(19) Europäisches Patentamt
European Patent Office
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(11) **EP 2 208 819 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
21.07.2010 Bulletin 2010/29

(51) Int Cl.:
D06F 39/00 *(2006.01)*

(21) Application number: **09150871.3**

(22) Date of filing: **19.01.2009**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA RS

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(54) A method to detect the end of life condition of a steamer used in domestic appliances, and domestic appliance using such method

(57) A method for assessing the ageing or clogging of a steamer (10) used in domestic appliances comprises measuring at least one parameter associated to the heating cycle of the steamer (10), comparing such measured value to a predetermined one (St1) and providing a signal indicative of the actual working conditions of the steamer or a prediction thereof.

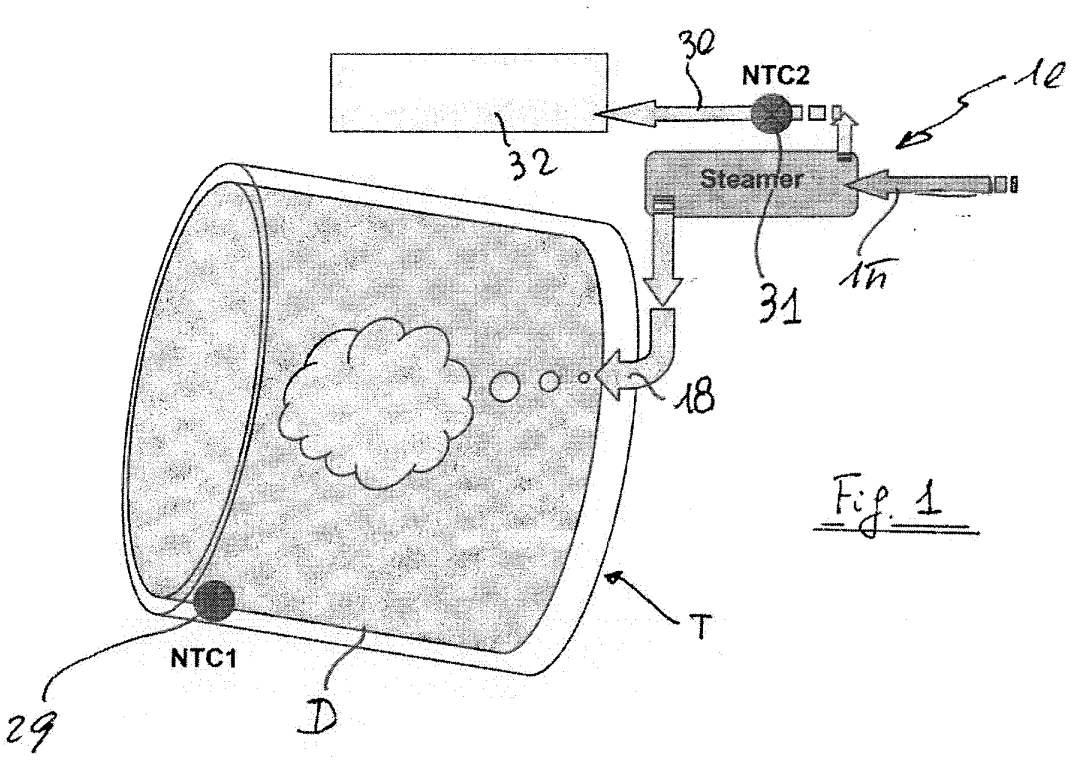


Fig. 1

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Description

[0001] The present invention relates to a method for assessing the working conditions of a flow through steamer used in domestic appliances, particularly for assessing the ageing or clogging of the steamer due to calcium deposits or the like.

[0002] It is well known in the art of washing machines provided with steamers that, as a result of the steam generation process, the flow-through (in-line) steamers generate deposits of soft and hard calcium carbonate as well as other solids commonly found in tap water.

[0003] Soft deposits usually start to build up on the steam chamber and become hard limestone (scale). When limestone is not removed from the walls, it will reduce the heat transfer capability (efficiency of steam generation) as well as facilitate new deposits to continue to stick on it until the whole chamber is clogged, so that there is no steam coming out through the exhaust. This condition is known as end of the life of the steamer.

[0004] When the steam is used in a washing process, it is very important to detect when the steamer is getting close to the end of its life so the machine can adapt other parameters accordingly as well as letting the consumer to know in advance when preventive maintenance is required.

[0005] It is an object of the present invention to provide a method for solving the above technical problem, in order to provide the user well in advance the steamer end of life with a warning of the near clogging, and/or for adapting automatically the washing machine to this new conditions. It is a further object of the present invention to provide a washing machine in which the above method can be carried out.

[0006] The above objects are reached thanks to the features listed in the appended claims.

[0007] According to the invention, it is provided an innovative method to detect and predict when the steam chamber is getting clogged and the efficiency of the steam unit is dropping.

[0008] A self controlled steamer can be used for carrying out the method, which uses an electromechanical control to regulate the water and temperature needed to produce steam. Of course other steamers, for instance electronically controlled, can be used as well.

[0009] In the self controlled steamer, a control thermostat located at the water inlet side, detects when the steam chamber is pre-heated to switch the heating element OFF and turn the electrical water supply valve ON, so the water is introduced in the chamber to continue with the steaming process.

[0010] When the fresh water introduced in the chamber cools the steamer down, the control thermostat will switch the water valve OFF and bring the steamer back ON to continue to boil all water sitting in the chamber. When all water is steamed out, the system will pre-heat again and repeat the steaming cycle. This steaming cycle will continue to repeat as long as the steam generator is energized.

[0011] Steaming cycle time will depend on voltage, water flow rate and mainly on the level of calcification in the chamber. When the calcium deposits start to build up, they become an insulation layer that will decrease the capability of the steamer to transfer the heat to the water, so the production of the steam and efficiency is affected. Since the heat will not easily go to the water, it will continue to heat up the outside of the chamber, causing the system to work at a higher temperature. The control thermostat will then see a higher temperature and will cause it to reach the set point temperature faster, so the steam cycle will also get shorter. According to the invention, the steamer will have a connection to the electronic board of the appliance which will not be used only for energizing or deenergizing the steamer in the appliance, but also for supervising (monitoring) the cycling of the thermostat, and particularly for measuring the duration of every thermostat cycle (steaming cycle) as well as counting the number of cycles through the life of the system or counting the life time of the steaming system (addition of steam time of every wash cycle). Knowing the cycle duration and total number of steaming cycles, the control of the appliance can predict the level of calcification in the unit.

[0012] Other features and advantages of the method and of the washing machine according to the invention will be clear from the following detailed description, provided by way of non limiting example, with reference to the attached drawings in which:

- figure 1 is a schematic view of the major components of a washing machine according to the invention;
- figure 2 is a detailed cross sectional view of the steamer used in the machine of figure 1;
- figure 3 is a wiring diagram of the steamer of figure 2;
- figure 4 is a performance curve of temperature vs. time of the steamer at brand new condition and at life end conditions;
- figure 5 is a curve similar to figure 4, and it shows the steamer behavior under water inlet blocked or water tab closed condition.
- figure 6 it a time to temperature curve showing the temperature gain in the washing machine tub;
- figure 7 is a flow chart showing the end of life detection routine according to a first embodiment; and
- figure 8 is a flow chart showing the end of life detection routine according to a second embodiment.

[0013] With reference to the drawings, with T is indicated a tub of a washing machine in which is mounted a rotating drum D. The washing machine comprises a flow through steamer 10 having a water inlet 15 controlled by an electrical valve 16 (figures 2 and 3) and a water outlet 18 connected to the tub T.

[0014] The electrical circuit of the steamer 10 comprises also a control thermostat 24, a safety thermostat 26 and two fuses 20, 22 all connected in series with a heating element 14 of the steamer. The control thermostat 24

has a connection 25 to a control unit 27 of the washing machine.

[0015] With reference to figure 4, every steaming cycle lasts approximately 160 seconds when the steamer 10 is brand new (St1: steam cycle time measured from peak to peak). In figures 4 and 5 temperatures T1 and T2 at different positions along the steamer 10 are reported, particularly temperature T1 of the metal tube near the inlet of the steamer 10 (position A in figure 2) and temperature T2 of the metal tube near the outlet of the steamer (position B in figure 2). Cycle time will drop approximately 40-50% to approx. 85 seconds when the steamer is almost clogged (St2), as seen in figure 5, i.e. near the "end of life" of the steamer 10.

[0016] Data can be saved as St1 time in the memory of the control unit 27 and such unit continues to do periodic actual time measurements to compare values through the life of the system. This comparison can be made with a fixed threshold value, or such value can be also calculated by the electronic control unit of the washing machine on the basis of the initial St1 time.

[0017] Since the production of steam per minute in the steam generator will drop through the life of the unit, the efficiency to heat the system up will also decrease and therefore the user has to be alerted when the steamer heating cycle has reached a value which is indicative of a near clogging of the steamer.

[0018] In addition the valve on time gives further information about the behavior of the steamer. In normal operation mode the valve on time is between 15 - 45s depending on the steamer life. In case of a new steamer the valve on time is short and due to calcification the valve on time increases. In case of the valve on time <15s the safety thermostat 26 is switching which indicates that either no water is going inside the steamer (fig.5) or the steamer is heavily calcified and running in a mode where only a little steam quantity can be expected. In case of no water is going inside the steamer there will follow a too long valve on cycle to the too short one. In case of several too long valve on cycles in a row, or sometimes interrupted by one normal, the steamer is completely blocked (Fig 4). Like the heater on time is measured in the above mentioned paragraph also the valve on time can be measured. The measured potential PSV (fig.4) is in case of valve on high and in case of heater on low.

[0019] The steaming cycle time can be also correlated with the temperature gain in the inside of the washing machine, where the steam is being supplied.

[0020] Combining the steamer cycle time and the temperature gain per minute, the system is able determine in a more accurate way the level of calcification of the steamer so the end of the life can de predicted more accurately.

[0021] According to such embodiment, the system can measure the temperature gain through a temperature sensor 29 located inside the tub T where the steam is being injected. When the steamer 10 is brand new, the generation of steam per minute will get the system to gain for example 3°C per minute.

[0022] Close to or at the end of the life, the efficiency drop on the steam generator will also drop the temperature gain in the system, for example to 0.5° C per minute.

[0023] When the steamer is completely calcified and clogged the gain will drop to approximately 0° C since no steam will be injected. The controls can then switch the steam system OFF. In figure 6 it is reported an experimental curve of the temperature gain in a washer tub. According to another embodiment of the invention, it is possible to use an additional alternative for malfunction detection, when the steamer's exhaust is completely clogged. According to such embodiment, despite the clogging of the steamer's exhaust the system may also continue to produce steam by releasing it through an overflow hose 30 connected to the detergent dispensing system 32 in the appliance. A second temperature sensor 31 can be advantageously located in this hose 30 to detect when steam and/or hot water are passing through. This solution can be implemented on any kind of steam generator.

[0024] Controls can also use this information to shoot the steam system down and display error messages as required.

[0025] In figure 7 it is shown a first routine used for detecting a condition of "end of life" of the steamer 10.

[0026] In step 40, carried out when the washing machine is switched on the first time, a heating cycle time St1 of the steamer is measured and stored in a memory of the control unit (step 42). In step 44 it is measured and recorded the temperature NTC1 reached by the tub T. After a predetermined period "m" is elapsed, the temperature NTC1 in the tub is measured again (step 46) and after a predetermined number of steaming cycles the heating cycle time is measured again (step 48), which will be St2, i.e. different from the cycle time St1 measured and stored when the washing machine was brand new. In the following step 50 a comparison is made between the temperatures NTC1 inside the tub at two different times; if the temperature gain is lower than a predetermined value, then the steamer is shut down. If the temperature gain is still at an acceptable level, then a comparison is made between the heating cycle time St1 stored in the control unit 27 and the actual cycle time St2 (step 52). If the ratio between St2 and St1 is equal or below a certain threshold value "X", then the routine carries out again the step 50 where the temperature gain is compared to a threshold value. If the ratio St2/St1 is above such threshold value, the steam routine can go on.

[0027] In figure 8 it is shown a second auxiliary routine for assessing the "end of life" condition of the steamer 10.

[0028] In step 54 the temperature NTC2 in the bypass conduit 30 (figure 1) is measured and in step 56 a comparison is made with a predetermined fix value AT. If the temperature NTC2 is substantially below AT, then steam routine is continued; if the temperature NTC2 is equal or higher than AT, then steamer 10 is shut down. In general temperature AT can be selected in a range of 70 - 95°C.

AT gets to 100°C when the steamer outlet 18 is completely calcified or blocked because the practically pressureless steam (100°C) goes through the overflow hose 30 and

[0029] NTC2 is sensing that. A temperature below 70°C for AT should be only selected if hot water should be sensed as well.

Claims

1. Method for assessing the working conditions of a steamer (10) used in domestic appliances, particularly for assessing the ageing or clogging thereof due to calcium deposits or the like, **characterized in that** it comprises measuring at least one parameter associated to the heating cycle of the steamer (10), comparing such measured value to a predetermined one (St1) and providing a signal indicative of the actual working conditions of the steamer or a prediction thereof.

2. Method according to claim 1, wherein said parameter is the time (St2) of heating cycles of the steamer (10).

3. Method according to claim 1 or 2, wherein said parameter is the total number of heating cycles performed by the steamer (10).

4. Method according to any of the preceding claims, in which the steamer (10) is used in a washing machine comprising a tub (T), wherein it further comprises measuring the temperature gain inside the tub (T) and comparing it to a predetermined value.

5. Method according to any of claims 1-3, in which the steamer (10) is used in a washing machine comprising a detergent dispenser (32), wherein it comprises providing the steamer (10) with a bypass (30) towards the detergent dispenser (32), measuring the temperature (NTC2) is said bypass (30) or in the detergent dispenser (32) and providing a signal indicative of a clogged steamer (10) if the measured temperature (NTC2) is higher than ambient temperature (AT).

6. Method according to claim 1, wherein said parameter is the time in which the supply valve (16) to the steamer (10) remains open, such time being further indicative of malfunction due to a closed water tap or to a failure of the water flow detection or to a blocked outlet of the steamer (10).

7. Washing machine comprising a control unit (27), a flow through steamer (10) with a heating element (14), an electrical water supply valve (16) and a temperature sensor (24) connected to the control unit (27), the temperature sensor (24) being adapted to provide temperature signals to the control unit (27), **characterized in that** the control unit (27) is adapted to measure the cycle time (St1, St2) of the heating element (14) and/or the total number of heating cycles and/or the total time during which the water supply valve (16) is in an open configuration and to compare such measured value to a predetermined threshold value, the control unit (27) being adapted to provide a signal indicative of the actual working conditions of the steamer (10), particularly in connection with its ageing and/or clogging due to calcium deposits or the like, or a prediction thereof.

8. Washing machine according to claim 7 comprising a tub (T), wherein it further comprises an auxiliary temperature sensor (29) located in the tub (T), the control circuit (27) being adapted to assess the temperature gain inside the tub (T) after the activation of the steamer (10), such gain being adapted to be compared by the control unit (27) with a predetermined value for providing a further signal indicative of the working conditions of the steamer (10).

9. Washing machine according to claim 7 or 8, comprising a detergent dispenser (32), wherein the steamer (10) has a bypass conduit (30) connected to the detergent dispenser (32), such dispenser (32) being provided with a further auxiliary temperature sensor (31), the control unit (27) being adapted to detect an increase of temperature upstream or inside the detergent dispenser (32) above the ambient temperature (AT) in order to provide a signal indicative of a clogging condition of the steamer (10).

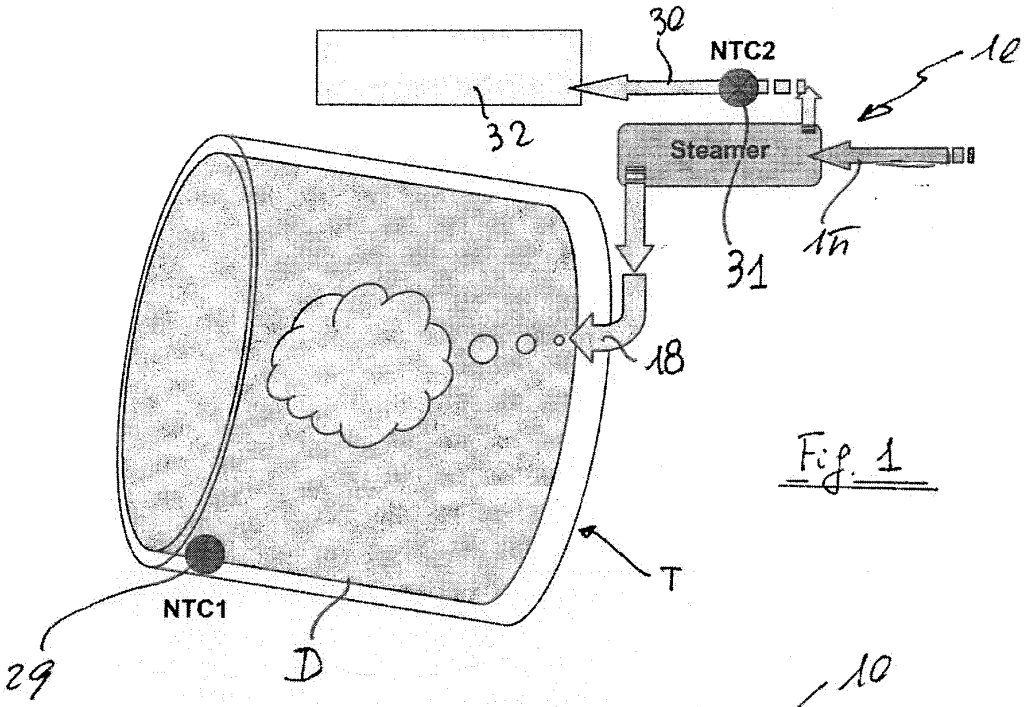


Fig. 1

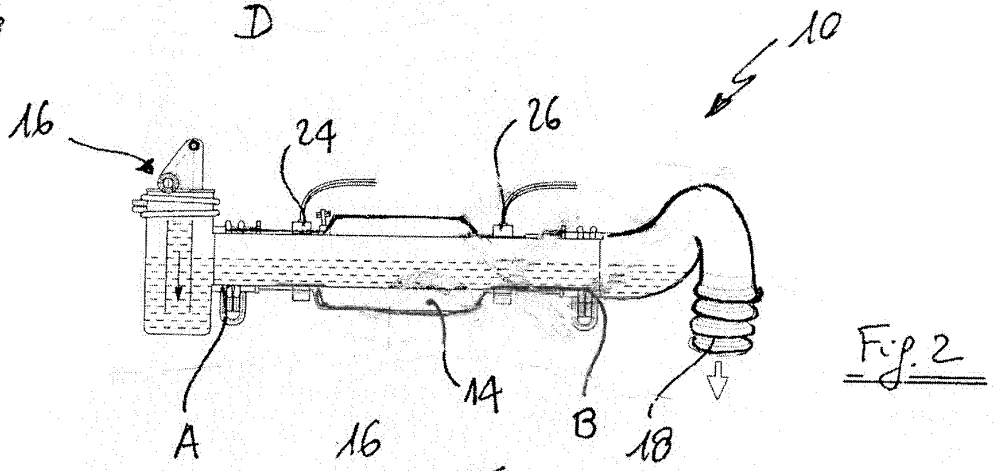


Fig. 2

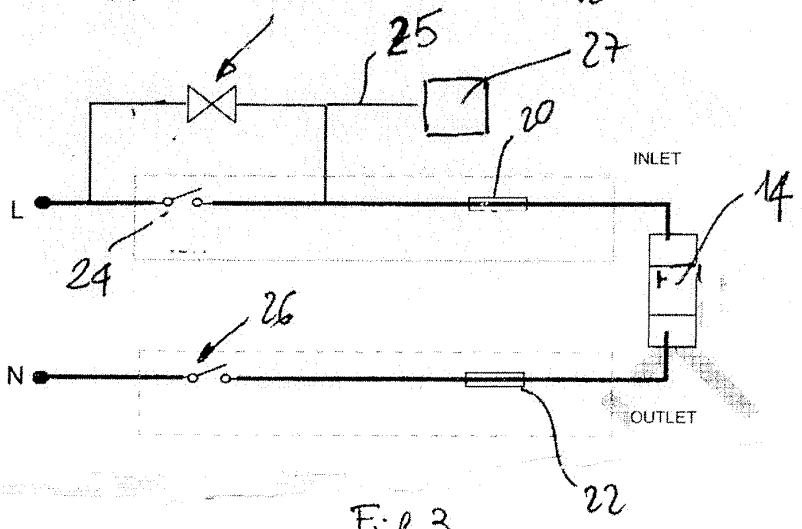


Fig. 3

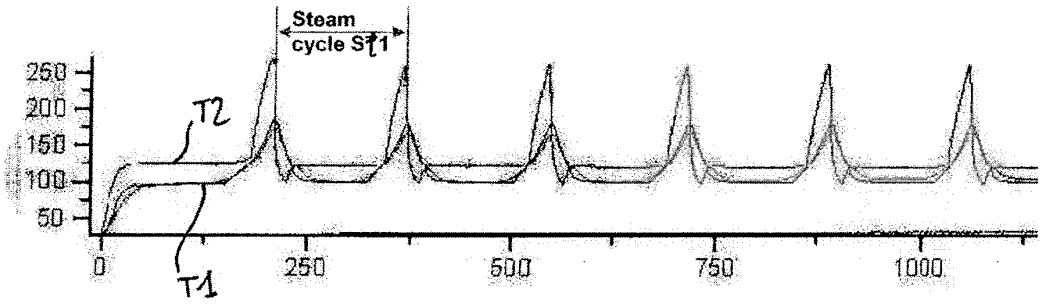


Fig. 4

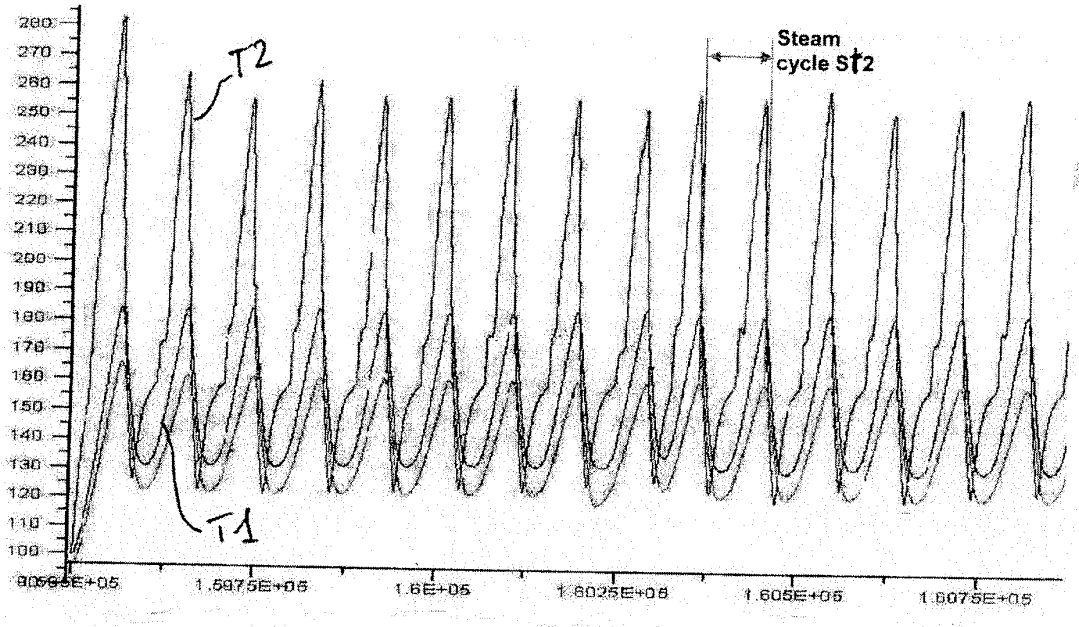


Fig. 5

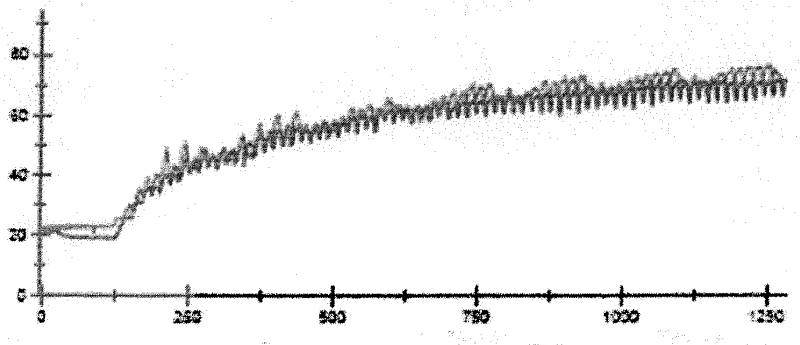


Fig. 6

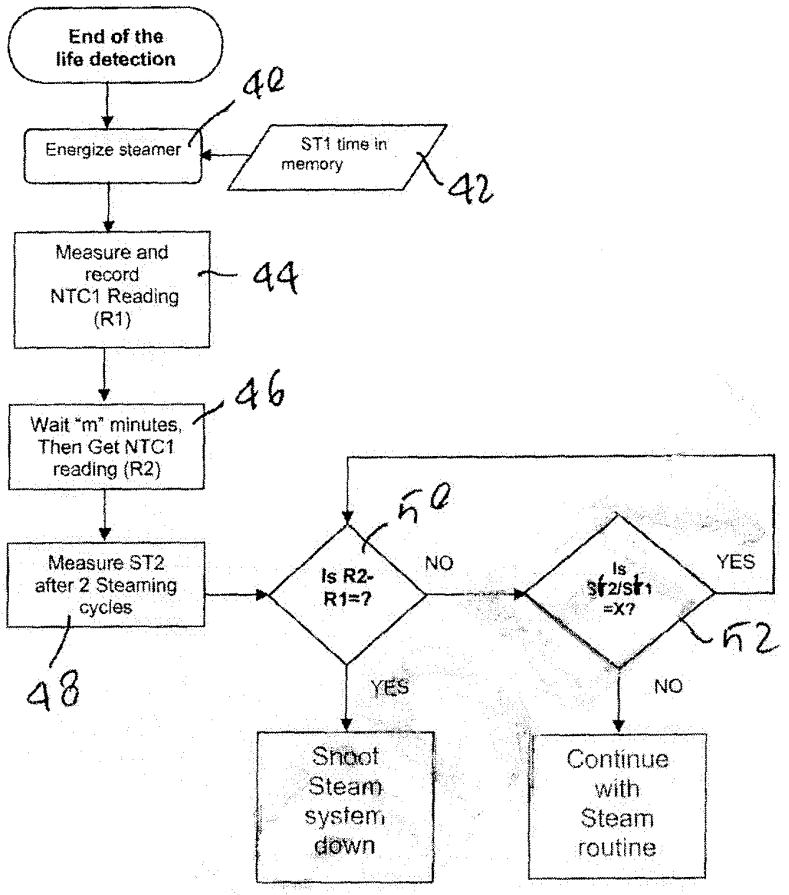

End of the life detection
40
Energize steamer
ST1 time in memory
42
Measure and record NTC1 Reading (R1)
44
Wait "m" minutes, Then Get NTC1 reading (R2)
46
Measure ST2 after 2 Steaming cycles
48
50
Is R2-R1=?
NO
Is St2/St1 =X?
YES
52
YES
NO
Shoot Steam system down
Continue with Steam routine

Fig. 7

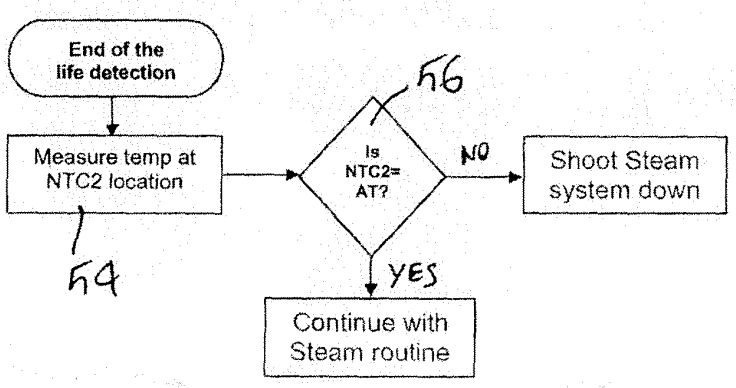

End of the life detection
Measure temp at NTC2 location
54
56
Is NTC2= AT?
NO
Shoot Steam system down
YES
Continue with Steam routine

Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 09 15 0871

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
E	EP 2 031 114 A (WHIRLPOOL CO [US]) 4 March 2009 (2009-03-04) * claims 1-7; figure 1 *	1-9	INV. D06F39/00
A	EP 1 889 960 A (WHIRLPOOL CO [US]) 20 February 2008 (2008-02-20) * claim 1; figure 1 *	1-9	
A	EP 1 865 099 A (WHIRLPOOL CO [US]) 12 December 2007 (2007-12-12) * claim 1; figure 1 *	1-9	

TECHNICAL FIELDS SEARCHED (IPC)

D06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	24 June 2009	Dupuis, Jean-Luc

CATEGORY OF CITED DOCUMENTS

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24-06-2009

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