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• **Ihne, Sarah**
21025 Comerio (IT)
• **Vaidhyanathan, Raveendran**
21025 Comerio (IT)

(71) Applicant: **WHIRLPOOL CORPORATION**
Benton Harbor
Michigan 49022 (US)

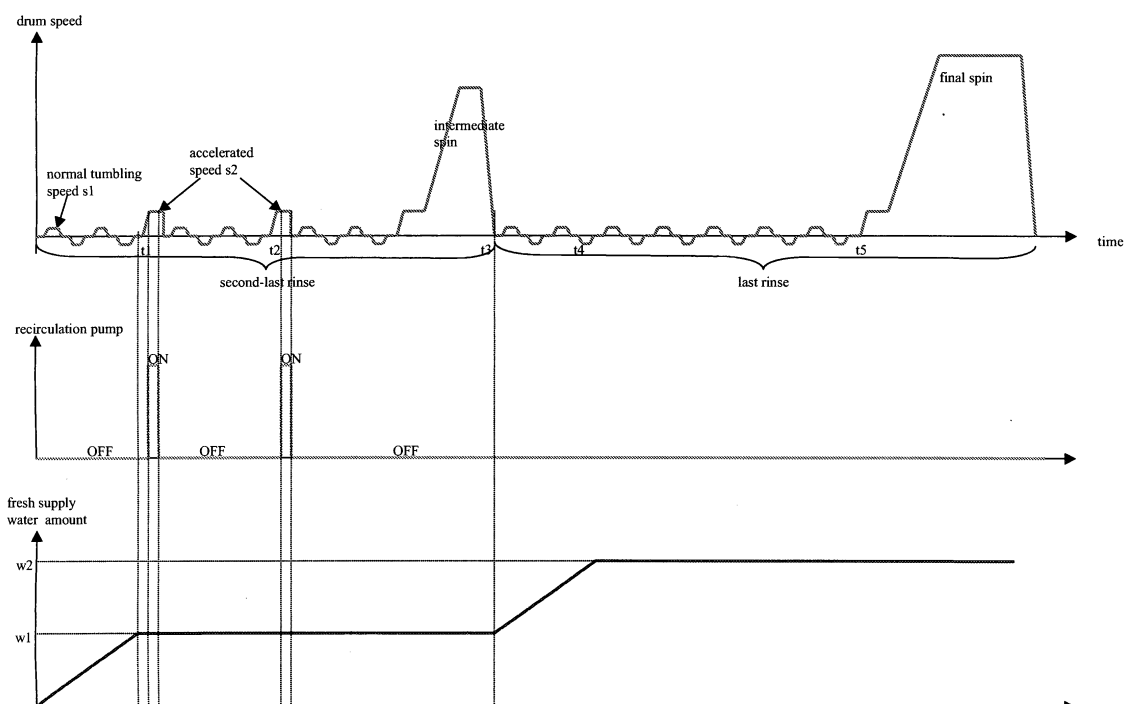
(74) Representative: **Guerci, Alessandro**
Whirlpool Europe S.r.l.
Patent Department
Viale G. Borghi 27
21025 Comerio (VA) (IT)

(72) Inventors:
• **Oberkirsch, Stefanie**
21025 Comerio (IT)

(54) **A method for rinsing fabric in a washer and washer adapted to carry out this method.**

(57) A method of rinsing fabric in a washer having a wash chamber rotatable about a horizontal axis comprises the step of adding water to the wash chamber and spraying the rinse water by recirculating it onto the fabric while spinning the wash chamber at a speed (s_2) to effect a centrifugal force on said fabric such that the fabric will

not tumble within the wash chamber as it spins. The method further comprises at least a last rinsing step in which the rotating speed (s_1) of the wash chamber is such that the fabric tumbles within the wash chamber and in that the rinsing water is not recirculated and sprayed onto the fabric.



Description

[0001] The present invention relates to a method of rinsing fabric in a washer having a wash chamber rotatable about a horizontal axis comprising the step of adding water to the wash chamber and spraying the rinse water by recirculating it onto the fabric while spinning the wash chamber at a speed to effect a centrifugal force on the fabric such that said fabric will not tumble within the wash chamber as it spins.

[0002] The above method is known as "recirculation method" and was designed for reducing water and energy consumption of European domestic washers. One of the above methods is disclosed by US-A-5191668.

[0003] As a matter of fact water consumption of European domestic washers has continuously decreased over the last decades mainly due the cost of supply water, the energy cost for heating such water and to environmental issues. By introducing a recirculation rinse the water amount to be used in each rinsing step was greatly reduced, because it was no longer necessary to have an amount of water sufficient to guarantee wetting of clothes in the drum when tumbling, since the water was sprayed on the clothes when these latter were maintained by centrifugal force against the circular wall of the drum.

[0004] On the other hand, beside the actual reduction of water consumption, consumers are increasingly complaining about laundry feeling soapy after wash, laundry crackling with foam residual after wash, spots of insoluble compounds (zeolites) on the laundry, and eczema from residual detergent on the fabric.

[0005] All the above negative effects are mainly due to a too high residual concentration of detergent in the rinsing water (including zeolites usually contained in detergent formulations), to laundry fluff, to chunky food particles, to sand and rust articles from plumbing. All these substances are brought back onto the clothes through recirculation. Therefore recirculation is rarely implemented in modern washers mainly because of added cost of parts, difficulty to draw benefit from it because specific cycle layout is required to avoid drawback of soil/detergent redeposition on laundry and drawback of suds.

[0006] An object of the present invention is to provide a method as stated at the beginning of the description that does not have the above drawbacks, while keeping water consumption comparable to that of the recirculation method already known.

[0007] According to the invention, the above object is reached thanks to the features listed in the appended claims.

[0008] The applicant has surprisingly discovered that by slightly modifying the known recirculation rinse method it is possible to avoid the above problems, while maintaining a good rinsing efficiency and a reduced consumption of water.

[0009] The preferred method according to the invention comprises a final rinse where water is no longer recirculated and sprayed on the clothes, while clothes are

tumbled in an increased amount of rinsing water compared to the previous rinsing step in which recirculation of rinsing water was carried out. If for instance there are three rinse cycles, the recirculation of water will be carried out in the second rinse and optionally also in the first one, but not in the last one where the amount of used rinsing water will be higher than that of the previous cycle. The rinse with recirculation can be done with a small water amount, typically 5 litres for a load of 5 kg of laundry instead of a normal amount of about 10 litres. During rinsing the water is pressed through the laundry by acceleration of the drum until the laundry forms a ring on the drum surface. The recirculated water is sprayed onto the laundry ring to achieve good distribution of the water through the laundry. With the term "sprayed" we mean every possible way in which the water is fed onto the laundry ring, independently on the way it is fed, either by gravity or by a water nozzle under water pressure.

[0010] Preferably, the drum is slowed down to normal tumbling movement to allow the rinsing water (which is continued to be sprayed) to access fibres of laundry in an uncompressed state. Preferably the rotation of the drum is reversed between the spinning step and the tumbling step. The process of recirculating and accelerating the drum can be repeated several times until the rinsing water is saturated with detergent. The washing machine according to the invention is preferably provided with a sensor (turbidity sensor, capacitive detergent concentration sensor, and conductivity sensor) which is capable of detecting when the rinsing water is substantially saturated with detergent. The same sensor can be used in order to assess the optimal number of rinsing cycles. The last rinse cycle is done with a normal tumbling movement, no recirculation, and an increased water amount since water has been saved in the previous rinse cycles.

[0011] The spinning speed of each rinsing cycle depends on the drum diameter, and it is preferably of 80 to 85 rpm for 548 mm drum diameter or of 65 to 75 rpm for 480 mm drum diameter. Centrifugal force must be strong enough so that laundry stops its tumbling movement inside the drum. Laundry must form a ring clinging to the inner drum wall, but speed must be safely below "critical speed". "Critical speed" is the speed corresponding to the resonance frequency of the wash unit. Every time the appliance goes through critical speed, there is strong noise and vibration. Appliance lifetime is shortened if it goes through critical speed often. Moreover speed should be as low as possible to avoid excessive suds creation. Excessive suds leads to bad rinse performance, difficult draining at the end of the rinse cycle and, in the worst case, oversudsing of appliance, with suds being pressed outside through the soap dispenser.

[0012] According to the tests performed by the applicant, the number of "accelerate + recirculate" repeats is preferably comprised between 2 and 12 in order to achieve saturation of liquor with detergent, where 12 repeats are used in case of large soakable washload (in washer drums having a diameter of about 548 mm) with

high dosage of high-foaming detergent, and where 2 repeats are used with small load (up to approx. 15 % of rated capacity) and moderate dosage of low-foaming detergent.

[0013] Load amount / soakability can be detected by measuring motor torque in acceleration ramp and use flowmeter to measure water amount, or by measuring gradient of water take-up (water level decrease after filling) with analogue level sensor. Foaming can be detected with analogue level sensor or optical (turbidity) sensors.

[0014] Even if an "accelerate + recirculate" methodology of rinsing is the preferred one, permanent recirculation without any slowing down can be used for small loads.

[0015] In order to determine when we have achieved saturation of the rinse water with detergent, it is possible to use either a lookup table linking the number of "accelerate + recirculate" repeats with the detected load amount / soakability and/or the presence or absence of foam, or a sensor (of the type already mentioned) to detect when the detergent concentration stays near-constant from one repeat to the next.

[0016] The recirculation system has the advantage that such a sensor can be mounted to the tub outlet or recirculation hose. In an appliance without recirculation, rinse sensors must be mounted to the tub wall. This is expensive and often reduces stability of the tub (turbidity sensor needs hole in tub wall with several cm diameter).

[0017] The design of a washing machine according to the present invention implies that highly concentrated liquor is recirculated. There is therefore a high risk of suds creation in such a design.

[0018] There is also a high risk of water ring. "Water ring" means that while the drum is spinning, the water that is pressed out through the drum holes cannot be drained off by the pump fast enough. Therefore it forms a rotating ring at the outside of the drum, leading to bad draining, noise, and vibration of the machine. This happens when a water-saturated large soakable load is accelerated to high speeds too fast, or the draining rate of the drain pump is too low since the pump is too weak or the pump is blocked with foam, fluff or foreign bodies (buttons, coins), or the outlet geometry is unsuitable.

[0019] To solve the above problems while keeping a low cost of the recirculation pump, it is suitable to apply a pump with 4 l/min to 6 l/min draining rate for a sump (free liquor) volume of 4 l.

[0020] Moreover, a fluff filter and foreign body trap is incorporated in the body of the drain pump. Further features and advantages of a rinse method according to the present invention will be clear from the following detailed description, given by way of non limiting example, with reference to the attached drawing which shows a speed profile of the last two rinse cycles according to the present invention, together with the recirculation pump status (on/off) and with the total supply of fresh water to the tub.

[0021] With reference to the upper part of the drawing,

on the y-axis is reported the drum speed, while in the intermediate and lower part of the drawing the status of the recirculation pump and the loaded water are reported respectively. On x-axis time is reported. On the left portion of the diagram (last but one rinse cycle), with an amount w1 of rinsing water the drum speed is changed from s1 (tumbling speed) to s2 tumbling speed for two times. Between recirculation phases (times t1 and t2) the drum is tumbled without recirculation and with inverted direction. This means that the drum is rotated in alternating directions: at speed s1 counterclockwise for some seconds and, after a pause of some seconds, at speed s1 clockwise for some seconds. At time t3, after an intermediate spin for removing rinse water from clothes, the drum is stopped, the rinsing water w1 is pumped out and fresh water is added to the tub, so that at time t4 the total water loaded in the tub in the last two rinse cycles is w2 (where added fresh water in the last rinse cycle is w2-w1, which is higher than w1). Then the drum is rotated at tumbling speed s1 (last rinsing cycle) in alternating directions up to time t5 when water is pumped out and the final spinning cycle is started.

[0022] Another further advantage of recirculated rinse according to the present invention is that in case of warm rinse (often applied in washers sold in US), the recirculated water can transfer the heat of the inlet rinse water to the laundry. Heat distribution is therefore more even and the heat of the inlet water is reaching the laundry surface much faster than in traditional rinsing. Thus the desired rinse result can be reached faster.

Claims

1. A method of rinsing fabric in a washer having a wash chamber rotatable about a horizontal axis comprising the step of adding water to the wash chamber and spraying the rinse water by recirculating it onto the fabric while spinning the wash chamber at a speed (s2) to effect a centrifugal force on said fabric such that the fabric will not tumble within the wash chamber as it spins, **characterised in that** it comprises at least a last rinsing step in which the rotating speed (s1) of the wash chamber is such that the fabric tumbles within the wash chamber and **in that** the rinsing water is not recirculated and sprayed onto the fabric.
2. A method according to claim 1, **characterised in that** the water amount added in said last rinsing step is higher than the water amount used in the previous rinsing steps.
3. A method according to claim 1 or 2, **characterised in that** in each rinsing step with recirculation of rinsing water the washing chamber is accelerated to the speed (s2) to effect a centrifugal force on the fabric and it is then slowed down in order to allow tumbling

of the fabric, such alternating acceleration and slowing down being repeated several times in each rinsing step.

4. A method according to claim 3, **characterised in that** the alternating sequence of acceleration and slowing down of the wash chamber is repeated from 2 to 12 times. 5
5. A method according to any of the preceding claims, **characterised in that** it comprises detecting the detergent concentration in the rinsing water, the last rinsing step being carried out when such detergent concentration is lower than a predetermined value. 10
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6. A washing machine adapted to carry out a rinsing method according to any of the preceding claims.
7. A washing machine according to claim 6, **characterised in that** it comprises a sensor for detecting the concentration of detergent in the rinsing water. 20
8. A washing machine according to claim 7, **characterised in that** said sensor is selected in the group consisting of turbidity sensors, capacitive sensors and conductivity sensors. 25

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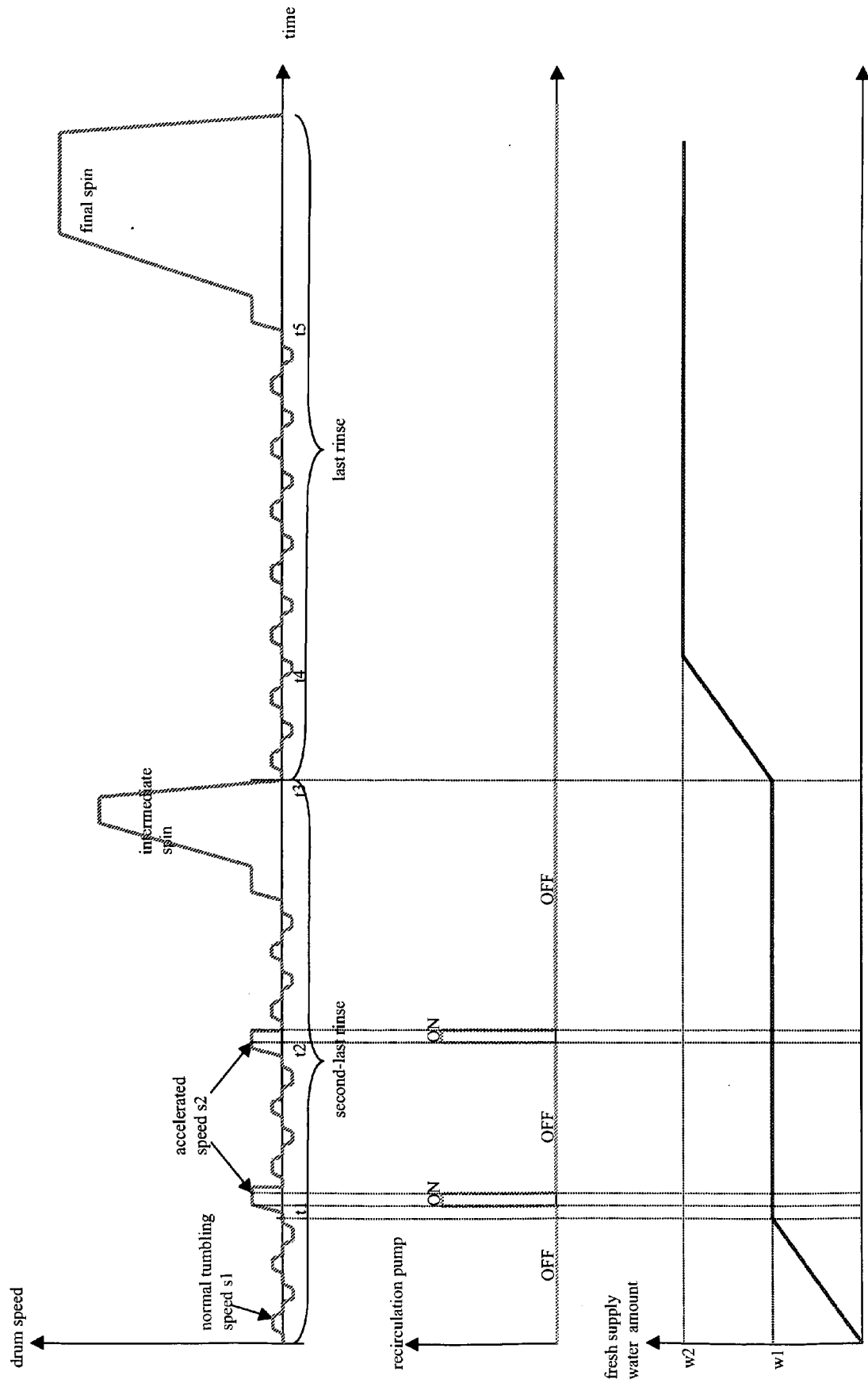
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EUROPEAN SEARCH REPORT

Application Number
EP 07 10 6394

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 5 October 2007	Examiner Clivio, Eugenio
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 07 10 6394

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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