

(19)



Europäisches Patentamt

European Patent Office

Office européen des brevets



(11)

EP 0 748 892 B2

(12)

NEW EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the opposition decision:

14.12.2005 Bulletin 2005/50

(51) Int Cl.7: **D06F 39/00**

(45) Mention of the grant of the patent:

04.04.2001 Bulletin 2001/14

(21) Application number: **96201658.0**

(22) Date of filing: **14.06.1996**

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

Waschmaschine mit Vorrichtung und Verfahren zur Steuerung der Spülung

Machine à laver avec dispositif et procédé pour commander le rinçage

(84) Designated Contracting States:

DE ES FR GB

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(30) Priority: **16.06.1995 IT TO950511**

(43) Date of publication of application:

18.12.1996 Bulletin 1996/51

(56) References cited:

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Remarks:

The file contains technical information submitted
after the application was filed and not included in this
specification

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Description

[0001] The present invention refers to a washing-machine, in particular a laundry washer, as described in the preamble of the annexed Claim 1. Such washing-machine is known from EP- B- 0030602.

[0002] 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.

[0003] To this purpose and before ending a wash cycle, the laundry washer executes the so-called 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.

[0004] 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.

[0005] 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.

[0006] 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.

[0007] 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.

[0008] 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 "quan-

titative" 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.

[0009] 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.

[0010] 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.

[0011] 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.

[0012] 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.

[0013] 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;

[0014] From FR-A-2.412.638 a washing machine is known, having a control system which allows for automatically obtaining an optimal rinsing performance, which assures that almost all the detergent residues are removed from the items on washing. This is obtained by:

- a) measuring and memorizing, at the beginning of the rinsing phase, the detergent concentration in the water;
- b) newly measuring, after a given time interval, the

detergent concentration, and calculating the difference between the new value and the previously memorized one;

c) repeating steps a) and b) until the above difference does not fall below a predetermined limit.

[0015] In the case of FR-A-2.412.638, therefore, the washing machine always gets the same and optimal rinsing performance, which cannot be modified by the user.

[0016] 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.

[0017] According to the present invention, said object is obtained by a washing-machine having the characterizing features of the annexed claims 1 and 10; further embodiment of the invention are contained in the dependent claims.

[0018] 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.

[0019] 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.

[0020] 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.

[0021] 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.

[0022] 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.

[0023] 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 water consumption.

[0024] 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.

[0025] 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.

[0026] Electrode B consists of an electrically conductive element directly in contact with the washing water and isolated against electrode A.

[0027] 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.

[0028] 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.

[0029] 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)

[0030] 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.

[0031] 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. $E/2 = 2.5\text{ V}$);
- 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.

[0032] 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.

[0033] Said information (resistivity 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.

[0034] 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).

[0035] 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.

[0036] 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 con-

sumption (MC).

[0037] 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.

[0038] 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).

[0039] 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 so-called 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

[0040] Operation of the laundry washer according to the present invention is as follows.

[0041] 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.

[0042] 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.

[0043] 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.

[0044] 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.

[0045] 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.

[0046] 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.

[0047] The relationship between the detergent concentration at wash end and the one at the end of each rinse is defined herein as a dilution relationship of the residual detergent concentration.

[0048] Thus, the criteria at rinse end consists in reaching a determined dilution 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.

[0049] Let us assume that the user has selected the position of max water saving (i.e. MC) through the knob M.

[0050] 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.

[0051] 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.

[0052] 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.

[0053] 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.

[0054] 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.

[0055] 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.

[0056] 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.

[0057] 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.

[0058] 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.

[0059] Control goes to block 204 to calculate the ionic concentration of the water from the last rinse according to the selected wash-cycle.

[0060] Control goes to block 205 to check the first rinse, then to block 206 to execute a second rinse.

[0061] Control goes to block 207 to calculate the ionic concentration degree of the water at the end of the second rinse.

[0062] Control goes to block 208, a test block, to check compatibility between the set value of the ionic concentration and the one actually measured.

[0063] 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.

[0064] According to another possible embodiment of the present invention the washing machine operates as follows.

[0065] 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.

[0066] 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.

[0067] 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.

[0068] 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.

[0069] 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.

[0070] 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.

[0071] 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.

[0072] 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.

[0073] According to another example of operation the user may have selected an intermediate rinsing level, since he prefers to save water.

[0074] 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.

[0075] 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.

[0076] 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.

[0077] 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.

[0078] 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 tentatively uses small quantities of detergent for the washing of not very soiled clothes.

[0079] 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.

[0080] 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.

[0081] 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.

[0082] 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.

[0083] 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.

[0084] 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 algorithms). Thus, it will be apparent that the control system of the machine can adapt itself with time to the changing characteristics of the water from the mains.

[0085] 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.

[0086] 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.

[0087] 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).

[0088] 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.

[0089] Block 108 verifies the various washing steps, including a first rinse, then the control goes to block 109 to execute a second rinse.

[0090] The control goes further to block 110 to calculate the ionic concentration degree of the water at the end of the second rinse.

[0091] 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).

[0092] 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.

[0093] 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).

[0094] 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.

[0095] 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.

[0096] 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.

[0097] 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.

[0098] 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.

[0099] 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 adjustable 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 a control unit (MP) and means (A,B) for detecting the detergent or ionic concentration degree of the water, wherein the control unit (MP) controls the execution of a rinsing process that goes on until a predetermined rinsing performance (MR,MC) has been reached, as detected in function of measures of detergent or ionic concentration of water realized through said detection means (A,B), **characterised in that** it comprises a selection device (M) of the quality of the predetermined rinsing performance, consisting e.g. of a rotary knob, actuated by the user to indicate the predetermined rinsing performance to the control unit, said selection device (M) allowing the selection of the predetermined rinsing performance (MR,MC) to be obtained among a plurality of different predetermined rinsing performances such that the user is actually able to operate a qualitative choice through said selection device (M) for the type of rinsing to be carried out by the washing machine, the control unit (MP) being designed for controlling the rinsing process (MR,MC) in a closed loop process in function of the selection operated by the user through said selection device (M) and in function of the detergent or ionic concentration measurements of the water carried out by said selection means (A,B), said selection device (M) being provided with two limit positions (MC,MR), between which the predetermined rinsing performance to be obtained can be selected, said limit positions respectively representing:

- a minimum water consumption for the rinsing process to be obtained, and
- a minimum ionic or detergent concentration the water should have at the end of the rinsing process to be obtained.

2. A household washing-machine, according to claim 1, **characterized in that** said control unit (MP) is of the electronic type and that non-volatile memory means (ROM, EEPROM) are associated to said electronic control unit (MP).

3. A household washing-machine, according to claim 2, **characterized in that** said non-volatile 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 detergent or ionic concentration that water should have at the end of a rinsing process, to consider it efficiently terminated.

4. A washing-machine, according to claim 3, **characterized in that** in said non-volatile memory means (ROM,EEPROM) the criteria are contained, used by the control unit (MP) for controlling the rinsing process in function of:

- the detergent or ionic concentration values detected in the water, and
- the detergent or ionic concentration value of the water corresponding to the predetermined rinsing performance selected through said selection device (M).

5. A household washing-machine, according to at least one of the previous claims, **characterized in that** said means (A,B) for detecting the detergent or ionic concentration degree of the water comprise a device for measuring the resistivity degree of the water, wherefrom the control unit (MP) can calculate the detergent or ionic concentration degree of water.

6. A household washing-machine, according to at least one of the previous claims, **characterized in that** said measuring device is provided for detecting the detergent or 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.

7. A washing-machine, according to at least one of the previous claims, **characterized in that** said non-volatile memory means (ROM, EEPROM) comprise a memory of the read/write type, which is used for storing and updating in the time the information related to the ionic concentration degree of the water from the mains.

8. A household washing-machine, according to at least one of the previous claims, **characterized in that** said non-volatile memory means (ROM) contain an operative programme being executed automatically in occasion of the first wash cycle of the machine's life, should it comprise a pre-wash step with the use of detergent.
9. A method for controlling the rinsing process in a household washing-machine, in particular a laundry washer, of the type comprising means for realizing the washing and the rinsing, a control unit (MP) and means (A,B) for detecting the detergent or ionic concentration degree of the water, wherein the control unit (MP) controls the execution of a rinsing process that goes on until a predetermined rinsing performance (MR,MC) has been reached, as detected in function of measures of detergent or ionic concentration of water realized through said detection means (A,B), **characterized by:**
- providing a selection device (M) of the quality of the rinsing process to be carried out by the machine, said selection device consisting e.g. of a rotary knob, actuated by the user to indicate the predetermined rinsing performance to the control unit;
 - supplying, through said selection device (M) actuated by the user, the control unit (MP) with information being representative of the quantity of detergent residues that may still be present in the water at the end of a rinsing process, to consider it terminated;
 - making the control unit (MP) to control the rinsing process in a closed loop process in function of the information provided through said selection device (M) and in function of the information resulting from the measurements carried out through said detecting means (A,B), such that the user is actually able to operate a qualitative choice through said selection device (M) for the type of rinsing to be carried out by the washing machine, said predetermined rinsing performance being selectable within a range of possible different predetermined performances which are comprised between two limit performances, wherein:
 - in the first limit performance the rinsing process is executed with a minimum water consumption,
 - in the second limit performance the rinsing process terminates upon reaching a minimum ionic or detergent concentration in the water at the end of the rinsing process.
10. A method according to claim 9, **characterized in that**, irrespective of the selected rinsing performance, the imposition of a pre-set 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 pre-set maximum quantity of water to be used for the rinsing process executed by the machine.

11. A method according to claim 9, **characterized in that** it provides for:

- setting a predetermined rinsing performance, each selectable performance corresponding to a pre-set 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 a 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.

12. 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 relation with the ionic concentration degree of the water at the end of each rinse being executed.

13. 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.

Patentansprüche

1. Haushaltswaschmaschine, insbesondere Wäschewaschmaschine, enthaltend eine Steuereinheit (MP) und Mittel (A, B) zum Erfassen der Detergenz- oder Ionenkonzentration des Wassers, wobei die Steuereinheit (MP) das Ausführen eines Spülvorganges steuert, der andauert, bis eine vorbestimmte Spüleistung (MR, MC) erreicht worden ist, die als Funktion von Messwerten der Detergenz- oder Ionenkonzentration des Wassers erfasst wird, was durch die Erfassungsmittel (A, B) ausgeführt wird, **dadurch gekennzeichnet, dass** eine Auswahlrichtung (M), z. B. bestehend aus einem Drehknopf, für die Qualität der Spüleistung vorgesehen ist, und von dem Benutzer betätigt wird, um die vorbestimmte Spüleistung der Steuereinheit anzugeben.

gen, wobei die Auswahleinrichtung (M), die Auswahl der vorbestimmten zu erzielenden Spülleistung (MR, MC) unter mehreren unterschiedlichen vorbestimmten Spülleistungen ermöglicht, so dass der Benutzer in der Lage ist, eine qualitative Auswahl durch die Auswahleinrichtung (M) für die Art der von der Waschmaschine auszuführenden Spülung vorzunehmen, und wobei die Steuereinheit (MP) zum Steuern des Spülvorganges (MR, MC) in einem geschlossenen Regelkreis als Funktion der durch die Auswahleinrichtung (M) erfolgten Auswahl durch den Benutzer und als Funktion der Detergenz- oder Ionenkonzentrationsmessungen des Wassers, die durch die Erfassungsmittel (A, B) ausgeführt werden, in der Lage ist, wobei die Auswahleinrichtung (M) mit zwei Grenzen (MC, MR) versehen ist, zwischen denen die vorbestimmte zu erzielende Spülleistung ausgewählt wird, wobei die Grenzen jeweils stehen für:

- einen minimalen Wasserverbrauch für den zu erzielenden Spülvorgang und
- eine minimale Detergenz- oder Ionenkonzentration, die das Wasser am Ende des zu erzielenden Spülvorganges haben sollte.

2. Haushaltswaschmaschine nach Anspruch 1, **dadurch gekennzeichnet, dass** die Steuereinheit (MP) eine elektronische Steuereinheit ist und dass nicht flüchtige Speichermittel (ROM, EEPROM) mit der elektronischen Steuereinheit (MP) zusammenwirken.

3. Haushaltswaschmaschine nach Anspruch 2, **dadurch gekennzeichnet, dass** die nicht flüchtigen Speichermittel (ROM, EEPROM) kodierte Daten enthalten, die für jede Position der Auswahleinrichtung (M) einen entsprechenden Wert oder einen entsprechenden Bereich an Werten für die Detergenz- oder Ionenkonzentration beinhalten, welche das Wasser am Ende des Spülvorganges aufweisen sollte, damit dieser als ordnungsgemäß beendet angesehen werden kann.

4. Waschmaschine nach Anspruch 3, **dadurch gekennzeichnet, dass** die nicht flüchtigen Speichermittel (ROM, EEPROM) Kriterien enthalten, die durch die Steuereinheit (MP) zum Steuern des Spülvorganges verwendet werden als Funktion von:

- den Detergenz- oder Ionenkonzentrationswerten, die in dem Wasser erfasst werden, und
- dem Detergenz- oder Ionenkonzentrationswert des Wassers entsprechend der vorbestimmten Spülleistung, die durch die Auswahleinrichtung (M) ausgewählt worden ist.

5. Haushaltswaschmaschine nach zumindest einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die Mittel (A, B) zum Erfassen der Detergenz- oder Ionenkonzentration des Wassers eine Einrichtung zum Messen des Widerstandswertes des Wassers enthalten, aus dem die Steuereinheit (MP) die Detergenz- oder Ionenkonzentration des Wassers berechnen kann.

6. Haushaltswaschmaschine nach zumindest einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die Messeinrichtung vorgesehen ist, um die Detergenz- oder Ionenkonzentration sowohl von klarem Wasser aus der Wasserleitung als auch des Wassers, welches während verschiedener Schritte eines Waschzyklus verwendet worden ist, zu erfassen.

7. Waschmaschine nach zumindest einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die nicht flüchtigen Speichermittel (ROM, EEPROM) einen Speicher des Lese-/Schreibtyps enthalten, welcher zum Speichern und Aktualisieren der Information bezüglich der Ionenkonzentration des Wassers aus der Wasserleitung verwendet wird.

8. Haushaltswaschmaschine nach zumindest einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die nicht flüchtigen Speichermittel (ROM) ein Betriebsprogramm enthalten, welches automatisch beim ersten Waschzyklus während der Lebensdauer der Maschine ausgeführt wird, sollte dieser einen Vorwaschschritt mit der Verwendung eines Waschmittels enthalten.

9. Verfahren zum Steuern des Spülvorganges in einer Haushaltswaschmaschine, insbesondere einer Wäschewaschmaschine, die Mittel zum Durchführen des Waschens und des Spülens, eine Steuereinheit (MP) und Mittel (AB) zum Erfassen der Detergenz- oder Ionenkonzentration des Wassers enthält, wobei die Steuereinheit (MP) das Ausführen eines Spülvorganges steuert, welcher andauert, bis eine vorbestimmte Spülleistung (MR, MC) erreicht worden ist, die als Funktion der Werte der Detergenz- oder Ionenkonzentration des Wassers erfasst wird, was durch die Erfassungsmittel (A, B) ausgeführt wird, **gekennzeichnet durch**

- Bereitstellen einer Auswahleinrichtung (M) für die Qualität des auszuführenden Spülvorganges **durch** die Maschine, wobei die Auswahleinrichtung (M), z. B. bestehend aus einem Drehknopf, **durch** einen Benutzer betätigt wird, um die vorbestimmte Spülleistung der Steuereinheit anzuzeigen,

- Einspeisen von Daten in die Steuereinheit (MP) mittels der Auswahleinrichtung (M), wobei die Daten für die Menge der Detergenzreste stehen, die in dem Wasser am Ende eines Spülvorganges noch vorhanden sein können, damit er als abgeschlossen angesehen werden kann, 5
 - Steuern des Spülvorganges **durch** die Steuereinheit (MP) in einem geschlossenen Regelkreis als Funktion der Information, die **durch** die Auswahleinrichtung (M) bereitgestellt wird, und als Funktion der Information, welche sich aus den Messungen, die **durch** die Erfassungsmittel (A, B) ausgeführt werden, ergibt, so dass der Benutzer in der Lage ist, eine qualitative Auswahl **durch** die Auswahleinrichtung (M) für die Art der von der Waschmaschine auszuführenden Spülung vorzunehmen, wobei die wählbare Spülleistung aus einem Bereich unterschiedlicher möglicher Leistungen ausgewählt werden kann, welche zwischen zwei Grenzen vorhanden sind, wobei: 10
 - bei der ersten Grenze der Spülvorgang mit einem minimalen Wasserverbrauch ausgeführt wird, 25
 - bei der zweiten Grenze der Spülvorgang bei Erreichen einer minimalen Detergenz- oder Ionenkonzentration im Wasser am Ende des Spülvorganges beendet wird. 30
10. Verfahren nach Anspruch 9, **dadurch gekennzeichnet, dass** unabhängig von der ausgewählten Spülleistung der voreingestellte Minimalpegel der Detergenz- oder Ionenkonzentration, die das Wasser während des letzten Spülvorganges, der durch die Maschine ausgeführt wird, haben sollte, und/oder die voreingestellte Maximalmenge des für den von der Maschine ausgeführten Spülvorgang verwendeten Wassers Vorrang hat. 35
11. Verfahren nach Anspruch 9, **dadurch gekennzeichnet, dass** das Verfahren weiterhin vorsieht: 40
- Einstellen einer vorbestimmten Spülleistung, wobei jede auswählbare Leistung einer voreingestellten Ionenkonzentration entspricht, die das Wasser am Ende eines Spülvorganges aufweisen sollte, 45
 - Messen der Ionenkonzentration des für einen Spülschritt verwendeten Wassers am Ende zumindest dieses Spülschrittes, 50
 - Vergleichen der Ionenkonzentration des Wassers am Ende des Spülschrittes mit der Konzentration bezogen auf die ausgewählte Spülleistung, wobei im Falle der Kompatibilität zwischen den beiden Konzentrationen der Spülvorgang beendet wird, und wobei im Falle der 55

Nichtkompatibilität zwischen den beiden Konzentrationen der Spülvorgang fortgesetzt wird.

12. Verfahren nach einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** es außerdem das Messen der Ionenkonzentration des Wassers während des letzten Waschschrilles, der durch einen Betriebszyklus der Maschine vorgesehen ist, und ihres Verhältnisses zur Ionenkonzentration des Wassers am Ende jedes ausgeführten Spülvorganges enthält.
13. Verfahren nach zumindest einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** es das Messen der Ionenkonzentration des Wassers aus der Wasserleitung und den Vergleich mit der Ionenkonzentration des Wassers von mindestens einem Spülschritt vorsieht.

Revendications

1. Machine à laver à usage domestique, notamment lave-linge, comprenant une unité de commande (MP) et des moyens (A, B) pour détecter le degré de concentration de détergent ou de concentration ionique de l'eau, dans laquelle l'unité de commande (MP) commande l'exécution d'un processus de rinçage qui se déroule jusqu'à ce que soit atteinte une performance prédéterminée de rinçage (MR, MC), telle que détectée en fonction de mesures de la concentration de détergent ou de la concentration ionique de l'eau réalisées à l'aide desdits moyens de détection (A, B), **caractérisée en ce qu'elle** comprend un dispositif (M) de sélection de la qualité de la performance de rinçage, comprenant par exemple un bouton rotatif, actionné par l'utilisateur pour indiquer la performance de rinçage prédéterminée à l'unité de commande, ledit dispositif (M) de sélection permettant d'obtenir la sélection de la performance de rinçage prédéterminée (MR, MC) parmi une pluralité de différentes performances prédéterminées de rinçage de telle sorte que l'utilisateur est réellement à même d'exécuter un choix qualitatif au moyen dudit dispositif de sélection (M) pour le type de rinçage devant être exécuté par la machine de lavage, l'unité de commande (MP) étant agencée de manière à commander le processus de rinçage (MR, MC) selon un processus en boucle fermée en fonction de la sélection exécutée par l'utilisateur à l'aide du dispositif de sélection (M) et en fonction des mesures de la concentration de détergent et de la concentration ionique de l'eau, exécutées par lesdits moyens de détection (A, B), ledit dispositif de sélection (M) étant pourvu de deux positions limites (MC, MR), entre lesquelles la performance prédéterminée de rinçage devant être obtenue peut être

sélectionnée, lesdites positions limites représentant respectivement:

- une consommation minimale d'eau pour le processus de rinçage, devant être obtenue, et
 - une concentration ionique minimale ou une concentration minimale de détergent, que l'eau doit posséder à la fin du processus de rinçage, devant être obtenue.
2. Machine à laver à usage domestique selon la revendication 1, **caractérisée en ce que** ladite unité de commande (MP) est de type électronique et que des moyens de mémoire non volatile (ROM, EEPROM) sont associés à ladite unité de commande électronique (MP).
3. Machine à laver à usage domestique selon la revendication 2, **caractérisée en ce que** lesdits moyens de mémoire non volatile (ROM, EEPROM) contiennent des données codifiées indiquant pour chaque position du dispositif de sélection (M) une valeur correspondante ou une gamme de valeurs correspondantes pour la concentration du détergent ou la concentration ionique, que l'eau doit posséder à la fin d'un processus de rinçage, pour que ce dernier soit considéré comme effectivement terminé.
4. Machine à laver à usage domestique selon la revendication 3, **caractérisée en ce que** lesdits moyens de mémoire non volatile (ROM, EEPROM) contiennent les critères qui sont utilisés par l'unité de commande (MP) pour commander le processus de rinçage en fonction:
- des valeurs de la concentration du détergent ou de la concentration ionique détectée dans l'eau, et
 - de la valeur de la concentration du détergent ou de la concentration ionique de l'eau correspondant à la performance prédéterminée de rinçage sélectionnée par ledit dispositif de sélection (M).
5. Machine à laver à usage domestique selon au moins l'une des revendications précédentes, **caractérisée en ce que** lesdits moyens (A, B) pour détecter le degré de concentration du détergent ou de concentration ionique de l'eau comprennent un dispositif pour mesurer le degré de résistivité de l'eau, à partir duquel l'unité de commande (MP) peut calculer le degré de concentration du détergent ou de concentration ionique.
6. Machine à laver à usage domestique selon au moins l'une des revendications précédentes, **caractérisée en ce que** ledit dispositif de mesure est

prévu pour détecter le degré de concentration du détergent ou le degré de concentration ionique à la fois de l'eau propre provenant du réseau et de l'eau qui a été utilisée pendant les différentes étapes d'un cycle de lavage.

7. Machine à laver à usage domestique selon au moins l'une des revendications précédentes, **caractérisée en ce que** lesdits moyens de mémoire non volatile (ROM, EEPROM) comprennent une mémoire du type à lecture / écriture, qui est utilisée pour mémoriser et mettre à jour dans le temps l'information associée au degré de concentration ionique de l'eau délivrée par le réseau.
8. Machine à laver à usage domestique selon au moins l'une des revendications précédentes, **caractérisée en ce que** lesdits moyens de mémoire non volatile (ROM) contiennent un programme de fonctionnement qui est exécuté automatiquement lors du premier cycle de lavage de la durée de vie de la machine, s'il devait comporter une étape de prélavage avec utilisation d'un détergent.
9. Procédé pour commander le processus de rinçage dans une machine à laver à usage domestique, notamment un lave-linge, du type comprenant des moyens pour réaliser le lavage et le rinçage, une unité de commande (MP) et des moyens (A, B) pour détecter le degré de concentration de détergent ou de concentration ionique de l'eau, selon lequel l'unité de commande (MP) commande l'exécution d'un processus de rinçage qui se déroule jusqu'à ce que soit atteinte une performance prédéterminée de rinçage (MR, MC) telle qu'elle est détectée en fonction de mesures de la concentration du détergent ou de la concentration ionique de l'eau, réalisées par lesdits moyens de détection (A, B), **caractérisée en ce qu'il** consiste à:
- prévoir un dispositif (M) de sélection de la qualité du processus de rinçage devant être exécuté par la machine, ledit dispositif de sélection étant constitué par exemple par un bouton rotatif, actionné par l'utilisateur pour indiquer la performance prédéterminée du rinçage à l'unité de commande;
 - envoyer à l'unité de commande (MP), par l'intermédiaire dudit dispositif de sélection (M), une information représentative de la quantité de résidus de détergent qui peuvent encore être présents dans l'eau à la fin d'un processus de rinçage, pour que ce dernier soit considéré comme terminé;
 - amener l'unité de commande (MP) à commander le processus de rinçage selon un processus en boucle fermée en fonction de l'information délivrée par l'intermédiaire dudit dispositif de

sélection (M) et en fonction de l'information résultant des mesures exécutées par lesdits moyens de détection (A, B), de telle sorte que l'utilisateur est réellement à même d'exécuter un choix qualitatif au moyen dudit dispositif de sélection (M) pour le type de rinçage devant être exécuté par la machine de lavage,

ladite performance prédéterminée de rinçage pouvant être sélectionnée dans une gamme de différentes performances prédéterminées possibles, qui sont comprises entre deux performances limites, selon lequel:

- dans la première performance limite, le processus de rinçage est exécuté avec une consommation d'eau minimale, 15
- dans la seconde performance limite, le processus de rinçage se termine lorsqu'est atteinte une concentration ionique ou une concentration du détergent minimale dans l'eau à la fin du processus de rinçage. 20

10. Procédé selon la revendication 9, **caractérisé en ce que**, indépendamment de la performance sélectionnée de rinçage, il est exigé d'obtenir un niveau minimum prééglé de la concentration ionique ou de la concentration du détergent, que l'eau doit posséder pendant le dernier rinçage exécuté par la machine, et/ou il est exigé qu'une quantité maximale prééglée d'eau soit utilisée pour le processus de rinçage exécuté par la machine. 25 30

11. Procédé selon la revendication 9, **caractérisé en ce qu'il inclut:**

- le réglage d'une performance prédéterminée de rinçage, pour chaque performance pouvant être sélectionnée correspondant à un degré de concentration ionique prééglé que l'eau doit posséder à la fin du processus de rinçage; 35 40
- la mesure du degré de concentration ionique - à la fin d'eau moins une étape de rinçage - de l'eau utilisée pour ladite étape de rinçage;
- la comparaison entre le degré de concentration ionique de l'eau à la fin de ladite étape de rinçage et le degré de concentration ionique de l'eau associée à la performance de rinçage sélectionnée, le processus de rinçage se terminant en cas de concordance entre les deux degrés de concentration, tandis que dans le cas où il n'y a pas de concordance entre les deux degrés de concentration, le processus de rinçage se poursuit. 45 50

12. Procédé selon la revendication précédente, **caractérisé en ce qu'il** comporte en outre la mesure du degré de concentration ionique de l'eau pendant l'étape de lavage final prévue dans un cycle de fon-

ctionnement de la machine, et sa relation avec le degré de concentration ionique de l'eau à la fin de chaque rinçage exécuté.

5 13. Procédé selon au moins l'une des revendications précédentes, **caractérisé en ce qu'il** inclut la mesure du degré de concentration ionique de l'eau délivrée par le réseau et sa comparaison au degré de concentration ionique de l'eau d'au moins une étape de rinçage.

FIG. 1

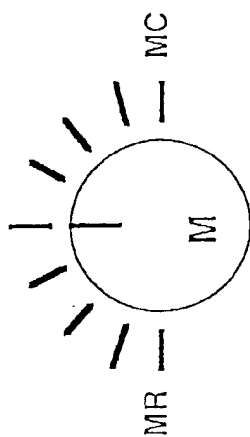


FIG. 3

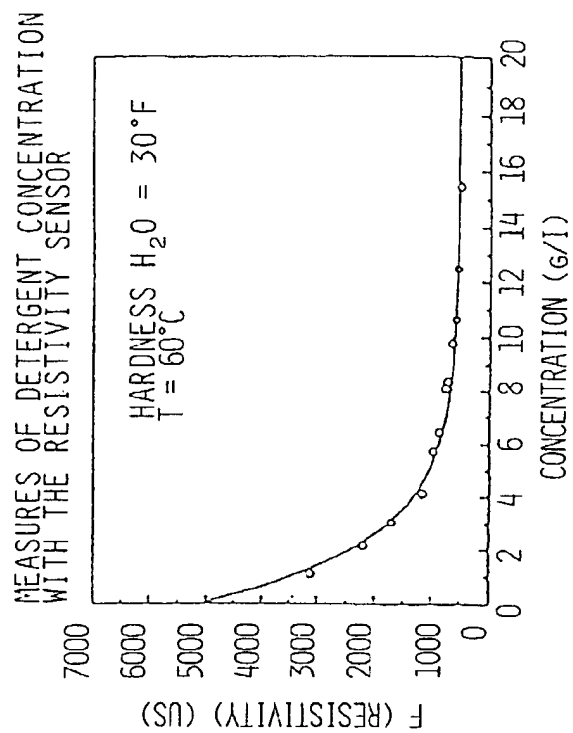


FIG. 2

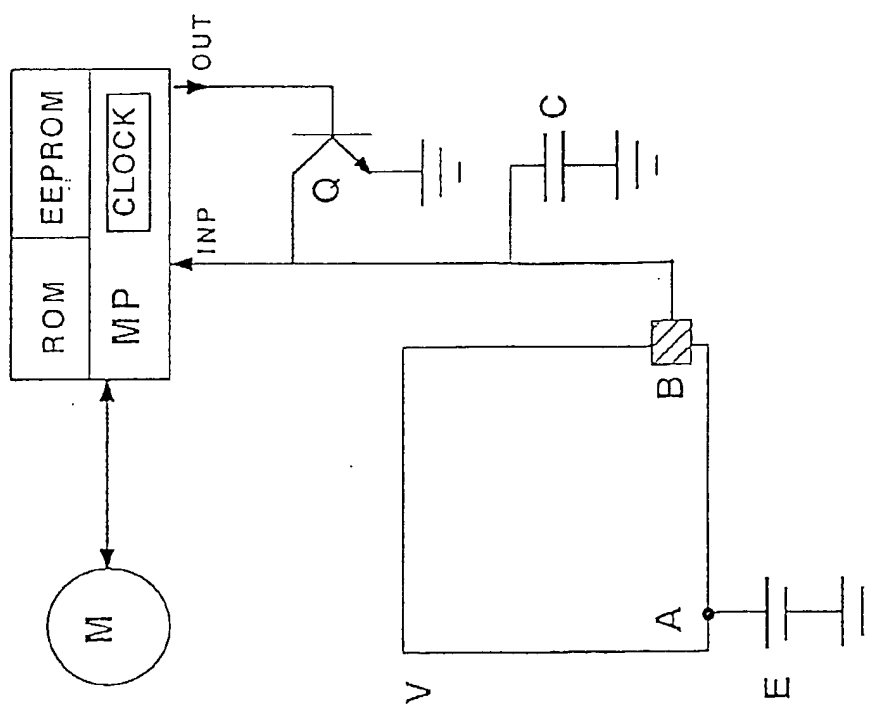


FIG. 4

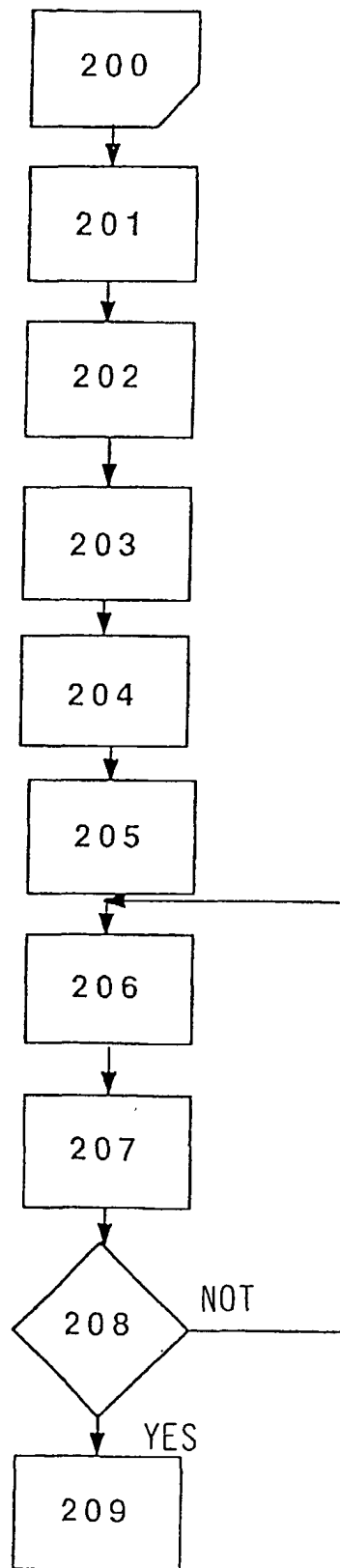


FIG. 5

