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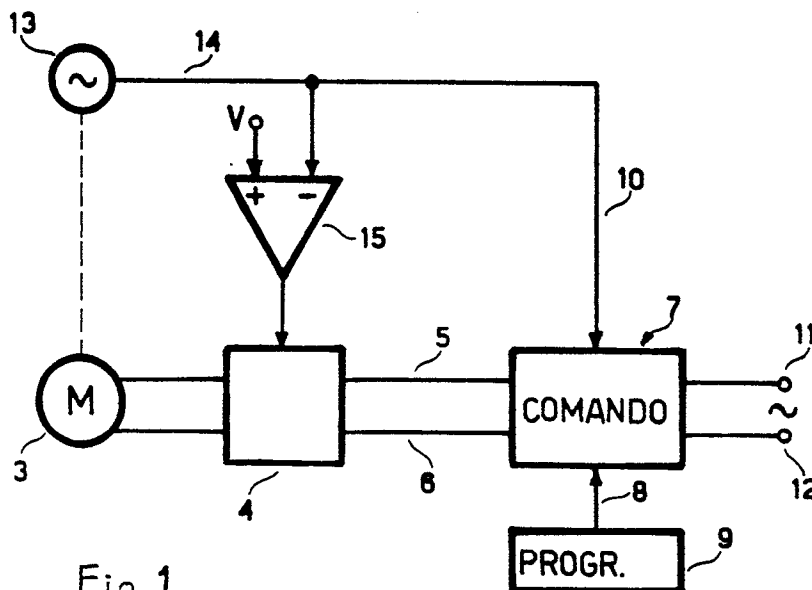

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 Automatic washing machine with rotating drum.


 Described is a washing machine comprising a drum rotated by a motor for carrying out a laundering cycle during which the laundry is soaked with a laundering liquid and the motor operates at a reduced speed, with at least one spin-drying period during this laundering cycle. Control means are provided for detecting the rotational speed of the motor and for deenergizing the motor when the spin-drying speed exceeds a predetermined value.



Automatic Washing Machine with Rotating Drum

The present invention relates to an automatic washing machine of the type designed to carry out laundry washing phases and spin-drying phases by the use of a rotatable drum containing the laundry. Described in Italian Patent Application No. 45715 A/85, filed on 5-24-85 in the name of the present applicant, is a laundry washing machine in which the washing liquid collected on the bottom of the laundering tub is recirculated to the interior of a rotatable drum to be absorbed by the laundry therein. In the course of the washing phase the drum may be rotated at the spin-drying speed for periodically recurring short intervals to the purpose of extracting from the laundry a sufficient amount of the laundering liquid for the operation of the washing liquid recirculation pump.

The laundry washing machine is particularly advantageous in that it permits considerable savings of water, detergents and electric energy to be obtained. In contrast to the state during the conventional final spin-drying phase, the laundering tub contains not only water, but also detergents during the periodic spin-drying phases.

As a result, the periodic spin-drying phases may give rise, particularly when their duration and/or the rotational speed of the drum exceeds a certain value, to the formation of an excessive amount of foam within the tub, such foam tending to escape from the machine for example through the detergent distributor. This troublesome phenomenon may occur with relative facility as a result of tolerances of the components of the machine and of the variability of certain parameters such as the size of the laundry charge.

It is therefore an object of the invention to provide an automatic washing machine having a rotating drum and adapted to carry out intervening spin-drying cycles during the laundry washing cycle without giving rise to the phenomenon of excessive foam formation

According to the invention this object is attained in an automatic washing machine comprising a tub and a drum mounted therein for being rotated by a controlled electric motor for carrying out at least one laundry washing phase during which the laundry is soaked with the laundering liquid and the motor operates at a reduced laundering speed.

During the laundering phase there is provided at least one interval during which the motor operates at the laundry spin-drying speed.

The washing machine is mainly characterized by comprising control means adapted to detect the rotational speed of the motor and to deenergize the motor when the spin-drying speed exceeds a predetermined value.

As a result, the rotation of the drum at the spin-drying speed occurring in the course of the laundering phase is terminated as soon as the drum has reached a predetermined rotational speed sufficient for extracting the laundering liquid from the laundry, but not so as to give rise to an excessive formation of foam.

The characteristics and advantages of the invention will become more clearly evident from the following description, given by way of example with reference to the accompanying drawings, wherein:

fig. 1 shows a block diagram of a preferred embodiment of a control circuit for the motor rotating the drum of the washing machine according to the invention, and

fig. 2 shows the variations of the rotational speed of the drum of the washing machine of fig. 1 during the laundry washing phase.

With reference to fig. 1, the washing machine according to the invention comprises as an essential component an electric motor 3, for example of the universal type, for rotating the laundering drum (not shown) of the machine.

Motor 3 is energized through a normally closed controlled breaker switch 4 from the two output terminals 5 and 6 of a control unit 7. The latter is adapted to control the speed of motor 3, for example by varying the phase or frequency of the voltage appearing at output terminals 5 and 6, in response to a first control signal applied to a first input terminal 8 by a program unit 9 of the machine, and to a second control signal applied to a second input terminal 10.

Control unit 7 has two additional terminals 11 and 12 connected to the electric supply mains, and is of a substantially conventional type comprising for instance an integrated circuit TDA 1085 supplied by Motorola Inc.. Program unit 9 is similarly of a conventional type, and the controlled breaker switch 4 may for instance be of the TRIAC type.

Associated to motor 3 is a device, preferably a tachymetric generator 13, adapted to generate at an output terminal 14 a DC or AC voltage in proportion to the rotational speed of the motor.

Output terminal 14 is connected to input terminal 10 of control unit 7, and in addition to the inverting input of a comparator 15 (for instance an operational amplifier) the non-inverting input of which has a reference voltage V applied thereto. The output terminal of comparator 15 is connected

to the control input terminal of breaker switch 4 for causing the latter to open in the per se known manner when the voltage at output terminal 14 of tachymetric generator 13 is higher than the reference voltage V.

According to an aspect of the invention, the reference voltage is calculated so as to represent a predetermined rotational speed of motor 3 and thus, taking into consideration the transmission ratio, a predetermined spin-drying speed of the drum of the machine.

With regard to the operation of the machine, reference is made to the sequence of a laundering cycle as diagrammatically shown in fig. 2.

In accordance with the program stored in program unit 9, control unit 7 generates at its output terminals 5 and 6 a voltage of a phase or frequency causing motor 3 to rotate at a speed corresponding to a rotational speed of the washing drum of for example 50 rpm, with the conventional inversions of the sense of rotation of the drum and intervening rest periods, the tub of the machine containing a laundering liquid during this period. In other words, the drum of the washing machine rotates at the laundering speed in one direction for a period t_0-t_1 , and after a rest period t_1-t_2 , in the opposite sense for a period t_2-t_3 .

At the end of a further rest period t_3-t_4 , control unit 7 energizes motor 3 to operate at the spin-drying speed for a preselected duration t_4-t_7 in a similar manner as described in the patent application no. 45715 A/85 cited above. In the known manner, rotation of the drum is thus started at t_4 with a relatively low acceleration for uniform distribution of the laundry within the drum. The spin-drying phase proper is initiated at t_5 with a sudden increase of the speed of the drum so as to attain a predetermined rotational speed n_2 of for instance 400 rpm at t_6 (after about two min.). As explained before, at the rotational speed n_2 of the drum the tachymetric generator 13 generates at its output terminal 14 a voltage identical to reference voltage V.

As a result, comparator 15 generates an output control signal adapted not only to terminate the spin-drying phase by the action of control unit 7 in a per se known manner, but also to cause breaker switch 4 to open immediately. At t_6 motor 3 thus abruptly deenergized, so that its rotational speed drops to approximately zero at t_7 . The laundering cycle then proceeds in the previously described manner, with further phases of rotation of the drum at the speed n_1 , interrupted by rest periods. It is also possible to provide further periodically recurring spin-drying cycles as described with reference to the period t_4-t_7 .

In the course of each of the periodic spin-drying phases the extraction of sufficient amount of the laundering liquid from the laundry is ensured, without however giving rise to the excessive formation of foam in the laundering tub. This effect is obtained by the use of the electronic components 4 and 15 operable to terminate the spin-drying phase at the proper time independently of any variables and tolerances which might give rise to an excessive formation of foam.

The automatic washing machine according to the invention may of course undergo numerous modifications without thereby leaving the scope of the invention.

Motor 3, comparator 5 and/or controlled breaker switch 4 may thus be of a different type; in addition, the periods of rotation and the rest periods of the drum during a laundering cycle may be variously modified, it being also possible to provide any number of periodic spin-drying phases analogous to the period t_4-t_7 .

A further modification may consist in the provision that the output of comparator 15 may be applied to a corresponding input of control unit 7, as will be readily evident to one skilled in the art. In this case the operation of breaker switch 4 is directly controlled by control unit 7.

The control means 13, 14, 15 and breaker switch 4 may finally be employed for limiting the maximum rotational speed of the drum during the final spin-drying cycle when there is no detergent in the laundering tub.

Claims

1. An automatic washing machine comprising a tub and a drum mounted therein for being rotated by a controlled electric motor for carrying out at least one laundry washing phase during which the laundry is soaked with a washing liquid and said motor operates at a reduced washing speed, and at least one phase during which said motor operates at the laundry spin-drying speed, characterized by comprising control means (13, 14, 15) adapted to detect the rotational speed of said motor (3) and to deenergize said motor when said spin-drying speed exceeds a predetermined value (n_2).

2. An automatic washing machine according to claim 1, characterized in that said motor (3) is connected to a controlled power supply (5, 6) through a normally closed controlled breaker switch (4) adapted to open when said control means (13, 14, 15) detects said predetermined speed value (n_2).

3. An automatic washing machine according to claim 2, characterized in that said control means comprises a tachymetric generator (13) driven by

said motor (3) and adapted to generate a control signal in proportion to the rotational speed of the drum,, said control signal being applied to comparator means (15) the output of which is adapted to control the opening of said breaker switch (4) on the spin-drying speed reaching said predetermined value (n2).

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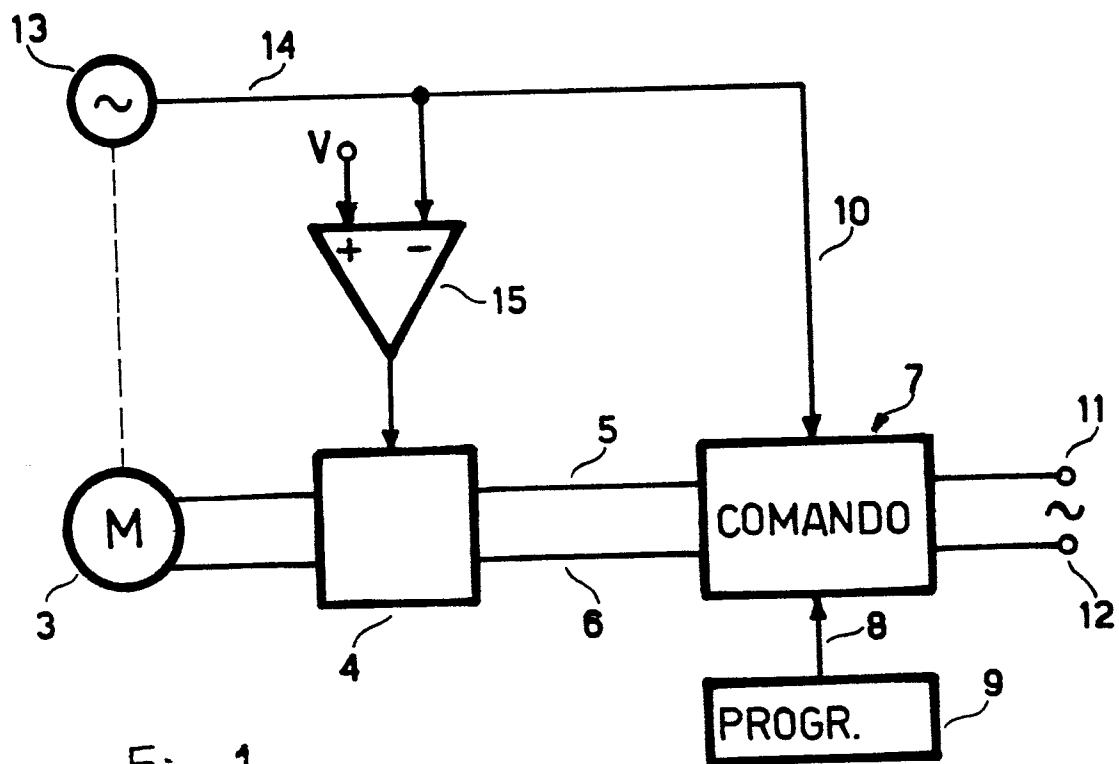


Fig. 1

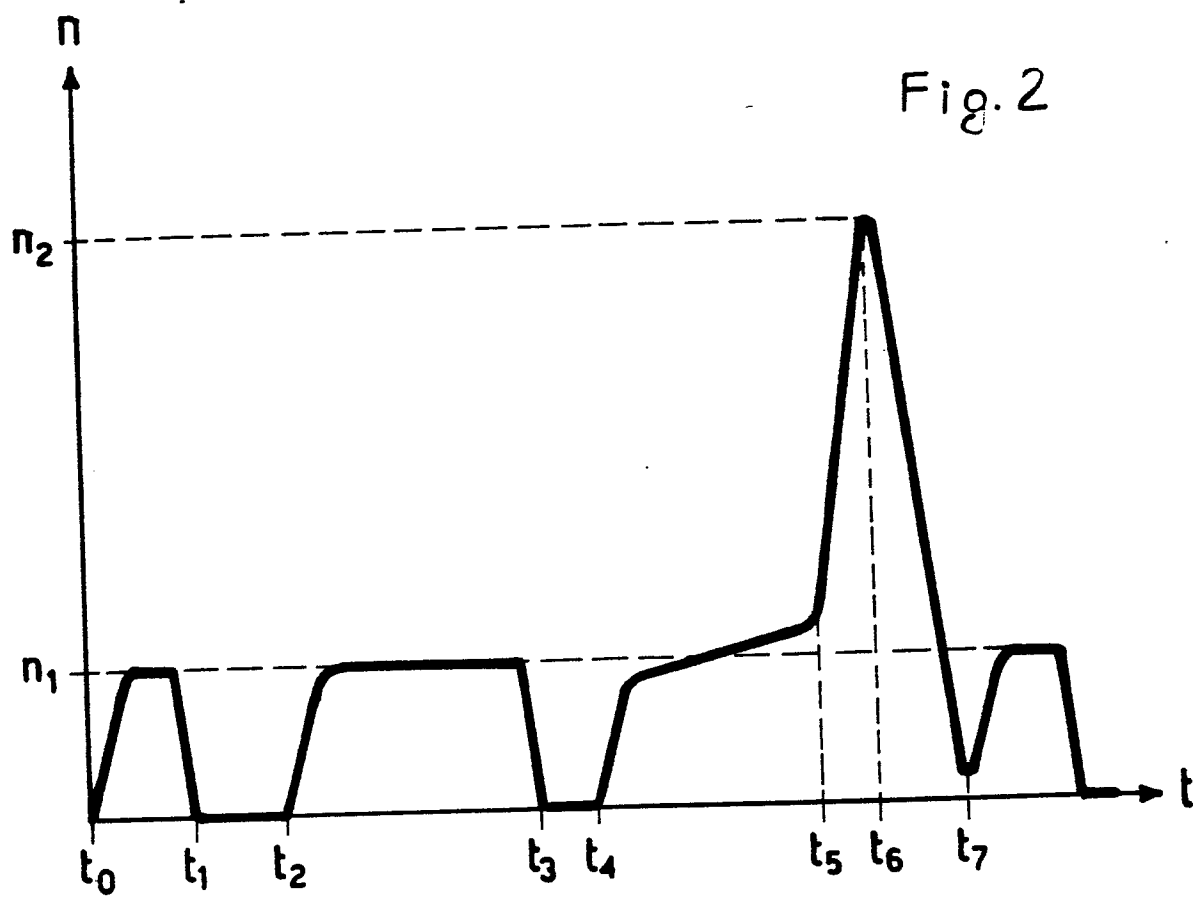


Fig. 2