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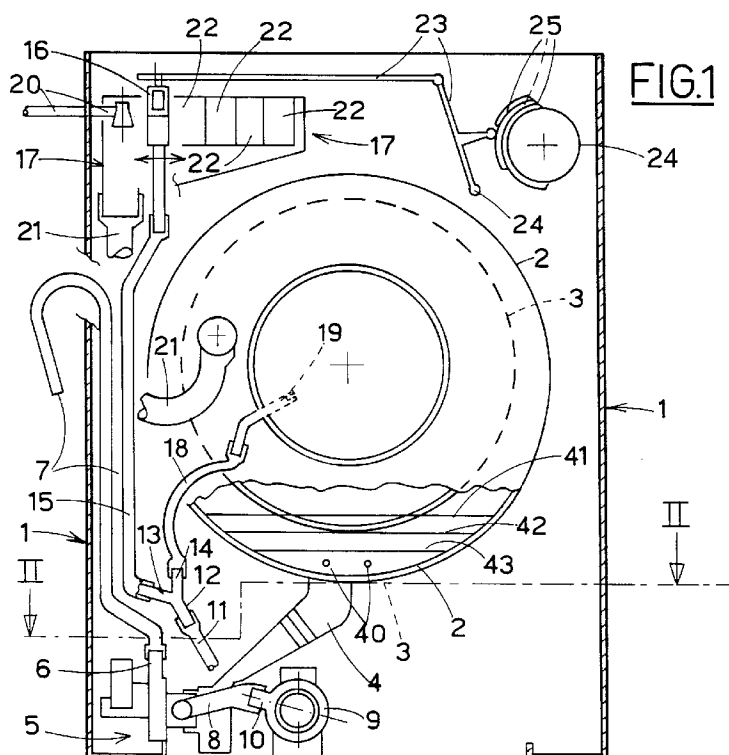
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I-20052 Monza (Milano) (IT)**(54) Method of washing for washing machine**

(57) A method of washing for a washing machine comprises at least one washing phase (L1-L3) which includes a cycle of work at high speed and recirculation of water during which a drum (3), containing the laundry to be washed and rotatably housed in a washing tub (2), is made to rotate at a first speed, sufficiently high to generate a centrifugal force which causes arrangement of the laundry along the periphery of the drum (3) and, simultaneously, the water in the washing tub (2) is taken from said tub (2) and is returned therein by spraying at a central part of the drum (3). A subsequent work cycle

at low speed then takes place, during which the drum (3) is made to rotate at a second speed, lower than said first speed and such as to allow remixing of the laundry, while the recirculation of water is substantially interrupted. The cycle of work at high speed and recirculation of water has a duration limited to the time necessary for the complete removal of detergent from a detergent container (22) and during its performance part of the water taken from the tub (2) is made to pass through the container (22) of detergent and subsequently reintroduced into the tub (2).

**FIG.1****EP 0 726 349 A2**

Description

The present invention relates to a method of washing for washing machines.

It is known that manufacturers of washing machines are engaged in constant efforts to make machines which, in line with the performances, allow savings to be made in the running costs, i.e. a reduction in consumption of electricity, water, detergent and additives.

In the US patent no. 3388410 in the name of Marshall, a washing method is described which provides, during the whole washing time as also during the entire rinsing time, an alternation of cycles in which the drum of the washing machine, containing the garments to be washed, is made to rotate at high speed, with cycles during which the drum is made to rotate at a lower speed. The high speed must be sufficient to make the centrifugal force acting on the clothes overcome the force of gravity and maintain the latter adhering to the walls of the drum (a speed of between 100 and 200 rpm), while during the cycles in which the drum is made to rotate at a lower speed (45 rpm) the clothes fall back onto the base of the drum itself. The soapy washing solution or the rinsing water is taken from the base of the washing tub of the washing machine (wherein the drum is contained) and is continuously fed again by spraying, by means of a recirculation pump, into the drum via nozzles. During rotation of the drum at the higher speed, there is thus the formation of a ring of solution or of water wherein the garments are constantly immersed.

The washing and rinsing at high speed with garments adhering to the wall of the drum and sprayed by the soapy solution or recycled rinsing water improve the efficiency of the washing and rinsing phases. Moreover recirculation of the soapy solution or of the rinsing water allows the quantity of liquid to be used to be reduced to a certain extent.

Moreover the quantity of water fed into the washing tub must in any case be sufficient to ensure that, during recirculation, a quantity of water always remains in the tub so as to prevent phenomena of cavitation of the recirculation pump. This is more likely to occur during cycles of rotation of the drum at low speed.

In the Marshall patent this problem is solved by making the tub very deep, and by feeding therein an abundant quantity of water. The subject of reducing water consumption was not however less felt during the years to which the Marshall patent dates back.

In the European patent application no. 0404047, in the name of Vellati, a washing method is described which, during at least part of the washing and possibly rinsing time, provides for rotation of the drum of the washing machine at a speed equal to or higher than that which causes adherence of the laundry to be washed to the wall of the drum. At each rotation of the drum the garments contained therein are immersed temporarily, and at least partially, in the soapy solution or in the rinsing water contained in the washing tub in a sufficient

quantity for the base of the drum to be always immersed therein.

Due to the very fact that, even when it is made to rotate at high speed, the drum is in any case partially immersed in the soapy solution, an excessive quantity of foam is formed.

Washing methods for washing machines are also known which provide for recirculation of the water, previously fed into the washing drum of the washing machine, via a detergent container, and the subsequent feeding of the soapy solution obtained in this way into the washing tub so as to spray the laundry to be washed. Some of these washing methods, which do not provide for cycles of rotation at high speed as in the aforementioned Marshall and Vellati patents, are described in the Italian Patent Application no. MI92A002562, filed on 9 November 1992.

Methods of this type allow, in addition to a certain reduction in the consumption of water, also better exploitation of the detergent, and hence a reduction in the consumption of the latter. However, the quantity of water to be fed into the washing tub must in any case ensure that, during recirculation, cavitation phenomena of the recirculation pump are not triggered.

In view of the state of the art described, the object of the present invention is that of providing a washing method which exploits the known concepts of rotation of the drum at high speed and of recirculation of the water, and which also allows a reduction in the quantity of water required compared to previously described washing methods.

In accordance with the present invention, this object is achieved thanks to a washing method for a washing machine comprising at least one phase of washing which provides for a work cycle at high speed and recirculation of water during which a drum, containing the laundry to be washed and rotatably housed in a washing tub previously fed with clean water, is made to rotate at a first speed, sufficiently high in order to generate a centrifugal force which causes an arrangement of the laundry along the periphery of the drum, and simultaneously the water contained in the washing tub is taken from said tub and is reintroduced therein by spraying (with the means already described) at a central opening of the drum, and a subsequent work cycle with rotation of the drum at low speed, during which the drum is made to rotate at a second speed, lower than said first speed and such as to allow remixing of the laundry, while recirculation of the water is interrupted, characterised in that said work cycle with rotation of the drum at high speed and recirculation of water has a duration limited to the time required for total removal of a detergent from a detergent container and, during said work cycle with rotation of the drum at high speed and recirculation of water, part of the water taken from the tub is made to pass through said detergent container and subsequently reintroduced into the tub.

Said high speed may be between 100 and 150 rpm,

and the duration of said work cycle at high speed and recirculation of water is preferably equal to approximately two minutes.

In the method according to the invention, unlike the provision in the washing methods according to the Marshall and Vellati patents, it is only during a brief initial space of time of the washing phase that the drum is made to rotate at a high speed which causes adherence of the laundry to the walls of the drum, while the washing water is simultaneously recirculated. Part of the recycled water is made to pass through the container of detergent, so that it mixes with the latter, and is then reintroduced into the tub. Another part is however reintroduced by spraying into the drum, where it washes over the laundry very rapidly and then returns quickly into the washing tub.

In this way, optimal washing efficiency is obtained, together with an appropriate exploitation of the detergent, which is mixed rapidly with the washing water.

Even higher results are obtained, according to a preferred embodiment, by providing, immediately after the conventional feeding of water up to a predetermined level, an initial cycle of washing at low speed during which the laundry absorbs the water, consequently reducing its level, which suitable pressure switch means, with a further feed of water, restore to the preset value. In this way a total feed of water is provided which is equal to the minimum necessary for that particular load of laundry.

The quantity of water in circulation is thus reduced, and consequently it is possible to reduce the quantity of water to be fed, at the same time ensuring that cavitation phenomena of the recirculation pump are not triggered. A reduction in the quantity of water fed consequently causes a reduction in the consumption of electricity for heating and of detergent.

Again in accordance with a preferred embodiment, the washing method moreover comprises at least one phase of rinsing which similarly provides for a short work cycle at high speed and recirculation of water, during which the drum rotates at said first speed and the water contained in the tub is simultaneously recirculated, partly made to pass through a container of rinsing additive and then fed again into the tub, and partly injected by spraying into the tub at the central part of the drum.

A feed of water which can be regulated automatically according to the load of laundry is preferably provided also for rinsing.

Thanks thereto, it is possible to restrict the consumption of water also during rinsing. Moreover, thanks to the fact that during rotation of the drum at high speed the water injected by spraying penetrates in depth between the fibres of the laundry, the action of detachment of the residues of detergent increases.

These and other features of the present invention will be made clearer from the following detailed description of some of its embodiments, illustrated by way of a non-limiting example in the accompanying drawings, in

which:

Figure 1 shows, schematically and sectioned, a first embodiment of a washing machine suitable for implementing a washing method according to the invention;

Figure 2 is a schematic view of the washing machine sectioned along line II-II of Figure 1;

Figure 3 is a detailed sectioned view of a device for deviating the recirculation flow of the washing machine in Figure 1;

Figures 4 and 5 are two views of a nozzle for supplying washing liquid in the drum of the washing machine of Figure 1;

Figures 7, 8 and 9 show respectively a washing phase, a rinsing phase and a prewash phase of a washing method according to the present invention; Figure 10 shows, schematically and sectioned, a second embodiment of the washing machine implementing the washing method of the present invention;

Figure 11 is a detailed sectioned view of a device for deviating the discharge flow of the washing machine of Figure 10.

Fig. 1 shows a first embodiment of washing machine suitable for implementing the washing method according to the present invention. The washing machine comprises in a known manner a frame 1 inside whereof a washing tub 2 is housed. The tub 2 rotatably houses a drum 3. On the bottom of the tub 2 heating resistors 40 are provided.

The bottom of the tub 2 leads, via a conduit 4, to a discharge pump 5 (which can be seen Figure 6), to the delivery whereof a discharge pipe 7 is connected. The inlet of the discharge pump 5 also leads, via a conduit 8, to the inlet of a recirculation pump 9, to whose delivery 10 a conduit 11 is connected (Fig. 2). The latter is in turn connected to a deviation device 12, which can be seen better in Figure 3, essentially composed of a "Y" connection of two conduits 13 and 14. The conduits 13 and 14 have different diameters, so as to partialise to a different extent a flow of liquid coming from the conduit 11. Connected to the conduit 13, greater in diameter, is a conduit 15 which is in turn connected to a nozzle 16 placed inside a basin 17 containing detergent. Connected to the conduit 14, smaller in diameter, is a conduit 18 which is in turn connected to a spray nozzle 19 positioned inside the tub 2 and which can be seen in detail in Figures 4 and 5. By choosing a pump 9 for recirculation with a flow rate of approximately 18 litres per minute, the fraction of water which is sent to the nozzle 19 is approximately 10-11 litres per minute, while the remaining 7-8 litres per minute are sent to the basin 17.

The nozzle 16 can be moved horizontally and can be positioned on each occasion at a particular compartment containing detergent or additive 22 of a row of containers provided in the basin 17. The movement of the

nozzle 16 occurs in a manner in itself known by means of a lever 23 hinged in 24 to the frame 1 and actuated by cams 25 of a timer 24, such as for example as described in the Italian Patent Application no. MI92A002562 in the name of the same Applicant.

A water supply conduit 20 also flows into the basin 17, and is connected externally to a water supply connection point (not shown). Connected to the bottom of the basin 17 is a conduit 21 which flows into the washing tub 2.

A washing method according to the present invention comprises in a manner in itself known a prewash cycle (Fig. 9), an actual washing cycle (Fig. 7) and a rinsing cycle (Fig. 8).

The prewash cycle is optional, and may even not be performed.

The washing cycle consists of three phases L1, L2 and L3 (Fig. 7). By means of the timer 24 it is possible to start up the washing cycle from point A, in which case all the phases L1, L2 and L3 (first washing programme) will be performed automatically and in sequence, or from point B, in which case phases L2 and L3 will be performed in sequence (second washing programme), or even from point C, in which case only phase L3 (third washing programme) will be performed.

The phase L1 includes an initial cycle of feeding clean water into the washing tub 2 (denoted by C in Figure 7), referring to the washing machine described previously. The water enters via the supply conduit 20, flows into the basin 17 without taking detergent, and from there flows into the tub 2 via the conduit 21, wetting the laundry to be washed which is contained in the drum 3. A pressure switch (not shown in that known) automatically cuts off the feed of water from the supply conduit 20 when a preset level of water has been reached in the tub 2, which may vary from 20 to 25 mm from the bottom of the drum 3 (levels 41 and 42 in Figure 1).

After the cycle of water feed, a first work cycle L starts, lasting about 4 minutes, during which the drum 3 is made to rotate at a relatively low speed (typically from 50 to 60 rpm): this rotation speed encourages remixing of the laundry contained in the drum 3, which is thus wetted and absorbs water. The consequent reduction in the level of water in the tub 2 causes further triggering of the pressure switch which re-actuates the feed of water from the conduit 20 directly into the tub, via the conduit 21, in order to restore the preset level of water. In this way the quantity of water fed into the tub is automatically calibrated on the basis of the quantity of laundry contained in the drum 3. During the first work cycle L the heating resistors 40 are also actuated.

After the first work cycle L, a cycle of work at high speed and recirculation (R in Figure 7) starts with rotation of the drum at a high speed (G in Figure 7) of between 100 and 150 rpm (preferably 120 rpm). During this cycle the recirculation pump 9 is actuated which causes intake of water from the tub 2 and the sending thereof, via the conduits 11, 13 and 15, to the nozzle 16,

which has in the meantime been positioned by the lever 23 at a first detergent container 22. The detergent is thus taken by the recirculated water, and flows out via the conduit 21 into the tub 2. At the same time, the recirculation pump 9, via the conduits 11, 14 and 18 and the spray nozzle 19, injects water directly into the tub 2 at the centre of the drum 3, spraying the laundry. The centrifugal force generated by rotation of the drum at the abovementioned high speed causes adherence of the laundry contained in the drum 3 to the walls of the same, creating at the centre of the drum 3 a space thanks to which the water injected by the nozzle 19 can evenly wet the laundry. During this phase, since part of the water is in circulation, the level of water in the tub 2 drops to a level between levels 42 (tangential to the drum 3) and 43 shown in Figure 1. As can be seen, covering of the heating resistors 40 is in any case guaranteed, and there is a sufficient water column for avoiding triggering of cavitation phenomena of the pump 9. This is made possible by the fact that, thanks to the rotation of the drum 3 at the abovementioned high speed, the liquid injected by the spray nozzle 19 rapidly washes over the laundry and returns quickly into the tub 2. Consequently it is possible to reduce the quantity of water to be fed into the tub 2. Moreover, since during rotation at high speed the drum 3 is not immersed, not even partially, in the water on the bottom of the tub 2, there is no generation of foam. The duration of this cycle must be barely sufficient to ensure complete removal of detergent; experimental tests have shown that two minutes are amply sufficient for this purpose.

After the cycle of work at high speed and recirculation, a second work cycle L is performed, similar to the first work cycle L, but lasting approximately fourteen minutes. At the end of this second work cycle, the first phase L1 of the washing cycle L1 ends.

The second phase L2 is identical to the first phase L1. If however the first phase has just been performed, the water feed (cycle C), provided at the start of the second phase L2, does not take place and the first work cycle L of the second phase L2 starts immediately, during which the level of water remains constant.

The third phase L3 comprises, similarly to the first phases L1 and L2, an initial cycle C of water feed (a feed which is not performed if the second phase L2 has just been performed), a first work cycle L, with relatively low rotation speed of the drum 3, lasting approximately 4 minutes, a work cycle of approximately two minutes with high rotation speed of the drum (G) and simultaneous recirculation of the water (R). The third phase is not performed if the temperature of the water heated during the previous phases reaches about 70°C. This temperature is considered safe in the event of accidental opening of the detergent container.

This inhibition is controlled by a thermostat sensor. This then followed by three work cycles L with low drum rotation speed, lasting approximately sixteen, eight and four minutes respectively, then a work cycle L with si-

multaneous actuation of the discharge pump 5, and finally a centrifugation cycle.

The prewash cycle (Fig. 9) which, as mentioned, is optional and can be actuated by appropriately positioning the timer 24, comprises a feed cycle C during which the water coming from the supply conduit 20 is sent directly into the tub 2. During this first cycle, or at least during part thereof, actuation of the recirculation pump 9 is provided, so that the water, from the tub 2, is sent into the basin 17 where, coming out of the nozzle 16, it will remove the detergent and then flow once again into the tub 2. The feed cycle C is followed by a first work cycle L with low drum rotation speed, during at least part of which the recirculation pump 9 is actuated again. The feed cycle C and the first work cycle L, during which autoregulation of the level of water according to the load of laundry is not possible, have a total duration of approximately sixteen minutes. This is then followed by a second and third work cycle L, each lasting approximately two minutes, during which the drum is made to rotate at low speed. At the end there is a discharge cycle S during which the discharge pump 5 is actuated. In the example shown and described, during the prewash cycle there are no cycles of rotation of the drum at high speed, whereas recirculation cycles are included. This naturally means that the quantity of water fed during the feed cycle C must be greater, in order to prevent, due to the water being circulated, the resistors from remaining uncovered and the recirculation pump 9 from cavitating. However, in the case of particularly dirty laundry, it may be useful to have in this phase a larger quantity of water in the tub 2. It is however possible, as an alternative to what is shown, to have a cycle of rotation of the drum at high speed even during the prewash cycle.

The rinsing cycle comprises four phases R1-R4, which are performed in sequence. The first phase R1 comprises an initial cycle G, lasting approximately two minutes, in which water is fed into the tub with simultaneous rotation of the drum 3 at high speed, and simultaneous actuation of the recirculation pump 9: the water contained in the tub 2 is sent by the pump 9 partly into the basin 17, where from one of the containers 22 any additive is taken (for example a conditioner), and is partly injected into the tub through the spray nozzle 19. The water feed continues, the laundry gradually absorbing the quantity of water necessary (according to the type of laundry), until the preset level controlled by the pressure switch is reached.

This is then followed by a first work cycle L with rotation of the drum 3 at low speed, for approximately two minutes, a cycle G of approximately two minutes with rotation of the drum 3 at high speed and with simultaneous actuation of the recirculation pump 9, and a second work cycle L of approximately two minutes with rotation of the drum 3 at low speed. The water is then discharged, with the drum rotating at low speed, and a centrifugation cycle of approximately two minutes is performed.

Phases R2 and R3 are identical one to the other and to phase R1.

Phase R4 comprises an initial cycle G of water feed with rotation of the drum 3 at high speed and simultaneous actuation of the recirculation pump 9, for the duration of approximately two minutes. This is then followed by a first work cycle L of approximately two minutes, in which the drum 3 rotates at low speed, then a second work cycle L with simultaneous actuation of the discharge pump 5, and finally two centrifugation cycles lasting two and four minutes respectively.

Experimental tests have shown that, considering a washing tub of standard capacity, and with a recirculation pump with flow rate of approximately 18 litres per minute, it is sufficient to feed into the washing drum a quantity of water of 12-13 litres to achieve optimum washing and to ensure that, during the cycles of recirculation of water with rotation of the drum at a high speed of between 100 and 150 rpm, phenomena of cavitation of the recirculation pump do not occur and the level of water in the tub does not drop below the heating elements 40. The same tests have however shown that, in the same conditions, rotation of the drum at the normal working speed of 50-60 rpm would trigger cavitation of the recirculation pump after about one minute.

Figure 10 shows schematically a second embodiment of washing machine, also suitable for implementing the washing method of the invention. A washing machine of this type is described for example in the aforementioned Italian Patent Application no. MI92A0002562. Unlike the washing machine in Figure 1, one single pump 30 is provided with functions both of discharge and of recirculation. The pump 30 is connected in input to the washing drum 2 via the conduit 4, and in output to a conduit 31. Also connected to the conduit 31 is a flow deviation device (of the type described in the Italian Patent Application no. 21702 A/81 of 14 May 1981), which can be seen better in Figure 11, substantially consisting of a Y connection with internally a gate valve 32 (actuated for example by an electromechanical actuator not shown) which can be moved between a position of closure of a first outlet conduit 33, and a position of closure of a second outlet conduit 34. The first outlet conduit 33 is connected to the discharge pipe 7, while the second outlet conduit 34 is connected to a conduit 35 supplying the nozzle 16 inside the basin 17. Connected to the second outlet conduit 34, branching off, is a conduit 36 supplying the spray nozzle 19 located in the centre of the drum 3.

Normally the gate valve 32 is in the position of closure of the first outlet conduit 33, shown in Figure 11, so that when the pump 30 is actuated, the water contained in the tub is recirculated. When however the water contained in the tub is discharged, the gate valve 32 is moved into the position of closure of the second outlet conduit 34.

It is important that the flow deviation device is placed at a height from the bottom of the tub 2 which is

sufficiently high so that, when the pump 30 is de-actuated, the vacuum which is created in the conduit 31 causes emptying of the conduit 31 of the water it contains, which takes with it any filamentous residues in the washing liquid, returning them to the pump 30.

Claims

1. Method of washing for washing machine comprising at least one washing phase (L1-L3) which includes a work cycle at high speed and recirculation of water during which a drum (3), containing the laundry to be washed and rotatably housed in a washing tub (2) previously fed with clean water, is made to rotate at a first speed, sufficiently high to generate a centrifugal force which causes arrangement of the laundry along the periphery of the drum (3), and simultaneously the water contained in the washing tub (2) is taken from said tub (2) and reintroduced therein by spraying at a central part of the drum (3), and a subsequent work cycle at low speed during which the drum (3) is made to rotate at a second speed, lower than said first speed and such as to allow remixing of the laundry, while recirculation of the water is substantially interrupted, characterised in that said work cycle at high speed and recirculation of water has a duration limited to the time required for complete removal of a detergent from a detergent container (22) and during said cycle at high speed and recirculation of water part of the water taken from the tub (2) is made to pass through said detergent container (22) and subsequently reintroduced into the tub (2).
2. Method according to claim 1, characterised in that said work cycle at high speed and recirculation of water has a duration substantially equal to two minutes.
3. Method according to claim 1 or 2, characterised in that said first speed is between 100 and 150 rpm.
4. Method according to claim 1, characterised in that it provides an initial feed of a quantity of water sufficient to guarantee reaching of a preset level (41,42) of water in the tub (2), and a subsequent work cycle, preceding said cycle at high speed and recirculation of water, during which the drum (3) is made to rotate at low speed, to allow the laundry to be uniformly wetted, with simultaneous feed of a further quantity of water, to restore automatically said preset level (41, 42) of water in the tub (2).
5. Method according to any one of the previous claims, also comprising at least one phase of rinsing (R1-R4), subsequent to said phase of washing (L1-L3), which provides for a work cycle at high speed and recirculation of water, during which the drum (3) rotates at said high speed and the water is simultaneously removed from the tub (2), said water partly being made to pass through a container (22) of rinsing additive and then reintroduced into the tub (2), and partly injected by spraying into the tub (2) at the central part of the drum (3).
6. Method according to claim 5, characterised in that said cycle at high speed and recirculation of water of the rinsing phase (R1-R4) has a duration of approximately two minutes.
7. Method according to claim 5 or 6, characterised in that it provides for feeding of water up to a preset level during said cycle of work at high speed and recirculation of water.
8. Method according to claim 5, 6 or 7, characterised in that said rinsing phase (R1-R4) comprises a further cycle of rotation of the drum (3) at said high speed and simultaneous recirculation of the water contained in the drum, alternating with cycles of work during which the drum (3) rotates at said low speed.
9. Method according to any one of the previous claims, comprising also a prewash phase which may be performed prior to said washing phase (L1-L3), characterised in that said prewash phase includes at least one cycle of recirculation during which the water contained in the tub (2) is made in part to pass into a container (22) of a prewash detergent and is then reintroduced into the tub (2), and is in part injected by spraying into the tub (2) at the central part of the drum (3).
10. Washing machine comprising a washing tub (2) wherein a drum (3) is rotatably housed for loading laundry to be washed, a first circuit of recirculation (8-13, 15-17, 21) for removing water from the tub (2), sending of the water removed to a container (22) of detergent or additive and return of the water removed into the tub (2), a second circuit of recirculation (8-12, 14, 18, 19) for removing water from the tub (2) and spray injection of the water removed into the tub (2) at a central part of the drum (3), and a recirculation pump (9, 30) connected to the tub and to said first and second circuits of recirculation, characterised in that it comprises means (24) for actuating said recirculation pump (9, 30) in combination with the rotation of the drum (3) at a sufficiently high speed to generate a centrifugal force such that the laundry is arranged along the periphery of the drum (3) and for a time equal to that required for emptying of the container of detergent or additive (22).

11. Machine according to claim 10, characterised in that said recirculation pump (9,30) has a flow rate of approximately 18 litres per minute, said first circuit of recirculation has a flow rate of approximately 7-8 litres per minute and said second recirculation circuit has a flow rate of approximately 10-11 litres per minute. 5
12. Machine according to claim 10 or 11, characterised in that said recirculation pump (9, 30) also works as a discharge pump with delivery which can be connected alternatively to said recirculation circuits (8-13, 15-17, 21; 8-12, 14, 18, 19) and to a discharge pipe (7) via a flow deviator (32) with electric control, said flow deviator (32) being placed at a height near the top of the tub (2). 10 15

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