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(54) **Washing machine with device and method to control the rinsing**

(57) A household washing-machine is described, specifically a laundry washer, comprising all known elements for its operation, including a control unit (MP) and means (A,B) to measure the ionic concentration degree of the water or detergent. According to the present invention, the control unit (MP) enables the execution of a rinsing process that goes on till a predetermined rinsing performance (MR,MC) has been reached, as detected by measuring water ionic concentration through said detection means (A,B).

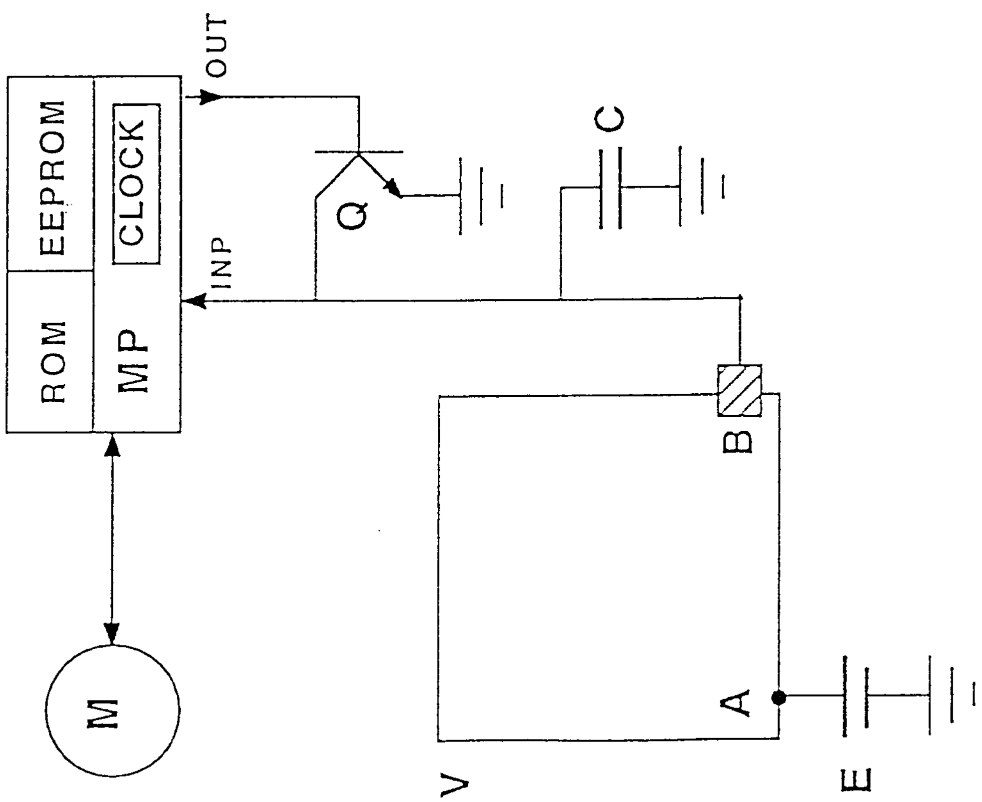

FIG. 2

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Description

The present invention refers to a washing-machine, in particular a laundry washer, as described in the preamble of the annexed Claim 1.

As known, household laundry-washers need to use detergents for the washing of clothes and it is also known at the end of a wash cycle the clothes should not retain any detergent residues. This to avoid that the clean clothes may cause a bad smell and/or prevent that likely detergent residues retained in some clothes may cause skin irritation.

To this purpose and before ending a wash cycle, the laundry washer executes the socalled rinse cycles, with the washer drum containing the clothes carrying out motion steps with fresh water from the mains. The rinses, usually a restricted number (normally four) are completed each one by a water discharge, a short spinning and a further discharge of the water being wringed out of the clothes during said spinning step.

In main line, the higher the number of rinsing cycles or the volume of water to execute each said cycle, the less the risk of detergent residues in the clothes will be.

However, this simple principle is contrary to the standard requirements of a reduced water consumption as dictated by specific rules in some countries and also to the fact that in some countries water costs are decidedly high. In this frame, some known laundry washers are for instance advertised as capable of operating with reduced water volumes for each wash-cycle. However, it should be pointed out that in some instances such known machines may have an unsatisfactory rinsing quality for the clothes, specifically when the user has introduced into the machine a higher dose of detergent than actually required.

As a matter of fact, the quantity of water used for the rinses and their number in the machines according to the known state of art are substantially fixed, and depend upon the parameters preset at the design stage of the machine control system. In particular, the volume of water taken in for each rinse depends on the configuration of a sensor with a fixed level, eg. a pressure switch (controlling input of water preset quantities), whereas the number of rinse steps depend on the kind of the preset wash-cycle and each cycle always will execute that specific number of rinses.

Therefore, the machines of the known type appear to have little flexibility with respect to the problem of an improved rinse quality and saving of water consumption.

Also other laundry washers are known, which are provided with a push-button to add at least a rinse step to the ones usually preset by the wash-cycle or to increase water level for the rinsing steps. In this case the user can press said push-button for a more efficient rinse. However, such a setting merely reflects a "quantitative" and approximate solution, being an open-ring adjustment, in the sense that if on one hand the pressure of said push-button surely determines a higher water consumption, on the other hand it does not necessarily warrant a full achievement of the desired result, i.e. a full removal of detergent residues. Such a result, in fact, is related to several factors, such as for instance the quantity of detergent introduced by the user into the machine, water hardness from the mains, type of fabric for the laundry to be washed and its quantity.

To this purpose, let us generally think of a user introducing an excessive quantity of detergent into the machine or of a user whose skin is easily irritable by the detergent residues. In both cases, at the end of the wash cycle the user might be forced to carry out an extra rinse (selecting a special short cycle) to remove likely residues of detergent that were not eliminated during the initial washing. Such a practice is quite spread in those countries, like Italy, where water has a relatively low cost.

On the other hand, let us think viceversa of a washing with a small laundry load, or of a user normally using small quantities of detergent. In this instance the machines of the known type could use a much higher quantity of water than actually needed.

According to another standpoint, the problem of a rinsing performance matching water consumption is also felt by the manufacturers of household appliances. Let us think for instance of one same type of laundry-washer sold to various countries where different standards for water consumption and/or different water price levels apply.

In this case the manufacturers of such laundry washers need different machine configurations for their sale to two different markets, i.e. either working on the calibration levels of the above pressure switch or changing the machine programmer to decrease or increase the number of rinses programmed by the selectable wash-cycles.

As a result, in the laundry washers of known type the amount of rinsing, i.e. the number of rinses and relevant water levels are always preset with a likely fair possibility for the user to operate from a quantitative standpoint (push-button as previously mentioned), though not necessarily warranting full achievement of the desired performance, specifically with respect to the user's varying requirements and individual types of rinsing.

Therefore, it is the object of the present invention to solve the above issues by providing a laundry washer capable of performing a "qualitative" selection related to the actual requirements of the rinsing efficiency and, in particular, allowing the user to manage a correct compromise in a direct customized way between the need of removing the detergent to a maximum extent from the clothes and keeping water consumption low.

According to the present invention said object is obtained by providing a laundry washer having the characteristics listed in the annexed Claims.

The characteristics and advantages of the invention will become apparent from the following detailed description and annexed drawings, which are supplied only by way of explanatory but not limiting example, wherein:

- Fig. 1 shows schematically a control device of the washing machine according to the present invention;
- Fig. 2 shows schematically a part of the control circuit of the washing machine according to the present invention;
- Fig. 3 shows the relationship between the detergent concentration and the resistivity as detected by a device available in the machine according to Fig. 2;
- Fig. 4 shows a block diagram of a part of the logic control circuit of the washing machine according to the present invention;
- Fig. 5 shows a block diagram of a part of the logic control circuit of the washing machine according to a possible embodiment of the present invention.

In the instance of the present invention described by way of example, the washing machine according to the present invention, specifically a laundry washer, comprises a control unit of the type with a microcontroller, containing appropriate programme information codified in associated permanent memory means.

The control unit also contains available information of specific physical characteristics of the washing fluid through proper sensing means. The machine according to the present invention also comprises a selecting device, consisting eg. of a rotary knob actuated by the user to indicate the required rinsing performance to the control unit.

Thus, the user is actually able to operate a qualitative choice through said selecting device for the type of rinsing to be carried out by the machine.

Fig. 1 shows schematically said knob as indicated by M, through which the user can choose a position comprised between two opposite extreme values: a position for a minimum water consumption indicated by MC and a position for a highest rinsing performance, indicated by MR.

Each of these two extreme values highlights a different user's standpoint whereby the actual position chosen for the knob M represents a right compromise between the need of removing as much detergent as possible from the clothes and the need to avoid a high a water consumption.

In the case described by way of example, the machine according to the invention has an adequate device to measure washing water resistivity; a possible embodiment of which is described in Fig. 2.

Said measuring device of the washing water resistivity inside the laundry washer according to the present invention comprises two electrodes, shown in fig. 2 with the letters A and B. Electrode A consists of an electrically conductive element directly in contact with the washing water, where in the instance of Fig. 2 coincides with the metal structure V itself of the machine (tub-drum assembly) but could also be separated by an adequate rubber seal.

Electrode B consists of an electrically conductive element directly in contact with the washing water and isolated against electrode A.

As shown in Fig. 2, connecting the electrode A with the positive pole of a direct voltage generator E (eg. E = 5V) and earthing the electrode B (negative pole of same voltage generator E) through a capacitor C of adequate capacity (eg. C = 1 microfarad), due to the conductive washing water we will have a current flow from A to B, which is proportional to the resistivity of the water inside the tub.

Said current flow will feed a charge transient of capacitor C and stop upon conclusion of said transient state, i.e. when voltage at capacitor C terminals equals the value of E. The transient is generated by the microcontroller MP and its duration depends on the capacity value of capacitor C and on the resistivity value of the medium (washing water) through which the charge current is flowing.

After establishing an adequate value of capacitor C (eg. C = 1 microfarad) it is possible to obtain information on the resistivity of the washing water by measuring the charge time of said capacitor C. As shown in fig. 2, charge time can be measured by any microcontroller available on the market MP (4 or 8 bit configuration) capable of measuring the time with a good resolution (eg. in the order of 1 microsecond).

A digital input of microcontroller MP, called INP in Fig. 2, is connected with the terminals of capacitor C, whereas a digital output, called OUT, is used to pilot a transistor Q, which is used as a control switch for the transient whose manifold is in its turn connected with capacitor C terminals.

Charge time for capacitor C is measured by the following operations of microcontroller MP:

- fast discharge of capacitor C through application of a short impulse (eg. 1 millisecond) on the base of capacitor C through output OUT;
- start of the time counting, right when the transistor Q goes back to its lock state upon terminating the discharge impulse of the capacitor, thus allowing the capacitor charge to start;
- stop of the time counting, right when the voltage at the capacitor terminals reaches the tripping threshold of digital input INP, whose value typically equals half the supply voltage of microcontroller MP (i.e. E/2 = 2.5 V);
- the value reached by the time counter inside MP at counting stop represents the measurement result and is directly related to the intrinsic resistivity characteristics of the washing fluid.

As mentioned, the microcontroller MP has a program codified in its permanent ROM memory to calculate the fluid resistivity in relation to the measurement of the charge time of said capacitor.

Said information (resistitivity degree) also enables the control system of the laundry washer according to the present invention to detect the presence of washing agents in the water; as a matter of fact, the value of ionic concentration in the water - proportional to the quantity of washing agent dissolved in water - can be desumed with the aid of an appropriate table by measuring the fluid resistivity after introduction of said washing agent.

Fig. 3 shows graphically by way of example the result of an experimental investigation showing the existing relation between the detergent concentration and the resistivity, as detected with the device of fig. 2, expressed in grams per liter at a temperature of 20°C (water hardness 30°F).

At any rate it should be mentioned that apart from the water temperature and hardness under normal conditions, since the difference of the ionic concentration between pure water and water containing detergent is remarkable, in the practice the measuring device shown in Fig. 2 proves to be capable of analyzing both differing conditions in a most exact manner.

Finally, in Fig. 2, M indicates the above selection device or knob interacting with the resistivity metering device and microcontroller Mp to set the required rinsing type; said knob M can eg. consist of a simple potentiometer with variable resistance according to its angular position; as said previously, the knob M provides a plurality of selectable positions ranging from a highest rinsing quality (MR) to a minimum water consumption (MC).

According to the present invention each selectable position of knob M refers to a determined concentration of detergent residue in the water from the last rinse.

In the instance of position MR, i.e. highest rinsing performance, detergent concentration in the water from the last rinse carried out by the machine shall be as little as possible, compatibly with a water consumption restricted to a certain max value as preset by the machine control system at design stage and based on relevant standards (as it will be further explained).

In the instance of position MC, ie. minimum water consumption, residual detergent concentration shall anyway be compatible with preset limits. In particular, said limits shall be based on the socalled ECO-Label Guideline indicating that detergent concentration of the last rinse carried out by the machine should at least be 60 times lower than the one of the last wash step.

Operation of the laundry washer according to the present invention is as follows.

The user loads the clothes for washing, selects the required wash cycle in a usually known manner and sets the desired rinsing performance through the knob M; then he starts the machine eg. actuating a proper start-button.

As said, each position of the knob M corresponds to a well determined ionic concentration of the water, which is indicative of the quantity of detergent residues still available in the water from the last rinse. Therefore, once the control unit is aware of knob M position, also the residual detergent concentration to be reached during the last rinse of the machine will be determined, so as to end the wash-cycle. To this purpose, the nonvolatile memory means related to the microcontroller MP may include codified data indicating for each position of the knob M a corresponding value or a range of values for the ionic concentration that water should have at the end of the rinse process.

While proceeding with its normal operation, the machine executes the normal washing steps according to the cycle selected by the user. The microcontroller MP will measure either the ionic or detergent concentration degree of the water during the last washing step through the measuring device shown in Fig. 2 and store said value in an adequate memory register, such as for instance a nonvolatile EEPROM type memory.

The rinses are executed before ending the wash cycle; let us assume, to this purpose, that also the machine according to the present invention will normally execute at least two rinses.

At the end of the second rinse and before discharging its water the microcontroller MP will measure - always through the device shown in Fig. 2 - the ionic or detergent concentration degree of the water during said final rinse.

Then the microcontroller MP will compare the ionic concentration value of the water measured at the end of the wash cycle with the ionic concentration value at rinse end (as said above, starting from said ionic concentration data the control system can trace back the quantity of detergent residues available in the water). As already mentioned, this comparison is achieved by the microcontroller MP bearing in mind that in agreement with the criteria dictated by ECO-Label Guideline, whenever the condition of least water consumption (MC) is selected, the detergent concentration during the final rinse shall be at least 60 times lower than the detergent concentration detected during the last wash.

The relationship between the detergent concentration at wash end and the one at the end of each rinse is defined herein as a diluition relationship of the residual detergent concentration.

Thus, the criteria at rinse end consists in reaching a determined diluiton relationship of the residual detergent concentration ranging from a minimum value, eg. 60 for the position MC of least water consumption (in agreement with ECO-Label Guideline) to a max value (eg. 600 for the position MR of highest rinse performance). Obviously, according to the present invention all intermediate positions from minimum to maximum values between both limit positions are included, in agreement with the actual position selected with the knob M.

Let us assume that the user has selected the position of max water saving (i.e. MC) through the knob M.

In the instance described above of two basic rinses the control unit compares the value of the water from the second rinse, the value of the last washing step and the data set by the user through the knob M. If the detergent concentration of the water from the second rinse is at least 60 times lower than the one from the last washing step, the rinsing process will stop, the water from the second rinse discharged and spinning executed.

Viceversa, the control system will enable water discharge from the second rinse, carry out the normal spinning step following each rinse with related water discharge and start a third rinse with fresh water. At the end of said third rinse the control unit will measure again the ionic concentration of the water and make a new data comparison.

Such a "loop" can be theoretically repeated till the concentration value of the water from the last rinse is at least 60 times lower than the one from the last washing step, according to ECO-Label Guideline.

Let us assume, on the other hand, that the user has selected the highest rinsing quality (position MR). In such a case the machine will operate exactly as described above, since the control unit compares the ionic concentration value of the water from the second rinse with the one from the last washing step and the value set by the user through the knob M. If the value of the detergent concentration in the water from the second rinse is compatible with the one set by the user through the knob M, then the rinsing process will terminate, the water from the second rinse is discharged and a relevant spinning will follow.

Viceversa, the control system will enable water discharge from the second rinse, the usual spinning step following each rinse and related water discharge, then start a third rinse with fresh water. At the end of said third rinse the control unit will measure again the ionic concentration of the water and make a new data comparison.

Also in this case the "loop" can be repeated, theoretically, till the concentration value from the last rinse step equals the one set by the user. Also in this case it may prove convenient - at logic control circuit level - to set a maximum value for water consumption.

Fig. 4 shows schematically the block diagram of a part of a likely control logic circuit of the laundry washing-machine according to the present invention.

Block 200 is the logic flow start block, to start a previously selected wash cycle; then control goes to block 201 to check the selected wash cycle type and from block 201 to block 202 to check the required rinse type, i.e. the selection actuated by the user through the knob M.

Control goes then to block 203, wash-cycle start, to start water by which the first water supply is obtained and the various steps are executed up to actual washing end.

Control goes to block 204 to calculate the ionic concentraction of the water from the last rinse according to the selected wash-cycle.

Control goes to block 205 to check the first rinse, then to block 206 to execute a second rinse.

Control goes to block 207 to calculate the ionic concentration degree of the water at the end of the second rinse.

Control goes to block 208, a test block, to check compatibility between the set value of the ionic concentration and the one actually measured.

In the positive (output SI), control goes to block 209 to terminate the wash cycle; in the negative (NO), control goes back to block 206 to execute a new rinse and a new measurement of the ionic concentration. The cycle or "loop" 206-208 will then be repeated till the rinse water tested from block 206 reaches the required ionic concentration level.

According to another possible embodiment of the present invention the washing machine operates as follows.

The user loads the clothes to be washed, sets the required wash-cycle in a usual known manner and always using the knob M he sets the desired rinse performance. After said operations the user starts the machine.

During the first water supply from the mains the microcontroller MP measures through the measuring device shown in Fig. 2 the resistivity degree of the water at the inlet and calculates both its relevant hardness and ionic concentration degrees. Thus, the machine control system is informed about the minimum ionic concentration degree available, i.e. the ionic concentration degree of fresh water from the mains feeding the machine. To this purpose it should be mentioned that likewise for the hardness degree, also the ionic concentration degree of the water mains can vary from place to place and in the same place from season to season.

The machine proceeds further with its normal operation and executes the normal washing steps according to the wash-cycle selected by the user. Rinses are carried out before cycle end. Let us assume that also the machine according to the above suggested embodiment normally executes at least two rinses.

At the end of the second rinse and before proceeding to the relevant water discharge the microcontroller MP calculates through the measuring device shown in Fig. 2 and as already described above the ionic concentration degree of the water inside the tub, i.e. the water used for the second rinse and from this value the control system will obtain the quantity of detergent residues in the water from said rinse.

The control unit will then compare the ionic concentration of the water from the second rinse with the ionic concentration value set by the user through the knob M.

Let us then assume that the user has selected a most intensive rinse type (position MR). In the case described above of the two basic rinses, the control unit compares the value related to the water from the second rinse with the value of the initial water supplied from the mains. If both data are compatible the rinse process will end and the water from the second rinse discharged followed by spinning.

Viceversa, the control system will enable water discharge from the second rinse, the normal spinning step following each rinse and its discharge, then start a third rinse with clean water. At the end of said third rinse the control unit will measure the ionic concentration in the water and proceed to a new comparison.

Said "loop" can go on theoretically till the concentration value of the repeated rinses equals the initial value of ionic concentration. At any rate, it is also possible to set the execution of a max number of rinses which surely allows to reach to reach the limits dictated by the ECO-Label Guideline.

According to another example of operation the user may have selected an intermediate rinsing level, since he prefers to save water.

In such an instance, the machine control system will compare the ionic concentration degree of the water at the end of the second rinse with the data set by the user through the knob M.

It should be underlined to this purpose that the value set by the user always represents a relative value, since the quality degree of the rinsing process is obviously depending on the ionic concentration characteristics of clean water from the mains, i.e. the value set by the user is interpreted by the control system based on the quality of the water available.

At any rate, if following a measurement of the water ionic concentration at the end of the second rinse the control system realized that the required result has not yet been reached, then the control system itself will enable water discharge and execution of the normal spinning step following each rinse with its related discharge, then start a third rinse step with clean water. At the end of such a third rinse the control system will measure again the ionic concentration degree of the water and make a subsequent data comparison repeating the "loop" as described above till the ionic concentration value detected is compatible (eg. either equal or very close and/or lower) with the one set through the knob M.

The above said, it will be apparent how the machine embodiment according to the characteristics of the present invention also allows in some instances a water saving in respect to the known state of the art.

Let us think for instance of a user who wants to execute a rough rinsing of specific items (eg. wiping clothes) or wash a small quantity of clothes or who tendentially uses small quantities of detergent for the washing of not very soiled clothes.

In such cases, according to the present invention it will be apparent that a water saving is possible in respect to the known solutions where the number of rinse steps is essentially a fixed one and may therefore turn out to be excessive or poor against the real need for each washing.

As described above, it can also be noticed how the machine control system according to the above suggested embodiment executes a relative measurement of the ionic concentration degree of the rinsing water, since the basic value for the comparison with the value set by the user will always be the one of the ionic concentration of the water from the mains, i.e. water first input into the machine. As mentioned, the characteristics of said initial water may change from place to place and from season to season; anyway, the machine according to the suggested embodiment is perfectly capable of adapting its operation to said variability of environmental conditions.

In the majority of the known machines, on the other hand, the water to the washing tub flows through a detergent dispenser consisting of several separated compartments, even if it will seldom occur that the user may wish to execute a pre-wash also with detergent.

Therefore, in this instance also the first water taken into the machine will contain some detergent so that the device measuring both the resistivity and ionic concentration is not in a position to indicate a significant data.

According to the present invention, in this instance the required comparisons will be made by the control system based on an historical value related to the ionic concentration of the water from the mains, which is updated every time a cycle with pre-wash with detergent is not carried out.

To this purpose, the control unit is advantageously equipped with a nonvolatile EEPROM type memory (Electrically Erasable Programmable Memory) capable of storing the values related to the ionic concentration degree of the water from the mains. Said indications can be picked up in the time, washing after washing, by the measuring device and stored in said nonvolatile memory, which is updated from time to time according to adequate criteria obtained from the modern learning software technology (learning algorythms). Thus, it will be apparent that the control system of the machine can adapts itself with time to the changing characteristics of the water from the mains.

Fig. 5 shows schematically the block diagram of a part of the logic control circuit of the laundry washing-machine according to the above embodiment of the present invention.

Block 100 is the logic flow start-block and corresponds to the start of a previously selected wash cycle; then control goes to block 101 to check the selected type of wash cycle and from block 101 to block 102 to check the required rinse type, i.e. the selection actuated by the user through the knob M.

Control goes to block 103, wash-cycle start, which starts water supply into the machine. Then control goes to block 104 to calculate the ionic concentration of the water during water supply and then to block 105, a test block, to check whether the value that has been calculated indicates the presence of detergent residues in the water (indicative of pre-wash).

In the positive (output SI), control goes to block 106 through which the control unit provides to read the mentioned historical value and stores it in a proper memory address, then the control goes to block 108. In the negative (NO), the control goes to block 107 to store the ionic concentration value detected in the water from the mains in said memory address and update the historical value. Then the control goes to block 108.

Block 108 verifies the various washing steps, including a first rinse, then the control goes to block 109 to execute a second rinse.

The control goes further to block 110 to calculate the ionic concentration degree of the water at the end of the second rinse.

The control goes to block 111, a test block, to check compatibility between the desired ionic concentration and the value actually detected (for instance the actual ionic concentration can be set to be always equal or lower).

In the positive (output SI), control goes to block 112 to terminate the wash cycle; in the negative (NO), control goes back to block 109 to execute a new rinse and a new measurement of the ionic concentration. The cycle or "loop" 109-111 is then repeated till the rinse water from block 109 will reach the ionic concentration level required.

Since by now nearly all modern laundry washing-machines are equipped with a microcontroller it will be apparent how the latter - if duly programmed - will obtain the required information as described; therefore, the innovative idea can be applied both to machines with an electronic microcontroller programmer and/or hybrid programmer as well as to conventional laundry washing-machines, i.e. with electromechanical cycle sequencer, provided they have a microcontroller within an incorporated electronic subassembly (for instance a microcontroller usually available in a digital electronic module for laundry-washer motor control).

The characteristics and advantages of the present invention will be apparent from the above description, which provides a laundry washing-machine allowing a "qualitative" or closed loop selection, i.e. related to the results obtained from the rinses for the selection of an optimal rinse performance according to varying requirements. Therefore, such a solution allows compliance with the variable requirements of users who can either decide for a water saving or a higher rinse quality according to the different situations or reach a compromise between both requirements. Additionally, the solution described above surely allows a water saving under particular washing conditions (such as small quantities of laundry, fair use of detergent, etc.) in respect to the solutions already known, since it can specifically adapt itself to each wash cycle.

Finally, it is obvious that many changes are possible to the laundry washing machine object according to the present invention without departing from the novelty spirit of the innovative idea.

As an example, referring to the embodiment of the invention described with reference to Fig. 5, the machine control system can favourably provide an adequate control routine to be realized automatically during machine installation should the first cycle be carried out with pre-wash, as in this instance, in fact, the control system cannot use the actual ionic concentration value of the water from the mains nor the historical data. Therefore, using this sequence the control system will control for said first wash-cycle of the machine life a higher pre-defined number of rinses than normally foreseen in average for a laundry washer (eg. twice the usual number), to achieve a presumably reliable value of the water characteristics from the mains at the end of the last rinse in the case of such a sequence.

Another embodiment may be a measuring device of the type already described above located directly on the water input pipe from the mains, i.e. upstream of the detergent dispenser. Thus, also in case of pre-wash the control system will obtain the actual ionic concentration value of the water from the mains even when carrying out a pre-wash with detergent. This solution also appears very economical thanks to the low-cost components of the resistivity sensor.

In the above example it has been referred to changing the set number of rinses with a fixed quantity of water. In another embodiment, however, it is possible to preset a fixed number of rinses with different water levels, i.e. the quantity of water of one or more rinses can be changed as a function of the result to be achieved. The first solution (changing the number of rinses) appears anyway a more efficient solution due to a higher water exchange (also using the same quantity) also considering, as said above, that each rinse is usually followed by a spinning step, whereby increase of the number of spinnings will in fact help for a better removal of detergent residues. Finally, a further possible embodiment to comply with the requirements of household appliance manufacturers provides some setting means instead of the knob M but not actuatable by the user, such as for instance a potentiometer inside the machine cabinet. Therefore, according to said embodiment, washing-machine manufacturers would be able to design machine configuration for the different markets using said setting means.

As an example, the countries with particular water consumption regulations could have the machines set to obtain best rinsing quality as a function of the max quantity of consumable water, leaving all other aspects and advantages of the present invention described above unchanged, whereas the countries where such regulations are not in force, i.e. where water cost rates are low, the machine could be steadily preset for best rinsing results.

Previously it has been referred to implementation of a microcontroller for the above invention as this is by now available in nearly all modern washing-machines. It should be mentioned, anyway, that the functions of the microcontroller and of the measuring device shown in Fig. 2 could eventually be obtained through an electronic circuit with adjustbable threshold by the user or by the machine manufacturer to measure the ionic concentration degree of the water during the rinsing process and, if required, capable of activating a change in the execution of the rinsing process as previously described, as long as the performance level desired by the user has not been reached.

Claims

1. A household washing-machine, specifically a laundry washer, comprising all known elements for its operation, including a control unit (MP) and means (A,B) to detect the detergent or ionic concentration degree of the water, characterized in that the control unit (MP) enables the execution of a rinsing process that goes on till a predetermined rinsing performance (MR,MC) has been reached, as detected in function of measures of ionic concentration of water realized through said detection means (A,B), the rinsing performance being in particular variable and adjustable within a plurality of possible settings.

2. A household washing-machine, specifically a laundry washer, comprising all known elements for its operation, including an electronic control unit (MP), nonvolatile memory means (ROM, EEPROM) associated with said control unit (MP) and detection means (A,B) of the degree of the detergent or ionic concentration of the water, characterized in that a selection device (M) is provided for selecting a determined rinsing performance (MR,MC) within a plurality of possible selectable performances and that the control unit (MP) executes the rinsing process as a function of the selection operated through said selection means (M) and as a function of detergent or ionic concentration measurements of the water realized by said detection means (A,B).

3. A washing-machine, according to at least one of the previous Claims, characterized in that said rinsing performance can be selected between two extremes (MC,MR) corresponding to a minimum water consumption for the rinsing process and to a max rinsing process efficiency, respectively, which is intended as a minimum ionic or detergent concentration the water should have at the end of the rinsing process.

4. A washing-machine according to Claim 2, characterized in that said nonvolatile memory means (ROM, EEPROM) contain codified data indicating for each position of the selection device (M) a corresponding value or range of values for the ionic concentration that water should have at the end of a rinsing process to consider it efficiently terminated.

5. A washing-machine according to Claim 2, characterized in that in said nonvolatile memory means (ROM,EEPROM) the criteria are codified used by the control unit (MP) to execute the rinsing process as a function of the ionic concentration values detected in the water and as a function of the ionic concentration va!ue of the water corresponding to the rinsing performance selected through said selection device (M).

6. A household washing-machine, according to at least one of the previous Claims, characterized in that said means to detect the detergent or ionic concentration degree of the water comprise a device to measure the resistivity degree of the water, wherefrom the control unit (MP) can calculate the ionic concentration degree of water.

7. A household washing-machine, according to at least one of the previous Claims, characterized in that said measuring device is provided to detect the ionic concentration degree both of the clean water from the mains and of the water that has been used during the various steps of a wash cycle.

8. A household washing-machine, according to at least one of the previous Claims, characterized in that said nonvolatile memory means (ROM, EEPROM) comprise a read/write memory type, which is used to store and update in the time the information related to the ionic concentration degree of the water from the mains.

9. A household washing-machine, according to at least one of the previous Claims, characterized in that said nonvolatile memory means (ROM) contain an operative programme being executed automatically in occasion of the first wash-cycle of the machine life, should it comprise a prewash step with the use of detergent.

10. A method to control the rinsing process in a household washing-machine, in particular a laundry washer, of the type comprising all known elements for its operation, including means for realizing the washing and rinsing of the laundry, a control unit (MP) and means (A,B) to detect the detergent or ionic concentration degree of the water characterized in that :

    - the possibility is provided of selecting a determined rinsing performance (MR,MC) within a plurality of possible selectable performances, wherein through said selection the control unit is supplied with an information being indicative of the quantity of detergent residues that may still be present in the water at the end of the rinsing process, to consider it terminated;

- the rinsing process is executed by the machine as a function of the selection actuated through said selection means (M) and of measurements of the ionic concentration of the water made by said detecting means (A,B).

11. A method according to Claim 10, characterized in that the rinsing performarce can be selected within a range of performances comprised between two limit positions, wherein:

- in the first position the rinsing process is executed with a minimum water consumption,
- in the second position the rinsing process terminates upon reaching the highest rinsing efficiency, i.e. reaching a minimum ionic or detergent concentration in the water at the end of the rinsing process.

12. A method according to Claim 10 or 11, characterized in that, independently from the selected rinsing performance, the imposition of a preset minimum level of ionic or detergent concentration is provided that the water should have during the last rinse executed by the machine, and/or the imposition of a preset max quantity of water to be used for the rinsing process executed by the machine.

13. A method according to Claim 12, characterized in that it provides for:

- setting a determined rinsing performance, each selectable performance corresponding to a preset ionic concentration degree that water should have at the end of the rinsing process;
- measuring the ionic concentration degree - at the end of at least at rinse step - of the water used for said rinse step;
- the comparison between the ionic concentration degree of the water at the end of said rinse step and the one related to the selected rinsing performance, where in case of compatibility between the two concentration degrees the rinsing process will end, whereas in case of non compatibility between the two concentration degrees the rinsing process will still go on.

14. A method according to the previous Claim, characterized in that it further comprises the measurement of the ionic concentration degree of the water during the final washing step being provided by an operative cycle of the machine and its relationship with the ionic concentration degree of the water at the end of each rinse being executed.

15. A method according to at least one of the previous Claims, characterized in that it provides for the measurement of the ionic concentration degree of the water from the mains and its comparison with the ionic concentration degree of the water of at least one rinse step.

FIG. 1

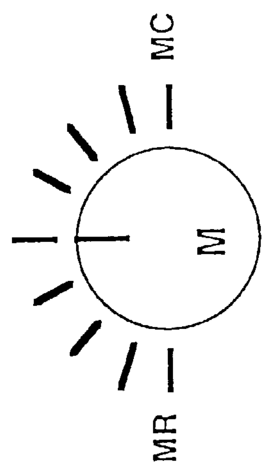


FIG. 3

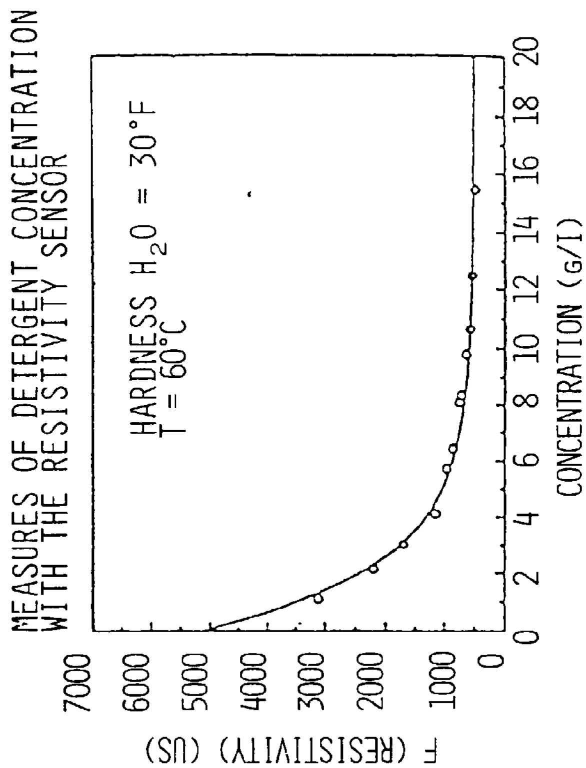
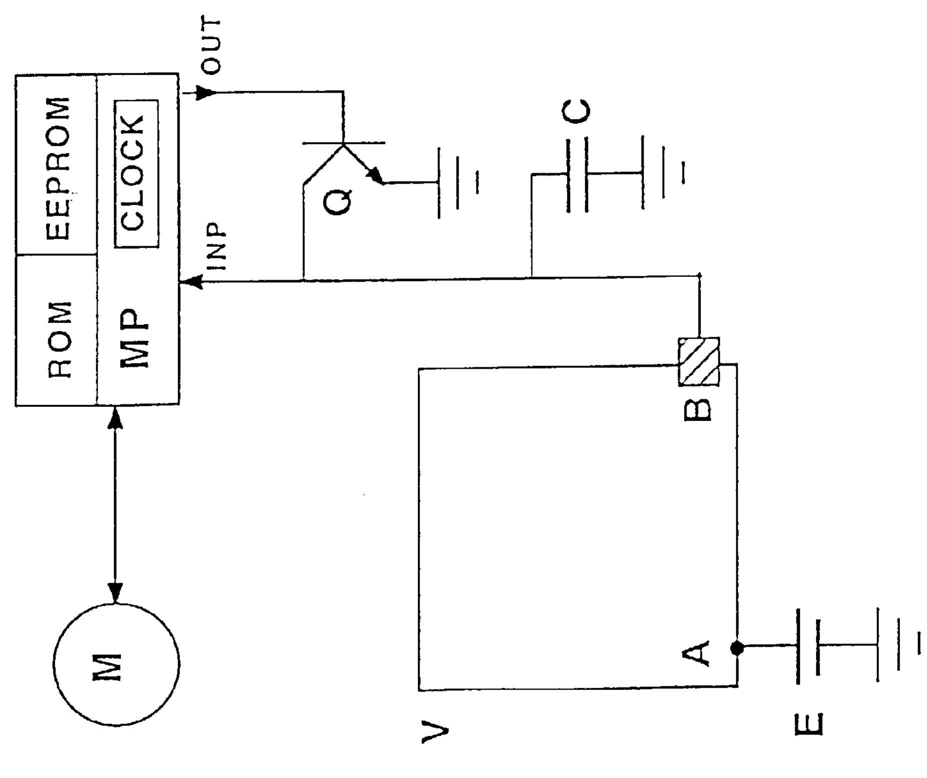


FIG. 2



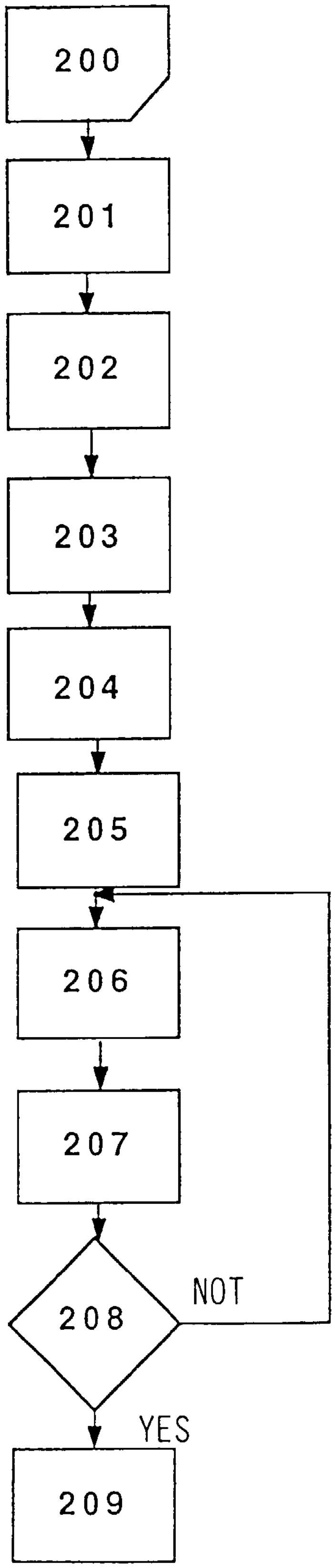


FIG. 4

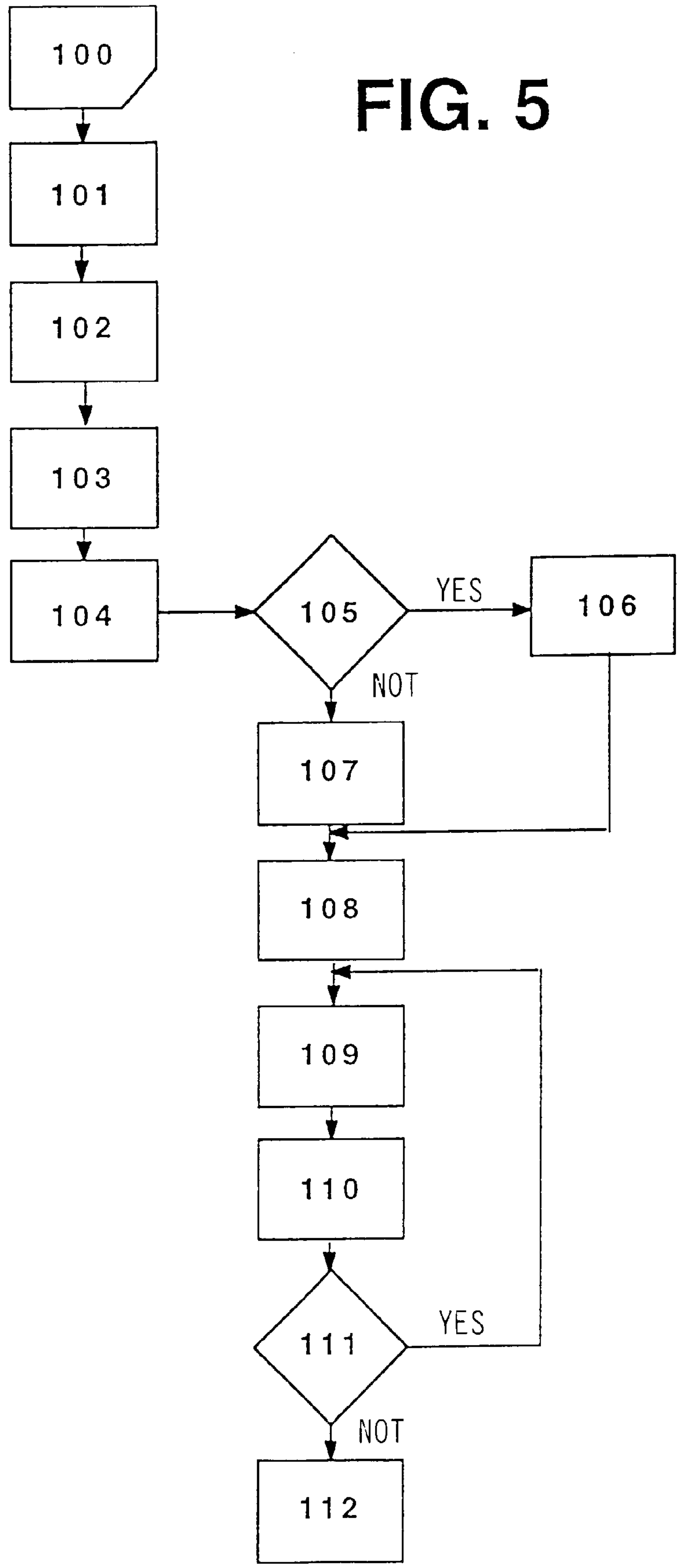

100
101
102
103
104
105
YES
106
NOT
107
108
109
110
111
YES
NOT
112

FIG. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 20 1658

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.6)
A	FR-A-2 412 638 (ASKO-UPO OY) * the whole document * ---	1,2,4-8, 10,12-15	D06F39/00
A	EP-A-0 030 602 (BOSCH-SIEMENS HAUSGERÄTE GMBH) * page 5, line 30 - page 6, line 24; figures * -----	1,6,10, 13,14	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
D06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23 September 1996	Courrier, G

CATEGORY OF CITED DOCUMENTS

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