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(54) Method for controlling the rotational speed of the drum of a clothes washing machine in the spin-extraction phase

(57) To start the spin-extraction phase, the water is first let off the tub (1) down to a minimum level (L2) and the rotating drum (2) is then accelerated. If the water in the tub (1) rises again up to a level (L3), it is again let off the tub and the instant rotational speed of the drum (2) is kept constant.
When the water decreases again down to the level (L2), water discharge is interrupted and the drum (2) is accelerated towards its highest spin-extraction speed (Vs).

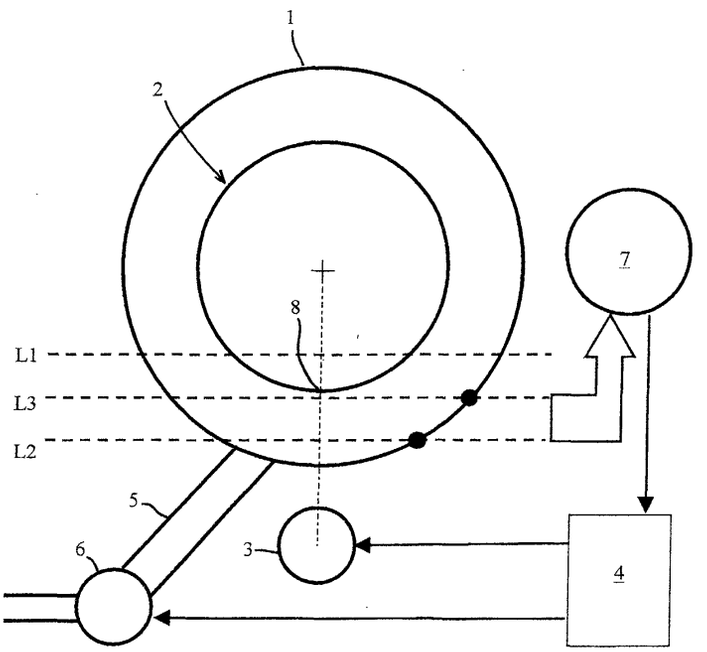

Fig. 1

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Description

[0001] The present invention refers to a method for controlling the rotational speed of the drum of an automatic clothes washing machine in the spin-extraction phase of a washing cycle.

[0002] Modern clothes washing machines are generally known to use small amounts of water and, therefore, are quite easily subject to considerable sudsing, i.e. heavy foam formation during clothes washing phases, owing for instance to the addition of an excessive amount of detergent in the water or the use of a detergent product that by its nature gives rise to excessive foaming.

[0003] Many such clothes washing machines are therefore provided with an anti-foaming arrangement formed by a pressure or level-control switch, or the like, adapted to de-energize the drum driving motor in response to an excessive formation of foam in the washing tub of the machine.

[0004] It should furthermore be noticed that an excessive formation of foam in the washing tub turns ultimately into a cause of inefficiency of the drain pump of the machine during the phases in which the washing liquor is let off under spin-extraction conditions of the clothes.

[0005] Ultimately, an excessive foaming in the washing tub brings about a whole set of disadvantages, i.e.:

- the rotating drum is repeatedly started to rise to its spin-extraction speed and then de-energized owing to the anti-foaming arrangement tripping, with a resulting sequence of aborted, i.e. "false starts";

- as a result, off-balance conditions and displacements of the machine are most likely to occur, along with considerable mechanical stresses imposed on the whole motion-transmission system between vthe driving motor and the rotating drum;

- the time needed to complete the water discharge phase turns out to be undesirably lengthened;

- the operating noise and the energy usage of the machine are increased.

[0006] It therefore is a main purpose of the present invention to provide a method for controlling the rotational speed of the drum of an automatic clothes washing machine, in the spin-extraction phase of the clothes, which is capable in doing away with the above-cited drawbacks.

[0007] In particular, it is a purpose of the present invention to provide a method of the above cited kind, with which the water discharge phases carried out under spin-extraction conditions of the clothes are substantially shortened and simplified, under resulting reduction in both the mechanical stresses imparted to the machine parts and the energy usage of the machine.

[0008] According to the present invention, these and further aims are reached in a method for controlling the rotational speed of the drum of an automatic clothes washing machine, in the spin-extraction phases of the clothes, incorporating the characteristics as recited and defined in the appended claims.

[0009] Anyway, features and advantages of the present invention may be more readily understood from the description that is given below by way of nonlimiting example with reference to the accompanying drawings, in which:

- Figure 1 is a purely schematic view of a washing machine adapted to implement the method according to the present invention; and

- Figure 2 is a diagrammatical view illustrating the variations in the rotational speed of the drum of the washing machine during significant phases of the method according to the present invention; and

- Figure 3 is a diagrammatical view illustrating the variations in the rotational speed of the drum under optimum theoretical conditions.

[0010] With reference to the above-mentioned Figures, the method according to the present invention may be implemented in a clothes washing machine featuring a substantially traditional structure, with a washing tub 1 that houses a rotating drum 2 adapted to hold the clothes and to be selectively driven rotatably at a low washing speed (under cyclical reversal of the direction of rotation) and a high spin-extraction speed by an electric motor 3 controlled by a programme sequence control unit 4.

[0011] A water discharge conduit 5, to which there is associated a drain pump 6, departs from said washing tub 1.

[0012] Again in a substantially traditional manner, the clothes washing machine shall be understood as being provided with a plurality of operational elements and parts controlled by said programme sequence control unit 4, which is preferably of an electronic type, to carry out a number of selectable operating cycles, at least one of which comprises in particular a washing phase carried out with detergent-added water that is let into the washing tub 1 up to a first operating level L1 and is preferably heated up. The washing phase is concluded by at least a water discharge phase, in which the drain pump 6 is energized by the programme sequence control unit 4 under the control of an analogue pressure switch 7 (or a similar level-control switch or sensor).

[0013] In particular, the pressure switch 7 drives the programme sequence control unit 4 with a signal that is indicative of the pressure determined by the variations in the level of the water (along with any possible foam in said water) in the washing tub 1. For reasons of greater simplicity, in the following description the assumption

is made that the pressure is directly proportional to the water level.

[0014] The programme sequence control unit 4 is set so as to be adapted to start the water discharge phase, through the energization of the drain pump 6, under substantially static conditions of the drum 2, in such a manner as to enable the foam that may be present in the washing tub to be substantially abated.

[0015] The programme sequence control unit is further set so as to stop the drain pump 6 and start the driving motor 3, in view of bringing the drum 3 up to a maximum spin-extraction speed Vs, when the water in the washing tub 1 lowers down to a minimum level L2 that preferably corresponds to the minimum pressure value P2 that can be detected by the pressure switch 7. In the example illustrated in Figure 2, this occurs at an instant t1, after which the drum is accelerated into spin-extraction, so that the resulting water released by the clothes causes the water level in the washing tub 1 to increase.

[0016] According to a further aspect of the present invention, the programme sequence control unit 4 is set so as to energize again the drain pump 6 and stop the acceleration of the driving motor 3, while keeping the instant speed thereof substantially constant, upon the pressure switch 7 detecting a pre-determined maximum pressure value P3 that substantially corresponds to a water level L3 that is greater than L2.

[0017] Preferably, said level L3 is lower than or equal to the level at the base 8 of the rotating drum 2, in such a manner as to prevent any further foam from forming owing to a contact of the rotating drum with the water containing sudsing, i.e. foaming additives.

[0018] In all cases, the drain pump 6 is advantageously energized when the priming conditions thereof are favourable, whereas the discontinuation in the acceleration of the rotating drum 2 enables the clothes to go on being spin-dried, i.e. to further undergo spin-extraction, while at the same time preventing the water in the washing tub from further increasing to any excessive level.

[0019] With reference to the example illustrated in Figure 2, the operation of the clothes washing machine shown schematically in Figure 1 with the method according to the present invention is briefly summarized below.

[0020] Up to an instant t0, an operational washing or similar phase is carried out in the machine with water let into the washing tub 1 up to the level L1 and, preferably, under a sequence of alternate rotations of the drum 2, as indicated schematically at A, at a rotating speed of approx. 50 rpm.

[0021] Upon reaching said instant t0, a water discharge phase is then triggered with the drum 2 substantially at a standstill, until the pressure switch 7 then, i.e. at an instant t1, detects a condition indicating that the minimum level L2 has been reached.

[0022] At this point, the drain pump 6 is de-energized and the drum 2 is driven to rotate up to its spin-extraction speed Vs.

[0023] During such an acceleration in the rotating speed of the drum, should the pressure switch 7 occur at an instant t2 to detect a condition indicative of a level L3 having been reached, the instant speed Vi of the drum is kept substantially constant and the pump 6 is energized again.

[0024] Upon the pressure switch 7 detecting again a level L2 of the water in the washing tub, the drain pump is again de-energized and the drum is again accelerated up to its pre-determined spin-extraction speed Vs.

[0025] The drum itself will reach said spin-extraction speed Vs thereof within a period of time t1-t3 which is variable depending on and according to the actual operating conditions (such as, in particular, the amount of foam generated in the suds or washing bath). In particular, during the period of time t1-t3 in which the drum 2 is accelerated into spin-extraction speed, a number of transients may possibly be experienced during which, in the above described manner, the drum 2 is accelerated in a gradual, step-like manner (as indicated schematically at B in Figure 2) up to said spin-extraction speed Vs.

[0026] In any case, from the above description it clearly appears that such an acceleration of the drum 2 takes always place in a gradual manner and under the most favourable operating conditions. Unlike the prior-art solutions, in particular, in the method according to the present invention the drum 2 reaches its spin-extraction speed Vs without going through any "false start", so that the time t1-t3 is drastically reduced and the mechanical stresses in the washing machine are kept down to a minimum.

[0027] As it may be noticed by comparing the curves in Figures 2 and 3, the actual speed variations of the drum 2 do not deviate from the optimum theoretical ones to any substantial extent.

[0028] After the instant t3, the operation of the washing machine can continue in a traditional manner, possibly with a further time-controlled energization of the drain pump 6.

[0029] It shall be appreciated that the above described control method may be the subject of a number of modifications without departing from the scope of the present invention.

[0030] For instance, the values of the water levels L1, L2 and L3 may be changed in accordance to the requirements, and the means used to implement the control method (such as for instance the pressure switch 7) may be of a different kind.

Claims

1. Method for controlling the rotational speed of the drum of a clothes washing machine in the spin-extraction phase thereof, in which at the end of an operational phase carried out with a first water level

(L1) in the washing tub of the machine, the water is let off the machine and the drum is driven into spin-extraction, **characterized in that:**

- the water is first let off the tub (1) under substantially static conditions of the drum (2);
- when the water in the tub (1) reaches down to a minimum level (L2), water discharge is discontinued and the rotating drum (2) is rotatably accelerated up to a maximum spin-extraction speed (Vs), in such a manner as to enable the clothes to release water in the washing tub;
- if the water in the tub (1) rises again up to a predetermined level (L3), it is again let off the tub and the instant rotational speed of the drum (2) is kept substantially constant;
- when the water lowers again down to the minimum level (L2), water discharge is interrupted and the drum (2) is accelerated towards said highest spin-extraction speed (Vs) thereof.

2. Control method according to claim 1, **characterized in that** said water discharge phases and said actuations of the rotating drum (2) as a function of said minimum water level (L2) and said pre-determined water level (L3) occur repeatedly until the drum reaches said highest spin-extraction speed thereof.

3. Control method according to claim 1, **characterized in that** said pre-determined level (L3) is lower than or equal to the level of the base (8) of the rotating drum (2).

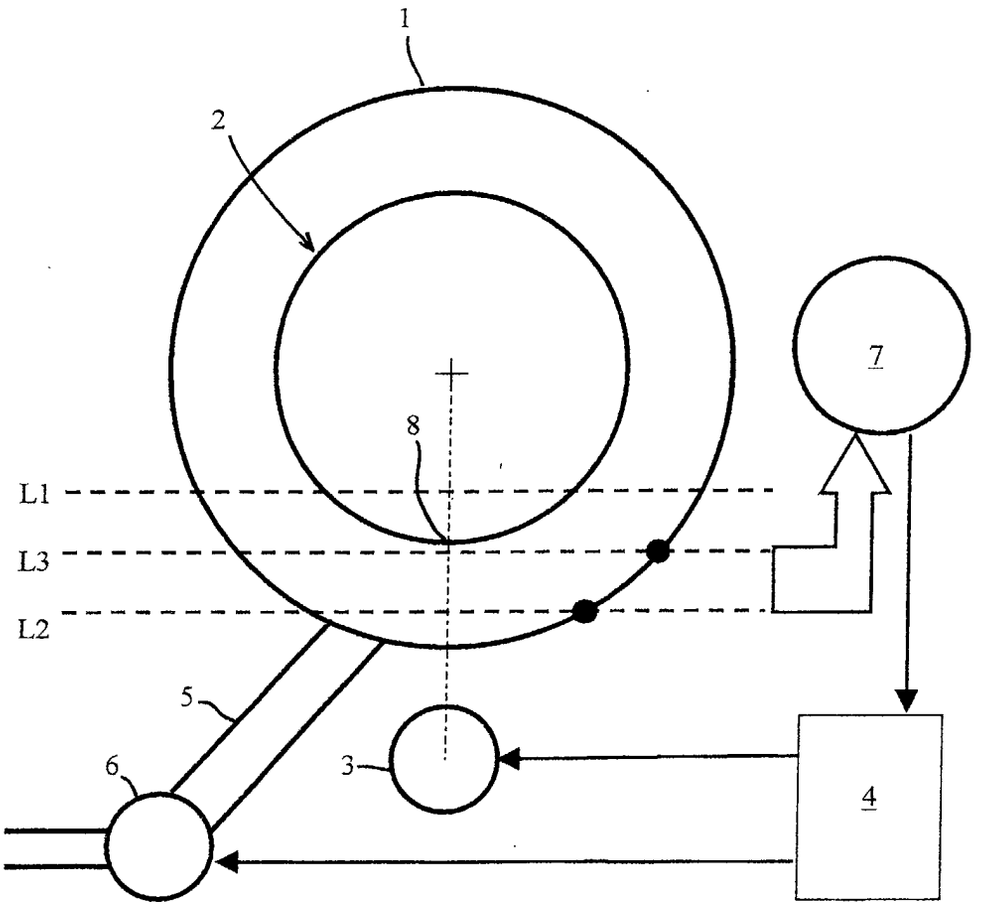

Fig. 1

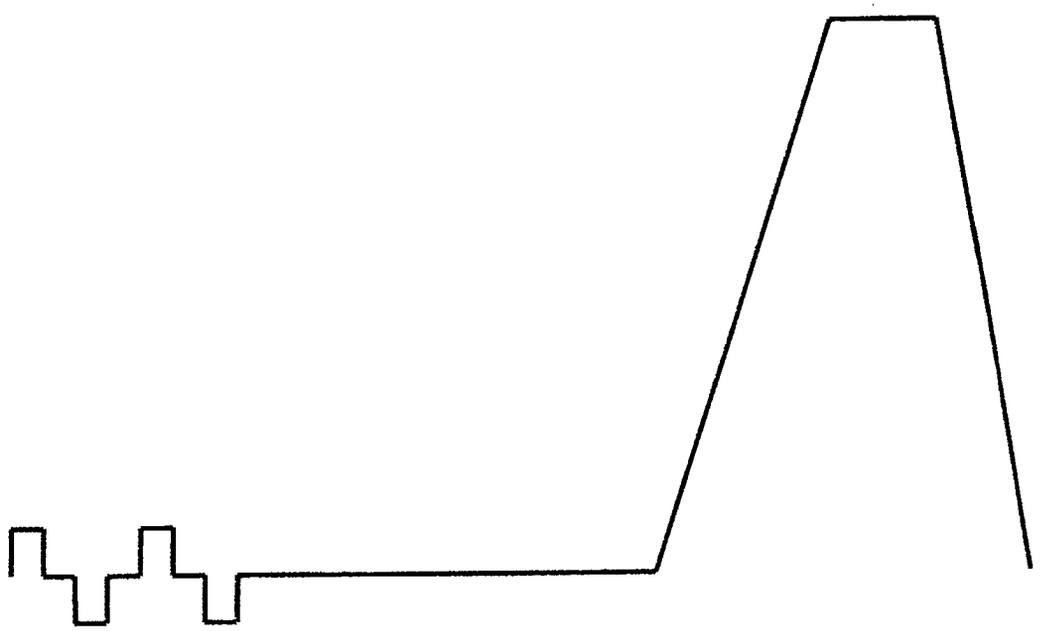

Fig. 3

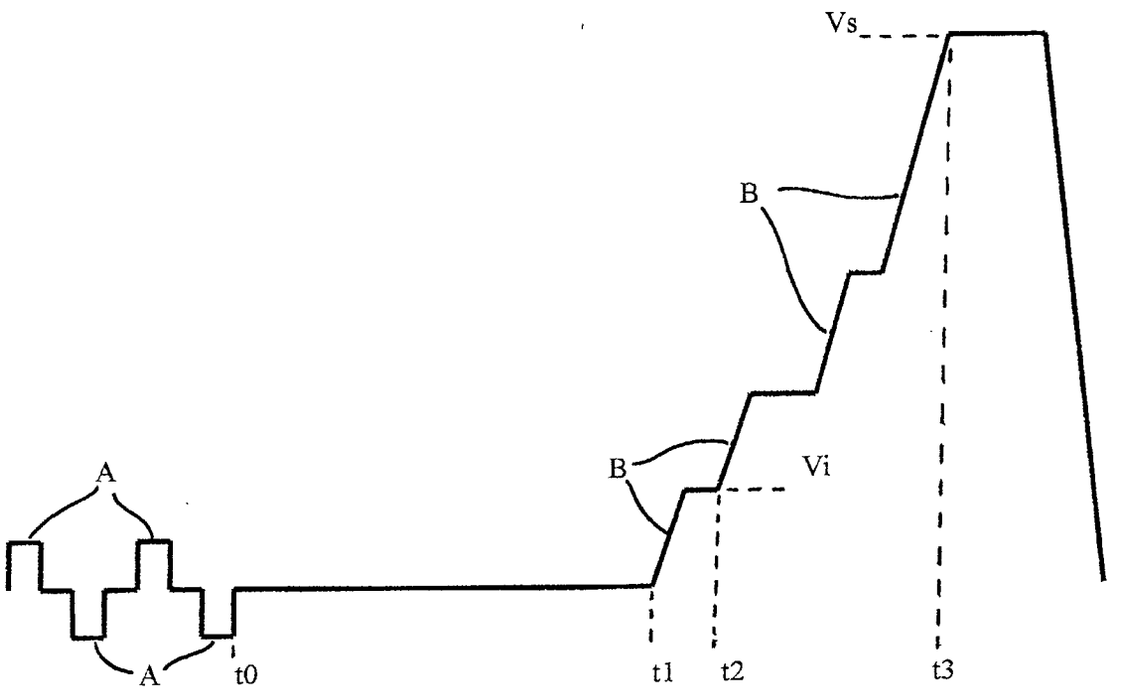

Fig. 2