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(54) A WASHING MACHINE WITH IMPROVED LONGTERM RELIABLITY AND SAFETY

(57) The invention relates to a heating unit (8) for a washing machine (1) comprising a casing (22), a pump (20) for pumping a washing liquid through the casing (22), a fuse (36), a thermally conductive element (30) for transferring heat to the washing liquid in the casing (22) and a temperature regulator (34) capable of supplying energy in the form of heat to the thermally conductive element (30), if a target temperature of the thermally conductive element (30) is below a first temperature limit. The fuse (36) and the temperature regulator (34) are arranged thermally conductive with the thermally conductive element (30), the fuse (36) being electrically connected to the temperature regulator (34) and configured to trigger and stop the energy supply to the temperature regulator (34), if a trigger temperature of the fuse (36) is reached by the thermally conductive element (30) The heating unit (8) comprises a electronic temperature sensing device (38) being electrically connected to the fuse (36) and the temperature regulator (34), said electronic temperature sensing device (38) being arranged thermally conductive with the thermally conductive element (30) and to detect and record the temperature of the thermally conductive element (30) over time in order to provide information about the operating condition of the washing machine.

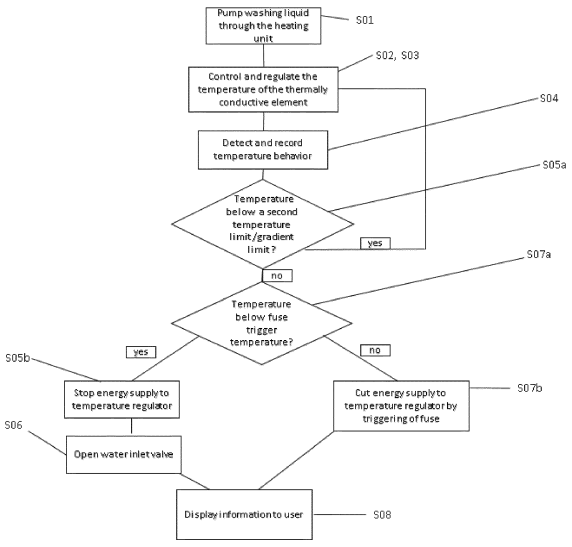

Fig. 5

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Description

Technical Field

[0001] The invention relates to the field of washing machines, in particular dishwashers and the improved safety and long-term reliability thereof. In particular the invention relates to improved protection surveillance of the washing machine over time and to an improved safety for the fuse in the heating unit. The washing machine according to invention allows to reduce service call rates and thus reduce costs for running the washing machine while at the same time the reliability is improved.

Background of the Invention

[0002] Dishwashers have been in use for many years operating under sometimes harsh conditions with high amounts of dirt and sometimes aggressive washing liquids. The washing liquids are usually a mixture of a detergent, water and remains of food/waste. The dishwashers generally comprise a cleaning container comprising one to several spraying arms, which rotate when the dishwasher is in use. Typically the water is supplied via an inlet valve, which is connected to a fresh water pipe, usually tap water, and an outlet valve for used washing liquid, which outlet valve is connected to a waste water pipe. The washing liquid is pumped with a pump through a washing liquid distribution system comprising several pipes and dividers that guide the washing liquid to the spraying arms for spraying the dishes in the container. After spraying the washing liquid is usually collected in a hole, which is typically funnel shaped, at the bottom of the container and from there it is pumped again into the washing liquid distribution system. In order to make sure that the washing liquid has the right temperature so that a maximum effect of the cleaning can be achieved, a thermostat is normally connected to a casing that houses the pump so that at least a part of the casing supplies the washing liquid in the pump with energy in the form of heat. Since the energy supplied to the thermostat and thus at least a part of the casing is quite substantial a safety mechanism is used. This known safety mechanism comprises a fuse arranged on the casing and configured to trigger when it reaches a trigger temperature. When the fuse triggers the energy supply to the thermostat is interrupted and stopped. The task of the fuse is it thus to avoid that the washing liquid starts to cook and that the dishwasher overheats, which may cause several electrical unsafe conditions and fire in the worst case.

[0003] Typically the entire unit with the thermostat and the pump needs to be replaced after the fuse triggered, which requires from the user to call in a technician and, which thus increases the service call rates of the washing machine and dishwasher, respectively.

[0004] In some cases the triggering of the fuse is wanted and should happen, for instance when the pump is malfunctioning or broken. The fuse might however trigger in other cases, for example when the dishwasher is very dirty, when filters are clogged, when raw eggs somehow made it into the machine, when there is excess limestone deposits in the dishwasher, when a rather big dish flipped over and blocked the travelling path of the washing liquid or when the wrong washing detergent is used such as hand-dishwashing detergent resulting in a high amount of foam. Today for any of the above incidents a technician has to be called and the unit has to be replaced since the thermostat and the fuse are usually fixedly connected to the casing of the pump. This is expensive for the user and increases service call rates, which service call rates many manufacturers of washing machines try to reduce.

[0005] DE 10 2013 217 276 A1 shows a dishwasher comprising a heating device, in particular a heating pump for the heating of washing liquid that passes through the pump. DE 10 2013 217 276 A1 object is to provide a dishwasher that can detect the danger of overheating before the dishwasher gets too hot. It is suggested to detect the overheating via two resistance thermometers arranged after one another in a direction of the flow of the washing liquid. The two resistance thermometers measure the temperature of the washing liquid on an outer side of a pipe, whereby on the inner side of the pipe, just on the other side of the two resistance thermometers, a limestone attracting area is arranged. By determining the temperature difference between the two resistance thermometers, it is possible to detect how much limestone is present on the limestone attracting area and if this is a problem or not, thus if the machine needs to be cleaned or not.

[0006] While the DE 10 2013 217 276 A1 can detect the deposition of limestone in the dishwasher, it cannot prevent a fuse from triggering in case the overheating is not related to limestone deposition. Thus any of the above mentioned malfunctions related to clogged filters, flipped dishes, eggs, wrong detergent, etc. will trigger the fuse in the DE 10 2013 217 276 A1.

[0007] The fuse and the thermostats typically use bimetal sensors for temperature regulation and also for triggering of the fuse. These sensors are thus not electronic nor digital and do not allow to monitor the temperature of a washing liquid over time.

Summary of the Invention

[0008] In view of the above the inventors of the present invention have discovered that there is a possibility to prevent the above mentioned malfunctions from triggering the fuse and thus from requiring a technician to replace the heating unit.

[0009] It is an object of the present invention to provide a washing machine, which has an improved reliability, which is easy in its maintenance and which allows to remedy problems related to the heating unit and pump prior to the need to replace either the heating unit and/or pump.

[0010] A further object of the present invention is to

provide a washing machine, which prevents a fuse from triggering due to overheating.

[0011] Another object of the present invention is to provide a method of operating a washing machine so that the risk of overheating triggering of a fuse is reduced.

[0012] The washing machine may in particular be a dishwasher.

[0013] The above objects are solved by heating unit for a washing machine, as claimed in claim 1 and by a method for controlling a heating unit according to claim 13.

[0014] Disclosed herein is a heating unit for a washing machine comprising a casing, a pump for pumping a washing liquid through the casing, a fuse, a thermally conductive element for transferring heat to the washing liquid in the casing and a temperature regulator capable of supplying energy in the form of heat to the thermally conductive element, if a target temperature of the thermally conductive element is below a first temperature limit. The fuse and the temperature regulator are arranged thermally conductive with the thermally conductive element, the fuse being electrically connected to the temperature regulator and configured to trigger and stop the energy supply to the temperature regulator, if a trigger temperature of the fuse is reached by the thermally conductive element. The heating unit further comprises an electronic temperature sensing device being arranged thermally conductive with the thermally conductive element and to detect and record the temperature of the thermally conductive element over time in order to provide information about the condition of the washing machine.

[0015] Disclosed herein is further a method of controlling a heating unit of a washing machine, comprising the steps of:

- pumping a washing liquid through the heating unit and thereby heating the washing liquid,
- controlling and regulating a temperature of a thermally conductive element with a temperature regulator so that the temperature of the thermally conductive element is not lower than a first given temperature limit,
- stopping the energy supply to the temperature regulator by triggering of a fuse electrically connected to the temperature regulator, if a trigger temperature of the fuse is reached by the thermally conductive element, and
- detecting and recording the temperature of the thermally conductive element via an electronic temperature sensing device over time in order to provide information about the operating condition of the washing machine.

[0016] The electronic temperature sensing device is thus configured to supply information regarding the physical and/or operating condition of the washing machine so that a user interface of the washing machine can inform the user that a cleaning program needs to be run. The information may also be used by a supplier of the washing machine, for example to directly send a machine cleaning package to the user upon receiving the information that the machine needs cleaning.

[0017] The electronic temperature sensing device may be a single electronic temperature sensing device.

[0018] Sensing the temperature of the thermally conductive element allows to extract the temperature of the washing liquid that flows through the heating unit. Thus the temperature of the washing liquid may be determined via measuring the temperature of the thermally conductive element, for example by calibration. A computer or processor and memory may determine the temperature of the washing liquid automatically by analysing the temperature of the thermally conductive element, for example by calibration and/or by correlating knwon data.

[0019] The temperature of the thermally conductive element may be sensed on a surface of the thermally conductive element. The surface may be an outer surface configured to not be in contact with the washing liquid or an inner surface configured to be in contact with the washing liquid.

[0020] A preferred embodiment of the above heating unit may comprise a single temperature sensing device for cost and simplicity reasons. It is however conceivable that the heating unit comprises a plurality of (single) temperature sensing devices.

[0021] The temperature sensing device is configured to sense an absolute temperature of the thermally conductive element.

[0022] The electronic temperature sensing device may be a digital electronic temperature sensor.

[0023] Although the electronic temperature sensing device may be electrically directly connected to the fuse and the temperature regulator the electrical communication may alternatively be directed via a controller, for example a processor of a user interface of the washing machine.

[0024] In an embodiment the electronic temperature sensing device may be electrically connected to the fuse and the temperature regulator, said temperature sensing device may be configured to stop the energy supply to the temperature regulator if the temperature of the thermally conductive element reaches a second temperature limit, whereby the second limit temperature is below the trigger temperature of the fuse.

[0025] This may help to protect the fuse from triggering and thus may give the user a chance to clean the machine and thus to restore the normal operating conditions of the washing machine. Further the inspection and reparation of a technician can be avoided, which saves the user time, effort and costs.

[0026] The stopping of the energy supply to the temperature regulator may be obtained directly between the electronic temperature sensing device or it may by communicated via a processor, for example via a user interface.

[0027] In an embodiment the electronic temperature sensing device may be configured to be electrically connected to a water inlet valve of the washing machine so that a water inlet valve can be opened, if the electronic temperature sensing device detects that a temperature gradient of the thermally conductive element is above a gradient limit, in order to avoid that the fuse triggers.

[0028] Sensing the temperature gradient in the thermally conductive element over time, may help to prevent an overcook effect. An overcook effect happens when something is cooked for example in a pan on a stove (not a gas stove) and then it boils and the user switches the heating plate off but the temperature in the pan continues to rise resulting in water and foam to run over the edge of the pan, despite the switched off (but still hot) heating plate.

[0029] Opening an inlet water valve may be done via a processor of a user interface or via direct electrical communication between the temperature sensing device and the water inlet valve.

[0030] In case the communication between the water inlet valve, temperature regulator and/or fuse and the electronic temperature sensing device is done directly, the processor may be integrated in the electronic temperature sensing device.

[0031] The effect of the above suggested opening of the water inlet valve may be that the washing liquid and thus the thermally conductive element is cooled down quickly to avoid triggering of the fuse due to overcooking after stopping the energy supply.

[0032] In a further embodiment the electronic temperature sensing device may be configured to send the information about the operating condition of the washing machine to a storage medium for extraction and/or analysis.

[0033] The water inlet valve may also be opened independent of the detected temperature gradient to cool down the heating unit, the thermally conductive element and thus the fuse.

[0034] Based on the recorded data various steps may be taken, for example by a supplier of cleaning goods for the washing machine. The information may even be used to improve the development of future washing machines.

[0035] The temperature sensing device may be positioned at a range of 0-30 mm, preferably 0-25 mm, more preferably 0-20 mm, more preferably 0-15 mm, even more preferably 0-10 mm and even more preferably 0-5 mm from the fuse.

The temperature sensing device may be positioned at the fuse.

[0036] The above minimizes the difference between the temperature at the fuse and the temperature sensing device and thus enhances reliability.

[0037] In an embodiment the temperature sensing device may be configured to measure the temperature of the washing liquid via the fuse.

[0038] Sensing the temperature directly at the fuse may provide a very accurate temperature of the fuse.

[0039] Alternatively the temperature sensing device may be configured to measure the temperature of the washing liquid via the thermally conductive element.

[0040] Sensing the temperature at the thermally conductive element may deliver accurate information of the temperature of the washing liquid over time.

[0041] The thermally conductive element may be a cover of casing, which casing is configured to receive at least a part of the pump of the washing machine.

[0042] In a preferred embodiment the second temperature limit may be about 2°C to 15°C, preferably 4°C to 12°C, more preferably 5°C to 10°C, more preferably 6°C to 10°C and even more preferably 7°C to 9°C lower than the trigger temperature of the fuse.

[0043] The above temperature difference between the trigger temperature of the fuse and the second temperature limit may ensure that the fuse is not triggering prior to the thermally conductive element reaching the second temperature limit.

[0044] The heating unit may be optimized to be used in a dishwashing machine.

[0045] Disclosed herein is further a dishwashing machine comprising a heating unit according to any of the above described embodiments.

[0046] The method according to the previous described embodiment may further comprise the steps of

- measuring a temperature gradient of the thermally conductive element by the electronic temperature sensing device,
- detecting if the temperature gradient of the thermally conductive element is above a gradient limit, and
- opening a water inlet valve by sending a signal from the electronic temperature sensing device to the water inlet valve, if the temperature sensing device detects that the temperature increase is above the gradient limit in order to avoid that the fuse triggers.

[0047] As previously mentioned this will prevent the fuse from triggering due to an overcooking effect, where the temperature of the thermally conductive element is still increasing even after stopping the energy supply to the temperature regulator.

Brief Description of the Drawings

[0048] The present invention will now be described, for exemplary purposes, in more detail by way of an embodiment and with reference to the enclosed drawings, in which:

Fig. 1 schematically illustrates a perspective front side view of a dishwasher;

Fig. 2 schematically illustrates a cross sectional view of the dishwasher through dashed line II of figure 1;

Fig. 3a illustrates a top down view onto an embodiment of a heating unit according to the inven-

tion;

Fig. 3b illustrates a top down view onto another embodiment of a heating unit according to the invention;

Fig. 4 illustrates a front side view of the embodiment of a heating unit according to figure 3b; and

Fig. 5 illustrates a method of controlling a heating unit according to the invention.

Detailed Description

[0049] The invention is herewith explained and partially illustrated by example of a dishwasher 1 as shown in figures 1 and 2, other washing machines such as for example laundry machines may however also fall within the scope of the invention.

[0050] Figures 1 illustrates a perspective view of the dishwasher 1, with a container 6, a door 16 for opening when dishes need to be placed in the dishwasher 1 or when they need to be removed from it. The dishwasher 1 comprises two drawers 18', 18" and upper drawer 18' and a lower drawer 18". The drawers 18', 18" are used to place and remove the dishes conveniently and to hold the dishes in place during the washing. The dishwasher further comprises a washing liquid distribution arrangement 4 comprising a spraying arrangement 14 with at least two rotating spray arms 14a, 14b, a rotating upper spray arm 14a and a rotating lower spray arm 14b. The washing liquid is collected after it has been sprayed onto the dishes in a funnel shaped sinkhole 13 arranged at the bottom of the container 6 so that it can be heated again in the heating unit 8 (c.f. figures 3a to 4) for another spraying round. The washing liquid distribution arrangement 4 is further illustrated in figure 2. The door 16 comprises a container 9 for receiving washing detergent and a cover 11 for closing the container 9. The cover 11 is configured to open once the dishwasher 1 finished the rinsing of the dishes and the detergent is needed for further cleaning.

[0051] The dishwasher 1 shown in figure 1 may further comprises a user interface 10 comprising a display 24 and several buttons 26. The user interface 10 may be configured to show the user the status of the machine, the washing program chosen and if cleaning of the machine is needed or not. The user interface 10 may further comprise a communication interface for communication with a network or it may comprise a storage medium (not shown) for the storage of information in the form of data. The user interface 10 may further comprise a controller or a processor.

[0052] Turning now to figure 2, which illustrates a cross sectional view of the dishwasher 1 according to figure 1 in use and thus with the door 16 closed, whereby the cross section is cut along dashed line II of figure 1. The container 6 or closed space is shown from the side with lower and upper drawers 18", 18' illustrated. The lower and upper rotating spraying arms 14b, 14a are also illustrated. The example of figure 2 shows two rotating spray arms 14a, 14b it is however possible to have more than two rotating spray arms or only one single rotating spray arm. The same is other than that possible with the upper and lower drawers, it is possible to have more than two drawers or only one single drawer in the dishwasher 1. In particular a special drawer for the cutlery may be installed. The upper and lower spray arms 14a, 14b are part of a washing liquid distribution system 4. The water distribution system 4 comprises a divider 12, for example a three-way valve, in order to supply the upper and lower spray arms 14a, 14b with washing liquid, several pipes 15 for guiding the washing liquid and the funnel shaped sinkhole 13. In order to limit the amount of dirt that enters the washing liquid distribution system, a sieve 42 is arranged on top of the funnel shaped sinkhole 13. The sinkhole 13 collects the washing liquid that is present in the container 6, which is illustrated by the washing liquid level illustrated with reference number 19 in figure 2.

[0053] Fresh water or tap water is supplied to the dishwasher via an inlet 2 comprising a water inlet valve 40. The water inlet valve 40 is electrically connected to a controller or processor (not shown) of the dishwasher 1 so that the water inlet valve 40 can be opened and closed when the controller or processor gives a corresponding signal. The controller or processor may for example be integrated behind a user interface 10 or behind the buttons 26 or display. The controller or processor may however by positioned at any suitable position in the dishwasher 1, as long as it is connected to the buttons 26, the display 24 and a heating unit 8. The waste water and thus the used washing liquid is disposed via a waste water outlet 3 comprising a one-way valve 41. The one way valve 41 ensures that the waste water cannot enter the dishwasher again once it is disposed.

[0054] Still referring to figure 2, the heating unit 8 is integrated in the washing liquid distribution arrangement 4. The heating unit 8 may be positioned at any suitable position in the washing liquid distribution arrangement 4 and is shown in figure 2 to be positioned more or less directly after the sinkhole 13.

[0055] Referring now to figures 3a to 4, the heating unit 8 will be explained in more detail.

[0056] Figure 3a illustrates a top down view onto the heating unit 8 according to the present invention. The heating unit 8 comprises a casing 22 for receiving a pump 20, illustrated in figure 4. Referring to figure 3a, the casing 22 comprises a thermally conductive element 30, which is illustrated as a cover of the casing 22. The thermally conductive element 30 is made of a thermally conductive material such as for example a metal. Although the thermally conductive element 30 is shown as a cover of the casing 22, it does not necessarily need to be the cover of the casing 22. It is conceivable to provide a thermally conductive element (not shown) that is any other part of the casing 22 or a separate part protruding into the casing 22 for being in contact with the washing liquid and thus for heating the washing liquid in the casing 22.

[0057] The thermally conductive element 30 compris-

es a temperature regulator 34, a fuse 36 and an electronic temperature sensing device 38. The electronic temperature sensing device 38 is preferably capable of recording data over time. In the embodiment shown, the temperature sensing device 38 is positioned on the thermally conductive element 30 on an outer side thereof, whereby said outer side is not in contact with the washing liquid. It is however also possible to position the temperature sensing device 38 on an inner side of the thermally conductive element 30 and the casing 22, respectively. The temperature regulator 34 comprises a thermostat and it is configured to supply energy in the form of heat to the thermally conductive element 30 in order to heat the washing liquid that is pumped through the casing 22, if the temperature of the washing liquid and the thermally conductive element 30, respectively, is below a first temperature limit. The temperature regulator senses the temperature of the thermally conductive element 30 and therefore indirectly the temperature of the washing liquid via the thermally conductive element 30. The fuse 36 is configured to trigger when the thermally conductive element 30 and thus when the fuse 36 reaches a temperature that is above a trigger temperature of the fuse 36. The first temperature limit is below the trigger temperature of the fuse 36, preferably 5°C - 20°C below, more preferably 8°C - 17°C below and even more preferably 10°C - 15°C below. When the fuse 36 triggers, the energy supply to the temperature regulator 34 is cut off as a safety measure, for example when there is too much air in the system and/or the washing liquid starts to cook. The cutting of the energy supply may be done directly as a communication between the fuse 36 and the temperature sensing device 34 by guiding the electric power supply via the fuse 36 to the temperature regulator 34, which electric power supply will be cut once the fuse 36 triggers, for example by dividing a conductor thus by creating a physical interruption, or it may be done digitally via the controller or processor of the dishwasher 1.

[0058] The electronic temperature sensing device 38, the temperature regulator 34 and the fuse 36 are electrically interconnected and they are also connected to a controller or processor of the dishwasher for controlling purposes. The electrical connection to a controller or processor of the dishwasher 1 may for example be done via electrical terminals 32, as illustrated in figures 3a and 3b. The electronic temperature sensing device 38 detects and records the temperature of the thermally conductive element 30 over time during washing cycles and stores this recorded data via the controller or processor on a memory medium. A technician can extract this data from the memory medium or alternatively the memory medium sends the data directly to a server via a communication module and the world wide web. The data may then be analysed and it is determined what type of measures should be taken.

[0059] The fuse 36 and the temperature regulator 34 are connected to the thermally conductive element 30 via a metal plate 44 (c.f. figure 4), preferably an aluminium plate.

[0060] Besides the function of recording temperature data of the thermally conductive element 30 and the washing liquid, respectively, via the thermally conductive element 30, the temperature sensing device 38 also has the task to protect the fuse 36 from triggering for unnecessary reasons, thus when the dishwasher 1 is too dirty and needs cleaning or when other "easy-to-fix" problems, such as a flipped container that interrupts washing liquid flow in the dishwasher 1, occur. The electronic temperature sensing device 38 is configured to stop the energy supply to the temperature regulator 34 in case it detects that a second temperature limit is reached, which second temperature limit is lower than a trigger temperature of the fuse 36 but higher than the first temperature limit. The triggering of the fuse 36 may thus be prevented by the electronic temperature sensing device 38. This may be done via communication between the controller/processor of the dishwasher 1 and the electronic temperature sensing device 38, which sends a signal to the controller upon detecting that the second temperature limit has been reached, whereby the controller then stops the energy supply to the temperature regulator 34 in order to protect and prevent the fuse 36 from triggering. The stopping of the energy supply to the temperature regulator 34 may also be done directly between the electronic temperature sensing device 38 and the temperature regulator 34, this may however require to position a further controller or microprocessor somewhere in between the electronic temperature sensing device 38 and the temperature regulator 34.

[0061] In an embodiment the electronic temperature sensing device 38 may also be configured to sense the temperature gradient of the thermally conductive element 30 and to detect if this temperature gradient is below or above a gradient limit. In case the temperature gradient of the thermally conductive element 30 is above a gradient limit the electronic temperature sensing device 38 may also cut off the energy supply by sending a corresponding signal to the controller in order to protect the fuse 36. This may prevent the fuse 36 from triggering since heat may be supplied even after switching off the energy supply to the temperature regulator 34. As an emergency measure to cool down the fuse 36 the controller may even open the water inlet valve 40 (figure 2) to cool down the heating unit 8 and thus the fuse 36 upon receiving a corresponding signal from the electronic sensing device 38. The water or tap water coming into the dishwasher 1 from the inlet 2 is typically cold and thus below 20°C and allows to cool down the heating unit 8 rather quickly.

[0062] Upon receiving a signal that the second temperature limit has been reached by the thermally conductive element 30 from the electronic temperature sensing device 38, the controller may display information on the display 24 to the user that the dishwasher 1 should be cleaned by using a cleaning program and/or cleaning detergent.

[0063] The electronic temperature sensing device 38 may measure the temperature of the washing liquid or the thermally conductive element 30 via the fuse 36, it may thus measure the temperature of the fuse 36. Alternatively the electronic temperature sensing device 38 may measure the temperature of the washing liquid via the thermally conductive element 30 and thus measure the temperature of thermally conductive element 30. The advantage would be that the electronic temperature sensing device 38 is not exposed to the washing liquid. A computer may be used to calculate the temperature of the washing liquid by analysing and using the temperature of the thermally conductive element 30. A calibration may be used to initiate such a calculation. It is advantageous to position the electronic temperature sensing device 38 as close to the fuse 36 as possible. Figure 3a illustrates that the electronic temperature sensing device 38 is positioned at a small distance from the fuse 36, whereby small means about 0 - 10 mm, preferably 0-5 mm. Figure 3b on the other illustrates that the electronic temperature sensing device 38 may be positioned directly at the fuse 36 or next to the fuse 36.

[0064] In an embodiment (not shown) the electronic temperature sensing device 38 may be integrated in the fuse 36 but still be configured to measure the temperature of the thermally conductive element 30.

[0065] Figures 3a and 3b further illustrate grounding contacts 46 a pump inlet 48 and a pump outlet 50. The washing liquid enters the casing 22 via the pump inlet 48 and exits the casing 22 via the pump outlet 50. During the actual pumping the washing liquid is heated up by the thermally conductive element 30.

[0066] The thermally conductive element 30 is connected to the lower part of the casing 22 via a fastening mechanism 52 comprising a plurality of latch and lock hooks 54, which engage a flange of the lower part of the casing 22. Other forms of fastening mechanisms 52 may however be used such as screwing or other form-fit solutions. The lower part of the casing 22 may be made of a polymer or similar any other suitable material may however be used.

[0067] Figure 4 illustrates a side view of the heating unit 8 with a pump 20 comprising a pump motor 20b, a pump rotor 20a, which is illustrated with dotted lines as it is theoretically not visible through the casing 22. The pump motor 20b is configured to be connected to the casing 22 and the pump rotor 20a, whereby a pivot 20c, rotatably connected to the pump motor 20b, is configured to engage the pump rotor 20a. In figure 4 the grounding contacts 46 are omitted.

[0068] As can be seen the fuse 36, the temperature regulator 34 and the electronic temperature sensing device 38 are arranged on the metal plate 44. They may be glued, soldered welded or screwed onto the metal plate 44. A clip on mechanism for connecting the temperature regulator 34, the fuse 36 and the electronic temperature sensing device 38 to the plate 44 may also be used. It is of course possible to fasten each of the temperature regulator 34, the fuse 36 and the electronic temperature sensing device 38 in a different manner to the metal plate 44.

[0069] In figure 4, the pump inlet 48 and the pump outlet 50 are also visible.

[0070] Turning now to figure 5, which illustrates method of controlling a heating unit of a washing machine in particular a dishwasher 1, the method comprises the steps of:

- pumping S01 a washing liquid through the heating unit 8 and thereby heating the washing liquid,
- controlling S02 and regulating S03 a temperature of a thermally conductive element 30 with the temperature regulator 34 so that a temperature of the thermally conductive element 30 is not lower than a first given temperature limit,
- detecting and recording S04 the temperature of the thermally conductive element 30 by an electronic temperature sensing device 38 over time in order to provide information about the operating condition of the washing machine, and
- cutting S07b the energy supply to the temperature regulator 34 by triggering of a fuse 36 electrically connected to the temperature regulator 34, if the electronic temperature sensing device 38 detects S07a that a trigger temperature of the fuse 36 is reached by the thermally conductive element 30.

[0071] The method may further comprise the step of stopping S05b the energy supply to the temperature regulator 34 whereby the electronic temperature sensing device 38 sends a signal to the temperature regulator 34, if the electronic temperature sensing device 38 detects S05a that a temperature of the thermally conductive element 30 reached a second temperature limit, whereby the second temperature limit is below the trigger temperature of the fuse 36 but above the first temperature limit.

[0072] The method may further comprise the steps of

- measuring S04 the temperature gradient of the thermally conductive element 30 by the electronic temperature sensing device 38,
- detecting S05a if the temperature gradient is above a gradient limit, and
- opening S06 a water inlet valve 40 by sending a signal from the electronic temperature sensing device 38 to the water inlet valve 40, if the electronic temperature sensing device 38 detects that the temperature increase is above the gradient limit in order to avoid that the fuse 36 triggers.

[0073] The water inlet valve 40 may also be opened if it is detected that the temperature of the thermally conductive element 30 is above a second temperature limit. Thus even if it is detected that the gradient of the temperature of the washing liquid is below a gradient limit, the water inlet valve 40 may be opened by sending a

signal from the electronic temperature sensing device 38.

[0074] The difference between cutting S07b the energy supply and stopping the energy supply is that the cutting is preferably a physical interruption of the electric power said cutting being created by the triggered fuse 36, while stopping S05b may be an electronic interruption of the electric power. The electronic interruption may be resolved upon cleaning of the dishwasher 1, while the physical interruption may only be resolved by a technician, who replaces the heating unit 8. Corresponding information may be displayed S08 via a display 24 to the user.

[0075] The method may further include the sending of information about the operating condition of the washing machine to a storage medium for extraction and analysis.

[0076] As previously mentioned, the above described heating unit 8 and method may be implemented in any suitable washing machine such as for example also a laundry machine.

[0077] As previously mentioned, the heating unit 8 may comprise only one single temperature sensing device 38. It is however possible to install a plurality of temperature sensing devices (not shown) on the heating unit in order to provide redundancy.

[0078] The positioning of the electronic temperature sensing device 38 may be changed to anywhere on the casing 22 as long as it can safely detect the temperature of the washing liquid in the casing 22 and/or the thermally conductive element 30 and as long as it is electronically connected to the temperature regulator 34, the fuse 36 and a controller or processor of the washing machine.

Claims

1. A heating unit (8) for a washing machine (1) comprising a casing (22), a pump (20) for pumping a washing liquid through the casing (22), a fuse (36), a thermally conductive element (30) for transferring heat to the washing liquid in the casing (22) and a temperature regulator (34) capable of supplying energy in the form of heat to the thermally conductive element (30), if a target temperature of the thermally conductive element (30) is below a first temperature limit, wherein the fuse (36) and the temperature regulator (34) are arranged thermally conductive with the thermally conductive element (30), the fuse (36) being electrically connected to the temperature regulator (34) and configured to trigger and stop the energy supply to the temperature regulator (34), if a trigger temperature of the fuse (36) is reached by the thermally conductive element (30),
characterized in that the heating unit (8) comprises an electronic temperature sensing device (38) being arranged thermally conductive with the thermally conductive element (30) to detect and record the temperature of the thermally conductive element (30) over time in order to provide information about the operating condition of the washing machine.

2. The heating unit according to claim 1, wherein the electronic temperature sensing device (38) is electrically connected to the fuse (36) and the temperature regulator (34), said electronic temperature sensing device (38) being configured to stop the energy supply to the temperature regulator (34), if the temperature of the thermally conductive element (30) reaches a second temperature limit, whereby the second limit temperature is below the trigger temperature of the fuse (36).

3. The heating unit according to claim 1 or 2, wherein the electronic temperature sensing device (38) is configured to be electrically connected to a water inlet valve (40) of the washing machine (1) so that a water inlet valve (40) can be opened, if the electronic temperature sensing device (38) detects that the temperature gradient of the thermally conductive element (30) is above a gradient limit, in order to avoid that the fuse (36) triggers.

4. The heating unit according to any of the previous claims, wherein the electronic temperature sensing device (38) is configured to send the information about the operating condition of the washing machine to a storage medium for analysis.

5. The heating unit according to any of the previous claims, wherein the temperature sensing device (38) is positioned at a range of 0-30 mm, preferably 0-20 mm, more preferably 0-10 mm, from the fuse (36).

6. The heating unit according to any of the previous claims, wherein the temperature sensing device (38) is positioned at the fuse (36).

7. The heating unit according to any of the previous claims, wherein the temperature sensing device (38) is configured to measure the temperature of the washing liquid via the fuse (36) and the thermally conductive element (30).

8. The heating unit according to any of claims 1 to 6, wherein the temperature sensing device (38) is configured to measure the temperature of the washing liquid via the thermally conductive element (30).

9. The heating unit according to any of the previous claims, wherein the thermally conductive element (30) is a cover of the casing (22).

10. The heating unit according to any of the previous claims 2 to 9, wherein the second temperature limit is about 2°C to 15°C, preferably 4°C to 12°C, more preferably 6°C to 10°C lower than the trigger temperature of the fuse (36).

11. The heating unit according to any of the previous claims, wherein the heating unit is configured to be used in a dishwashing machine.

12. A dishwashing machine comprising a heating unit according to any of claims 1 to 11.

13. A method of controlling a heating unit of a washing machine, comprising the steps of:

- Pumping (S01) a washing liquid through the heating unit and thereby heating the washing liquid,
- controlling and regulating (S02, S03) a temperature of a thermally conductive element (30) with a temperature regulator (34) so that the temperature of the washing liquid is not lower than a first given temperature limit,
- cutting (S07b) the energy supply to the temperature regulator (34) by triggering of a fuse (36) electrically connected to the temperature regulator (34), if a trigger temperature of the fuse (36) is reached (S07b) by the thermally conductive element (30),

characterized by

- detecting and recording (S04) the temperature of the thermally conductive element (30) via an electronic temperature sensing device (38) over time in order to provide information about the operating condition of the washing machine.

14. The method according to claim 13, comprising the step of:

- stopping (S05b) the energy supply to the temperature regulator (34) whereby the electronic temperature sensing device (38) sends a signal to the temperature regulator (34), if the electronic temperature sensing device (38) detects (S05a) that a temperature of the thermally conductive element reached a second temperature limit, whereby the second temperature limit is below the trigger temperature of the fuse (36).

15. The method according to claims 13 or 14, comprising the steps of:

- Measuring (S04) a temperature gradient of the thermally conductive element (30) by the electronic temperature sensing device (38),
- Detecting (S05a) if the temperature gradient of the thermally conductive element (30) is above a gradient limit, and
- Opening (S06) a water inlet valve (40) by sending a signal from the electronic temperature sensing device (38) to the water inlet valve (40), if the electronic temperature sensing device (38) detects that the temperature increase is above the gradient limit in order to avoid that the fuse (36) triggers.

16. The method according to any of claims 13 to 15, wherein the washing machine is a dishwashing machine.

17. The method according to any of claims 13 to 16, comprising the step of:

- sending the information about the operating condition of the washing machine to a storage medium for analysis.

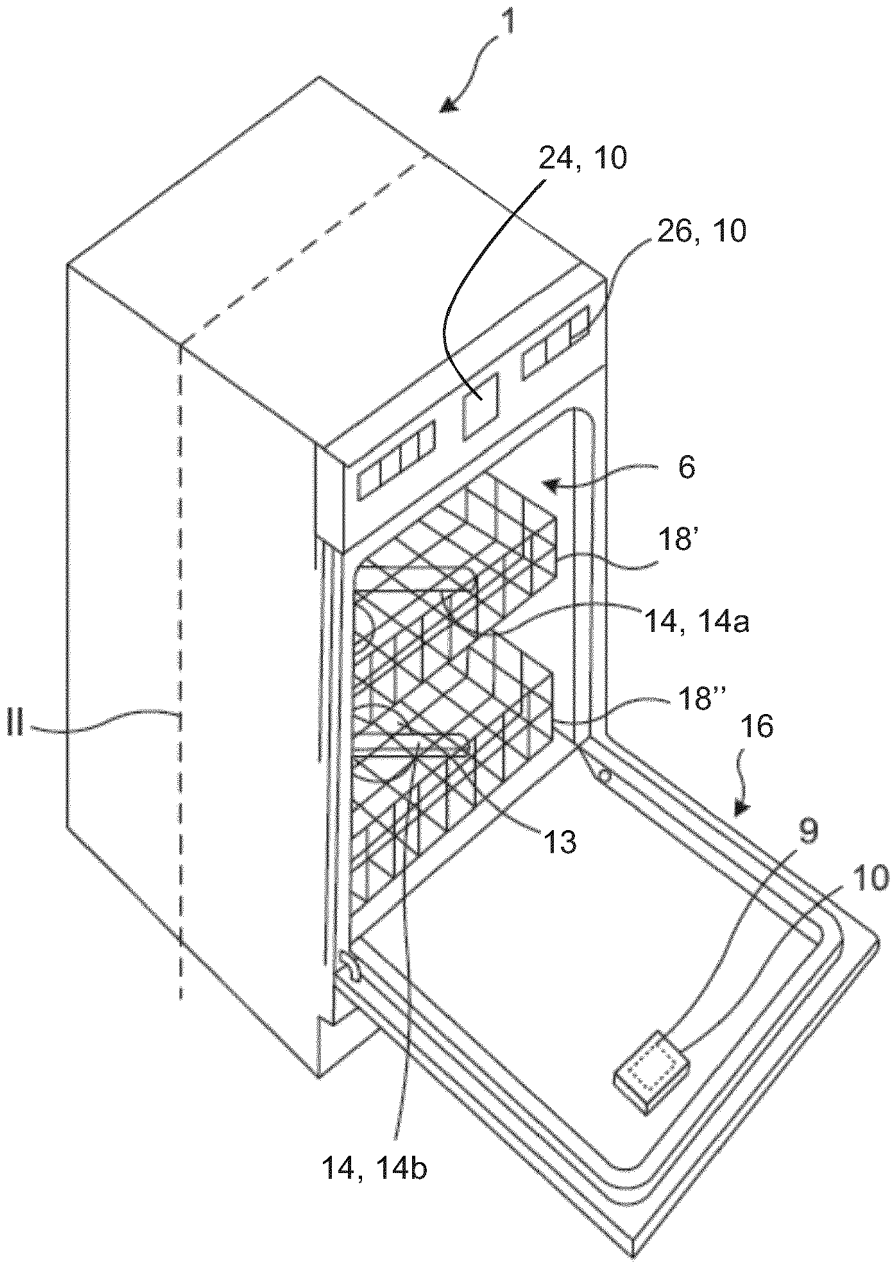


Fig. 1

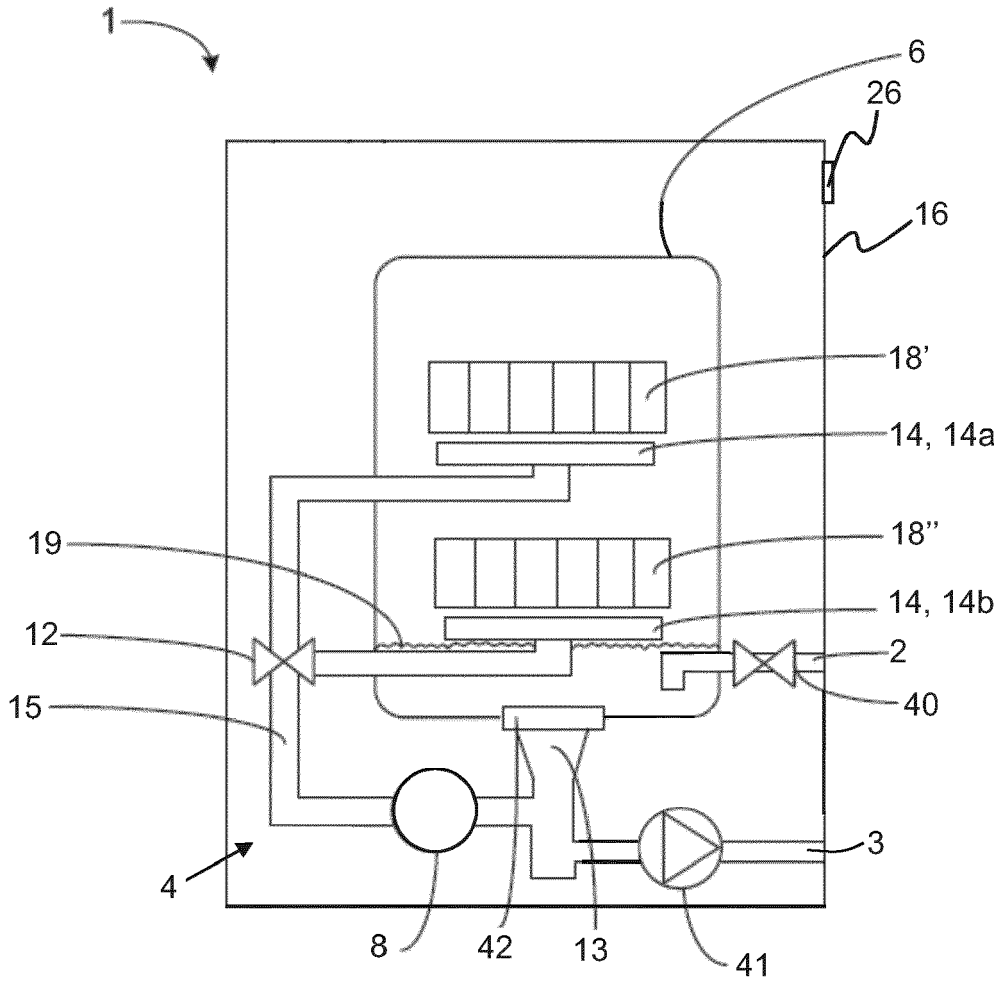

1
6
26
16
18'
14, 14a
19
18''
14, 14b
12
2
40
15
3
4
8
42
13
41

Fig. 2

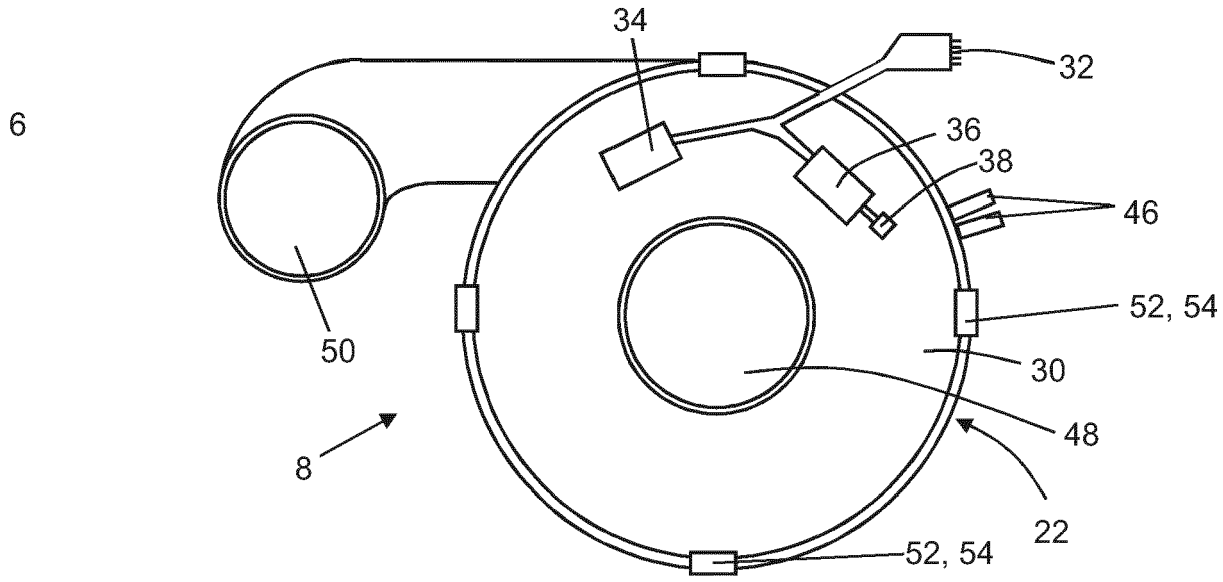
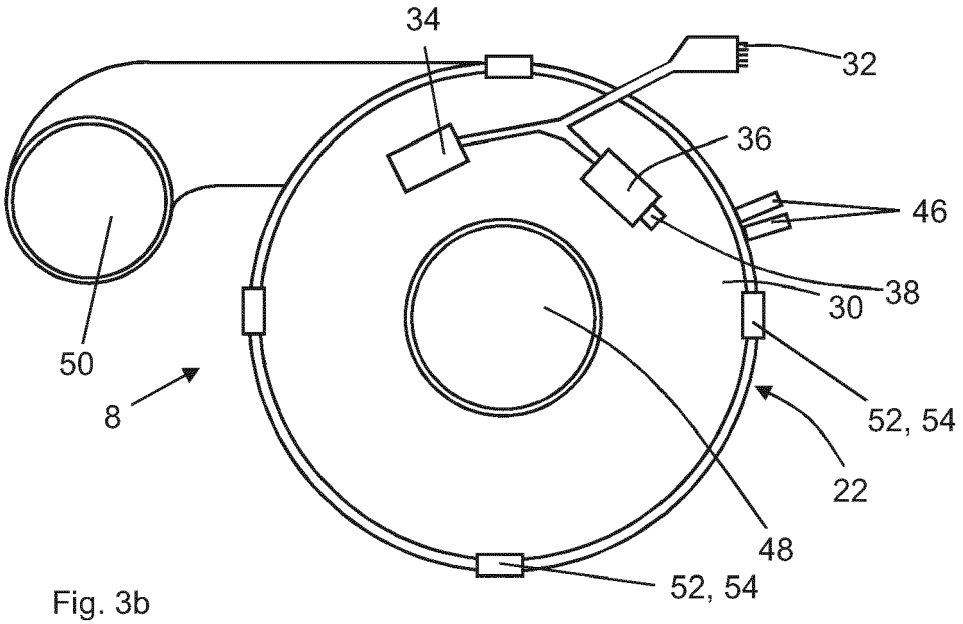

6
34
32
36
38
46
52, 54
50
30
48
8
22
52, 54

Fig. 3a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36
46
38
30
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8
52, 54
22
48
52, 54

Fig. 3b

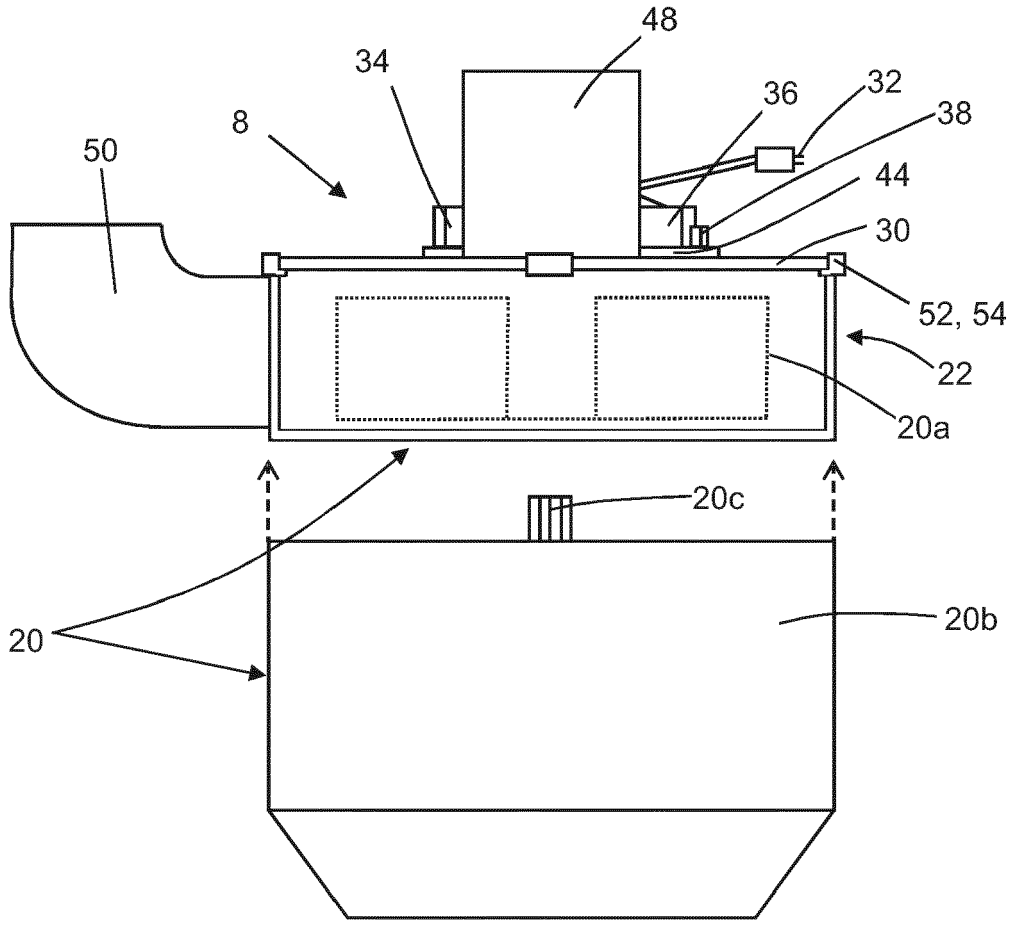
48
34
36
32
38
8
50
44
30
52, 54
22
20a
20c
20
20b

Fig. 4

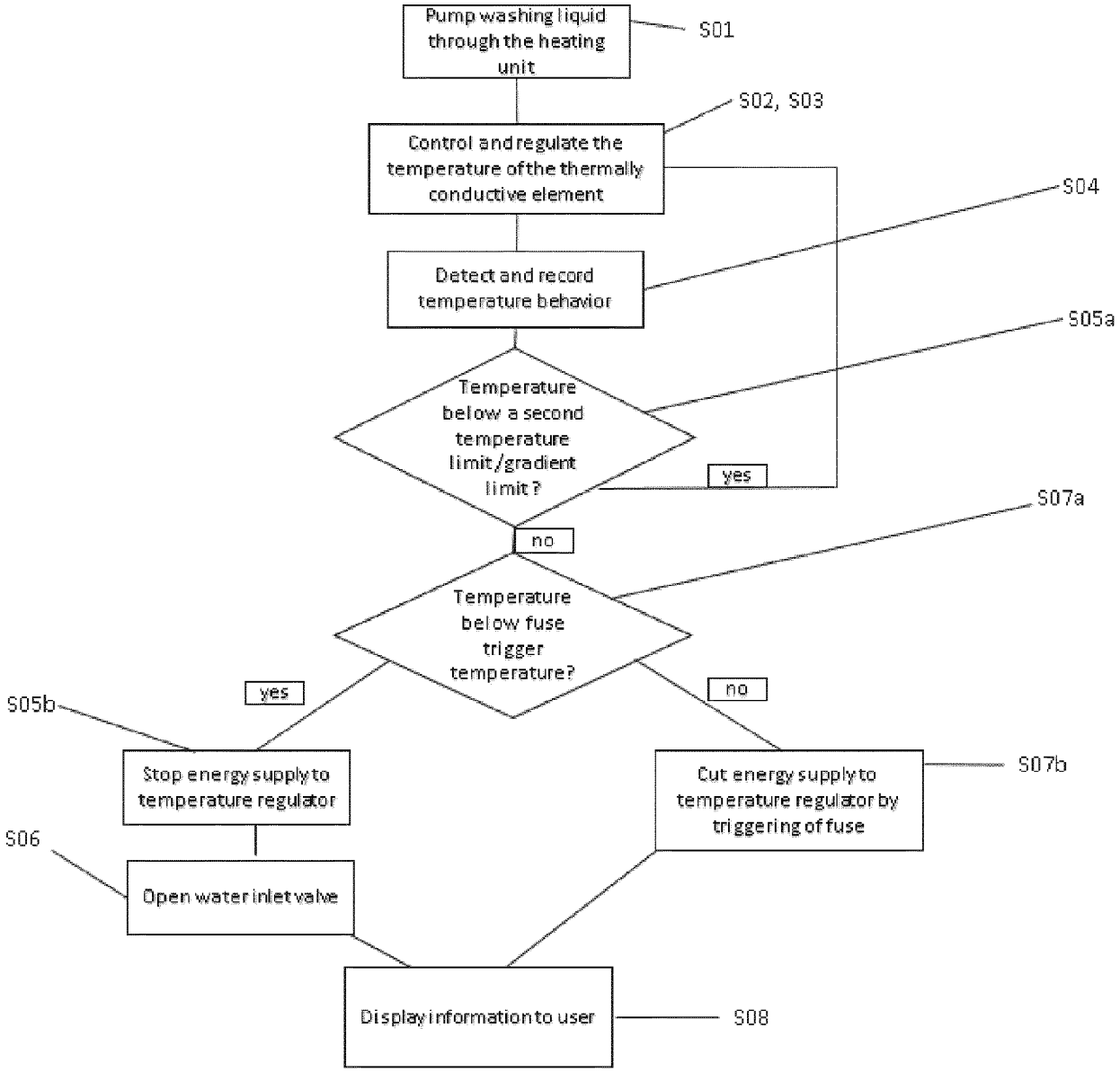
Pump washing liquid through the heating unit
S01
Control and regulate the temperature of the thermally conductive element
S02, S03
Detect and record temperature behavior
S04
Temperature below a second temperature limit/gradient limit?
S05a
yes
no
Temperature below fuse trigger temperature?
S07a
yes
no
S05b
Stop energy supply to temperature regulator
Cut energy supply to temperature regulator by triggering of fuse
S07b
S06
Open water inlet valve
Display information to user
S08

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 17 16 7558

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