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(54) WASHING MACHINE AND METHOD OF UNCLOGGING A DRAIN FILTER OF A WASHING MACHINE

(57) The present invention provides a washing machine (10), such as a machine for laundering clothes or a dishwasher, which comprises a washing chamber (12) having an outlet (14) for waste water. The outlet (14) is in fluid communication with a drain and waste water is pumped from the washing chamber (12) to the drain via a drain pump (26). The drain pump (26) is protected from debris and sludge which may be present in the waste water by a drain filter (24). In order to unclog the drain filter (24), a path for waste water upstream from the drain filter (24) to the outlet (14) bifurcates into first and second routes. The first route comprises a bypass channel (20) for waste water, which is used during normal operation of the washing machine (10). The second route is for use during an unclogging operation of the drain filter (24) and comprises an unclogging chamber (22) for containing an unclogging agent. During the unclogging operation, the waste water is diverted to pass through the unclogging chamber (22) by a three-way valve (18), which has a first state, wherein waste water is directed along the first route, and a second state, wherein waste water is directed along the second route. The three-way valve (18) is switched between the first and second states thereof according to whether the rate of waste water drainage from the washing machine (10) is less than or equal to a predetermined value, and possibly also whether the temperature of the waste water is greater than or equal to a predetermined temperature. The present invention also provides a corresponding method of unclogging a drain filter of a washing machine and a computer program product or a program code or system for executing such a method.

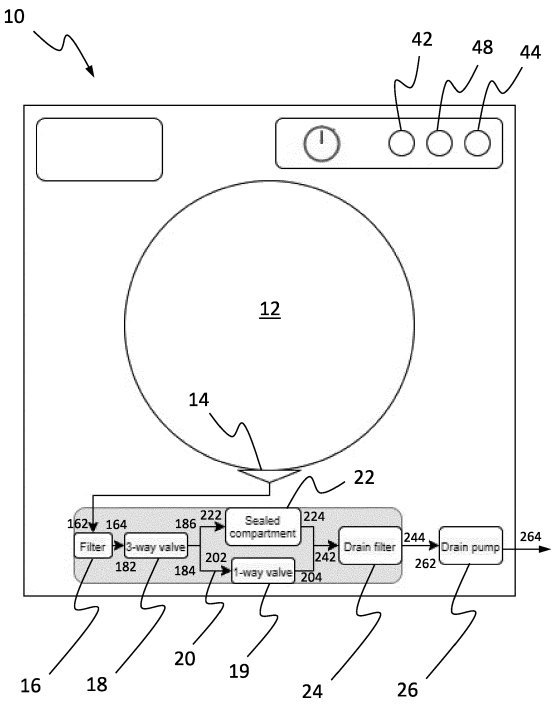


Fig. 2

EP 4 015 698 A1

Description

[0001] The present invention relates to a washing machine according to claim 1, a method of unclogging a drain filter of a washing machine according to claim 10 and a computer program product or a program code or system according to claim 15.

Background of the Invention

[0002] Washing machines, which include both machines for laundering clothes and machines for cleaning crockery and/or cutlery (the latter generally being known as dishwashers), operate by introducing fresh water into a washing chamber, where items to be washed are held, and ejecting waste water from the washing chamber when the items are washed. A washing machine usually comprises a drain pump to pump the waste water out of the washing chamber into a drain. Since the items to be washed are dirty, solid debris and/or sludge washed off the items risks clogging the drain pump, causing the drain pump to malfunction and/or be damaged. In the case of dishwashers, this debris may include, for example, particles of food and/or viscous liquids, such as grease. In the case of laundry washing machines, this debris may include, for example, particles of mud and/or fibres of clothing material. The washing machine therefore usually also comprises a drain filter, located upstream of the drain pump in a path for waste water from the washing chamber to the drain, in order to protect the drain pump from clogging. However, the drain filter should also be unclogged from time to time, to ensure continuing correct operation of the washing machine. The drain filter may be unclogged chemically, by means of a chemical unclogging agent, and/or mechanically.

[0003] Manual unclogging of the drain filter by a user of the washing machine is known in the prior art. However, this is messy and inconvenient for the user and may also risk harm to the user, the washing machine and/or the items to be washed, if a chemical unclogging agent is used. Moreover, if the clogging is serious enough to prevent drainage of waste water to the drain, unclogging the drain filter may also require waste water to be pumped out of the washing chamber manually, use of a plunger, and so on. Several solutions to this problem have therefore been proposed in the prior art, wherein an unclogging operation is incorporated into a washing machine as part of its design.

[0004] For example, US 2014/158163 A describes a method and system of removing a clogging condition of a filter in a dishwasher. The method includes detecting the clogging condition of the filter by detecting a deviation of a water level or rate of water level change during a wash cycle from a normal water level or normal rate of water level change.

[0005] CN 105316913 A describes a washing machine and a control method for cleaning a filtering assembly of the washing machine. In such a washing machine, waste water from a washing chamber is circulated through a drain filter in a closed loop back to the washing chamber. The drain filter comprises a pre-filter and an ultrafiltration membrane. In order to unclog the pre-filter and ultrafiltration membrane, an air pump is controlled to pump air through the pre-filter and ultrafiltration membrane.

[0006] However, some of these prior art solutions have various disadvantages.

Object of the Invention

[0007] It is therefore an object of the invention to provide a washing machine, a method of unclogging a drain filter of a washing machine, and a computer program product or a program code or system for executing such a method.

Description of the Invention

[0008] The object of the invention is solved by a washing machine according to claim 1. The washing machine at least comprises a washing chamber having an outlet for waste water, a pre-filter, a three-way valve, a bypass channel, an unclogging compartment for containing an unclogging agent, a drain filter, a drain pump, a waste water measuring device, a temperature measuring device, processing means and switching means under control of the processing means. The pre-filter has an inlet in fluid communication with the outlet of the washing chamber and has an outlet. The three-way valve has an inlet in fluid communication with the outlet of the pre-filter and has first and second outlets. The three-way valve has a first state, wherein the inlet of the three-way valve is in fluid communication with the first outlet thereof and is closed off from the second outlet thereof, and a second state, wherein the inlet of the three-way valve is in fluid communication with the second outlet thereof and is closed off from the first outlet thereof. The bypass channel has an inlet in fluid communication with the first outlet of the three-way valve and has an outlet. The unclogging compartment has an inlet in fluid communication with the second outlet of the three-way valve and has an outlet. The drain filter has an inlet in fluid communication with both the outlet of the bypass channel and with the outlet of the unclogging compartment, and has an outlet. The drain pump has an inlet in fluid communication with the outlet of the drain filter and has an outlet configured to be connected to a drain. The waste water measuring device is for measuring a rate of waste water drainage from the washing machine via the bypass channel when the three-way valve is in its first state, and has an output. The temperature measuring device is for measuring a temperature of the waste water and also has an output. The processing means has a first input connected to the output of the waste water measuring device and a second input connected to the output of the temperature measuring device. The processing means is for determining whether the rate of waste water drainage from the wash-

ing machine is less than or equal to a predetermined value and for determining whether the temperature of the waste water is greater than or equal to a predetermined temperature. The switching means is for switching the three-way valve between the first state thereof and the second state thereof. The processing means is configured to instruct the switching means to switch the three-way valve from the first state thereof to the second state thereof if the processing means determines that the rate of waste water drainage from the washing machine is less than or equal to the predetermined value.

[0009] The washing machine may, for example, be a machine for laundering clothes or a machine for cleaning crockery and/or cutlery, also known as a dishwasher.

[0010] The pre-filter is for catching larger and relatively more heavy items of debris borne by the waste water, in order to protect the three-way valve and other components of the washing machine downstream of the three-way valve from becoming blocked or damaged. In the case of a machine for laundering clothes, such larger items may, for example, comprise rings, buttons, coins, and so on. In the case of a dishwasher, such larger items may, for example, comprise fruit stones, larger chunks of food, and so on. However, the pre-filter is coarse enough to permit the passage of waste water containing smaller items of debris therethrough.

[0011] The drain pump is for pumping waste water from the washing chamber to a drain.

[0012] The drain filter is for catching smaller and relatively lighter items of debris and/or sludge, in order to protect the drain pump from becoming blocked or damaged. However, as a result, the drain filter may itself become clogged. The present invention therefore provides technical solutions for unclogging the drain filter.

[0013] The unclogging agent may, for example, comprise a chemical unclogging agent, such as sodium hypochlorite.

[0014] The temperature measuring device may, for example, comprise a thermocouple.

[0015] The processing means may, for example, comprise a central microprocessor and/or microcontroller, a memory and associated logic circuitry, a bus, and so forth.

[0016] The switching means may, for example, comprise a servo mechanism and/or servo motor.

[0017] This solution is beneficial because if the processing means determines that the rate of waste water drainage from the washing machine is less than or equal to the predetermined value, this may indicate that the drain filter has become clogged. The processing means can then instruct the switching means to switch the three-way valve from the first state thereof to the second state thereof. This diverts the waste water from the bypass channel to pass through the unclogging compartment, where the waste water picks up the unclogging agent. The unclogging agent then passes through the drain filter, thereby unclogging it. This has the advantage of obviating the need for a user of the washing machine to access the drain filter and unclog it manually, which would inevitably be messy and dirty. By carrying out this unclogging operation when the rate of waste water drainage becomes less than or equal to the predetermined value, this also have the advantage of being a preventative action, which unclogs the washing machine before drainage of waste water from the washing chamber stops completely, which would risk damaging the contents of the washing chamber with dirty waste water. Moreover, such preventative action also avoids the need for the user to pump any remaining waste water out of the washing chamber manually and possibly also use a plunger and/or apply an unclogging agent manually to the outlet from the washing chamber, in order to unclog the drain filter, which would further risk damaging not only the contents of the washing chamber, such as clothes or crockery, still further, but also components of the washing machine itself, and may be harmful to the user.

[0018] The predetermined value for the rate of waste water drainage from the washing machine may be set at an appropriate level to achieve this unclogging effect, in a manner discussed in greater detail below. If the predetermined value is set equal to a critical value at which the unclogging operation is necessary in order to avoid a complete blockage of the drain filter, the unclogging operation may take place in any event.

[0019] Optionally, however, the processing means may be configured to instruct the switching means to switch the three-way valve from the first state thereof to the second state thereof if the processing means also determines that the temperature of the waste water is greater than or equal to the predetermined temperature.

[0020] This solution is beneficial because in such a case, the predetermined value for the rate of waste water drainage from the washing machine may then be set at a level which is higher than the aforementioned critical value and the predetermined temperature may be set at a level which ensures that the waste water is hot enough for the temperature of the waste water to positively affect the action of the unclogging agent on the drain filter, according to the Arrhenius equation. In other words, the use of hot waste water with the unclogging agent is more effective at unclogging the drain filter than just the unclogging agent would be on its own or in combination with only tepid or cold waste water. Using hot waste water in this way also has the advantage of avoiding the need for the washing machine to heat up water especially for use with the unclogging agent, which would be more costly and less energy efficient than re-using waste water which is already hot for this purpose.

[0021] Advantageous embodiments of the invention may be configured according to any claim and/or part of the following description.

[0022] In some embodiments, the washing machine may further comprise a sensor for sensing the presence of unclogging agent in the unclogging compartment, a first indicator for indicating to a user to insert unclogging agent into the unclogging compartment, and a detector

for detecting whether the unclogging compartment has been opened and/or closed. In such embodiments, the sensor has an output connected to a third input of the processing means, the first indicator indicates to the user to insert unclogging agent into the unclogging compartment when instructed to do so by the processing means, and the detector has an output connected to a fourth input of the processing means. In such cases, the processing means is configured to instruct the first indicator to indicate to the user to insert unclogging agent into the unclogging compartment if the sensor senses that unclogging agent is not present in the unclogging compartment until the detector detects that the unclogging compartment has been opened and/or closed by the user and the sensor senses that unclogging agent is present in the unclogging compartment. This has the advantages that the unclogging operation is not run by the processor unless and until unclogging agent is present in the unclogging compartment, and also of indicating to a user when unclogging agent is required. The sensor may, for example, comprise scales able to sense the presence of unclogging agent in the unclogging compartment by its weight. The first indicator may, for example, comprise an LED indicator light or LCD screen. The detector for detecting whether the unclogging compartment has been opened and/or closed may, for example, comprise electrical contacts on a door of the unclogging compartment which complete an electrical circuit when the door is closed.

[0023] Preferably, the unclogging compartment further comprises a door lock for locking the unclogging compartment during operation of the washing machine, and the door lock is under control of the processing means. This has the advantage that the user is thereby prevented from accidentally or deliberately opening the unclogging compartment during an unclogging operation.

[0024] In some embodiments, the washing machine may further comprise a pre-filter monitor for monitoring a condition of the pre-filter, and a second indicator for indicating to a user that manual intervention is required to clean the pre-filter. In such embodiments, the pre-filter monitor has an output connected to a fifth input of the processing means and the second indicator indicates to a user that manual intervention is required to clean the pre-filter when the second indicator is instructed to do so by the processing means. In such cases, the processing means is configured to instruct the second indicator to indicate to the user to clean the pre-filter if the pre-filter monitor finds that the pre-filter is in an adverse condition. An adverse condition of the pre-filter may, for example, comprise reduced flow through the pre-filter, indicating the presence of one or more larger items of debris in the pre-filter. Since the pre-filter is at the outlet from the washing chamber, it has the advantage that it may easily be manually cleaned by a user. The pre-filter monitor may, for example, comprise a flow meter for monitoring the flow of waste water through the pre-filter. The second indicator may, for example, comprise an LED indicator light or LCD screen.

[0025] In some embodiments, the washing machine may further comprise a third indicator for indicating to a user that manual intervention is required to unclog the drain filter when the third indicator is instructed to do so by the processing means. This solution is beneficial because the processing means may then instruct the third indicator to do so in case the unclogging agent is not completely effective in unclogging the drain filter, in order that the user may be notified to unclog the drain filter manually and/or to call out an engineer to investigate why the rate of waste water drainage from the washing machine remains equal to or less than the predetermined value and to carry out a repair, if necessary. The third indicator may, for example, comprise an LED indicator light or LCD screen.

[0026] In some embodiments, the first, second and third indicators may comprise different states of illumination of a single indicator light or display screen, such as different colours or displayed messages.

[0027] In some embodiments, the waste water measuring device may comprise means for measuring an amount of waste water remaining in the washing machine a predetermined period of time after waste water is directed to drain from the washing machine. For example, in such a case, the waste water measuring device may comprise scales for weighing the amount of waste water remaining in the washing chamber. Alternatively or additionally, the waste water measuring device may comprise a flow meter for measuring a rate of flow of waste water downstream of the outlet from the washing chamber.

[0028] Preferably, the washing machine comprises a non-return valve located downstream of the three-way valve and upstream of the drain filter. The non-return valve allows waste water to pass from the three-way valve towards the drain filter, but not vice versa. This solution is beneficial because both the three-way valve and the contents of the washing chamber, if any, are then protected against the contents of the drain filter, the drain pump, and ultimately, the drain, in case the pressure downstream of the drain filter exceeds the pressure upstream of the drain filter, which may be the case, for example, if the drain becomes blocked. In different embodiments, the washing machine may comprise one or more such non-return valves in different locations, such as in the bypass channel, upstream and/or downstream of the unclogging chamber, and so on.

[0029] The present invention also relates to a method of unclogging a drain filter of a washing machine, wherein the method at least comprises the following. When waste water is directed to drain from the washing machine, determining whether a rate of waste water drainage from the washing machine is less than or equal to a predetermined value. If not, repeating said determination a next time that waste water is directed to drain from the washing machine, whereas if so, determining whether a temperature of the waste water is greater than or equal to a

predetermined temperature. If the temperature of the waste water is not determined to be greater than or equal to the predetermined temperature, determining whether the rate of waste water drainage from the washing machine is less than or equal to a critical value which is less than the predetermined value. If the rate of waste water drainage from the washing machine is not determined to be less than or equal to the critical value, waiting until the temperature of the waste water is determined to be greater than or equal to the predetermined temperature. If the temperature of the waste water is determined to be greater than or equal to the predetermined temperature or if the rate of waste water drainage from the washing machine is determined to be less than or equal to the critical value, diverting the waste water through an unclogging compartment of the washing machine to the drain filter, wherein the unclogging compartment is for containing an unclogging agent. Waiting a predetermined period of time, then rediverting the waste water to the drain filter whilst bypassing the unclogging compartment, and determining whether the rate of waste water drainage from the washing machine is less than or equal to the predetermined value. If not, alerting the user to insert unclogging agent into the unclogging compartment and the next time that waste water is directed to drain from the washing machine, determining whether the rate of waste water drainage from the washing machine is less than or equal to the predetermined value, whereas if so, alerting the user that manual intervention is required to unclog the drain filter.

[0030] This solution is beneficial because the drain filter may then be unclogged either when the rate of waste water drainage from the washing machine is less than or equal to the predetermined value and the temperature of the waste water is determined to be greater than or equal to the predetermined temperature, or when the rate of waste water drainage from the washing machine is determined to be less than or equal to the critical value, regardless of the temperature of the waste water. Moreover, this method has the advantage that the success of the unclogging operation is also checked, and the user is notified to replenish the unclogging agent in the unclogging compartment after each successful unclogging operation or to take remedial action if the unclogging operation has not been successful.

[0031] In some embodiments, determining whether the rate of waste water drainage from the washing machine is less than or equal to the predetermined value and/or the critical value may comprise measuring an amount of waste water remaining in the washing machine a predetermined period of time after waste water is directed to drain from the washing machine. This has the advantage of obviating the need for a flow meter downstream of the outlet from the washing chamber of the washing machine, which can result in reduced manufacturing cost and increased reliability in measuring the rate of waste water drainage from the washing machine.

[0032] In some embodiments, the method may further comprise, before diverting the waste water through the unclogging compartment, sensing whether unclogging agent is present in the unclogging compartment. If not, alerting a userto insert unclogging agent into the unclogging compartment, waiting until detecting that the unclogging compartment has been opened and closed, and then again sensing whether unclogging agent is present in the unclogging compartment, whereas if so, diverting the waste water through the unclogging compartment. This has the advantage that an attempt is then not made to unclog the drain filter unless unclogging agent is present in the unclogging compartment.

[0033] In some embodiments, the method may comprise locking the unclogging compartment during operation of the washing machine. This has the advantage of avoiding the unclogging compartment being accidentally or deliberately opened by a user during operation of the washing machine. Preferably, the unclogging compartment is locked during the unclogging operation when waste water is passing through the unclogging compartment.

[0034] In some embodiments, the method may comprise establishing the predetermined value of the rate of waste water drainage from the washing machine by comparing the rate of waste water drainage from the washing machine over a plurality of cycles of operation of the washing machine with each other. This solution is beneficial because the rate of waste water drainage from the washing machine during normal operation (i.e. not during an unclogging operation) may then be established according to the particular conditions in which the washing machine is installed, such as a cross-sectional area of a drainage pipe to which the outlet from the drain pump is connected, the back pressure from the drain, if any, and so on. Moreover, this solution also has the advantage that the rate of waste water drainage from the washing machine during normal operation can then also be compared with the rate of waste water drainage from the washing machine during an unclogging operation to help establish the predetermined value of the rate of waste water drainage.

[0035] On the other hand, the predetermined temperature may, for example, instead be established by storing the predetermined temperature in a memory of the processing means, the value of the predetermined temperature being determined according to the reaction kinetics of the unclogging agent, for example.

[0036] The present invention further relates to a computer program product or a program code or system for executing one or more than one of the herein described methods.

[0037] Further features, goals and advantages of the present invention will now be described in association with the accompanying drawings, in which exemplary components of the invention are illustrated. Components of the devices and methods according to the invention which are at least essentially equivalent to each other with respect to their function can be marked by the same

reference numerals, wherein such components do not have to be marked or described in all of the drawings.

[0038] In the following description, the invention is described by way of example only with respect to the accompanying drawings.

Brief Description of the Drawings

[0039]

Fig. 1 is a schematic diagram of a first embodiment of a washing machine;

Fig. 2 is a schematic diagram of a second embodiment of a washing machine;

Fig. 3 is a schematic block diagram of an embodiment of a control system for controlling unclogging of a drain filter of a washing machine, such as those shown in Figs. 1 and 2; and

Fig. 4 is a flow diagram schematically representing an embodiment of a method of unclogging a drain filter of a washing machine.

Detailed Description of the Drawings

[0040] Fig. 1 schematically shows a first embodiment of a washing machine 10. The washing machine 10 comprises a washing chamber 12 having an outlet 14 for waste water, a pre-filter 16, a three-way valve 18, a non-return valve 19, a bypass channel 20, an unclogging compartment 22 for containing an unclogging agent, a drain filter 24 and a drain pump 26. The washing machine 10 also comprises a control system 50 not shown in Fig. 1 but shown in Fig. 3 and described in relation thereto in greater detail below.

[0041] The pre-filter 16 has an inlet in fluid communication with the outlet 14 of the washing chamber 12 and an outlet. The three-way valve 18 has an inlet 182 in fluid communication with the outlet of the pre-filter 16 and first and second outlets 184, 186, respectively. The first outlet 184 is in fluid communication with an inlet 202 of the bypass channel 20. The second outlet 186 is in fluid communication with an inlet 222 of the unclogging chamber 22. The three-way valve 18 has a first state, wherein the inlet 182 is in fluid communication with the first outlet 184 and is closed off from the second outlet 186, and a second state, wherein the inlet 182 is in fluid communication with the second outlet 186 and is closed off from the first outlet 184.

[0042] During normal operation of the washing machine, the three-way valve 18 is in its first state, so that waste water from the washing chamber 12 which has passed through the pre-filter 16 is directed by the three-way valve 18 towards the bypass channel 20. During an unclogging operation, the three-way valve 18 is in its second state, so that waste water from the washing chamber 12 which has passed through the pre-filter 16 is instead directed by the three-way valve 18 towards the unclogging chamber 22.

[0043] The bypass channel 20 has an outlet 204. The unclogging chamber 22 has an outlet 224. The outlet 204 of the bypass channel 20 and the outlet 224 of the unclogging chamber 22 are both in fluid communication with an inlet 242 of the drain filter 24, so that regardless of whether the three-way valve 18 is in the first or second state thereof, the waste water next arrives at the drain filter 24. The drain filter 24 has an outlet 244, which is in fluid communication with an inlet 262 of the drain pump 26. Thus, waste water filtered by the drain filter 24 then encounters the drain pump 26, which pumps the waste water from the washing chamber 12 into a drain via an outlet 264 of the drain pump 26.

[0044] The non-return valve 19 only allows waste water to pass from the washing chamber 12 towards the drain filter 24, but not vice versa. In the embodiment of Fig. 1, the non-return valve 19 is located between the outlet 224 of the unclogging chamber 22 and the inlet 242 of the drain filter 24. Thus if the drain filter 24 is clogged, waste water is prevented by the non-return valve 19 from backing up into the unclogging chamber 22 and mixing with the unclogging agent. From there, if the three-way valve 18 were in its second state during an unclogging operation of the drain filter 24, if the non-return valve 19 were not present, the waste water could pass back up through the three-way valve 18 via the pre-filter 16 and into the washing chamber 12, where the contents of the washing chamber 12 would risk being dirtied by the waste water and damaged by the unclogging agent. Thus the presence of the non-return valve 19 prevents such an incident.

[0045] Switching of the three-way valve 18 between its first state and its second state, in order to select between normal operation and an unclogging operation of the drain filter 24, is controlled by the control system 50, which is described below in relation to Fig. 3.

[0046] Fig. 2 schematically shows a second embodiment of a washing machine 10. Similarly to the washing machine 10 shown in Fig. 1, the washing machine 10 shown in Fig. 2 comprises a washing chamber 12 having an outlet 14 for waste water, a pre-filter 16, a three-way valve 18, a non-return valve 19, a bypass channel 20, an unclogging compartment 22 for containing an unclogging agent, a drain filter 24 and a drain pump 26. The washing machine 10 of Fig. 2 further comprises a control system 50 not shown in Fig. 2 but shown in Fig. 3 and described in relation thereto in greater detail below.

[0047] The components of the washing machine 10 shown in Fig. 2 are connected to each other and function in a similar manner to the components of the washing machine 10 shown in Fig. 1, except for the location of the non-return valve 19. In this embodiment, the non-return valve 19 is instead located in the bypass channel 20. Thus if the drain filter 24 is clogged, waste water is prevented by the non-return valve 19 from backing up

into the three-way valve 18, where, if the three-way valve 18 were in its first state during normal operation of the washing machine 10, if the non-return valve 19 were not present, the waste water could pass back up through the three-way valve 18 via the pre-filter 16 and into the washing chamber 12, where the contents of the washing chamber 12 would risk being dirtied by the waste water. Thus the presence of the non-return valve 19 prevents such an incident.

[0048] Switching of the three-way valve 18 between its first state and its second state, in order to select between normal operation and an unclogging operation of the drain filter 24, is controlled by the control system 50, which is described below in relation to Fig. 3.

[0049] Whereas Fig. 1 shows a first embodiment of a washing machine 10 having a non-return valve 19 located between the outlet 224 of the unclogging chamber 22 and the inlet 242 of the drain filter 24 and Fig. 2 shows a second embodiment of a washing machine 10 having a non-return valve 19 located in the bypass channel 20, preferably, in other embodiments, a non-return valve 19 is located in both such locations, in order to prevent waste water from backing up into the three-way valve 18 via either the bypass channel 20 or the unclogging chamber 22, regardless of whether the three-way valve 18 is in its first or second state.

[0050] Fig. 3 schematically represents an embodiment of a control system 50 for controlling unclogging of a drain filter 24 of a washing machine 10, such as those shown in Figs. 1 and 2. The control system 50 comprises a waste water measuring device 28, a temperature measuring device 30, a microcontroller 32, switching means 34 for switching the three-way valve 18 between its first and second states, an unclogging agent sensor 36, a door open/close detector 38, a door lock 40, a pre-filter monitor 46, a first indicator 42, a second indicator 48 and a third indicator 44.

[0051] The waste water measuring device 28 and the temperature measuring device 30 may typically be located in a path of the waste water from the washing chamber 12 to the drain pump 26. The unclogging agent sensor 36, door open/close detector 38 and door lock 40 may typically be located in the unclogging chamber 22. The microcontroller 32 may typically be located on a main circuit board of the washing machine 10, along with a memory and associated logic circuitry. The switching means 34 may typically be located alongside the three-way valve 18. The pre-filter monitor 46 may typically be located alongside the pre-filter 16. The first, second and third indicators 42, 48 and 44 may typically be located on a front panel of the washing machine 10, as shown, for example, in Fig. 2.

[0052] The waste water measuring device 28 may comprise means for measuring an amount of waste water remaining in the washing machine a predetermined period of time after waste water is directed to drain from the washing machine. For example, the waste water measuring device 28 may measure how much waste water remains in the washing machine one minute after the drain pump 26 is switched on. The waste water measuring device 28 may measure the amount of waste water remaining in the washing machine, for example, by detecting a level of water remaining in the washing chamber 12. Alternatively or additionally, the waste water measuring device 28 may comprise a flow meter for measuring a rate of flow of the waste water downstream of the outlet 14 from the washing chamber 12 and using the flow rate, measured in units of volume per unit of time, multiplied by the predetermined period of time, to derive the volume of waste water which has left the washing chamber 12. If the flow rate of fresh water into the washing chamber 12 is also measured in a similar fashion, the amount of waste water remaining in the washing machine may then be obtained by subtracting the volume of waste water which has left the washing chamber 12 from the volume of fresh water which has entered the washing chamber 12.

[0053] The waste water measuring device 28, temperature measuring device 30, unclogging agent sensor 36, a door open/close detector 38 and pre-filter monitor 46 have respective outputs 282, 302, 362, 382 and 462, which are respectively connected to respective inputs 322a, 322b, 322c, 322d and 322e of the microcontroller 32. The switching means 34, door lock 40 and first, second and third indicators 42, 48 and 44 are under control of the microcontroller 32.

[0054] During normal operation of the washing machine 10, the microcontroller 32 instructs the switching means 34 to switch the three-way valve 18 into the first state thereof. Thus during normal operation of the washing machine 10, waste water is pumped by the drain pump 26 from the washing chamber 12 via the bypass channel 20 to the drain filter 24. Functioning of the control system 50 during an unclogging operation of the drain filter 24 can be better understood by reference to the flow diagram of Fig. 4.

[0055] Fig. 4 is a flow diagram schematically representing an embodiment of a method 100 of unclogging a drain filter 24 of a washing machine 10, such as those shown in Figs. 1 and 2, by means of a control system 50, such as that shown in Fig. 3. The method 100 comprises firstly, when waste water is directed to drain from the washing machine 10 during its normal operation, the microcontroller 32 determines 101 whether a rate of waste water drainage from the washing machine 10 is less than or equal to a predetermined value. The microcontroller 32 can do this by comparing the current rate of waste water drainage as measured by the waste water measuring device 28 with the predetermined value thereof stored in memory.

[0056] The predetermined value of the rate of waste water drainage from the washing machine may be established by comparing the rate of waste water drainage from the washing machine over a plurality of cycles of normal operation of the washing machine 10 with each other to determine a normal range of values for the rate

of waste water drainage, and then setting the predetermined value equal to a percentage of the average rate of waste water drainage, which is below the normal range of values for the rate of waste water drainage. Forexample, the predetermined value may be set equal to 80% of the average rate of waste water drainage if the normal range of values is from 90% to 110% of the average rate.

[0057] If the current rate of waste water drainage is found not to be less than or equal to the predetermined value, the microcontroller 32 repeats the same determination 101 a next time that waste water is directed to drain from the washing machine during its normal operation. On the other hand, if the current rate of waste water drainage is found to be less than or equal to the predetermined value, the microcontroller 32 next determines 102 whether a temperature of the waste water is greater than or equal to a predetermined temperature. The microcontroller 32 can do this by comparing the current temperature of the waste water with the predetermined temperature stored in memory. The value of the predetermined temperature may be determined according to the reaction kinetics of the unclogging agent being used, for example.

[0058] If the temperature of the waste water is not determined to be greater than or equal to the predetermined temperature, the microcontroller 32 next determines 103 whether the rate of waste water drainage from the washing machine is less than or equal to a critical value which is less than the predetermined value. The microcontroller 32 can do this by comparing the current rate of waste water drainage as measured by the waste water measuring device 28 with the critical value thereof stored in memory. For example, if the predetermined value has been set equal to 80% of the average rate of waste water drainage, the critical value may be set equal to 50% of the average rate of waste water drainage.

[0059] If the rate of waste water drainage from the washing machine is not determined to be less than or equal to the critical value, the microcontroller 32 waits until the temperature of the waste water is determined to be greater than or equal to the predetermined temperature, which may, for example, be during a later cycle of normal operation of the washing machine 10. If the temperature of the waste water is determined 102 to be greater than or equal to the predetermined temperature or if the rate of waste water drainage from the washing machine is determined 103 to be less than or equal to the critical value, the microcontroller 32 checks 104 whether the unclogging agent sensor 36 can sense that unclogging agent is present in the unclogging compartment 22. If not, the microcontroller 32 instructs the first indicator 42 to alert 105 a user to insert unclogging agent into the unclogging compartment 22, waits until the door open/close detector 38 detects that the unclogging compartment 22 has been opened and closed, and then again checks 104 whether the unclogging agent sensor 36 can sense that unclogging agent is present in the unclogging compartment 22. If so, the microcontroller 32 instructs 106 the door lock 40 to lock the door of the unclogging compartment 22 and then instructs 107 the switching means 34 to switch the three-way valve 18 into the second state thereof, so that the waste water is diverted through the unclogging compartment 22, where it mixes with the unclogging agent, before passing to the drain filter 24.

[0060] The microcontroller 32 then waits a predetermined period of time to allow the unclogging agent to take effect on the drain filter 24. The predetermined period of time may, for example, be stored in memory, and may be determined by trial and error before manufacture of the washing machine 10, for example.

[0061] The microcontroller 32 then instructs 108 the switching means 34 to switch the three-way valve 18 back into the first state thereof, so that the waste water is rediverted to the drain filter 24 via the bypass channel 20 again, thereby bypassing the unclogging compartment 22. The microcontroller 32 also instructs 109 the door lock 40 to unlock the door of the unclogging compartment 22.

[0062] In order to check that the unclogging operation has been effective, the microcontroller 32 again determines 110 whether the rate of waste water drainage from the washing machine 10 is less than or equal to the predetermined value. The microcontroller 32 can do this, for example, by using the same procedure as described above in relation to the determination 101.

[0063] If the rate of waste water drainage from the washing machine is not determined to be less than or equal to the predetermined value, the microcontroller 32 instructs the first indicator 42 to alert 111 the user to insert unclogging agent into the unclogging compartment 22, so that the unclogging compartment 22 is ready for the next unclogging operation. The next time that waste water is directed to drain from the washing machine 10, the microcontroller 32 again determines 101 whether the rate of waste water drainage from the washing machine 10 is less than or equal to the predetermined value.

[0064] If, on the other hand, the determination 110 finds that the rate of waste water drainage from the washing machine is still less than or equal to the predetermined value, in spite of the unclogging operation which has just been carried out, this may indicate either that the unclogging operation has been ineffective or that there is some other problem with the washing machine, such as a malfunction of the drain pump 26, a blocked drain, and so on. In such a case, the microcontroller 32 therefore instructs the third indicator 44 to alert 112 the user that manual intervention is required to unclog the drain filter.

[0065] Both during normal operation of the washing machine 10 and during an unclogging operation of the drain filter 24 described above in relation to Fig. 4, the pre-filter monitor 46 monitors a condition of the pre-filter 16. If the pre-filter monitor 46 finds that the pre-filter 16 is in an adverse condition, indicating, for example, the presence of one or more larger items of debris in the pre-filter 16, the microcontroller 32 instructs the second indi-

cator 48 to indicate to a user that manual intervention is required to clean the pre-filter 16.

[0066] In summary, therefore, the present invention provides a washing machine, such as a machine for laundering clothes or a dishwasher, which comprises a washing chamber having an outlet for waste water. The outlet is in fluid communication with a drain and waste water is pumped from the washing chamber to the drain via a drain pump. The drain pump is protected from debris and sludge which may be present in the waste water by a drain filter. In order to unclog the drain filter, a path for waste water upstream from the drain filter to the outlet bifurcates into first and second routes. The first route comprises a bypass channel for waste water, which is used during normal operation of the washing machine. The second route is for use during an unclogging operation of the drain filter and comprises an unclogging chamber for containing an unclogging agent. During the unclogging operation, the waste water is diverted to pass through the unclogging chamber by a three-way valve, which has a first state, wherein waste water is directed along the first route, and a second state, wherein waste water is directed along the second route. The three-way valve is protected from being blocked or damaged by a pre-filter, which is coarser than the drain filter. The three-way valve is switched between the first and second states thereof according to whether the rate of waste water drainage from the washing machine is less than or equal to a predetermined value, and possibly also whether the temperature of the waste water is greater than or equal to a predetermined temperature. Further, the present invention also provides a corresponding method of unclogging a drain filter of a washing machine and a computer program product or a program code or system for executing such a method.

Reference Numerals :

[0067]

10	Washing machine
12	Washing chamber
14	Outlet for waste water
16	Pre-filter
18	Three-way valve
19	Non-return valve
20	Bypass channel
22	Unclogging compartment
24	Drain filter
26	Drain pump
28	Waste water measuring device
30	Temperature measuring device
32	Processing means
34	Means for switching three-way valve
36	Unclogging agent sensor
38	Door open/close detector
40	Door lock
42	First indicator
44	Third indicator
46	Pre-filter monitor
48	Second indicator
50	Control system
100	Method of unclogging a washing machine
101	Is rate of waste water drainage less than or equal to predetermined rate?
102	Is temperature of waste water greater than or equal to predetermined temperature?
103	Is rate of waste water drainage less than or equal to critical rate?
104	Is unclogging agent present in unclogging compartment?
105	Alert user to insert unclogging agent into unclogging compartment
106	Lock unclogging compartment
107	Switch three-way valve to divert waste water through unclogging compartment
108	Wait, then switch three-way valve to redivert waste water via bypass channel
109	Unlock unclogging compartment
110	Is rate of waste water drainage less than or equal to predetermined rate?
111	Alert user to insert unclogging agent into unclogging compartment
112	Alert user that manual intervention is required
162	Inlet of pre-filter
164	Outlet of pre-filter
182	Inlet of three-way valve
184	First outlet of three-way valve
186	Second outlet of three-way valve
202	Inlet of bypass channel
204	Outlet of bypass channel
222	Inlet of unclogging compartment
224	Outlet of unclogging compartment
242	Inlet of drain filter
244	Outlet of drain filter
262	Inlet of drain pump
264	Outlet of drain pump
282	Output of waste water measuring device
302	Output of temperature measuring device
322a	First input of processing means
322b	Second input of processing means
322c	Third input of processing means
322d	Fourth input of processing means
322e	Fifth input of processing means
362	Output of unclogging agent sensor
382	Output of door open/close detector
462	Output of pre-filter monitor

Claims

1. A washing machine (10) at least comprising:

a washing chamber (12) having an outlet (14) for waste water;
a pre-filter (16) having an inlet (162) in fluid com-

munication with the outlet (14) of the washing chamber (12) and an outlet (164);
a three-way valve (18) having an inlet (182) in fluid communication with the outlet (164) of the pre-filter (16) and first and second outlets (184, 186), the three-way valve (18) having a first state, wherein the inlet (182) of the three-way valve (18) is in fluid communication with the first outlet (184) thereof and is closed off from the second outlet (186) thereof, and a second state, wherein the inlet (182) of the three-way valve (18) is in fluid communication with the second outlet (186) thereof and is closed off from the first outlet (184) thereof;
a bypass channel (20) having an inlet (202) in fluid communication with the first outlet (184) of the three-way valve (18) and an outlet (204);
an unclogging compartment (22) for containing an unclogging agent and having an inlet (222) in fluid communication with the second outlet (186) of the three-way valve (18) and an outlet (224);
a drain filter (24) having an inlet (242) in fluid communication with both the outlet (204) of the bypass channel (20) and with the outlet (224) of the unclogging compartment (22), and having an outlet (244);
a drain pump (26) having an inlet (262) in fluid communication with the outlet (244) of the drain filter (24) and an outlet (264) configured to be connected to a drain;
a waste water measuring device (28) for measuring a rate of waste water drainage from the washing machine via the bypass channel (20) when the three-way valve (18) is in its first state, the waste water measuring device (28) having an output (282); and
a temperature measuring device (30) for measuring a temperature of the waste water and having an output (302);
processing means (32) having a first input (322a) connected to the output (282) of the waste water measuring device (28) and a second input (322b) connected to the output (302) of the temperature measuring device (30), for determining whether the rate of waste water drainage from the washing machine is less than or equal to a predetermined value and for determining whether the temperature of the waste water is greater than or equal to a predetermined temperature; and
switching means (34) under control of the processing means (32), for switching the three-way valve (18) between the first state thereof and the second state thereof;
wherein the processing means (32) is configured to instruct the switching means (34) to switch the three-way valve (18) from the first state thereof to the second state thereof if the processing means (32) determines that the rate of waste water drainage from the washing machine is less than or equal to the predetermined value.

2. A washing machine (10) according to claim 1, wherein the processing means (32) is configured to instruct the switching means (34) to switch the three-way valve (18) from the first state thereof to the second state thereof if the processing means (32) determines that the temperature of the waste water is greater than or equal to the predetermined temperature.

3. A washing machine (10) according to claim 1 or claim 2, further comprising:

a sensor (36) for sensing the presence of unclogging agent in the unclogging compartment (22), the sensor (36) having an output (362) connected to a third input (322c) of the processing means (32);
a first indicator (42) for indicating to a user of the washing machine to insert unclogging agent into the unclogging compartment (22) when the first indicator (42) is instructed to do so by the processing means (32); and
a detector (38) for detecting whether the unclogging compartment has been opened and/or closed, the detector (38) having an output (382) connected to a fourth input (322d) of the processing means (32);
wherein the processing means (32) is configured to instruct the first indicator (42) to indicate to the user to insert unclogging agent into the unclogging compartment (22) if the sensor (36) senses that unclogging agent is not present in the unclogging compartment (22) until the detector (38) detects that the unclogging compartment has been opened and/or closed and the sensor (36) senses that unclogging agent is present in the unclogging compartment (22).

4. A washing machine (10) according to any one of the preceding claims, wherein:

the unclogging compartment (22) comprises a door lock (40) for locking the unclogging compartment (22) during operation of the washing machine; and
the door lock (40) is under control of the processing means (32).

5. A washing machine (10) according to any one of the preceding claims, further comprising:

a pre-filter monitor (46) for monitoring a condi-

tion of the pre-filter (16), the pre-filter monitor (46) having an output (462) connected to a fifth input (322e) of the processing means (32); and a second indicator (48) for indicating to a user that manual intervention is required to clean the pre-filter (16) when the second indicator (48) is instructed to do so by the processing means (32);

wherein the processing means (32) is configured to instruct the second indicator (48) to indicate to the user to clean the pre-filter (16) if the pre-filter monitor (46) finds that the pre-filter (16) is in an adverse condition.

6. A washing machine (10) according to any one of the preceding claims, further comprising a third indicator (44) for indicating to a user that manual intervention is required to unclog the drain filter (24) when the third indicator (44) is instructed to do so by the processing means (32).

7. A washing machine (10) according to any one of the preceding claims, wherein the waste water measuring device (28) comprises means for measuring an amount of waste water remaining in the washing machine a predetermined period of time after waste water is directed to drain from the washing machine.

8. A washing machine (10) according to any one of the preceding claims, wherein the waste water measuring device (28) comprises a flow meter for measuring a rate of flow of waste water downstream of the outlet (14) of the washing chamber (12).

9. A washing machine (10) according to any one of the preceding claims, further comprising a non-return valve (19) located downstream of the three-way valve (18) and upstream of the drain filter (24), wherein the non-return valve (19) allows waste water to pass from the three-way valve (18) towards the drain filter (24), but not vice versa.

10. A method (100) of unclogging a drain filter of a washing machine, the method at least comprising:

when waste water is directed to drain from the washing machine, determining (101) whether a rate of waste water drainage from the washing machine is less than or equal to a predetermined value;

if not, repeating said determination (101) a next time that waste water is directed to drain from the washing machine;

whereas if so, determining (102) whether a temperature of the waste water is greater than or equal to a predetermined temperature;

if the temperature of the waste water is not determined (102) to be greater than or equal to the predetermined temperature, determining (103) whether the rate of waste water drainage from the washing machine is less than or equal to a critical value which is less than the predetermined value;

if the rate of waste water drainage from the washing machine is not determined (103) to be less than or equal to the critical value, waiting until the temperature of the waste water is determined (102) to be greater than or equal to the predetermined temperature;

if the temperature of the waste water is determined (102) to be greater than or equal to the predetermined temperature or if the rate of waste water drainage from the washing machine is determined (103) to be less than or equal to the critical value, diverting (107) the waste water through an unclogging compartment of the washing machine to the drain filter, wherein the unclogging compartment is for containing an unclogging agent;

waiting a predetermined period of time, then rediverting (108) the waste water to the drain filter whilst bypassing the unclogging compartment;

determining (110) whether the rate of waste water drainage from the washing machine is less than or equal to the predetermined value;

if not, alerting (111) the user to insert unclogging agent into the unclogging compartment and the next time that waste water is directed to drain from the washing machine, determining (101) whether the rate of waste water drainage from the washing machine is less than or equal to the predetermined value;

whereas if so, alerting (112) the user that manual intervention is required to unclog the drain filter.

11. A method (100) according to claim 10, wherein determining (101, 103, 110) whether the rate of waste water drainage from the washing machine is less than or equal to the predetermined value and/or the critical value comprises measuring an amount of waste water remaining in the washing machine a predetermined period of time after waste water is directed to drain from the washing machine.

12. A method (100) according to claim 10 or claim 11, further comprising:

before diverting (107) the waste water through the unclogging compartment, sensing (104) whether unclogging agent is present in the unclogging compartment;

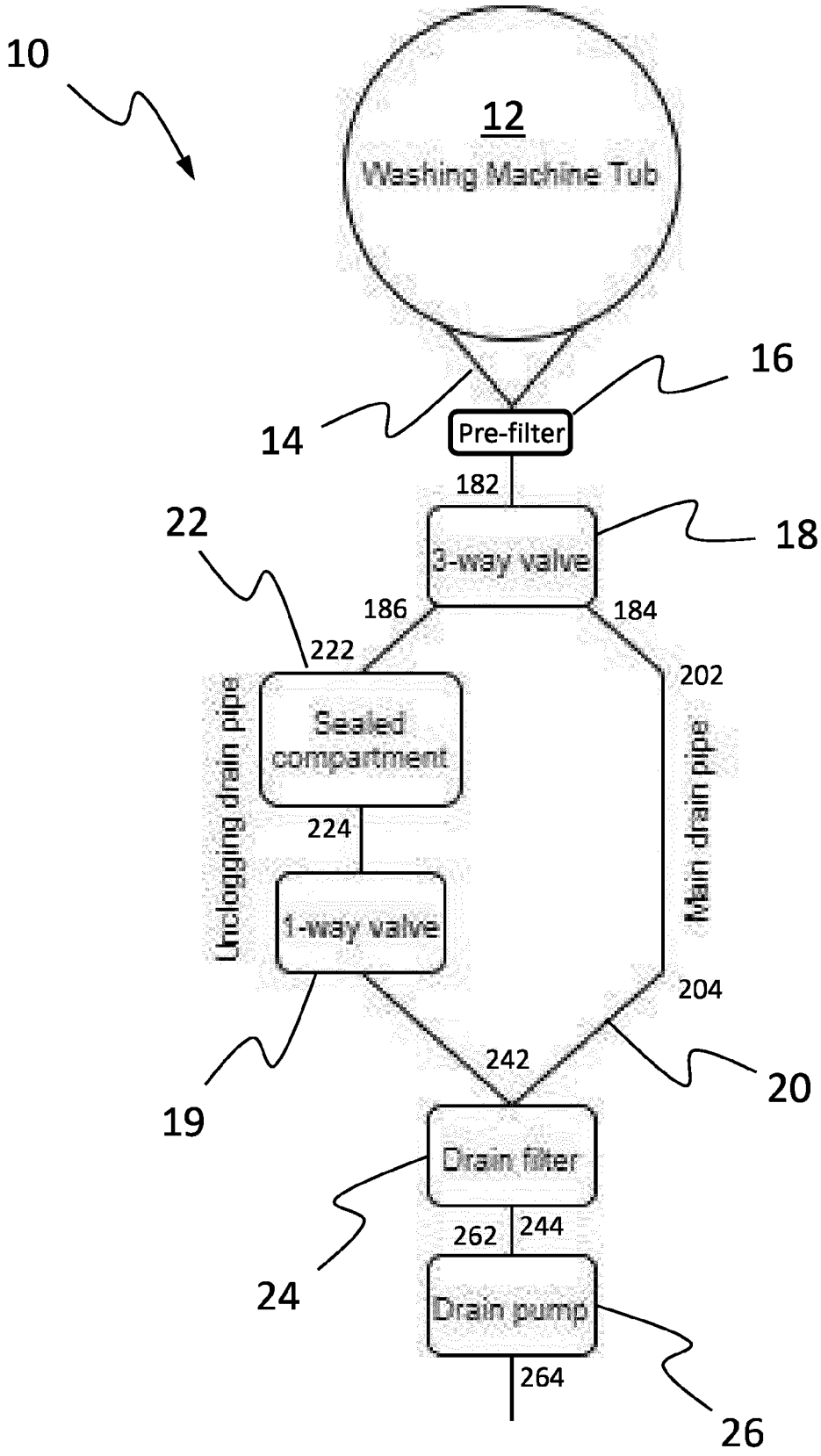
if not, alerting (105) a user to insert unclogging agent into the unclogging compartment, waiting until detecting that the unclogging compartment has been opened and closed, and then again sensing (104) whether unclogging agent is

present in the unclogging compartment;
whereas if so, diverting (107) the waste water through the unclogging compartment.

13. A method (100) according to any one of claims 10 to 12, further comprising locking (106) the unclogging compartment during operation of the washing machine.

14. A method (100) according to any one of claims 10 to 13, further comprising establishing the predetermined value of the rate of waste water drainage from the washing machine by comparing the rate of waste water drainage from the washing machine over a plurality of cycles of operation of the washing machine with each other.

15. A computer program product or a program code or system for executing one or more than one of the methods of claims 10 to 14.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14
16
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182
22
3-way valve
18
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Unclogging drain pipe
Main drain pipe
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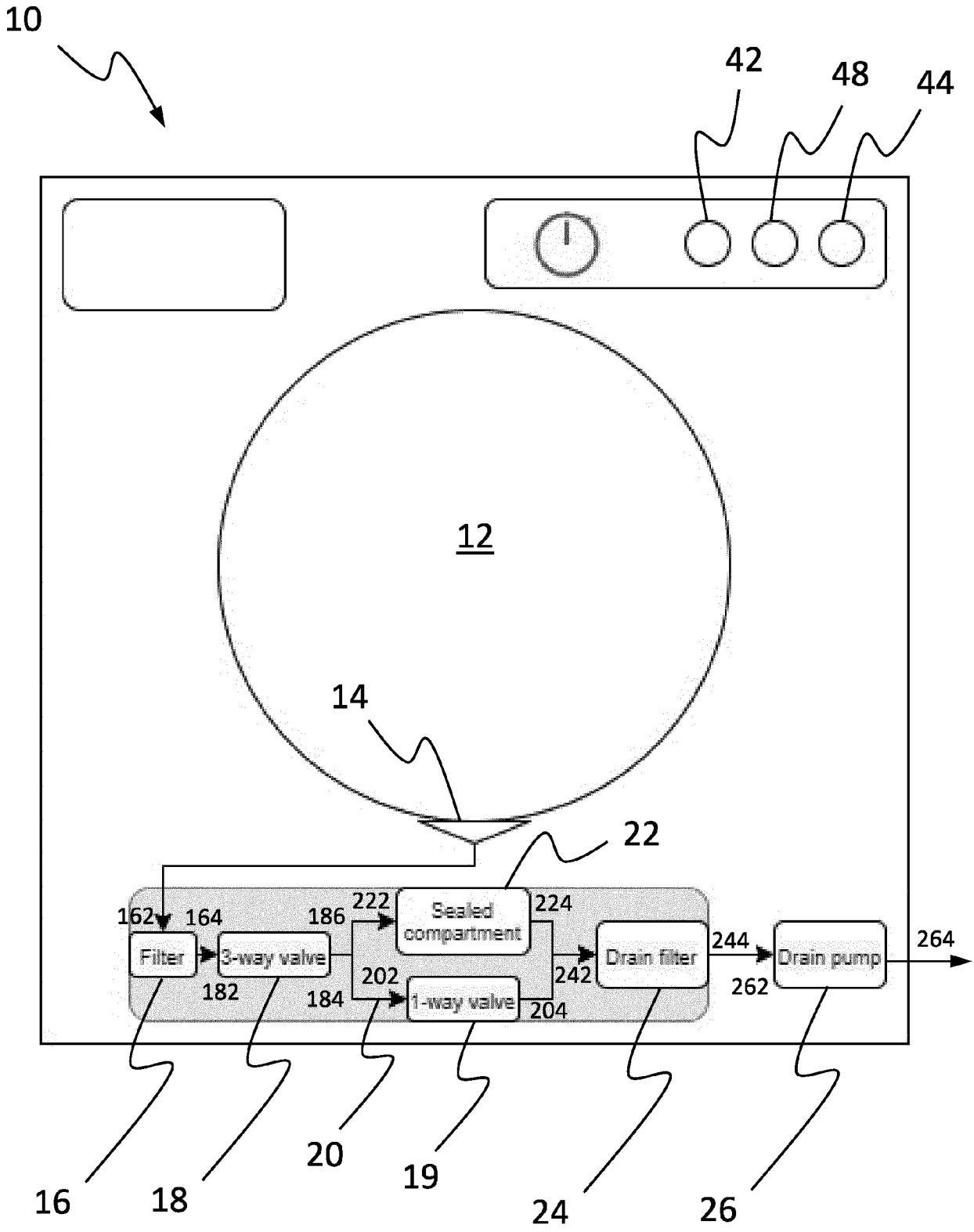
1-way valve
204
19
242
20
Drain filter
262
244
24
Drain pump
264
26

Fig. 1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Drain filter
244
Drain pump
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Fig. 2

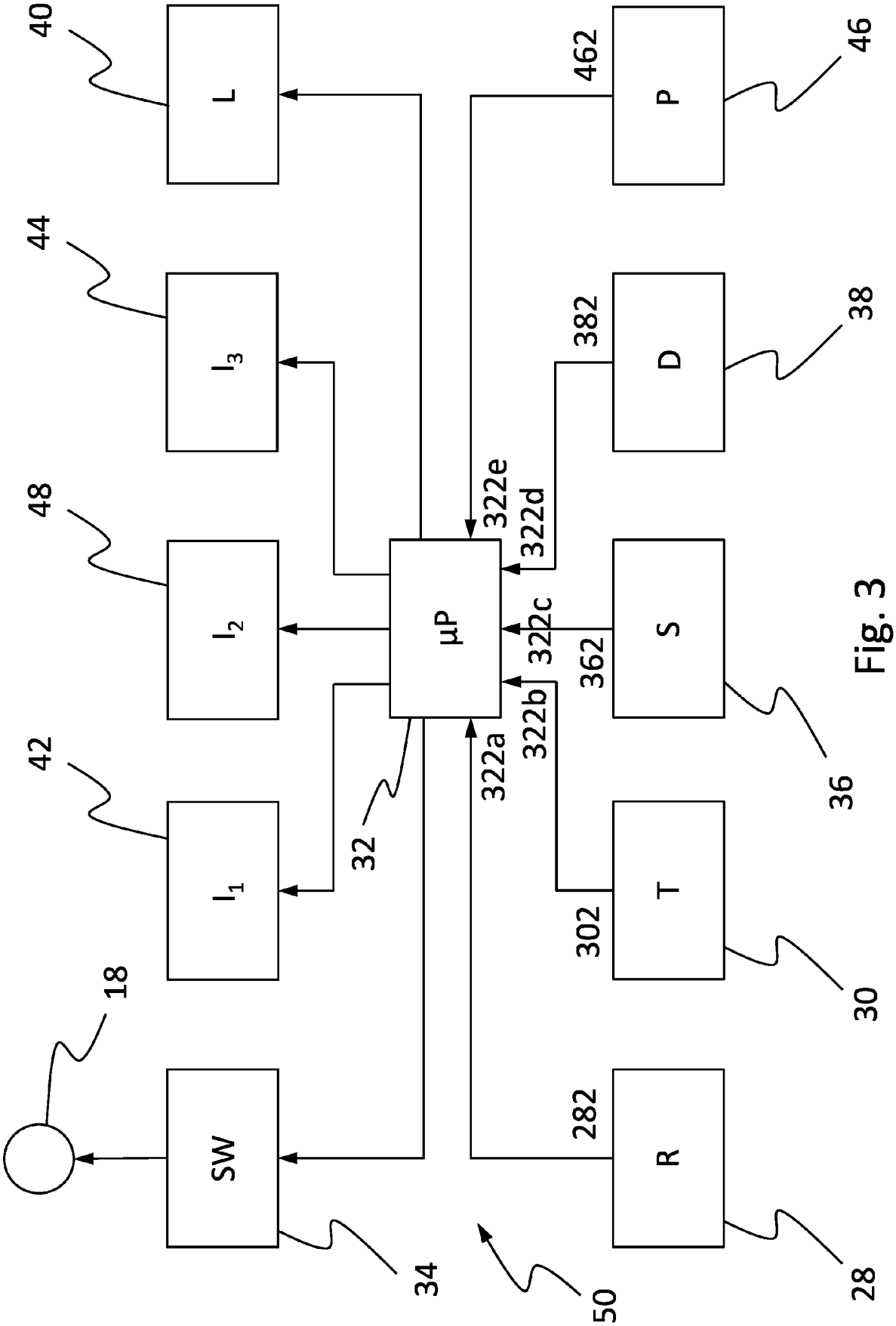
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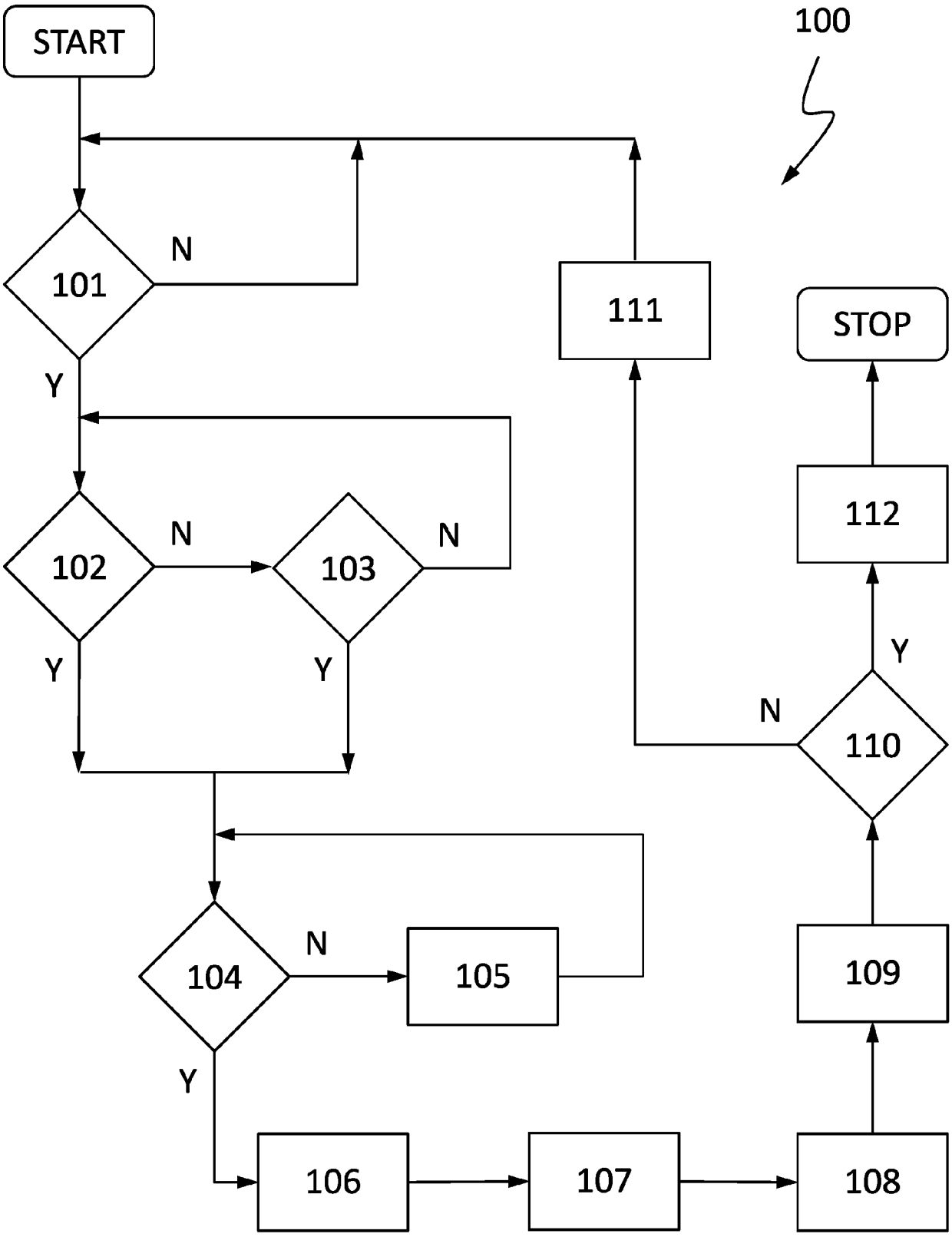
Fig. 3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101
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Y
111
STOP
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103
N
112
Y
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105
109
Y
106
107
108

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 20 21 4105

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D06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	15 April 2021	Popara, Velimir

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