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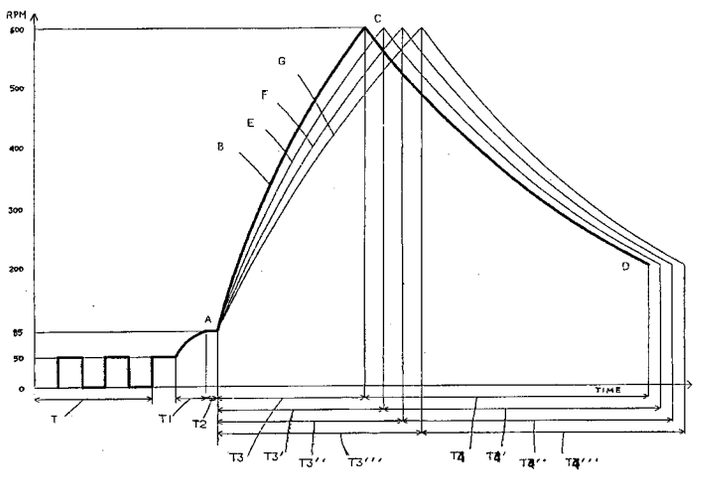
(54) Method for measuring the weight of the washload in a clothes washing machine.

(57) Method for measuring the weight of the wash load in a clothes washing machine or a combined clothes washing and drying machine, comprising an electronic microprocessor and a rotating clothes-holding drum driven by an electric motor. Method in which, before any wash cycle is started, said clothes-holding is rotatably driven, without any water being yet filled into the wash tub, with a sequence of movements at the regular wash speed, and then at a first speed (A) that is higher than the regular wash one, and at a second speed (C) which ranges anywhere between the wash and the spin-extraction ones.

Then said clothes-holding drum is slowed down so as to reach a third pre-set rotation speed (D). In the process, the microprocessor will measure the period of time T3 + T4 needed by the drum to proceed from speed (A) to speed (D), said period of time being in exact correlation with the actual weight of the washload.

Based on said measurement of the weight of the clothes, the microprocessor will then adapt all washing and rinsing cycles to be performed next, thereby optimizing the water, detergent and energy consumption figures thereof.



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The present invention relates to a method for measuring the weight of the wash load in a clothes washing machine or, as the case may be, in a combined clothes washing and drying machine, which is capable of enabling said weight of the wash load to be detected and determined in a simple and quick way.

Clothes washing machines and combined clothes washing and drying machines are already well-known, which are arranged to perform a plurality of pre-determined washing cycles as appropriately selected from time to time by the user, according to the type and the quantity of the clothes to be washed, through the actuation of specially provided push-buttons for the selection of the washing cycles to be performed , as well as special push-buttons that are associated with different quantities of the washloads being introduced in the drum of said machines, all these push-buttons being in turn connected functionally with the timer-sequence control switch of the machines so that their actuation puts said timer-sequence control switch in such a position as to appropriately perform fixed washing cycles that will enable satisfactory washing results to be obtained with such process conditions as cycle duration, detergent requirements, as well as water and energy consumption being reduced to the lowest possible level.

However, these machines are not able to perform any kind of adaptive cycle control, ie. to adapt their washing cycles to the actual quantity, nature and type of fabrics of the washload being each time introduced in the drum for laundering, and therefore to the actual weight of said wash load, as it would on the contrary be desirable with a view to optimize the usage or consumption of water, electrical energy and detergent required to carry out said washing cycles, so as to rationalize and make the best possible utilization of the actual performance capabilities of the washing machines concerned.

Clothes washing machines are furthermore known (EU 159202) which comprise a microprocessor for controlling the sequence of the washing cycles set by the user, as well as appropriate electronic sensors for detecting the phase displacement between the voltage and the current input to the electrical driving motor equipping said washing machines, said current being in a proportion, within a certain functional domain, to the resisting torque of the motor, which is dependent on the weight of the washload in the drum, so that the microprocessor, based on the measurement of said phase displacement and the electrical supply voltage to the motor, is each time able to determine the resisting torque of the motor and, as a consequence, the weight of the washload contained in the drum, whereas it will in this way be enabled to adapt the various process variables of each washing cycle being selected by the user to the actual weight of the washload that has been measured in the described way. As a consequence, each washing cycle will be each time enabled to be performed under optimized water, detergent and energy requirements for fully staisfactory washing results.

In all these cases, however, washing machines require the use and the presence of various electronic sensors to indirectly measure the weight of the washload according to the afore described principles, so that the electrical circuitry of these machines inevitably turns out to be quite complicated and rather unreliable.

It is the purpose of the present invention to overcome the drawbacks and the limitations of the afore cited solutions by providing a simple, reliable method for measuring the weight of the wash load which, as performed in either a clothes washing machine or a combined clothes washing and drying machine provided with an electronic microprocessor for controlling the washing cycles, enables the weight of the clothes that are each time introduced in the drum for laundering to be precisely measured and the process variables of the selected washing cycle to be adaptively matched to this measured weight so as to enable the washing process to be each time performed satisfactorily under optimized water, detergent and electrical energy consumption values.

This and further aims are reached according to the present invention in the utilization of a method for measuring the weight of the washload which has the particular features as recited in the appended claims.

For a better understanding, however, the invention will be further described in the following, by way of non-limiting example, with reference to the accompanying drawing in which:

- Figure 1 schematically illustrates the diagram relating to a portion of the washing cycle as performed by clothes washing machines, or combined clothes washing and drying machines, and showing the variation vs. time of the rotational speed of the clothes-holding drum of said machines, said variation being used as the actual basis for determining the weight of the wash load according to the measurement method described here.

The method according to the present invention for measuring the actual weight of the clothes being each time introduced in the drum of a clothes washing machine or a combined clothes washing and drying machine for laundering (neither of them shown in the Figure), comprises at least an electronic microprocessor that can be set to control the process sequence and the variables of a num-

ber of pre-determined washing cycles. This method is substantially based on the fact that it performs the measurement of the weight of the wash load according to the principles as set forth hereinafter, and that it then uses the measured value of said weight to enable the microprocessor to each time adapt the various process variables of the selected washing cycle accordingly, so as to obtain satisfactory washing results with washing cycles whose duration has each time been selected to be as short as possible so as to enable the amount of water, detergent and electrical energy required to carry out the same cycle to be optimized.

To this purpose, the various process variables that combine to enable the washing cycle to be performed in an optimized way (such as amount of water and detergent filled in or added, duration of each single phase of the cycle, temperature of the wash and rinse liquor, etc.) according to the actual nature of the fabrics and the quantity (and, therefore, weight) of the clothes in the wash load, are stored in advance, in an appropriately coded form for each one of the phases of the various predetermined washing cycles that are available for selection, in the memory of the microprocessor. As a consequence, for any weight of the washload that is each time measured based on the measurement method according to the present invention, this microprocessor is actually enabled to automatically adapt the value of each one of said process variables to said weight, thereby causing each selected washing cycle to be modified correspondingly so as to enable the same cycle to be each tame performed under flexibly optimized conditions in view of satisfactorily washing exactly that type and that amount of clothes.

The clothes weight measuring method according to the present invention is more clearly understood in its way of working if reference is made to the diagram illustrated in Figure 1, in which the variation of rotational speed (indicated in the ordinates) is shown vs. time (indicated in the abscissae) with reference to a phase in which the drum of a clothes washing machine, or combined clothes washing and drying machine, is rotatably driven by an electric motor of a traditional type (not shown) before any selectable washing cycle is started, with the whole washload duly introduced in the same drum and no water yet filled in the tub.

Under these conditions, the weight of the dry washload contained in the drum is then measured according to the principles of the measuring method as described hereinafter, so as to enable the microprocessor of the machine to start and perform the selected washing cycle with such a control sequence and such process variables as it determines as being optimally adapted to that measured quantity of clothes to be laundered.

The way in which the above cited measuring method operates can be described in a particularly effective manner by referring to the diagram shown in Figure 1, in which it can be noticed that the microprocessor starts by first of all letting the electrical driving motor, and therefore also the rotating drum, be rotatably driven at the rated value of the supply voltage through a predetermined sequence of alternating movements in both directions at the low wash speed (ie. at a rotating speed of SO rpm in this particular case), so as to prevent the washload from undesirably getting entangled, as well as to arrange the same wash load in view of the next distribution phase.

This sequence of alternating movements of the drum is performed during a period of time T, as it can be noticed in the afore cited diagram. Later on, when the drum is driven to perform its last rotational movement in a determined direction of rotation, as soon as this movement is stopped, the drum is no longer driven to rotate in the reverse direction until it stops again, as it occurred previously, but keeps on the contrary being driven in the same direction of rotation at a gradually increasing speed, until a speed is reached which is slightly higher than the regular wash speed, so as to promote an even distribution of the washload in the drum and prevent, to the greatest possible extent, washload unbalance condition from forming inside the same drum. During this particular phase, the electrical driving motor is supplied at a predetermined, reduced electrical voltage, whose value is lower than the rated one and, anyway, is situated anywhere between 130 and 170 V in the example being illustrated here.

At the end of this phase, which is performed during a period of time T1 until the drum reaches a rotation speed that in the present example is of approx. 85 rpm, the drum is then kept constantly rotating at the same rotation speed for a short period of time T2. Immediately thereafter, the microprocessor steps in to switch over the electrical driving motor of the machine to its high spin-extraction speed, starting from the previous rotating speed marked with an A in the Figure and keeping the motor supplied at the same pre-determined, reduced voltage rating as before, so that the drum will be driven at a progressively increasing speed, said rotating speed of the drum being increased in a very quick way owing to the greater driving torque of the motor, as it is clearly emphasized in the diagram by the particularly steep slope of curve B showing the way in which the rotational speed is caused to rise vs. time, such a rise taking place with a slope angle that varies proportionally to the weight of the washload and the related distribution condition thereof inside the drum, as it has been confirmed by several observations in the

laboratory.

The motor and the drum are at this point driven during a period of time T3, which is long enough to allow the drum to reach a pre-determined rotational speed that is lower than or equal to the final spin-extraction speed, and is determined experimentally for the reasons explained hereinafter, said speed being of 600 rpm in this example and being further marked with a C in the diagram. Upon reaching this speed, the microprocessor steps in to switch off the power supply to the motor, so that the drum and the motor are still rotatably driven by the inertial movement of the same drum, however at a gradually increasing rotational speed owing to the resisting torque generated by the mass of clothes in the drum and the friction of the rotating mechanical members of the machine.

In this case, what actually matters at this point to the purposes of the washload weight measuring method according to the present invention is the period of time T4 which is needed by the drum driven at the afore cited speed C to reach another pre-determined speed D that is lower than the previous one and is determined by experiments according to the principles and for the reasons as described hereinafter, said speed D being equal to approx. 200 rpm in the example described here.

Said periods of time T3 and T4 are therefore measured automatically by the microprocessor, and stored in the memory thereof, so as to be then able to indirectly determine, in the way described below, the weight of the washload that is from time to time introduced in the drum.

In particular, the period of time T3 is dependent on the value of the driving torque of the motor, the resisting torque and the rotating mass of the drum holding the wash load, whereas the period of time T4 is only dependent on the resisting torque and the rotating mass of the drum.

Of these three parameters affecting the overall duration of the periods of time T3 and T4, both the driving torque of the motor, owing to the fact that the high-speed spin-extraction rotation of the drum is as usual obtained by energizing the high-speed windings of the electrical driving motor and keeping them energized until the afore cited speed C is reached, and the rotating mass of the drum holding the washload have constant values for an equal load of clothes in the drum.

On the contrary, the value of the resisting torque is variable, since it is affected by a number of factors that are either inherent to the rotating system (ie. wear of bearings, possible clearances, slacks or mechanical alterations of the driving belt or other driving gears used to transmit movement to the drum, etc...) or unconnected therewith (such as the distribution of the wash load in the drum and, as a consequence, the dynamic balance or unbalance thereof).

However, since the resisting torque, when referred to said inherent factors only, will be always identical in each individual machine considered and for each loading condition of the drum thereof (ie. either empty or fully loaded drum), and can therefore be neglected since it practically takes on a constant value, it ensues that the changing value of this torque that is each time measured in the afore described manner may be considered as being only and solely affected by the distribution of the washload in the drum as the latter is rotatably driven. Under these circumstances, then, said resisting torque will take on a variable value in the case of an uneven distribution of the wash load in the drum, which therefore will be unbalanced, whereas it on the contrary takes on a constant value if the distribution of the washload in the drum has occurred in a correct and even way, ie. if the clothes in the drum form a balanced load.

Based on a number of laboratory test results and practical observations it has been possible to establish the general rule affirming that, when a wash load distribution in the drum which proves to be in a certain state, ie. unbalanced or balanced , at the rotation speed A of the drum, the same state will turn out to be true even at the rotation speeds C and D: however, in the first case said rotation speed C is reached in a time 13 that is longer than the time T3 needed in the second case, whereas the rotation speed D is in the first case reached in a time T4 that is shorter than the time T4 needed in the second case. Anyway, under both conditions, and for an equal washload, the rotation speed D will in all cases be reached in an identical total period of time as resulting from the sum of T3 + T4. Under these conditions, therefore, such a total period of time T3 + T4 may be considered as being exactly correlated with the load and, as a consequence, the weight of the clothes contained in the drum.

As it cab again be seen in the diagram shown in Figure 1, in which a number of further experimentally determined characteristic curves marked with the letters E, F and G are plotted in a similar manner as the afore described curve B for progressively increasing wash loads in the drum, it can be noticed that also the corresponding periods of time T3' + T4', T3'' + T4'', T3''' + T3''' needed by the drum to reach said rotation speed D are increased accordingly. From the above cited experimental work it has further emerged that said periods of time are in all cases directly correlated to the weight of the washload filled in the drum. In conclusion, therefore, the measurement of these periods of time T3 + T4 according to the present invention automatically and precisely determines the weight of the washload that is each time introduced in the

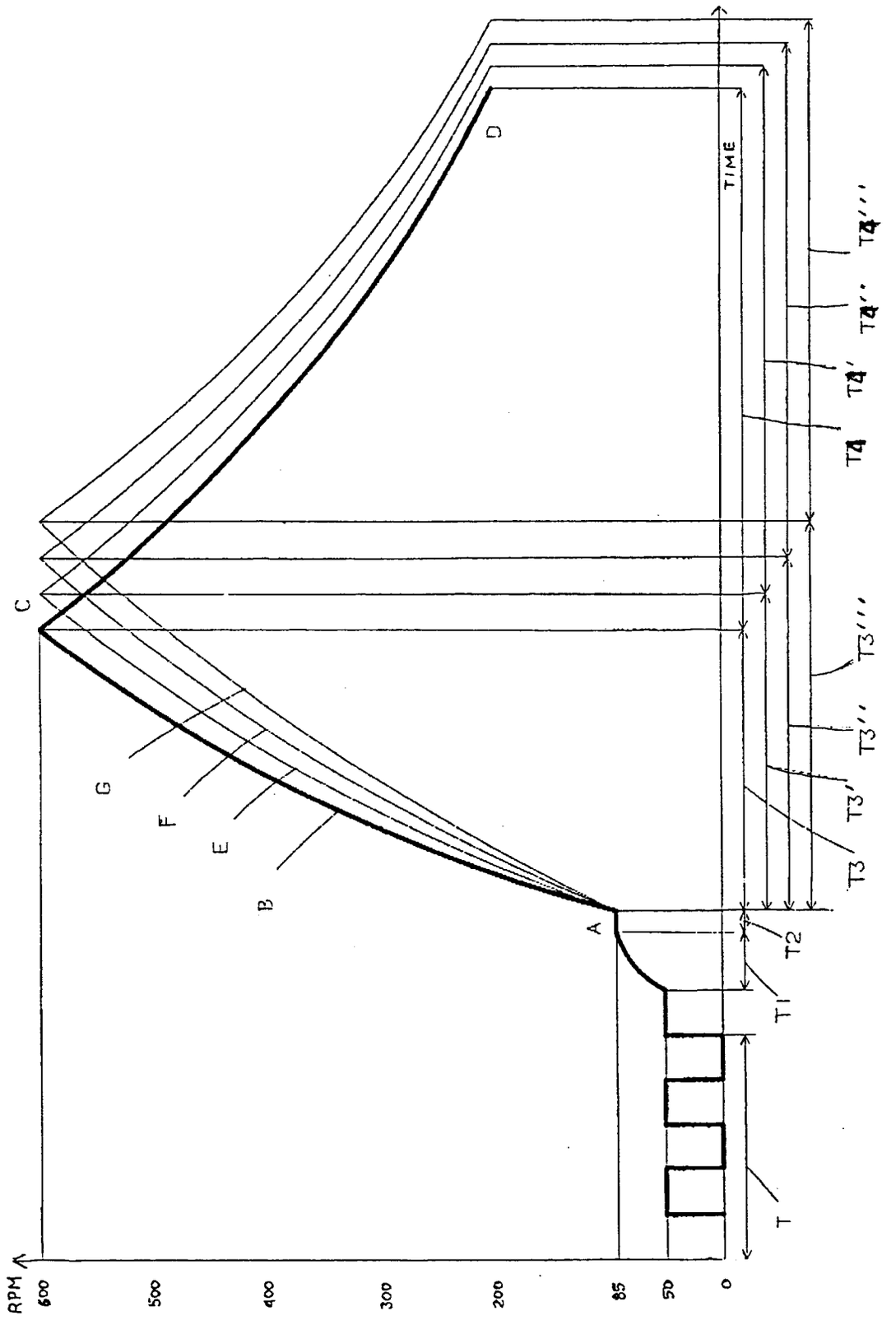
drum of the clothes washing machine or combines clothes washing and drying machine.

In particular, it has also been found experimentally that the T4-to-T3 ratio is ≈2.

In this manner, the microprocessor of the machine can be arranged to store, for each one of the various washing cycles that the machine can be set to perform, appropriately coded information relating to differently long periods of time and corresponding weights of the washload, so that the measurement of such weights during each washing cycle is determined by the microprocessor directly from the reading of said periods of time and is then stored in the same microprocessor so as to enable a washing cycle to be performed thereupon, which is in this way each time adapted to the actually measured weight of the washload in the drum, under optimized water, detergent and energy usage characteristics.

Claims

1. Method for measuring the weight of the washload in a clothes washing machine, or combined clothes washing and drying machine, comprising a washload holding drum that can be rotatably driven at its wash and spin-extraction speeds by means of at least an electric motor of a traditional type, and comprising at least a microprocessor, or similar electronic arrangement, to control the performance of a plurality of washing cycles, characterized in that before any selected washing cycle is actually started, the wash load holding drum is rotatably driven, under the control of said microprocessor or similar electronic arrangement and without any water being in this phase filled in the tub of the machine, by letting said electric motor operate in the same direction of rotation until a first rotation speed (A) is reached, which is slightly faster than the wash speed and in all cases slower than the spin-extraction speed, said motor being supplied with a predetermined electric voltage that is lower than the rated one, and then said drum is rotatably driven at its spin-extraction speed until a second pre-determined rotation speed (C) is reached, which is higher than said first rotation speed and lower than or equal to the highest attainable spin-extraction speed, preferably of approx. 600 rpm, said motor being also in this case supplied with a pre-determined reduced electric voltage, said power supply to said electric driving motor being then cut off so that said wash load holding drum is rotatably driven by reason of its inertia at a gradually decreasing speed and, before coming to a standstill, reaches a third pre-determined speed (D), and characterized in that said microprocessor or similar electronic arrangement is arranged to measure and store the sum of the periods of time (T3 and T4) needed for said wash load holding drum to be rotatably driven from said first speed (A) to said second speed (C) and, respectively, from said second speed (C) to said third speed (D), said sum being directly correlated with the weight of the washload in the drum, and is further arranged to each time adapt, in accordance with the measured weight corresponding to said sum of the periods of time (T3 + T4), each subsequently performed washing cycle to the so measured weight of the washload.


RPM
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EUROPEAN SEARCH REPORT

Application Number

EP 92 11 5257

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	EP-A-0 415 743 (FISHER & PAYKEL LIMITED) * claims 1,2,4,5,23,25-27,34,35 * * claims 37,39,43,44; figures 6,7 *	1	D06F39/00
A,D	EP-A-0 159 202 (ESSWEIN SA.) * page 6 - page 9, line 11; figure 4 *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

D06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21 JANUARY 1993	COURRIER G.L.A.

CATEGORY OF CITED DOCUMENTS

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