to calculate the number of times that further water is supplied to the fixed water tub each time that the pump is stopped and, to determine the amount of laundry in the rotary drum in dependence on the calculated number of times that further water is supplied to the fixed water tub. 35 40
8. A method of controlling a washing machine comprising a fixed water tub, a rotary tub within said fixed water tub, a pump unit and a control unit **characterised by** the steps of feeding a set amount of water into the fixed water tub, operating the pump unit to circulate the water between the fixed tub and the rotary tub, and determining the size of the laundry load. 45
9. A method according to claim 8 further comprising the step of rotating the rotary tub whilst the pump unit circulates the water. 50
10. A method according to claim 8 or claim 9 wherein the operation of the pump unit is variable dependent upon user input criteria. 55
11. A method according to any of claims 8-10 including

the steps of performing a number of additional water feeding operations within a preset time period to maintain the water level at a predetermined level, calculating the number of additional water feeding operations, and determining the size of the laundry load based on the number of additional water feeding operations.

12. A drum washing machine comprising a water tub, a rotary tub rotatably provided in the water tub, a pumping unit to pump water contained in a lower portion of the water tub into the rotary tub, and a control unit to control the pumping unit, wherein the control unit controls the pumping unit to pump the water contained in the lower portion of the water tub into the rotary tub while determining an amount of a laundry load.
13. The drum washing machine according to claim 12 wherein the pumping unit comprises a circulating pipe having a first end coupled to an inside of the water tub and a second end disposed at an inlet of the rotary tub, a pump to pump the water contained in the water tub into the rotary tub and a spray nozzle disposed at the second end of the circulating pipe.
14. The drum washing machine according to claim 13 further comprising a motor to rotate the rotary tub wherein the control unit controls the motor to rotate the rotary tub in opposite directions while controlling an operation of the pumping unit.
15. The drum washing machine according to claim 14 further comprising a water level sensor to detect a water level of the rotary tub wherein the control unit determines the water level from the water level sensor in response to the pump and the motor being simultaneously stopped.
16. The drum washing machine according to claim 12 further comprising a key input unit to receive washing courses according to materials of the laundry load wherein the control unit operates the pump according to ON-OFF periods corresponding to the washing courses.
17. The drum washing machine according to claim 16 wherein the key input unit is provided with washing course buttons for one or more of cotton fabrics, mixed fabrics, woollen fabrics and synthetic fibres.
18. The drum washing machine according to claim 17 wherein the ON-OFF periods of the pump are set according to a chosen one of the washing course buttons.
19. The drum washing machine according to claim 18

wherein durations of OFF periods of the ON-OFF periods increase from the cotton fabrics, to the mixed fabrics, to the woollen fabrics to the synthetic fibres.

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20. A method of controlling a drum washing machine, the drum washing machine having a water tub, a rotary tub, and a pumping unit to pump water contained in a lower portion of the water tub into the rotary tub, the method comprising feeding a set amount of water according to a selected washing course, and operating the pumping unit to pump the water contained in a lower portion of the water tub into the rotary tub while determining an amount of laundry load. 10 15
21. The drum washing machine control method according to claim 20 further comprising operating a motor to rotate the rotary tub in opposite directions while controlling an operation of the pumping unit. 20
22. The drum washing machine control method according to claim 21 further comprising determining a water level of the rotary tub through a water level sensor which detects the water level of the rotary tub in response to the pumping unit and the motor being simultaneously stopped. 25
23. The drum washing machine control method according to claim 20 wherein the pumping unit is designed so that a time duration of pumping operations thereof is preset according to materials of the laundry load. 30
24. The drum washing machine control method according to claim 23 wherein the time duration of pumping operations of the pumping unit increases from a cotton fabrics washing course to a mixed fabrics washing course, to a woollen fabrics washing course to a synthetic fibre washing course. 35 40
25. A drum washing machine comprising a control unit to control a time duration of water pumping operations according to a determination of a type of fabric in a laundry load wherein the control unit determines a load amount of the laundry load by determining the number of the water pumping operations required to reach a predetermined water level. 45
26. A drum washing machine comprising a pumping unit to pump water and a control unit to control the pumping unit to perform supplemental pumping operations until a predetermined water level is reached wherein the control unit determines a laundry load amount according to a total of the supplemental pumping operations. 50 55

FIG. 1

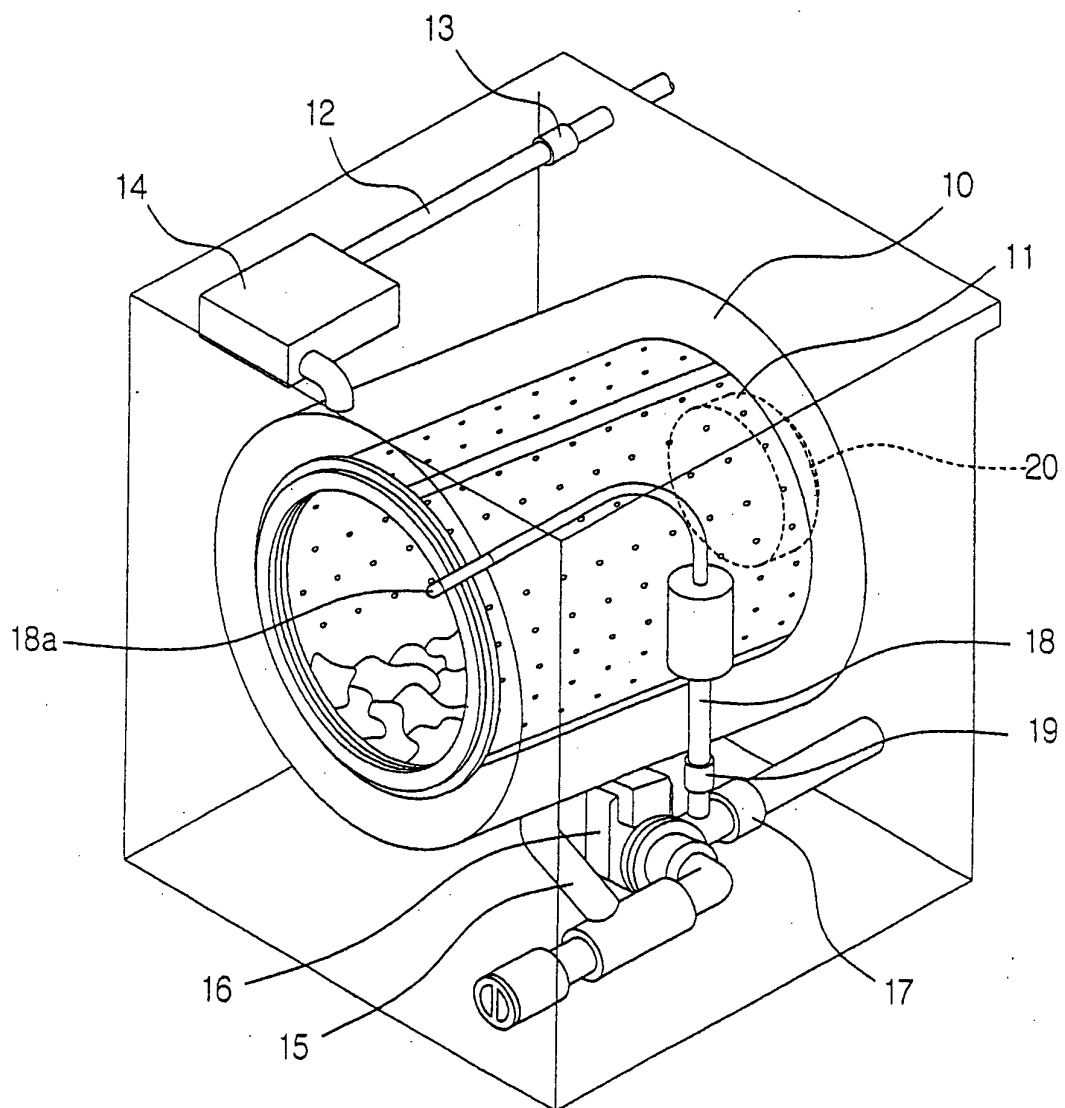
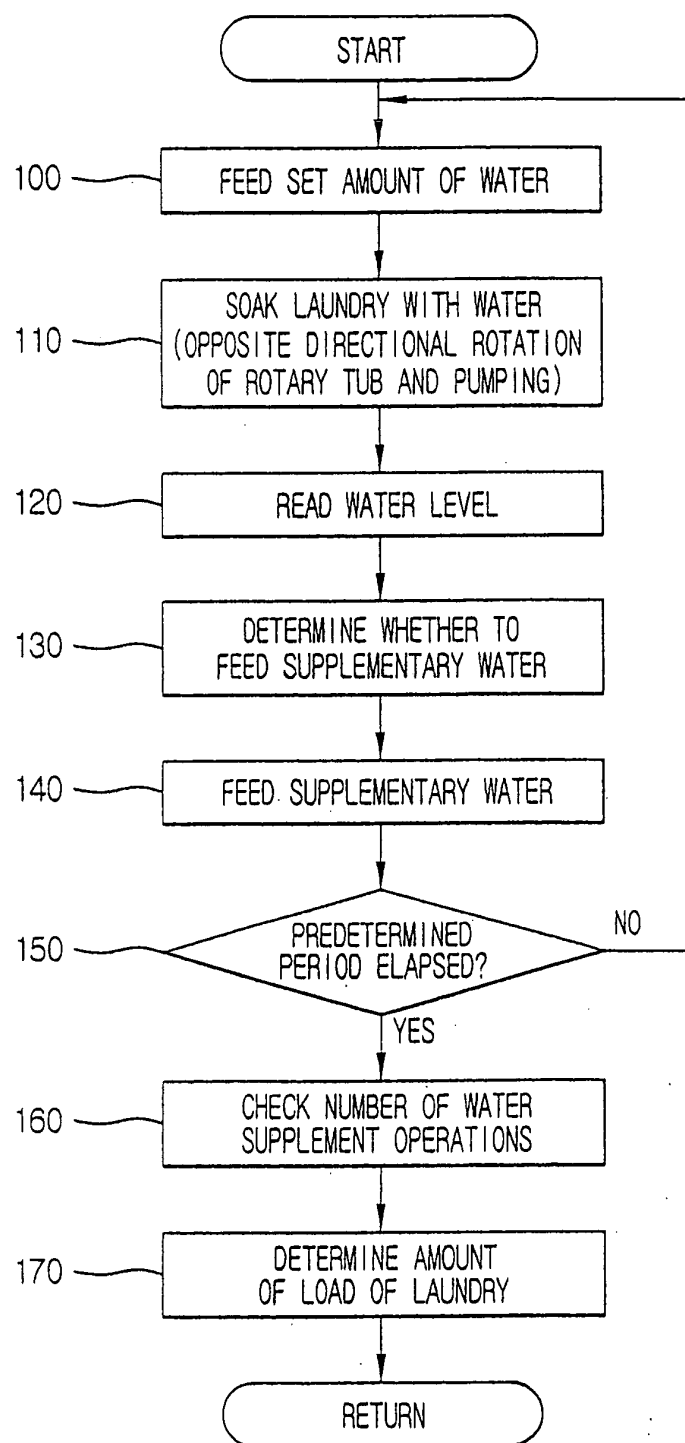


FIG. 2



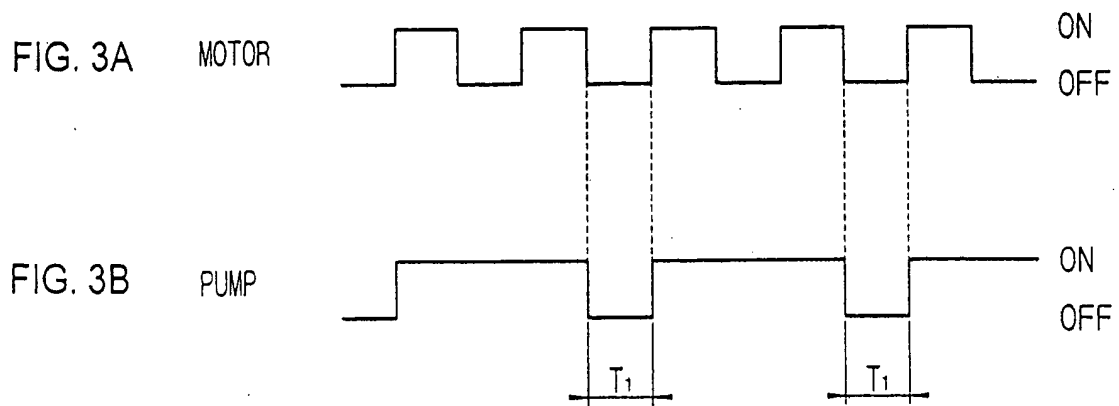
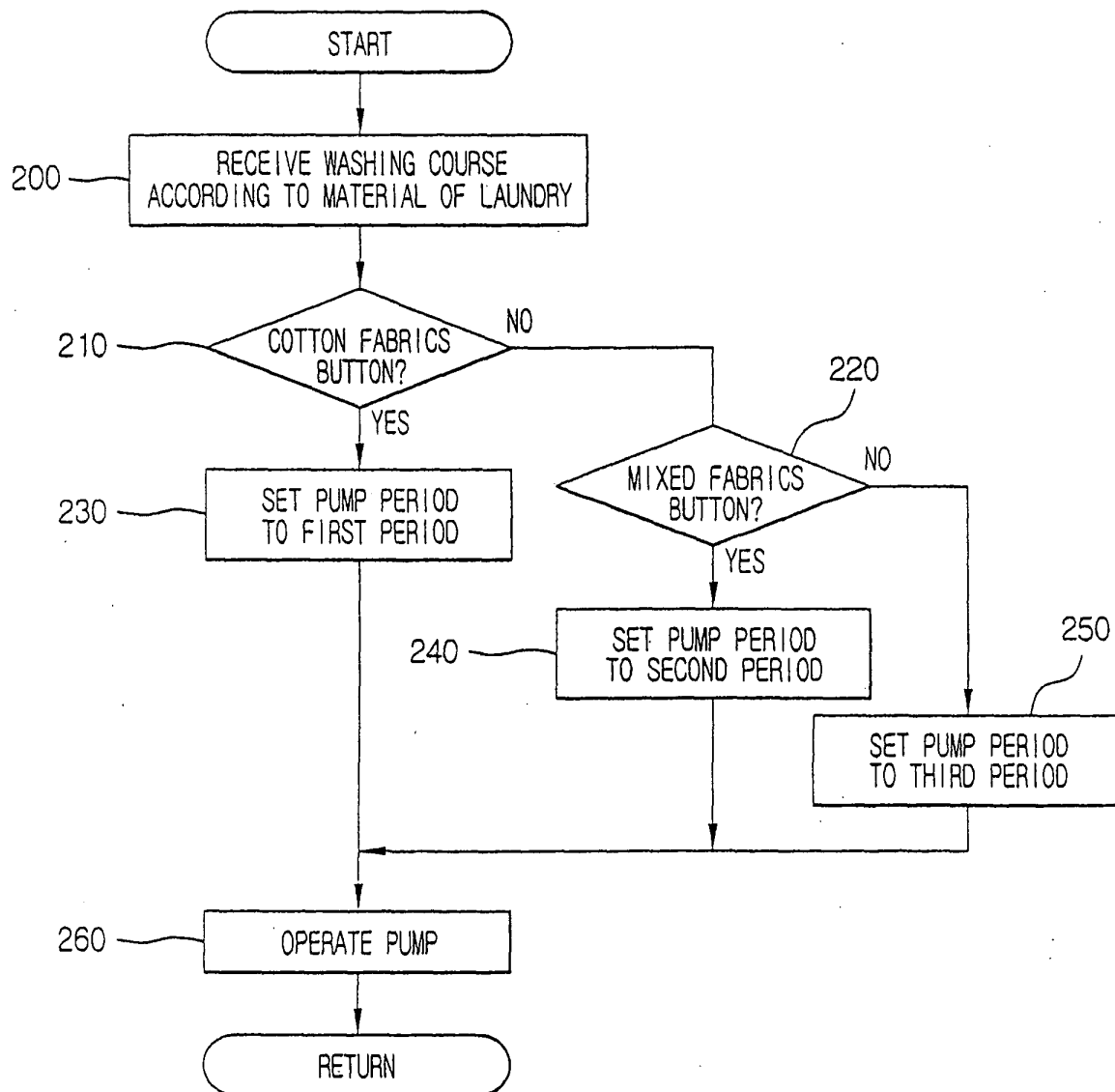
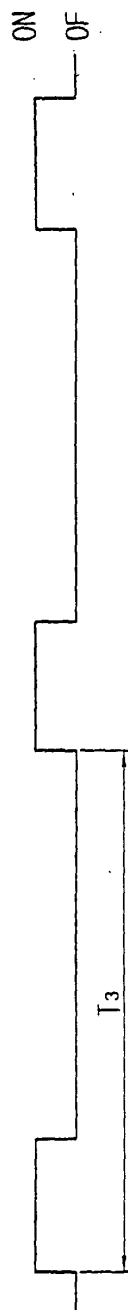
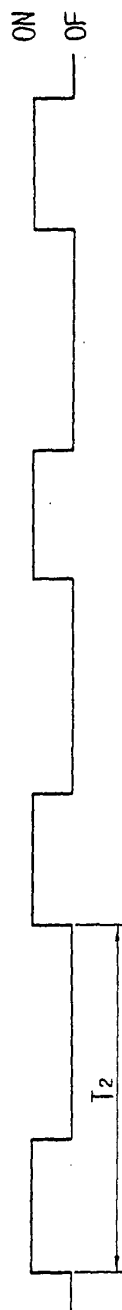
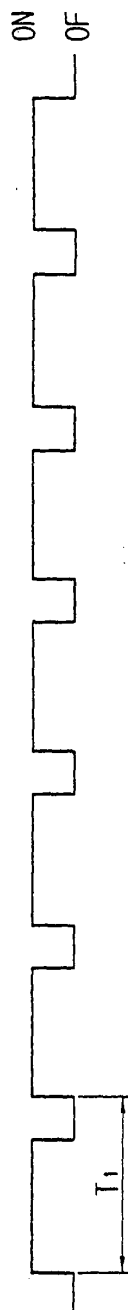


FIG. 4







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EUROPEAN SEARCH REPORT

Application Number
EP 04 25 2396

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	EP 0 464 776 A (ZANUSSI ELETTRODOMESTICI) 8 January 1992 (1992-01-08)	1,2,8, 13,20, 25,26	D06F39/00
Y	* the whole document *	3-5,7,9, 11,12	
A		6,10, 14-19, 21-24	
X	----- PATENT ABSTRACTS OF JAPAN vol. 1996, no. 12, 26 December 1996 (1996-12-26) -& JP 08 215483 A (SHARP CORP), 27 August 1996 (1996-08-27) * abstract *	1,2	
A		3-26	
Y	----- EP 0 787 848 A (MERLONI ELETTRODOMESTICI SPA) 6 August 1997 (1997-08-06) * the whole document *	3-5,7,9, 11,12	
A		1,2,6,8, 10,13-26	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			D06F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 22 November 2004	Examiner Spitzer, B
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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22-11-2004

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 0464776	A	08-01-1992	IT 1246260 B	17-11-1994
			DE 69110356 D1	20-07-1995
			DE 69110356 T2	26-10-1995
			EP 0464776 A1	08-01-1992
			ES 2076419 T3	01-11-1995

JP 08215483	A	27-08-1996	NONE	

EP 0787848	A	06-08-1997	IT T0960076 A1	05-08-1997
			DE 69712380 D1	13-06-2002
			DE 69712380 T2	09-01-2003
			EP 0787848 A1	06-08-1997
			ES 2177838 T3	16-12-2002
