(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 208 818 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
24.12.2014 Bulletin 2014/52

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

(21) Application number: **09150868.9**

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

(54) **Washing machine provided with a self-controlled and self-cleaned flowthrough steamer generator**

Waschmaschine mit einem selbstgesteuerten und selbstreinigenden Durchfluss-Dämpfergenerator

Machine à laver dotée d'un générateur de vapeur d'écoulement auto-contrôlé et auto-nettoyant

(84) Designated Contracting States:
DE ES FR GB IT PL

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

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Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The present invention relates to a washing machine having a steam generating device with a heating element for heating supplied water to generate steam, comprising a temperature sensor for sensing a temperature of the steam generating device and a water supply valve for supplying water to the steam generating device.

[0002] The present invention relates to a method for removing calcium deposits from the walls of a steam generating device of a washing machine as well in order to extend the life of the unit.

[0003] With the term "washing machine" we mean every kind of domestic appliance which uses water for cleaning clothes or dishes, including washers and dishwashers as well.

[0004] A washing machine of the above type is disclosed by EP 1659205, in which the temperature sensor of the steam generating device outputs the sensed temperature to a control unit. Such unit receives also the temperature signal from a temperature sensor which senses the temperature of the water supplied to the tub. It is clear that the use of a control unit also for controlling the steaming operation requires a more powerful hardware of the control unit itself, which increases the overall cost of the appliance. Moreover the interposition of an electronic control unit between the temperature sensor and the water supply valve may reduce the reliability and safety of the steam generating system, particularly in a zone of the washing machine where the heating element reaches high temperature, for instance during the preheating phase of the steam generating device. Another drawback of the system disclosed by EP 1659205 is the use of the temperature signal from the temperature sensor of the steam generating device for controlling only the preheating phase thereof, while for switching off the water supply valve reference is made to a fixed designated time. This approach makes the overall control more complex and moreover does not allow the system to continuously self-adapt to the actual conditions of the steam generating device, particularly to the amount of scale on the inside walls of the steamer.

[0005] EP-A-1889966 discloses a water supply control for a steam generator of a fabric treatment appliance using a temperature sensor.

[0006] EP-A-1865101 discloses a method for draining liquid from a steam generator of a fabric treatment appliance.

[0007] It is well known in the art of 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. 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 (end of the life).

[0008] Calcium deposits building up on areas where temperature measurement devices are installed will also result in wrong temperature readings. Calcium deposits should be then broken off from the walls and carried out of the steam chamber towards the exhaust, so efficiency of the system and life are extended. During normal steam generation, some of the deposits can be spitted out of the chamber but a certain amount will stay in there and start clogging the outlet.

[0009] It is an object of the present invention to provide a washer of the type mentioned at the beginning of the description which does not present the above drawbacks and which is reliable and has a low overall production cost.

[0010] According to the invention, such object is reached thanks to the features listed in the appended claims.

[0011] The present invention uses a method to control the steam generator in such a way a sudden thermal expansion is created in the chamber to break off the calcium deposits from the walls, without the need of an electronic control of the steamer.

[0012] The control is a simple, economical and self-adjusting one since it uses a combination of a thermostat mounted on the steam chamber to regulate the temperature of the steam generator and the amount of water going into it, and a solenoid valve controlling the water supply to the steam chamber.

[0013] The thermostat controlling the steaming temperature can be located at the inlet or the outlet side of the steam generator, depending on the power distribution along the chamber. Control thermostat setting is preferably in the range 140°-160°C, with a differential preferably comprised between 5° and 45°C. This means that the thermostat mechanism will operate when the setup temperature between 140° and 160°C is reached and reset back when temperature drops 5°- 45°C (differential).

[0014] Further advantages and features of the present invention will be clear from the detailed description provided by way of non limiting example, with reference to the attached drawing in which:

- figure 1 is a cross sectional view of the steam generating device according to the invention;
- figure 2 is a schematic diagram of the electrical circuit of the steam generating device of figure 1;
- figure 3 is a diagram showing the behavior of the steam generating device of figures 1 and 2;
- figure 4 is a diagram showing the relationship between the amount of spitted water and the relative amount of water loaded in the steam generating device according to the invention; and
- figure 5 is a cross sectional view of the steam generating device according to a second embodiment of the invention.

[0015] With reference to the drawings, a flow-through steamer 10 is shown comprising a tube-shaped steam chamber

12, a heating element 14 placed around the chamber 12, a water inlet 16 and an exhaust hose 18 connected to a tub (not shown) of a washing machine. The water inlet 16 communicates with the central portion of a siphon 17 so that steam cannot go backwards unless inner pressure in the chamber 12 is higher than water column in the siphon, for instance when the steamer is clogged. The steamer 10 is also provided with a safety outlet 19 in case inner pressure is too high (clogged steamer). The inner wall of the tube-shaped chamber 12 presents a plurality of longitudinal grooves in order to improve cracking of calcium deposits in small pieces.

[0016] The electrical circuit of the steamer 10 (figure 2) consists of a four thermal elements, i.e. two fuses 20, 22 and two thermostats 24 and 26. All these elements are in serial connection with the heating element 14. The fuse 20 and thermostat 24, as well as the fuse 22 and thermostat 26, are in contact with a shaped plate soldered on the tube-shaped steam chamber 12 and outside wall 14a of the heater 14. This arrangement leads to a more stable steaming process over life and reduces significantly the reaction time in abnormal situations. Additionally it leads to a more precise valve control and therefore energy efficient steaming process. A valve 21 for water supply control, placed upstream the water inlet 16, is a solenoid valve and it is connected in parallel with the control thermostat 24. This latter can be for example a 150-25°C, which means that the bimetal mechanism of the thermostat will operate (i.e. close the circuit) until the set point temperature of 150°C is reached and reset back when temperature drops 25°C (differential).

[0017] When the system gets to the control thermostat temperature setting (T1, figure 3), it will open the circuit and leave the valve 21 electrically connected in series with the heating element 14. Since the resistance value of the solenoid will be much lower than the heater, the water valve 21 will turn ON and supply water to the steam chamber 12 until the temperature drops to the reset value (125°C in the example) of the control thermostat 24.

[0018] The differential setting will then self-regulate the time the water supply is ON. The higher the difference between off and on set points, the longer the time; the longer the time, the bigger the amount of water supplied.

[0019] When low set point is reached, the thermostat 24 will switch the water supply OFF and heating element 14 back ON to allow the steamer 10 to continue to boil the water supplied to the chamber 12. After all the water is steamed out, the system's temperature will start to go back up until it reaches the high set point temperature again (T1) to repeat the cycle. The thermostat differential will self regulate the time during which the solenoid valve is open/closed. Such thermostat differential can be fixed (inherent to the specific features of the thermostat), it can be set within the factory or it may be adjusted by the user through the user interface, for instance depending on actual water hardness.

[0020] The steam generator 10 has also a normally closed (NC) safety thermostat 26 which will be rated 20-40°C above the control thermostat setting so it keeps the steam generator energized as long as the water valve is off during the steaming process. In the case there is no water in the water supply, the control and safety thermostats will switch the steamer OFF.

[0021] The terminals of the simple electrical circuit shown in figure 2 are connected to the control circuit of the machine (which is simply switching the unit on and off); in the simplest case they can be connected to a mechanical timer which turns on and off the steam heater for one or more predetermined periods of the washing cycle of the machine, according to the washing cycle selected by the user. Of course the circuit can be also connected to an electronic control unit of the washer; nevertheless it is important to notice that the control unit of the washer is involved only in switching on and off the steamer as a single component, and not in the control of the valve or of the heating element thereof, since their functions are self-adjusted by the circuit itself.

[0022] With reference to figure 3, where on Y axis steam chamber temperature is plotted vs. time in minutes on X axis, when the steam generator is at T1 temperature (around 140°C) and fresh water is suddenly introduced in the chamber, it will create a thermal expansion which will break off the calcium deposits from the walls, the grooved surface of the tube-shaped chamber 12 improving the detachment of such deposits.

[0023] The triangle profile in the inner wall of the steam chamber additionally guaranties that the calcium deposits are breaking off in small pieces. The calcium is then transported out by the turbulence and the inner pressure created by the heating of the boiling water. With the spitting of water, the broken calcium is leaving the tube. While in the beginning of the steamer life the spit water is neglectable, the amount of spitting water is increasing over lifetime due to the amount of residual calcium deposits which are still sticking at the tube walls. This means a higher thermal mass which takes longer to cool down and causes therefore a longer valve on time.

[0024] The temperature differential of the control thermostat can be specified in such a way it puts enough water in the chamber 12 so when the boiling process starts, it creates enough turbulence and water spitting though the exhaust 18 to carry out the broken deposits from the steam chamber. For example, using a steamer with 175 cm^3 capacity and 1000 W heating element, when filled over 40% of its volume, it will start spitting a certain amount of the water supplied. The amount of spitted hot water needed to carry out the deposits can be calculated and defined through the differential value of the control thermostat (Valve ON time), as shown in the following table:

Water input (cm^3)	Spit water (cm^3)	% Full	% Spit
59.56	0	34.04%	0.00%

(continued)

Water input (cm^3)	Spit water (cm^3)	% Full	% Spit
59.92	0	34.24%	0.00%
69.55	0	39.74%	0.00%
71.33	7	40.76%	9.81%
73.12	3	41.78%	4.10%
73.83	5	42.19%	6.77%
74.90	6	42.80%	8.01%
77.40	11	44.23%	14.21%
84.17	15	48.10%	17.82%
111.64	39	63.79%	34.93%
115.92	42	66.24%	36.23%
119.13	47	68.07%	39.45%

[0025] In figure 4 it is shown the relationship between filling % and the % amount of spitted hot water needed to remove the scale deposits.

[0026] Tests carried out by the applicant have shown that volumes of the chamber 12 comprised between 100 and 250 cm^3 are the preferred ones for the purposes of removing scale, with power of the heating element 14 preferably comprised between 500 and 1500 W.

[0027] In figure 5 it is shown a second embodiment of the present invention in which a calcium trap 30 is used in order to collect the free pieces of scale breaking off from the steam chamber walls. The trap 30 consists of a container located right in between the steam chamber 12 and the exhaust of the steamer 10. When big pieces of broken calcium are carried towards the outlet, they can precipitate down into the container by gravity. Since deposits are not staying in the steam chamber 12 anymore, it will also slow down the building of calcium on the walls when boiling the water so the efficiency and life of the steamer are extended.

[0028] Calcium can be collected in this container to avoid blocking the exhaust, and in this embodiment the safety outlet 19 shown in figure 1 (first embodiment) can be avoided. Small pieces will also precipitate down and some other will be still pushed out by the steam flow and spitted water.

[0029] A periodic, automatic cleaning routine can be used to dump the calcium contained in the trap directly to the drain through an automatic valve 32 or, it can be cleaned manually. Depending on usage, calcium trap can also be maintenance free through the life of the system. Trap can be drained out or stay full of water at all times. Since the container is directly attached to the steam chamber 12, it will always be in contact with boiling water so the formation of mold and bacteria is avoided.

[0030] A further embodiment of the present invention is to drive the steamer 10 with a combination of hot water and steam generation. A predetermined amount of hot water can be calculated and defined through a differential value of the control thermostat (valve-on time) or by an electronic control.

Claims

1. A washing machine having a steam generating device (10) with a heating element (14) for heating the supplied water to generate steam comprising a temperature sensor (24) for sensing a temperature of the steam generating device (10) and a water supply valve (21) to the steam generating device, **characterized in that** the temperature sensor is a control thermostat (24) with a predetermined differential, electrically connected in series with the heating element (14) and **in that** the water supply valve is a solenoid valve (21) electrically connected in parallel with the control thermostat (24) so that the differential setting self-regulates the time the water supply is ON.

2. A washing machine according to claim 1, wherein a safety thermostat (26) is connected in series with the control thermostat (24).

3. A washing machine according to claim 1 or 2, wherein the control thermostat (24) is located at the inlet of the steam

generating device (10).

4. A washing machine according to claim 2, wherein the safety thermostat is located at the outlet side of the steam generating device (10).

5. A washing machine according to any of the preceding claims, wherein the control thermostat (24) has an off set point comprised between 130° and 170°C and a differential comprised between 5° and 45°C respectively.

6. A washing machine according to any of the preceding claims, wherein the steam generating device (10) ha a volume comprised between 100 and 250 cm^3.

7. A washing machine according to any of the preceding claims, wherein the steam generating device has a heating element (14) whose power is comprised between 500 and 1500 W.

8. A washing machine according to any of the preceding claims, wherein the steam generating device (10) comprises a tube-shaped chamber (12) with an internal surface provided with a plurality of grooves.

9. A washing machine according to claim 8, wherein the heating element (14) is in contact with a shaped plate soldered to the outside surface of the tube-shaped chamber (12).

10. A washing machine according to any of the preceding claims, wherein the steam generating device (10) comprises a siphon (17) downstream the water supply valve (21).

11. A washing machine according to any of the preceding claims, wherein the steam generating device comprises a calcium trap device (30) upstream an exhaust hose (18).

12. A method for removing calcium deposits from the walls of a steam generating device (10) of a washing machine comprising a heating element (14) and a water supply valve (16), filling a predetermined amount of water in the pre-heated steam generating device (10) so that a certain amount of hot water is spitted in order to remove calcium deposits from the device, **characterized in that** the temperature is controlled by means of a control thermostat (24) with a predetermined differential, electrically connected in series with the heating element (14), the water supply valve being a solenoid valve (21) electrically connected in parallel with the control thermostat (24), and **in that** the differential setting self-regulates the time the water supply is ON.

13. A method according to claim 12, wherein the water filled to the steam generating device (10) is over 40% of the volume of the steam generating device.

14. A method according to claim 12 or 13, wherein the steam generating device has a volume around 175 cm^3 and the heating element (14) has a power around 1000 W.

Patentansprüche

1. Waschmaschine mit einer Dampferzeugungsvorrichtung (10) einschließlich eines Heizelements (14) zum Erhitzen des zugeführten Wassers zum Erzeugen von Dampf, umfassend einen Temperaturfühler (24) zum Erfassen der Temperatur der Dampferzeugungsvorrichtung (10) und ein Wasserzuflussventil (21) zur Dampferzeugungsvorrichtung, **dadurch gekennzeichnet, dass** der Temperaturfühler ein Regelthermostat (24) mit einem voreingestellten Differenzial ist, das mit dem Heizelement (14) elektrisch in Reihe geschaltet ist und das Wasserzuflussventil ein Magnetventil (21) ist, das mit dem Regelthermostat (24) elektrisch parallel geschaltet ist, so dass die Differenzialeinstellung die Zeit, in der die Wasserzufuhr eingeschaltet ist, selbsttätig regelt.

2. Waschmaschine nach Anspruch 1, wobei ein Sicherheitsthermostat (26) mit dem Regelthermostat (24) in Reihe geschaltet ist.

3. Waschmaschine nach Anspruch 1 oder 2, wobei das Regelthermostat (24) am Eingang der Dampferzeugungsvorrichtung (10) angebracht ist.

4. Waschmaschine nach Anspruch 2, wobei das Sicherheitsthermostat an der Auslassseite der Dampferzeugungs-

vorrichtung (10) angebracht ist.

5. Waschmaschine nach einem der vorhergehenden Ansprüche, wobei das Regelthermostat (24) einen Ausschaltsollwert zwischen 130 °C und 170 °C bzw. ein Differenzial zwischen 5 °C und 45 °C hat.

6. Waschmaschine nach einem der vorhergehenden Ansprüche, wobei das Volumen der Dampferzeugungsvorrichtung (10) zwischen 100 und 250 cm^3 beträgt.

7. Waschmaschine nach einem der vorhergehenden Ansprüche, wobei die Dampferzeugungsvorrichtung ein Heizelement (14) hat, dessen Leistung 500 bis 1.500 W beträgt.

8. Waschmaschine nach einem der vorhergehenden Ansprüche, wobei die Dampferzeugungsvorrichtung (10) eine röhrenförmige Kammer (12) mit einer Innenfläche mit mehreren Rillen umfasst.

9. Waschmaschine nach Anspruch 8, wobei das Heizelement (14) in Berührung mit einer geformten Platte ist, die an die Außenfläche der röhrenförmigen Kammer (12) gelötet ist.

10. Waschmaschine nach einem der vorhergehenden Ansprüche, wobei die Dampferzeugungsvorrichtung (10) stromabwärts des Wasserzuflussventils (21) einen Siphon (17) aufweist.

11. Waschmaschine nach einem der vorhergehenden Ansprüche, wobei die Dampferzeugungsvorrichtung eine Kalkauffangvorrichtung (30) stromaufwärts eines Abluftschlauches (18) aufweist.

12. Verfahren zum Entfernen von Kalkrückständen von den Wänden einer Dampferzeugungsvorrichtung (10) einer Waschmaschine, umfassend ein Heizelement (14) und ein Wasserzuflussventil (16), das eine vorbestimmte Wassermenge in die vorerhitzte Dampferzeugungsvorrichtung (10) einfüllt, so dass eine bestimmte Menge heißen Wassers eingespritzt wird, um Kalkrückstände aus der Vorrichtung zu entfernen, **dadurch gekennzeichnet, dass** die Temperaturregelung durch ein Regelthermostat (24) mit einem voreingestellten Differenzial erfolgt, das mit dem Heizelement (14) elektrisch in Reihe geschaltet ist, wobei das Wasserzuflussventil ein Magnetventil (21) ist, das mit dem Regelthermostat (24) elektrisch parallel geschaltet ist, und dadurch, dass die Differenzialeinstellung die Zeit, in der die Wasserzufuhr eingeschaltet ist, selbsttätig regelt.

13. Verfahren nach Anspruch 12, wobei das in die Dampferzeugungsvorrichtung (10) eingefüllte Wasser über 40 % des Volumens der Dampferzeugungsvorrichtung beträgt.

14. Verfahren nach Anspruch 12 oder 13, wobei die Dampferzeugungsvorrichtung ein Volumen von ungefähr 175 cm^3 und das Heizelement (14) eine Leistung von ungefähr 1.000 W aufweist.

Revendications

1. Machine à laver ayant un dispositif générateur de vapeur d'eau (10) avec un élément de chauffage (14) pour chauffer l'eau fournie pour générer de la vapeur d'eau, comprenant un capteur de température (24) pour détecter la température du dispositif générateur de vapeur d'eau (10) et une vanne d'alimentation en eau (21) pour alimenter le dispositif générateur de vapeur d'eau, **caractérisée en ce que** le capteur de température est un thermostat de commande (24) avec un différentiel prédéterminé, connecté électriquement en série avec l'élément de chauffage (14) et **en ce que** la vanne d'alimentation en eau est une électrovanne (21) connectée électriquement en parallèle avec le thermostat de commande (24) de sorte que le réglage du différentiel autorégule la période pendant laquelle l'alimentation en eau est sur MARCHE.

2. Machine à laver selon la revendication 1, dans laquelle un thermostat de sécurité (26) est connecté en série avec le thermostat de commande (24).

3. Machine à laver selon la revendication 1 ou la revendication 2, dans laquelle le thermostat de commande (24) est situé à l'entrée du dispositif générateur de vapeur d'eau (10).

4. Machine à laver selon la revendication 2, dans laquelle le thermostat de sécurité est du côté de sortie du dispositif générateur de vapeur d'eau (10).

5. Machine à laver selon l'une quelconque des revendications précédentes, dans laquelle le thermostat de commande (24) présente un point de consigne arrêt compris entre 130 et 170 °C et un différentiel compris entre 5 et 45 °C, respectivement.

6. Machine à laver selon l'une quelconque des revendications précédentes, dans laquelle le dispositif générateur de vapeur d'eau (10) a un volume compris entre 100 et 250 cm^3.

7. Machine à laver selon l'une quelconque des revendications précédentes, dans laquelle le dispositif générateur de vapeur d'eau présente un élément de chauffage (14) dont la puissance est comprise entre 500 et 1500 W.

8. Machine à laver selon l'une quelconque des revendications précédentes, dans laquelle le dispositif générateur de vapeur d'eau (10) comprend une chambre de forme tubulaire (12) avec une surface interne pourvue d'une pluralité de rainures.

9. Machine à laver selon la revendication 8, dans laquelle l'élément de chauffage (14) est en contact avec une plaque moulée brasée à la surface externe de la chambre de forme tubulaire (12).

10. Machine à laver selon l'une quelconque des revendications précédentes, dans laquelle le dispositif générateur de vapeur d'eau (10) comprend un siphon (17) en aval de la vanne d'alimentation en eau (21).

11. Machine à laver selon l'une quelconque des revendications précédentes, dans laquelle le dispositif générateur de vapeur d'eau comprend un dispositif de piégeage de calcium (30) en amont d'un tuyau souple d'évacuation (18).

12. Procédé d'élimination de dépôts de calcium des parois d'un dispositif générateur de vapeur d'eau (10) d'une machine à laver comprenant un élément de chauffage (14) et une vanne d'alimentation en eau (16), qui envoie une quantité d'eau prédéterminée dans le dispositif générateur de vapeur d'eau préchauffé (10) de sorte qu'une certaine quantité d'eau chaude soit projetée afin d'éliminer les dépôts de calcium du dispositif, **caractérisé en ce que** la température est commandée au moyen d'un thermostat de commande (24) avec un différentiel prédéterminé, connecté électriquement en série avec l'élément de chauffage (14), la vanne d'alimentation en eau étant une électrovanne (21) connectée électriquement en parallèle avec le thermostat de commande (24), et **en ce que** le réglage du différentiel autorégule la période pendant laquelle l'alimentation se trouve sur MARCHE.

13. Procédé selon la revendication 12, dans lequel l'eau fournie au dispositif générateur de vapeur d'eau (10) atteint plus de 40 % du volume du dispositif générateur de vapeur d'eau.

14. Procédé selon la revendication 12 ou la revendication 13, dans lequel le dispositif générateur de vapeur d'eau a un volume aux environs de 175 cm^3 et l'élément de chauffage (14) a une puissance aux environs de 1000 W.

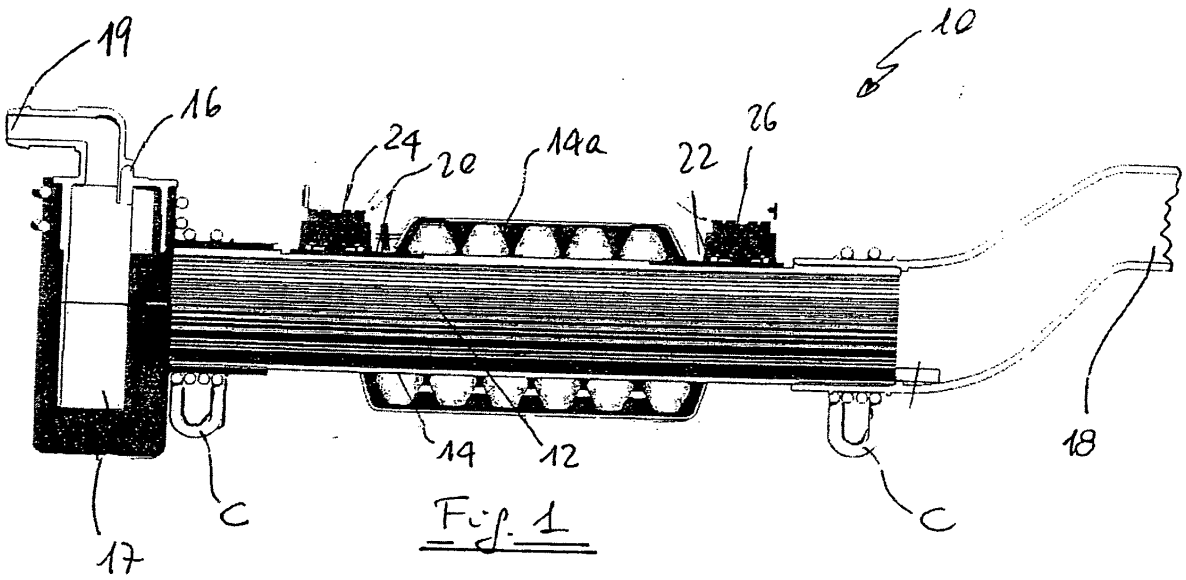
19
16
24
20
14a
22
26
10
14
12
18
17
C
C

Fig. 1

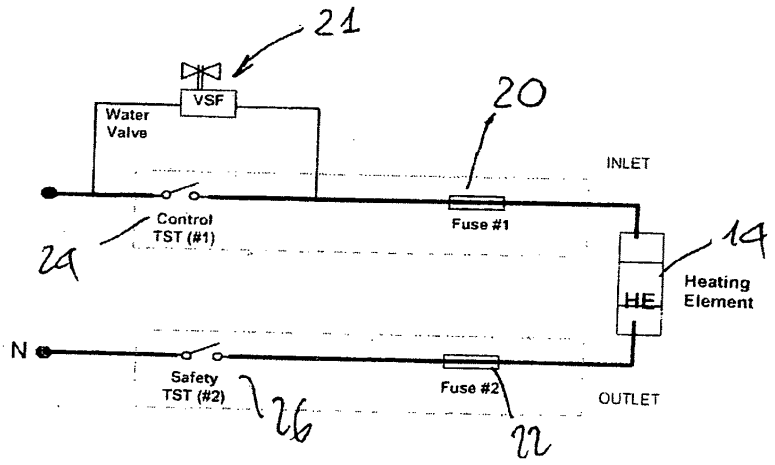
21
VSF
Water Valve
20
INLET
Control TST (#1)
Fuse #1
24
14
Heating Element
HE
N
Safety TST (#2)
Fuse #2
OUTLET
26
22

Fig. 2

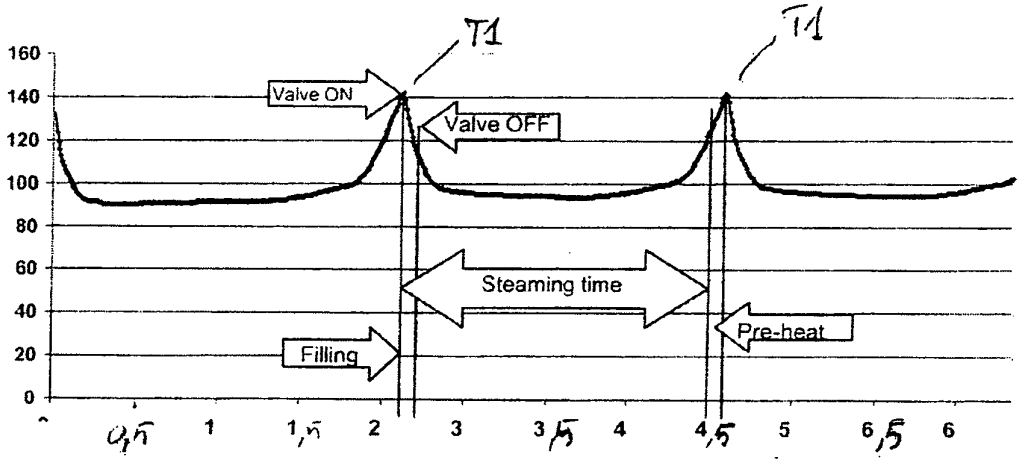

Fig. 3

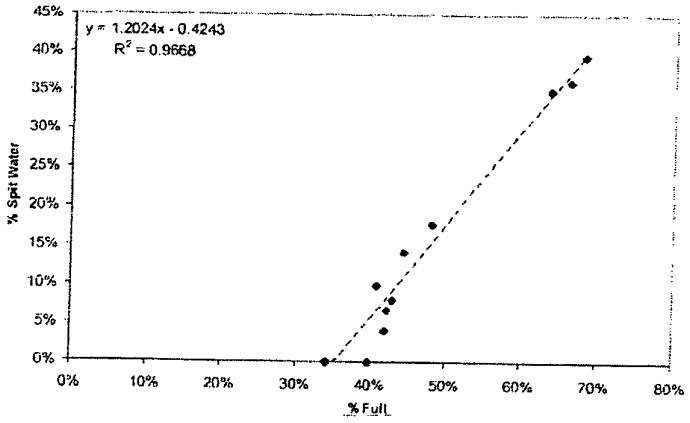

Fig. 4

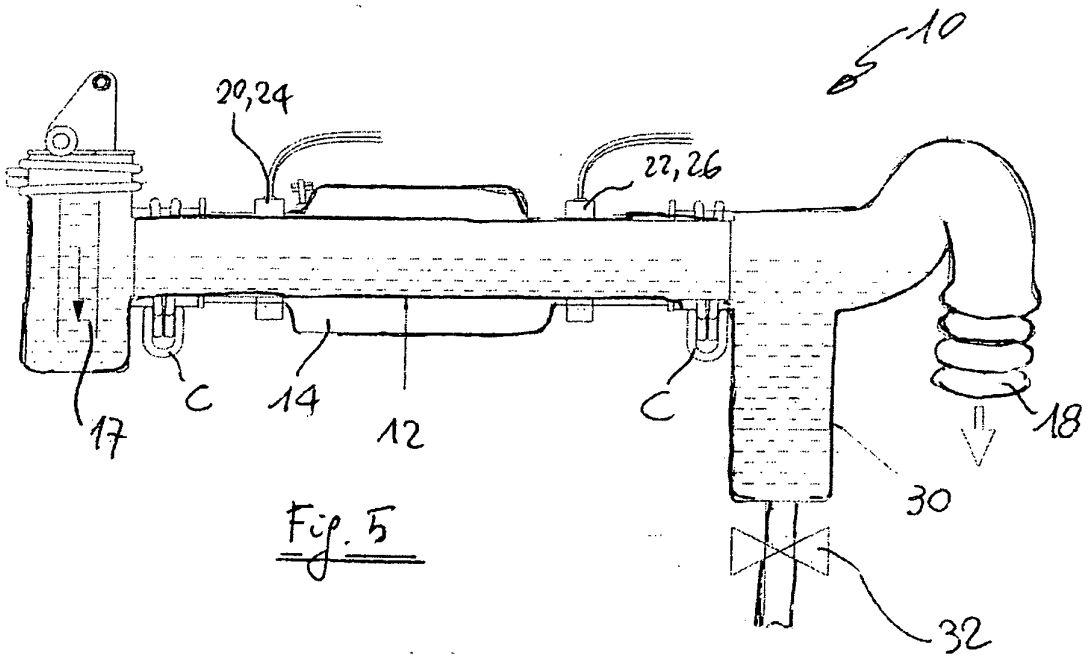

Fig. 5

REFERENCES CITED IN THE DESCRIPTION

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