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(54) Low water-usage, recirculation-type household clothes washing machine

Haushaltwaschmaschine mit Wasserrückführung und niedrigem Wasserverbrauch

Machine à lessive du type à recirculation avec une baisse utilisation d'eau

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EP-A- 0 030 602 **FR-A- 1 372 338**

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Description

[0001] The present invention refers to an improved kind of clothes washing machine, preferably for home use, which is adapted to ensure a particularly low water usage.

[0002] Generally known and felt is nowadays the general need for the water amounts taken in from the water distribution mains to be reduced as much as possible in view to cut down water usage. Well-known are also the efforts that are being done by all home appliance manufacturers in view of complying with such a general need by designing appliances that imply an increasingly reduced water usage, i.e. that are capable of doing their job with less and less water being required. This is a universally known and accepted fact, so that it shall be not discussed any longer in this context.

[0003] One of the home appliances that normally requires appreciable water amounts in each working cycle thereof is the clothes washing machine; such an appliance works by letting a first amount of water into a washing tub, together with the clothes to be washed and the detergent or washing product, and then appropriately processing such clothes until they are thoroughly washed. At the end of the washing cycle, the liquor used to carry it out is discharged outside the machine by means of a drain pump via an appropriate siphon-shaped outlet hose. This is subsequently followed by a sequence of rinsing phases consisting of pre-determined amounts of water being let into the tub and related agitation and water-discharge steps being performed, so that detergent residues are gradually rinsed off the washed clothes.

[0004] During the phases in which the washing or rinsing liquor is let off the machine, the discharge pipe is generally known to become filled with the liquor that was previously contained in the washing tub, and such a liquor so contained in the discharge pipe is in turn generally known to be retained there until the subsequent discharge phase takes place and, of course, it is heavily contaminated with detergent and soil particles.

[0005] FR 1 372 338 discloses a washing machine comprising means for the control of the water supply of the tub, an electric motor for the drive of washing means, as well as a pump which can be actuated at will or automatically and being used to eliminate water from the tub and whose driving means under operation are cut off by a commutation device when the lower level of washing liquid in the tub is reached. Furthermore the washing machine comprises a timed control device adapted to short-circuit the commutation device when the lower level of washing liquid in the tub is reached in order to extend the operation time of the pump for a period which can be regulated at will.

[0006] In clothes washing machines featuring a water-recirculation provision, it is a largely known fact that the liquor contained in said discharge pipe during the subsequent rinsing phases flows back into the tub, since

it is taken in by the circulation pump that is directly connected to the discharge manifold from which said discharge pipe actually departs.

[0007] This liquor is then normally mixed with fresh water flowing in from the water distribution mains, but, owing to said liquor being rather heavily contaminated as already pointed out above, it unavoidably worsens the rinsing effectiveness of the resulting mixture to a considerable extent.

[0008] In order to bring the level of purity of the rinsing liquor again to an acceptable value, it is therefore necessary for a larger amount of fresh water from the mains to be added to the mixture so as to obtain a greater dilution of the polluting substances that are present in said liquor contained in the discharge pipe and brought back into the tub with such a liquor.

[0009] This greater amount of fresh water needed in the rinsing phases must furthermore be multiplied by the number of all such rinses and, considering that no less than three rinses are usually provided in a washing programme of a clothes washing machine, the aggregate additional amount of fresh water, needed to adequately dilute the polluting substances contained in the liquor flowing back from the discharge pipe, ultimately bears heavily on the total water usage of the washing machine to complete a washing programme, so that it is becoming less and less acceptable.

[0010] It therefore would be desirable, and is actually a main purpose of the present invention, to provide a clothes washing machine of the type including a provision to recirculate washing and rinsing liquor, which is effective in sensibly reducing such an additional water usage deriving from the need for the polluting substances retained by the liquor in the discharge pipe to be appropriately diluted.

[0011] Furthermore, the clothes washing machine of the above cited kind shall be capable of being easily implemented through the use of readily available means and techniques; it shall in addition be competitive in its construction and convenient in its use; in particular, it shall be capable of being made with a minimum extent of modifications to be introduced with respect to clothes washing machine designs being currently produced. The new features so added to the washing machine shall furthermore be such as to avoid impairing or affecting the overall reliability of the machine itself.

[0012] According to the present invention, these aims are reached in a particular kind of clothes washing machine that is provided with operating and control means as described below by way of non-limiting example with reference to the accompanying drawing.

[0013] A clothes washing machine according to the present invention comprises a perforated drum 1 that is provided rotatably within an enclosed tub 2; an arrangement 3 for letting water from the mains into said tub comprises a dispenser and a conduit 3A connecting said dispenser with said tub.

[0014] Below said tub there is provided a discharge

manifold 4 which is connected on one side to the discharge pipe 6 and, on the opposite intake side, to the sleeve 7 which is in turn connected, at the other end portion thereof, with an aperture 8 provided in the bottom of said tub.

[0015] The above cited discharge manifold is provided with an appropriate pump 5 which, owing to its being of a generally traditional type and adapted to perform generally traditional duties, shall not be described here any further.

[0016] In an appropriate position on said sleeve there is arranged an outlet for the attachment of a pressure switch 3.

[0017] Owing to the present invention applying to a washing machine arranged to recirculate liquor in its tub, there is provided a suitable recirculation manifold 10 that is connected via an appropriate first conduit 11 to said discharge manifold and, via a second conduit 12, to per se known means 13 adapted to direct a water jet towards the interior of said drum. Although the illustration in the Figure may be assumed to show that said means 13 are seemingly arranged within the drum, it will be appreciated that different solutions are possible, such as for instance the ones in which said means 13 are provided between the tub and the rotating drum and the jet thereof enters the drum and hits the therein contained clothes by passing through the perforations of the same drum.

[0018] Also said recirculation manifold 10 is provided with a suitable pump 14 that is adapted to take in liquor from the discharge manifold and pump it towards said means 13 for letting the liquor into said drum.

[0019] The manner in which such a clothes washing machine operates is partly traditional; the machine carries out a washing cycle, followed by a cycle in which liquor is let out of the tub and then, preferably, a cycle in which the clothes-holding drum is rotated at a high speed with the discharge pump 5 still operating. After a certain pre-determined period of time, said spin-extracting and discharge operations are stopped and, at the same time, a sequence of rinsing and related water discharge cycles are started, which however are well known in the art so that they shall not be explained any further here. It is a generally known fact that, during these cycles, the discharge pipe 6 fills up with liquor, which is however drawn in again by the subsequent rinse cycle to flow back into the tub. Furthermore, during a discharge phase, the water head in the discharge manifold tends to stabilize at a level L_{min} , at which the pump 5 is no longer able to draw in.

[0020] It is therefore clearly appears that the polluting substances that are contained in said liquor are brought back into the tub and this in turn increases the concentration of pollutants there and, as a result, makes it necessary for a greater amount of fresh water to be let in for proper dilution.

[0021] According to the present invention, such a drawback is fully eliminated by providing a short phase

for letting in a correspondingly small amount of fresh and clean water at the end of the afore mentioned discharge and spin-extraction cycle, while the discharge phase is still going on.

[0022] It can be readily appreciated that, if provisions are taken through the use of generally known means in view of preventing such a pre-defined amount of fresh water from being intercepted by the drum, and ensuring on the contrary that it is directly introduced in said sleeve 7, and then in the discharge manifold 4, this clean water will practically work as a liquid piston that is effective in definitively eject the polluted liquor from the discharge pipe.

[0023] It therefore ensues that, in the subsequent discharge phase of the machine, the only polluted water involved will be the one that soaks the clothes, so that a remarkably smaller amount of rinsing water shall be actually let into the tub in order to obtain a same concentration of polluting substances, as this emerges from the following quantitative demonstration.

[0024] The concentration of polluting substances in the discharge pipe at the end of the discharge phase following the actual washing cycle is equal to:

$$25 \quad \text{Conc. (pipe)} = \frac{Q \text{ pollut.}}{V_1}$$

where V_1 is the inner volume of the discharge pipe, so that the quantity of pollutants in the discharge pipe will be:

$$Q \text{ pollut.} = V_1 \cdot \text{Conc. (pipe)}$$

[0025] The concentration of polluting substances in the clothes is equal to:

$$40 \quad C_f = \frac{Q(\text{fabrics})}{V(\text{fabrics})}$$

where $V(\text{fabrics})$ is the amount of water retained in the clothes, so that the quantity of pollutants in the clothes will be:

$$45 \quad Q(\text{fabrics}) = C_f \cdot V(\text{fabrics})$$

[0026] If an amount of fresh water = V is now let into the tub for rinsing, the aggregate concentration throughout the rinsing process will of course be equal to:

$$55 \quad \frac{\sum Q(\text{pollutants})}{\sum (V + V_1)} = \frac{Q(\text{poll.}) + Q(\text{fabrics})}{\sum (V + V_1)}$$

so that, through proper substitution, the result is obtained according to which the final concentration of pol-

lutants at the beginning of the subsequent rinse phase is:

$$C_1 = \frac{V_1 \cdot \text{Conc. (pipe)} + C_f \cdot V(\text{fabrics})}{V_1 + V(\text{fabrics}) + V}$$

[0027] Let us now assume that before said rinsing phase is started, such an amount of fresh water is let in as to cause the discharge pipe to be completely emptied and then re-filled with said fresh water.

[0028] In this case, the overall concentration of pollutants becomes:

$$C_2 = \frac{C_f \cdot V(\text{fabrics})}{V_1 + V(\text{fabrics}) + V}$$

since the value $V_1 \cdot \text{Conc. (pipe)}$ most obviously becomes equal to zero.

[0029] Furthermore, if the amount of fresh water being let in for the rinsing is reduced by the amount of fresh water V_1 previously used to drive out the polluted liquor from the discharge pipe, then, for a same overall amount of water used for both rinsing the clothes and replacing the polluted liquor in the discharge pipe, the resulting concentration would become:

$$C_3 = \frac{C_f \cdot V(\text{fabrics})}{V(\text{fabrics}) + V}$$

[0030] The two values of the concentrations C_1 and C_3 are homogeneous since they are obtained with equal amounts of water being used in the aggregate, even though the first value is referred to a traditional cycle, while the second value refers to a cycle according to the present invention.

[0031] As a result, they are correctly comparable and from their comparison, through simple passages and processing work, and considering that before the rinsing phase the concentration of pollutants in the pipe is substantially the same as the concentration of pollutants in the clothes, it emerges that

$$C_1 > C_3$$

Since what we substantially have before the rinsing phase is

$$C_f = \text{Conc. (pipe)}$$

[0032] It is therefore clearly demonstrated that, in a clothes washing machine according to the present invention, it is possible for a reduction in the concentration of pollutants to be obtained for a same amount of fresh water used in the rinsing phase.

[0033] It will of course be appreciated that the reduced concentration obtained in this manner may be used to

advantage also in the opposite way, i.e. by accepting a normal concentration, but reducing the amount of fresh water used in the rinsing phase accordingly.

[0034] This method becomes particularly advantageous if use is made of a discharge pipe with a very small inside diameter, since this would favour a reduction in the water plug needed to drive out the polluted liquor from the discharge pipe.

[0035] At this point it can of course be more readily understood that the above described method can be similarly applied, with obvious adaptations, also to the subsequent rinsing cycles, thereby contributing to a further improved water saving effect.

[0036] An improvement of the present invention can be easily obtained considering that the water of the last rinse cycle is usually clean enough as to be capable of being re-used without any problem; as a result, the just described mode of operation is avoided and, through the pressure switch 9, the water discharge phase is interrupted as soon as the water head in the sleeve and, possibly, even in the lower portion of the tub reaches down to a level L lying just below the lowest level of the drum, so as to avoid hindering the spin-extraction phase. Exhaustive tests carried out on average-performance clothes washing machines have demonstrated that it is possible for approx. 2 litres of fresh water to be saved in this manner per washing programme.

30 Claims

1. Clothes washing machine, preferably for use in the home, comprising:

- 35 - a perforated rotating drum (1) for holding and handling the clothes to be washed,
- a stationary tub (2) containing said drum (1),
- a water supply arrangement (3) provided externally with respect to said tub (2) and adapted to selectively let pre-defined water amounts into said tub;
- a discharge manifold (4) provided below said tub and housing appropriate water-pumping means (5),
- 40 - a discharge pipe (6) connected at an end portion thereof to said discharge manifold and adapted to convey the water pushed by said pumping means (5) outside,
- a sleeve (7) connecting an aperture (8) in the bottom of said tub with said discharge manifold (4),
- a pressure switch (9) connected to said sleeve (7) at an intermediate point thereof,
- 45 - a re-circulation manifold (10) connected via a first conduit (11) to said discharge manifold (4) and, via a second conduit (12), to appropriate means (13) adapted to spray or, anyway, deliver washing liquor into said drum,
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- appropriate pumping means (14) associated to said re-circulation manifold (10) and adapted to pump water from said discharge manifold to said spray means (13) for letting liquor into said drum, via said first conduit (11) and said second conduit (12),
 in which said clothes washing machine is adapted to carry out a preestablished sequence of phases including at least a washing phase and a water discharge phase followed by one or more rinsing phases, which can include respective water discharge sub-phases, all such water discharge phases being possibly followed by respective phases of simultaneous water discharge and spin-extraction, **characterized in that** it is adapted to carry out, at the end of said simultaneous water discharge and spin-extraction phases and before said rinsing phase is started, while the discharge phase is still in operation, a drive-out sub-phase in which a pre-defined amount of fresh and clean water is directly introduced in said discharged manifold (4) to eject said liquor from said discharge pipe (6).
2. Clothes washing machine according to claim 1, **characterized in that** said water drive-out sub-phase comprises following conditions and operating steps:
- regular operation of said water pumping means (5) of said discharge manifold so as to as much as possible empty said sleeve (7), when the level of the water head stabilizes down at the minimum level (L_{min}),
 - upon conclusion of the above mentioned operating step, letting into said tub, from the outside via said external water-supply arrangement (3), said pre-defined additional amount of water,
 - continuation of the operation of said water pumping means (5) in said discharge manifold until the level of the water head in said sleeve is substantially restored to said level (L_{min}).
3. Clothes washing machine according to claim 2, **characterized in that** the volume of said pre-defined additional amount of water that is let into the tub is just slightly greater than the inside volume of said discharge pipe (6).
4. Clothes washing machine according to claim 2 or 3, **characterized in that** during the final discharge and, possibly, spin-extraction phase the operation of said pumping means (5) is interrupted when the water head in said sleeve (7) lowers down to a pre-determined level (L) that is higher than said minimum level (L_{min}).
5. Clothes washing machine according to claim 4,
- 5
- characterized in that** said pre-determined level (L) lies slightly below the lowest point of said drum so as to prevent the latter from interfering with the liquor therebelow when driven at a high rotational speed.
- Patentansprüche**
- 10 1. Wäschewaschmaschine vorzugsweise für den Gebrauch im Haushalt, welche umfasst:
- eine mit Löchern versehene Trommel (1) für die Aufnahme und die Behandlung der zu waschenden Wäschestücke,
 - einen stationären Bottich (2), welcher die genannte Trommel (1) enthält,
 - eine Wasserzuführungseinrichtung (3), welche sich außerhalb des genannten Bottichs (2) befindet und so ausgelegt ist, dass sie wahlweise vorher festgelegte Wassermengen in den genannten Bottich einlässt;
 - einen Ausflussverteiler (4), welcher sich unterhalb des genannten Bottichs befindet und geeignete Mittel zum Pumpen von Wasser (5) enthält,
 - ein Ausflussrohr (6), welches mit einem seiner Enden an den genannten Verteiler angeschlossen und so ausgelegt ist, dass es das von den genannten Pumpmitteln (5) verdrängte Wasser nach außen befördert,
 - eine Verbindungsmuffe (7), welche eine Öffnung (8) im Boden des genannten Bottichs mit dem genannten Ausflussverteiler (4) verbindet,
 - einen Druckschalter (9), welcher mit der genannten Verbindungsmuffe (7) an einer dazwischen liegenden Stelle verbunden ist,
 - einen Umwälzverteiler (10), welcher über eine erste Leitung (11) an den genannten Ausflussverteiler (4) angeschlossen und über eine zweite Leitung (12) mit geeigneten Mitteln (13) verbunden ist, welche darauf ausgerichtet sind, Waschlauge in die genannte Trommel zu sprühen oder ihr auf irgendeine andere Weise zuzuführen,
 - geeignete Pumpmittel (14), welche an den genannten Umwälzverteiler (10) angeschlossen und so ausgelegt sind, dass sie Wasser über die genannte erste Leitung (11) und die genannte zweite Leitung (12) vom genannten Ausflussverteiler zu den genannten Sprühmitteln (13) pumpen, damit Lauge in die genannte Trommel gelangt,
- wobei die genannte Wäschewaschmaschine so ausgelegt ist, dass sie eine vorher eingestellte zeitliche Aufeinanderfolge von Phasen ausführt, welche mindestens eine Waschphase und eine Was-

- serentzugsphase enthält, denen eine oder mehrere Spülphasen folgen, welche zugehörige Wasserentzugs-Unterphasen enthalten können, wobei möglicherweise allen derartigen Wasserentzugsphasen zugehörige Phasen aus gleichzeitigem Wasserentzug und Schleudern folgen können, **dadurch gekennzeichnet, dass** sie so ausgelegt ist, dass sie am Ende der genannten gleichzeitig ablaufenden Wasserentzugs- und Schleuderphasen und vor dem Beginn der genannten Spülphase, während die Wasserentzugsphase noch läuft, eine Austreibungs-Unterphase ausführt, in welcher eine vorher festgelegte Menge an frischem und sauberem Wasser direkt in den genannten Ausflussverteiler (4) eingeleitet wird, um die genannte Waschlauge aus dem genannten Ausflussrohr (6) hinaus zu drücken.
2. Wäschewaschmaschine gemäß Anspruch 1, **dadurch gekennzeichnet, dass** die genannte Wasseraustreibungsphase die nachfolgenden Bedingungen und Betriebsschritte umfasst:
- normaler Betrieb der genannten Wasserpumpmittel (5) des genannten Ausflussvertellers der gestalt, dass die genannte Verbindungsmuffe (7) weitestgehend geleert wird, wenn sich der Füllstand der Wassersäule nach unten hin bei einem minimalen Füllstand (L_{min}) stabilisiert,
 - nach Beendigung des weiter oben genannten Betriebsschrittes lässt man über die genannte äußere Wasserzuführungseinrichtung (3) die genannte vorher festgelegte zusätzliche Menge an Wasser in den genannten Bottich fließen,
 - Weiterführung des Betriebes der genannten Wasserpumpmittel (5) im genannten Ausflussverteiler, bis der Füllstand der Wassersäule in der genannten Verbindungsmuffe im Wesentlichen sich wieder auf den genannten Füllstand (L_{min}) eingestellt hat.
3. Wäschewaschmaschine gemäß Anspruch 2, **dadurch gekennzeichnet, dass** das Volumen der genannten vorher festgelegten zusätzlichen Menge an Wasser, welche in den Bottich eingeschlossen wird, lediglich geringfügig größer als das Innenvolumen des genannten Ausflussrohres (6) ist.
4. Wäschewaschmaschine gemäß Anspruch 2 oder 3, **dadurch gekennzeichnet, dass** während der abschließenden Wasserentzugsphase und möglicherweise Schleuderphase der Betrieb der genannten Pumpmittel (5) unterbrochen wird, wenn sich die Wassersäule in der genannten Verbindungs-muffe (7) auf einen vorher festgelegten Füllstand (L) absenkt, welcher höher als der minimale Füllstand (L_{min}) ist.
5. Wäschewaschmaschine gemäß Anspruch 4, **dadurch gekennzeichnet, dass** der vorher festgelegte Füllstand (L) geringfügig unter dem niedrigsten Punkt der genannten Trommel liegt, so dass verhindert wird, dass die Letztere mit der darunter befindlichen Lauge in Berührung kommt, wenn die Trommel mit einer hohen Drehzahl betrieben wird.
- 10 **Revendications**
1. Machine à laver le linge, de préférence pour utilisation domestique, comprenant :
 - un tambour rotatif (1) perforé, pour contenir et manipuler les tissus à laver,
 - un bac (2) stationnaire contenant ledit tambour (1),
 - un agencement d'alimentation en eau (3), prévu extérieurement par rapport audit bac (2) et adapté pour faire passer sélectivement des quantités d'eau prédéfinies dans ledit bac ;
 - un distributeur de décharge (4), prévu au-dessous dudit bac et logeant des moyens de pompage d'eau (5) appropriés,
 - un tube de décharge (6) relié, à une partie d'extrémité de celui-ci, audit distributeur de décharge et adapté pour guider vers l'extérieur l'eau refoulée par lesdits moyens de pompage (5),
 - une douille (7) reliant une ouverture (8), ménagée au fond dudit bac, audit distributeur de décharge (4),
 - un interrupteur de pression (9), connecté à ladite douille (7), en un point intermédiaire de celle-ci,
 - un distributeur de recirculation (10) connecté, via un premier conduit (11), audit distributeur de décharge (4) et, via un deuxième conduit (12), à des moyens (13) appropriés, adaptés pour pulvériser ou, d'une manière quelconque, délivrer un bain détergent dans ledit tambour,
 - des moyens de pompage (14) appropriés, associés audit distributeur de recirculation (10) et adaptés pour pomper de l'eau depuis ledit distributeur de décharge vers lesdits moyens de pulvérisation (13), pour introduire un bain ou lessive dans ledit tambour, via ledit premier conduit (11) et ledit deuxième conduit (12),

dans lequel ladite machine à laver le linge est adaptée pour effectuer une séquence préétablie de phases, incluant au moins une phase de lavage et une phase de décharge d'eau, suivie par une ou plusieurs phases de rinçage, pouvant comprendre des sous-phases de décharge d'eau respectives ; la totalité de telles phases de décharge d'eau étant éventuellement suivie par des phases respectives de décharge d'eau et d'extraction par essorage

- centrifuge simultanées, **caractérisée en ce qu'elle**
est adaptée pour, à la fin desdites phases simulta-
nées de décharge d'eau et d'extraction par essora-
ge centrifuge et avant le démarrage de ladite phase
de rinçage, tandis que la phase de décharge est en-
core en cours, effectuer une sous-phase d'expul-
sion, dans laquelle une quantité prédefinie d'eau
neuve et propre est directement introduite dans le-
dit distributeur de décharge (4), afin d'éjecter ladite
lessive dudit tube de décharge (6). 10
- 5
2. Machine à laver le linge selon la revendication 1,
caractérisée en ce que ladite sous-phase d'expul-
sion d'eau comprend les conditions et étapes de
fonctionnement suivantes : 15
- fonctionnement régulier desdits moyens de
pompage d'eau (5) dudit distributeur d'eau, de
manière à vider autant que possible ladite
douille (7) lorsque le niveau de la colonne d'eau
se stabilise en descente à un niveau minimal
(L_{min}), 20
- à l'achèvement de l'étape de fonctionnement
mentionnée ci-dessus, introduction dans ledit
bac depuis l'extérieur, via ledit agencement
d'alimentation en eau externe (3), ladite quan-
tité d'eau additionnelle prédefinie, 25
- continuation du fonctionnement desdits
moyens de pompage d'eau (5) dans ledit distri-
buteur de décharge jusqu'à ce que le niveau de
la colonne d'eau dans ladite douille soit sensi-
blement revenu audit niveau (L_{min}). 30
3. Machine à laver le linge selon la revendication 2,
caractérisée en ce que le volume de ladite quan-
tité d'eau additionnelle prédefinie introduite dans le
bac est juste légèrement supérieur au volume inté-
rieur dudit tube de décharge (6). 35
4. Machine à laver le linge selon la revendication 2 ou
3, **caractérisée en ce que**, durant la décharge fi-
nale et, éventuellement, la phase d'extraction par
essorage centrifuge, le fonctionnement desdits
moyens de pompage (5) est interrompu lorsque la
colonne d'eau dans ladite douille (7) descend jus-
qu'à un niveau (L) préterminé, supérieur audit ni-
veau minimum (L_{min}). 40
- 45
5. Machine à laver le linge selon la revendication 4,
caractérisée en ce que ledit niveau (L) préterminé
est situé légèrement au-dessous du point le
plus bas dudit tambour, pour empêcher ce dernier
d'interférer avec le bain détergent situé au-des-
sous, lorsqu'il est entraîné à une haute vitesse de
rotation. 50
- 55

