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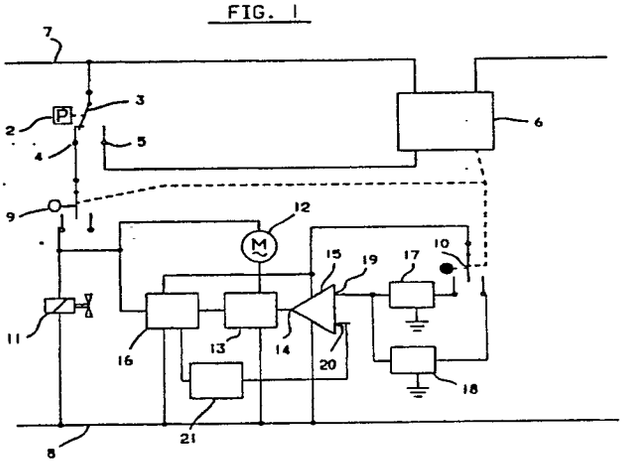
(54) Apparatus for controlling the supply of liquid detergents in a washing machine, particularly a laundry washing machine.

(57) Described is an apparatus for controlling the supply of liquid detergents to the tub of a laundry washer, adapted to establish preselected detergent concentrations in the water admitted to the tub.

The apparatus comprises an electronic comparator (15) for comparing a preselected reference voltage generated by a control circuit (21) adjusted to a value corresponding to the degree of hardness of the water, to a voltage generated by one of two integrator circuits (17, 18) each having a different time constant, said integrator circuit being selected by an electric contact (10) of the programme timing control unit (6) of the machine for energizing or deenergizing a liquid detergent metering pump (12) via a pilot stage (13) connected to said comparator (15). Also described are two alternative embosiments of the invention.

FIG. 1



EP 0 331 149 A2

APPARATUS FOR CONTROLLING THE SUPPLY OF LIQUID DETERGENTS IN A WASHING MACHINE, PARTICULARLY A LAUNDRY WASHING MACHINE

The present invention relates to an apparatus for controlling the supply of liquid detergents in a washing machine, particularly a laundry washer, specifically for automatically controlling the supply of metered amounts of liquid detergents determined in accordance with the amount of laundry contained in the drum of the machine.

Already known are devices for controlling the supply of liquid detergents to the tub of a washing machine substantially comprising at least a pump for the supply of metered amounts of the detergents, and an electronic control circuit connected to the metering pump and provided with suitable electronic components operable to determine the energization and deenergization of the metering pump in accordance with preselected operative parameters of the machine, such as the concentration of the detergent to be supplied to the tub, the hardness of the water supplied by the water mains system and the like.

Control devices of this type are usually installed in laundry washing machines designed for the execution of washing cycles in which the tub is filled with water up to predetermined levels for the various laundering and rinsing operations, so that the laundry contained in the drum is completele immersed in the water.

During the laundry washing operations, the control devices of this type determine the supply of metered amounts of liquid detergents to the tub, to result in a detergent concentration required for effectively laundering an amount of laundry corresponding to the maximum capacity of the drum, this concentration being maintained practically invariable even for laundering reduced amounts of laundry.

Although these control devices permit a satisfactory laundering operation to be performed by laundry washers of the type described above, they are of questionable usefulness in laundry washing machines of the type designed for washing the laundry with a reduced supply of water to the tub, as described for instance in the present applicant's European Patent Application no. 0146719 filed on October 24, 1984.

In laundry washing machines of this type the washing operations are performed by soaking the laundry in a highly concentrated detergent solution in water, this solution being drained from the bottom portion of the tub and returned to the upper portion thereof by means of a pump and a recirculation conduit, to be repeatedly sprayed onto the laundry.

As in a laundry mashing machine of this type the laundry is laundered with reduced amounts of water, the supply of detergents has to be metered very accurately for obtaining detergent solutions having the correct concentration for any given amount of laundry contained in the drum, this being an indispensable condition for obtaining an efficient laundering of the laundry without the danger of damage thereof due to the corrosive action of excessively concentrated detergent solutions.

The thus required accurate metering of the detergents for any given amount of laundry cannot be obtained or optimized when using a control device of the type indicated above.

It is therefore an object of the present invention to eliminate the described shortcomings and restrictions by providing an apparatus for controlling the supply of detergents, particularly liquid detergents, in a laundry washing machine of the detergent solution recirculation type, and to design a control apparatus of this type in a manner permitting any given amount of laundry to be efficiently laundered with an optimum amount of detergents.

These and other objects are attained according to the invention by an apparatus for controlling the supply of liquid detergents in a washing machine, particularly a laundry washing machine comprising a tub, a rotatable drum for containing the laundry, a program timer unit for controlling the execution of respective washing cycles, at least one solenoid valve and a pressure switch or similar level control device for admitting water to said tub to fill it up to a preselected maximum level, said pressure switch having a movable contact adapted to be actuated between a first and a second operative position in response respectively to said tub being empty or filled to a level below said maximum level, or filled up to said maximum level, the apparatus additionally comprising at least one metering pump connected to a supply reservoir containing the liquid detergents to be supplied to said tub.

The control apparatus referred to above is characterized in that it comprises control means connected to said metering pump and adapted to determine, in response to preselected concentrations of said detergents in the water, the energization and deenergization of said metering pump, respectively, wehn said movable contact of said pressure switch is in its first operative position, and when the respective preselected concentration of said detergent has been attained in said tub.

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

figs. 1, 2 and 3 show electric circuit diagrams of a control apparatus according to three different embodiments of the invention.

With reference to fig. 1, there is shown an electric block circuit diagram of a control apparatus according to the invention, adapted to control the metered supply of liquid detergents to the tub (not shown) of a laundry washing machine, particularly a washing machine of the type in which selected washing cycles are performed by soaking the laundry, contained in a drum (not shown) rotatably mounted in the tub, in a highly concentrated water-detergent solution. To this purpose, the machine is provided with a pump and a recirculation conduit (not shown) for draining the solution from the lower part of the tub and returning it to an upper part thereof, whereat the solution is sprayed onto the laundry. A laundry washing machine of this type is described for example in EP No. 0146719, filed by the present applicant on October 24, 1984.

The present control apparatus substantially comprises at least one pressure switch 2 or similar level control device, provided with a movable contact 3 adapted to be displaced between a first operative position in engagement with a fixed contact 4, this first operative position being assumed when the tub is empty or filled with water to a level below a predetermined maximum level, and a second operative position in engagement with a fixed contact 5, this second operative position being assumed when the tub is filled to the predetermined maximum level, with a limited amount of water (in the order of a few litres) sufficient for maintaining the laundry in a soaked condition during the laundering operations.

The laundry washing machine is additionally provided with at least one further pressure switch (not shown) permitting the tub to be filled with water to a level above the predetermined maximum level for the execution of rinsing phases or special laundering cycles as provided for instance for laundering synthetic fabrics.

The at least one additional pressure switch shall not, however, be considered in the following description, because it does not take part in the metering of the liquid detergents.

The control apparatus further comprises a programme timer unit 6 of a conventional type, which is energized from the electric mains circuit via two main conductors 7 and 8 and contains a stack of cams (not shown) adapted to actuate two separate electric contacts 9 and 10 provided for purposes to be described in the following, said stack of cams being adapted to be rotated by a synchronous motor (not shown) when movable contact 3, wich is connected to main conductor 7, is in its second operative position defined above.

When on the other hand movable contact 3 is in its second operative position, it is connected in series to solenoid valve 11 via electric contact 9, the opposite terminal of solenoid valve 11 being connected to the other main conductor 8. Solenoid valve 11 is thus caused to open for admitting water to the tub.

For the supply of metered amounts of liquid detergents from a suitably dimensioned supply reservoir (not shown) to the tub is further provided at least one metering pump 12, which is connected to the reservoir and preferanly designed as a positive displacement pump permitting the liquid detergents to be metered at a constant rate.

In particular, metering pump 12 is connected in parallel to solenoid valve 11 through a pilot stage 13 formed by a triac or a similar control element adapted to control the energization and deenergization of pump 12 in the manner to be described.

To this purpose pilot stage 13 is connected to the output 14 of an electronic comparator 15 and to a power supply circuit 16, the latter being connected in parallel to solenoid valve 11 and adapted to generate an electric voltage for energizing pilot stage 13 and comparator 15.

The thus generated voltage is also applied to contact 10 of programme timer unit 6. Contact 10 is connected to power supply circuit 16 and adapted to close on a selected one of two integrator circuits 17 and 18, each of which is connected to a first input 19 of comparator 15 and composed in a per se known manner of a plurality of capacitors connected in parallel to one another to limiter resistors, diodes and other per se known electronic components (none of which are shown in the drawing).

In particular, integrator circuits 17 and 18 contain respective capacitors having preselected and different time constants so as to generate different charge voltages to be selectively applied to input 19 of comparator 15, depending on whether contact 10 is closed on integrator circuit 17 or 18.

A secong input 20 of comparator 15 is connected to power supply circuit 16 through a control circuit 21 adapted to generate a predetermined reference voltage to be applied to input 20. Control circuit 21 comprises at least one voltage divider or the like, which is adjustable for generating reference voltages in a predetermined relationship to the hardness of the water sopplied from the mains network.

In view of the fact that the detergents can be dissolved in the water supplied to the tub in concentrations which are directly proportional to the hardness of the water, the thus selected reference voltages represent a decive parameter for obtaining detergent solutions of a preselected concentration.

The described control apparatus operates as

follows:

In the first place, programme timer unit 6 is adjusted to the type of laundering cycle to be executed by the washing machine, depending on the type of fabrics to be laundered. Control circuit 21 on its part has been adjusted to a determined control position corresponding to the hardness of the water supplied from the mains network, to thereby permit a constant concentration of dissolved detergents in the water to be obtained.

The machine is thus prepared for admitting water to the tub up to a maximum level determined by pressure switch 2. At this level the tub contains a reduced amount of water in the order of just a few litres. For the execution of specific washing cycles it may be necessary to fill the tub to different levels above the predetermined maximum level under the control of the at least one additional pressure switch (not shown).

At the same time, a predetermined reference voltage generated by control circuit 21 is applied to input 20 of comparator 15 for comparison to the tension generated by one of the two integrator circuits 17 or 18 and applied to the other input 19 of comparator 15.

After the present control apparatus has been thus energized, movable contact 3 of pressure switch 2 is switched to its first operative position in engagement with fixed contact 4 of the pressure switch. Programme timer unit 6 then acts to initiate the selected washing cycle. At this stage electric contacts 9 and 10 are closed respectively on solenoid valve 11 and integrator circuit 17.

This causes solenoid valve 11 to open for admitting water to the tub of the washing machine. At the same time pilot circuit 13 acts to energize metering pump 12 for supplying a metered amount of a liquid detergent to the tub. Pilot stage 13 is enabled to thus energize metering pump 12 by the absence of a signal at the output 14 of comparator 15 due to the different levels of the reference voltage applied to input 20 and the voltage generated by integrator circuit 17 and applied to input 19.

The supply of liquid detergent to the tub continues as long as the voltage generated by integrator circuit 17 is lower than the reference voltage, and is only discontinued when the two voltages are at the same level. At this time a corresponding signal appearing at output 14 of comparator 15 enables pilot stage 13 to deenergize metering pump 12.

Solenoid valve 11 is deenergized on its part by the displacement of movable contact 3 of pressure switch 2 to its second operative position, in which it is closed on fixed contact 5 of the pressure switch, as soon as the maximum filling level of the tub as determined by the pressure switch is attained.

The supply of water to the tub of the machine is thus interrupted, while the closing of movable contact 3 on fixed contact 5 causes the stack of cams of programme timer unit 6, which had been held stationary as long as water was supplied to the tub, to be rotated. The rotation of the stack of cams causes contact 9 to be maintained in its closed state and electric contact 10 to close on integrator circuit 18, and controls the operation of the remaining electric components (not shown) of the washing machine in the sequence determined by the selected washing cycle.

In the presence of a particularly great absorption capacity of the laundry to be laundered, the present control apparatus is adapted to successively admit additional quantities of water to the tub.

When the laundry has absorbed a sufficient amount of water for causing movable contact 3 of pressure switch 2 to return to its first operative position, solenoid valve 11 is again energized for admitting an additional amount of water to the tub. During these phases of renewed energization of solenoid valve 11, which are repeated until the laundry is completely soaked, i.e. saturated, comparator 15 acts to compare the reference voltage, which has remained unchanged, to the voltage generated by integrating circuit 18, to thereby control the energization and deenergization of metering pump 12 through pilot stage 13 in the manner described above.

It is thus evident that the present control apparatus permits the supply of liquid detergents to be accurately metered in accordance with the amount of water admitted to the tub for laundering the amount of laundry actually contained in the drum of the machine, to thereby optimize the consumption of water and detergents during each and any washing cycle.

Under these conditions the control apparatus permits the preparation of washing solutions having the required detergent concentration during all phases of the washing cycle, to thereby ensure efficient washing of the laundry without the danger of it being damaged in the process, and at the same time to ensure highly reliable operation of the washing machine.

With reference now to fig. 2, there is shown a second embodiment of the present control apparatus.

Similar to the embodiment described in precedence, the control apparatus shown in fig. 2 includes a pressure switch 2 having a movable contact 3, a programme timer unit 6 for actuating in this case only a single electric contact 9, a solenoid valve 11, and a metering pump 12.

In this embodiment movable contact 3 of pressure switch 2 is also movable between a first and a

second operative position to close on fixed contacts 4 and 5, respectively, in the same manner as described above, with the difference, however, that fixed contact 5 is a blind contact.

Metering pump 12 is connected to the electric circuit of the control apparatus in a different manner, that is, pump 12 is connected between main electric conductor 7 and a pilot stage 22, which is of the same type and has the same function as pilot stage 13 in fig. 1, and is on its part connected to the other main conductor 8.

The control apparatus depicted in fig. 2 further comprises three electronic comparators 23, 24 and 25, two power supply circuits 26 and 27 and two integrator circuits 28 and 29, which are composed of the same electronic components as integrating circuits 17 and 18 in fig. 1 for thus generating charge voltages each with a preselected and different time constant.

In particular, circuit 28 is a conventional integrator-derivator circuit adapted to apply a charge voltage to the comparator 25, to which it is connected, as long as a charge voltage is being applied to the integrator circuit itself, and to discontinue the voltage supply to comparator 25 when it is completely charged.

The control apparatus shown in fig. 2 finally includes a control circuit 30 which is identical to the circuit 21 in fig. 1 and adapted to generate a preselected reference voltage to be applied to a first input 31 of comparator 25 for a purpose to be described. In particular, power supply circuit 26 is connected to main conductor 7 and to comparators 23, 24 and 25, themselves connected to ground, and to integrator circuit 29 and control circuit 30, both of which are likewise connected to ground, for thus generating corresponding electric voltages for the energization of all these components. Power supply circuit 26 is additionally connected to a first input 32 of comparator 24, the output 33 of which is connected to control circuit 30 for permitting the level of the reference voltage generated by the latter to be varied under conditions to be described, said power supply circuit 26 being finally connected to a first input 34 of comparator 23.

Power supply circuit 27 on its part is connected to a common junction point between solenoid valve 11 and electric contact 9 of programme timer unit 6, and to the second input 36 of comparator 23. The output 37 of the latter is connected to the second inputs 38 and 39 of comparators 24 and 25, respectively, through integrator circuit 29 and integrator-derivator circuit 28. The present control apparatus finally comprises a positive reaction circuit 40 connected between the second input 38 and output 33 of comparator 24 so as to maintain output 33 at the same logic level as second input 38 during the entire washing cycle of the machine to a purpose to be described.

The control apparatus described in precedence operates as follows: As in the first embodiment described, a washing cycle to be executed by the washing machine is initiated by adjusting programme timer unit 6 to the position of the selected washing cycle, and adjusting the voltage divider of control circuit 30 to the control position corresponding to the hardness of the water to be supplied to the tub of the machine. At this stage the machine is prepared to have water admitted to its tub in the manner described with reference to the first embodiment. At the same time control circuit 30 is operable to generate a determined reference voltage to be applied to first input 31 of comparator 25 for comparison to the voltage generated by integrator-derivator circuit 28 and applied to second input 39 of comparator 25.

Depending on the result of this comparison, output 41 of comparator 25 may assume one of two different logic states to thereby determine the energization or deenergization of metering pump 12 through pilot stage 22. After the present control apparatus has been thus energized, movable contact 3 of pressure switch 2 is switched to its first operative position to close on fixed contact 4 of the pressure switch, while programme timer unit 6 operates to advance the selected washing cycle to a state in which its electric contact 9 closes on solenoid valve 11.

While the thus energized solenoid valve 11 opens to admit water to the tub of the machine, output 37 of comparator 23 assumes a high logic level due to the fact that both of its inputs 34 and 36 have a voltage applied thereto by power supply circuits 26 and 27, respectively, and are thus at a high logic level.

Under these conditions integrator circuit 29 is slowly charged up to its predetermined maximum voltage level, whereas input 38 of comparator 24 remains at a low logic level as long as this maximum voltage level is not yet attained. At the same time input 32 of comparator 24 is at a high logic level due to the voltage directly applied thereto by power supply circuit 26. As a result, output 33 of comparator 24 also remains at a low logic level to thereby maintain the reference voltage initially selected by adjusting the voltage divider of control circuit 30 unchanged.

Integrator-derivator circuit 28 on its part is also energized, the respective voltage level being directly applied to second input 39 of comparator 25, causing it to assume a high logic level.

Since first input 31 of comparator 25 is also at a high logic level due to the presence thereat of the reference voltage generated by control circuit 30, output 41 of comparator 25 also assumes a high logic level to thereby enable pilot stage 22 to

energize metering pump 12.

As the water is thus being admitted to the tub of the machine, metering pump 12 is simultaneously operated to supply liquid detergent to the tub as long as the voltage generated by integrator-derivator circuit 28 is lower than the reference voltage.

When the voltages applied to inputs 31 and 39 of comparator 25 are equal, input 39 is switched to a low logic level, as a result of which output 41 of comparator 25 likewise assumes a low logic level to thereby enable pilot stage 22 to deenergize metering pump 12.

In a similar manner, as soon as the voltage generated by integrator circuit 29 and applied to input 38 of comparator 24 has attained its maximum level corresponding to that of the voltage applied to the other input 32 of this comparator, output 33 of the latter assumes a high logic level to thereby vary the reference voltage generated by the voltage divider of control circuit 30.

Output 33 is subsequently maintained at the high logic level due to the presence of positive reaction circuit 40, so that the reference voltage applied to input 31 of comparator 25 is maintained at its new preselected level for all of the remainder of the washing cycle of the machine.

As soon as the determined maximum filling level of the tub is attained, movable contact 3 of pressure switch 2 is displaced to its second operative position to close on fixed contact 5 of the pressure switch, to thereby deenergize solenoid valve 11, so that water is no longer admitted to the tub of the machine.

Under these conditions programme timer unit 6 operates to maintain electric contact 9 closed and to control all of the remaining electric components (not shown) of the machine in the sequence of the selected washing cycle.

The opening of solenoid valve 11 results in power supply circuit 27 being no longer energized, whereas power supply circuit 26 continues to have the mains voltage applied thereto. As a result, inputs 36 and 34 of comparator 23 connected respectively to the power supply circuits are at a low logic level and a high logic level, respectively, so that output 37 of this comparator is also at a low logic level.

Since moreover neither integrator circuit 29 nor integrator-deviator circuit 28 have a voltage applied thereto, inputs 39 and 38 of comparators 25 and 24, respectively, are also switched to a low logic level.

Under these circumstances, output 41 of comparator 25 also assumes a low logic level, to thereby maintain metering pump 12 in the deenergized state.

The present control apparatus may then successively and automatically operate to admit additional amounts of water to the tub, for instance when the laundry in the drum has an excessive absorption capacity.

For thus admitting additional amounts of water, solenoid valve 11 is energized as a result of movable contact 3 of pressure switch 2 closing on fixed contact 4, while electric contact 9 of programme timer unit 6 is maintained in its closed state.

Since under these conditions both power supply circuits 26 and 27 are energized, ouput 37 of comparator 23 assumes a high logic level to thereby apply a voltage to input 39 of comparator 25 through integrator-deviator circuit 28.

Since the other input 31 of comparator 25 has the reference voltage generated by control circuit 30 applied thereto and is thus also at a high logic level, output 41 of comparator 25 will now also assume a high logic level, to thereby enable pilot stage 22 to again energize metering pump 12, causing it to supply additional metered amounts of liquid detergent to the tub of the machine.

In the course of each additional water admission phase described above, metering pump 12 is thus automatically energized and deenergized simultaneously with the admission of water to the tub and for the full duration of the respective phase.

The voltage generated by power supply circuit 27 is also applied to integrator circuit 29, as a result of which the latter is progressively charged and input 38 of comparator 24 is maintained at a low logic level until integrator circuit 29 has been charged to its maximum voltage.

In this case, moreover, and since output 33 of comparator 24 is also maintained at a high logic level due to the presence of positive reaction circuit 40, comparator 24 acts to maintain the reference voltage generated by control circuit 30 at a constant level, irrespective of the logic levels of inputs 38 and 32 of comparator 24, and for the full duration of the washing cycle of the machine.

On termination of any selected washing cycle, programme timer unit 6 automatically acts to deenergize all the electric components of the present control apparatus, as a result of which output 33 of comparator 24 is returned to the logic level zero, and the voltage divider of control circuit 30 is automatically readjusted to again generate a reference voltage equal to that generated initially. The machine is thus ready for initiating a further wasging cycle in a similar manner as described.

With reference finally to fig. 3, there is described a further embodiment of the present control apparatus, which in this case comprises a microprocessor 42 for performing the functions of the programme timer unit 6 of the preceding embodiments, a pressure switch 2, a solenoid valve 11 and a metering pump 12, the last-named elements

being substantially identical to the respective elements employed in the preceding embodiments.

In particular, microprocessor 42 is energized from electric main conductors 7 and 8 of the machine through an associated power supply circuit 43, and is operatively connected to movable contact 3 and fixed contacts 4 and 5 of pressure switch 2, and in addition to solenoid valve 11 and metering pump 12 through respective pilot stages 44 and 45 each comprising a triac or similar control elements.

Solenoid valve 11 and metering pump 12 on their part are connected respectively to main conductor 7 and main conductor 8 through the associated pilot stages 44 and 45.

Microprocessor 42 is programmed to control the energization and deenergization, respectively, of solenoid valve 11 through pilot stage 44 in response to movable contact 3 closing on fixed contact 4 or 5 of pressure switch 2, and to simultaneously store the time interval during which solenoid valve 11 is thus energized, for using this time interval as a reference value for determining the time interval during which metering pump 12 is to be energized in the course of the washing cycle.

Microprocessor 42 thus controls the energization of metering pump 12 through pilot stage 45, to maintain it in its energized state for a duration which is proportional to the thus established reference value and automatically determined by microprocessor 42 so as to obtain the desired liquid detergent concentration in the water admitted to the tub, whereupon metering pump 12 is deenergized.

The presently described embodiment of the control apparatus operates as follows:

After a main power switch (not shown) of the machine has been closed, microprocessor 42 is energized through power supply circuit 43 while movable contact 3 is closed on fixed contact 4 of pressure switch 2, as a result of which solenoid valve 11 is energized through pilot stage 44.

At the same time microprocessor 42 notes the energized state of solenoid valve 11 and acts to control the energization of metering pump 12 through pilot stage 45, mainaining it in its energized state for a time interval stored in microprocessor 42 and calculated so as to ensure that the desired concentration of liquid detergents in the water to be admitted to the tub of the machine is obtained.

When the water admitted to the tub subsequently attains the predetermined maximum level, movable contact 3 closes on fixed contact 5 of pressure switch 2, causing microprocessor 42 to control the deenergization of solenoid valve 11, as a result of which the admission of water to the tub is interrupted.

Subsequentls microprocessor 42 acts to automatically control the execution of the washing cycle and, in the case that the level of the water contained in the tub drops below the predetermined maximum level due to an excessive water absorption capacity of the laundry in the drum, causing movable contact 3 to again close on fixed contact 4 of pressure switch 2, to again and repeatedly energize and deenergize solenoid valve 11 and metering pump 12 in the manner described above.

As a result, additional amounts of water and liquid detergent are supplied to the tub in a manner ensuring that the desired concentration of the detergent is always maintained and that the laundering operation proceeds in a satisfactory manner with optimized consumption of water and detergents.

Claims

1. Apparatus for controlling the supply of liquid detergents in a washing machine, particularly a laundry washing machine comprising a tub, a rotatable drum for containing the laundry, a programme timer unit for controlling the execution of selected washing programmes, at least one solenoid valve and a pressure switch or similar level control device for the admission of water to said tub up to a preselected maximum level, said pressure switch having a movable contact adapted to assume a first and a second operative position in response respectively to said tub being empty of filled to a level below said preselected maximum level, or to said tub being filled up to said preselected maximum level, the apparatus further comprising at least one metering pump connected to a supply reservoir containing liquid detergents to be supplied to said tub,
characterized by comprising control means connected to said metering pump (12) and operable, depending on a preselected concentration of the detergents in the water, to control the energization and deenergization of said metering pump (12) when said movable contact (3) of said pressure switch (2) is in its first operative position, and when the preselected concentration of the detergents in said tub has been attained, respectively.

2. Control apparatus according to claim 1, characterized in that said control means comprise at least one electronic comparator (15) having one input (20) adapted to have applied thereto a reference voltage through adjustable control means (21) connected to at least one power supply circuit (16) disposed in parallel to said solenoid valve (11), and a second input (19) adapted to have applied thereto a voltage generated by one or the other of integrator means (17, 18) connected to said input

(19) and adapted to be selected by an electric contact (10) operable by said programme timer unit (6), and connected to said power supply means (16), the output (14) of said comparator (15) being connected to at least one pilot stage (13) or the like, itself connected, together with said metering pump (12), in parallel to said solenoid valve (11).

3. Control apparatus according to claim 1, characterized in that said control means comprise a first, a second and a third electronic comparator (23, 24, 25), and integrator means (29) and integrator-deviator means (28), both of conventional type, the inputs (34, 36) of said first comparator (23) being adapted to be energized through at least one power supply circuit (26, 27) connected respectively to a main power supply conductor (7) and to said solenoid valve (11), the output (37) of said first comparator (23) being connected through said integrator means (29) to one input (38) of said second comparator (24), the other input (32) and the output (33) of which are connected respectively to said power supply circuit (26) and to adjustable control means (30) itself connected to said power supply circuit (26) and adaoted to generate a preestablished reference voltage, the inputs (39, 31) of said third comparator (25) being connected respectively to the output (37) of said first comparator (23) through said integrator-deviator means (28), and to said adjustable control means (30), the output (41) of said third comparator (25) being connected through at least one pilot stage (22) or the like to said metering pump (12) itself connected to said main power supply conductor (7).

4. Control apparatus according to claims 2 and 3, characterized in that said adjustable control means (21, 30) include at least one voltage divider or the like operable to vary said reference voltage according to the degree of hardness of the water supplied from the mains system.

5. Control apparatus according to claims 2 and 3, characterized in that said each of said integrator means (17, 18; 29) is composed of a plurailty of capacitors connected in parallel to one another to limiting resistors, diodes and further per se known electronic components, said capacitors having preselected time constants so as to be adapted to generate corresponding voltages.

6. Control apparatus according to claim 3, characterized by comprising positive reaction means (40) connected between said input (38) and said output (33) of said second comparator (24) and adapted to vary the reference voltage generated by said adjustable control means (30) and to maintain it at the thus adjusted level in the presence of the same voltage levels at the inputs (38, 32) of said second comparator (24).

7. Control apparatus according to claim 1, characterized in that said control means comprise at least one microprocessor (42) performing the functions of said programme timer unit (6) and connected between the main power supply conductors (7, 8) of the machine through at least one power supply circuit (43), said microprocessor being connected to said movable contact (3) and said fixed contacts (4, 5) of said pressure switch (2), and to pilot stages (44, 45) adapted respectively to control the energization and deenergization of said solenoid valve (11) and said metering pump (12) both of which are connected between said main power supply conductors (7, 8) through the respective pilot stage (44, 45), said microprocessor (42) being adapted to store the time interval of the energization of said solenoid valve (11) when said movable contact (3) is closed on said one fixed contact (4) in the first operative position of said pressure switch (2), for controlling the energization of said metering pump (12) through said pilot stage (45) for durations proportional to said energization time interval.

FIG. 1

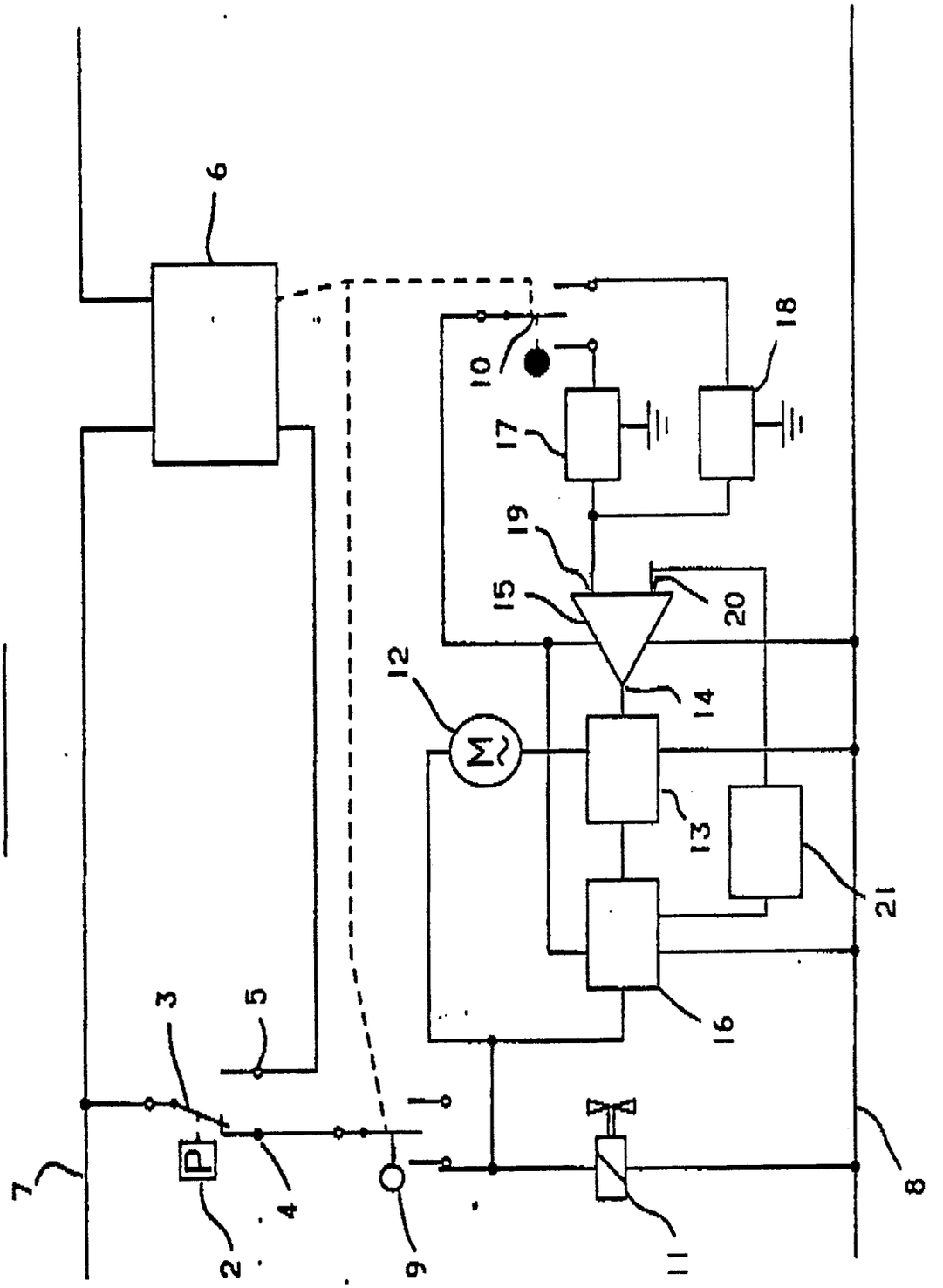
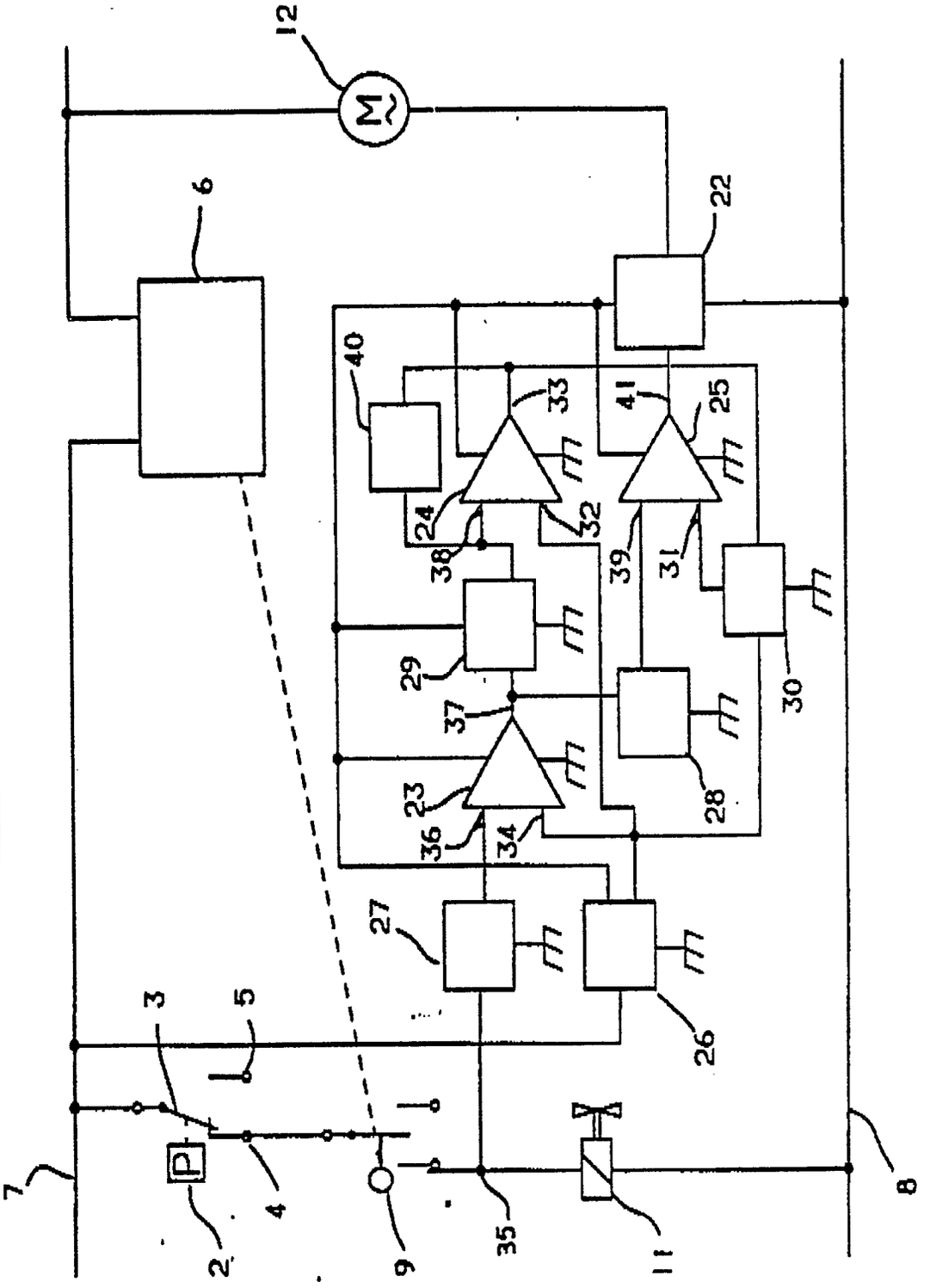


FIG. 2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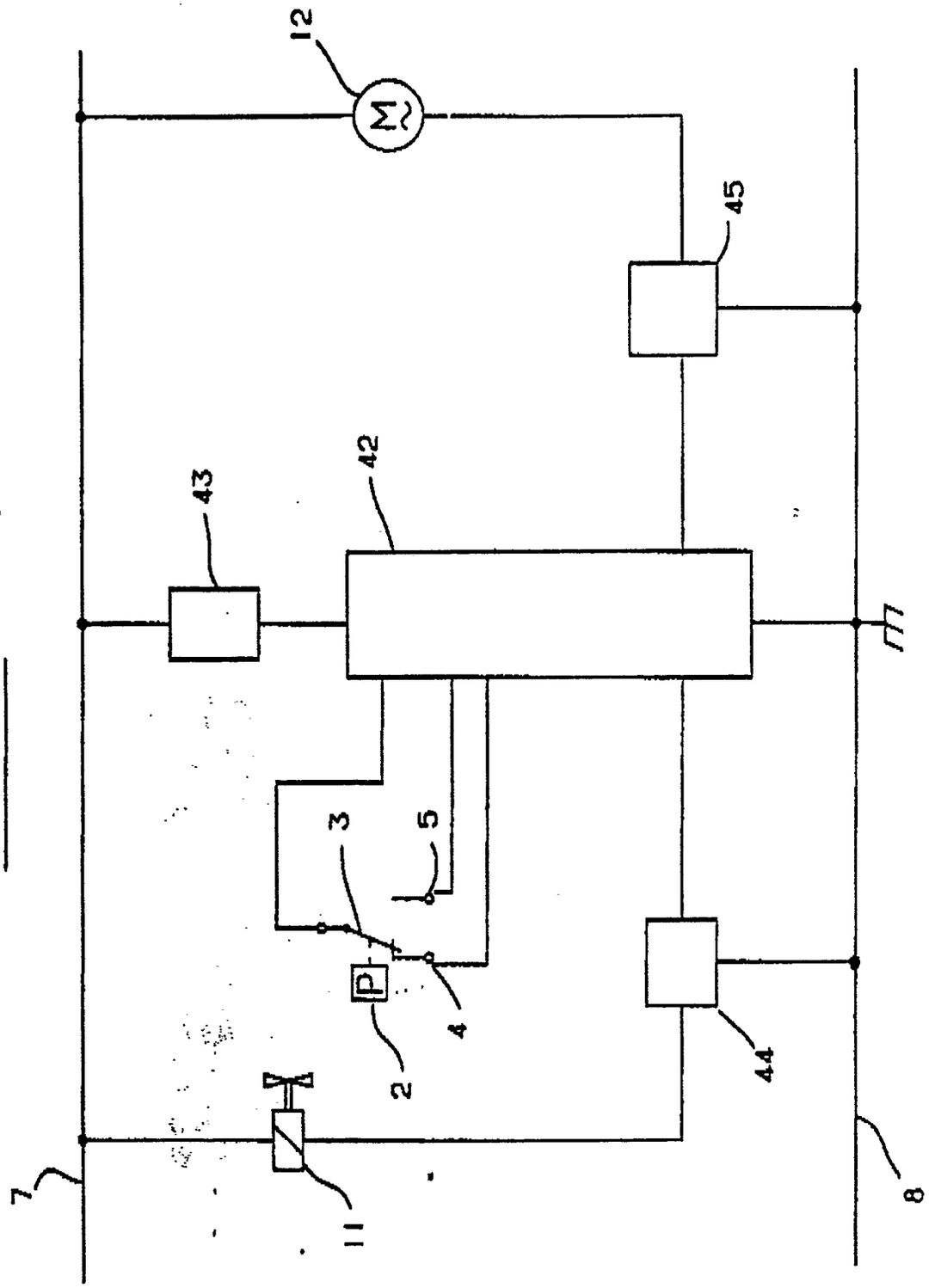

FIG. 3