



(11) **EP 2 140 209 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention
of the grant of the patent:

13.08.2014 Bulletin 2014/33

(21) Application number: **08737500.2**

(22) Date of filing: **21.04.2008**

(51) Int Cl.:

F24H 9/20 (2006.01)

(86) International application number:

PCT/IB2008/000979

(87) International publication number:

WO 2008/132573 (06.11.2008 Gazette 2008/45)

(54) **OPTIMISING METHOD FOR THE MANAGEMENT OF WATER TEMPERATURE IN A STORAGE
WATER HEATER AND CONTROL**

OPTIMIERTES VERFAHREN ZUR REGELUNG DER WASSERTEMPERATUR IN EINEM
HEISSWASSERSPEICHER UND STEUERUNG

AMÉLIORATION D'UN PROCÉDÉ PERMETTANT DE GÉRER LA TEMPÉRATURE DE L'EAU DANS
UN CHAUFFE-EAU À ACCUMULATION ET CONTRÔLE

(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 MT NL NO PL PT
RO SE SI SK TR**

(30) Priority: **27.04.2007 IT AN20070026**

(43) Date of publication of application:

06.01.2010 Bulletin 2010/01

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WO-A-94/10620 JP-A- 61 110 840

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Description

[0001] The object of this invention is a new method for the management of water maintenance temperature in a generic storage water heater controllable by electronic control.

[0002] It is known that in storage water heaters, the main cause of inefficiency is due to the thermal dispersions that can be even very high, due to the fact that water is brought to the preset temperature required even with great advance over the actual time of use.

[0003] It is equally known that if the storage water heater is kept exactly at the useful temperature T_u for hygienic use, it is capable of dispensing at such temperature an amount of water equal to a significant fraction of the tank volume but not equal to the volume itself, due to the so-called mixing phenomenon (the incoming cold water mixes with a part of the hot water in the tank, thus decreasing the temperature thereof below the useful temperature T_u). If the preset temperature T_{set} at which the storage water heater is kept is much higher than said useful temperature T_u , moreover, it is capable of ensuring, through mixing with cold water, amounts of water at useful temperature T_u much larger than the storage volume.

[0004] In the practice, it is difficult for the user to determine which the optimum value of the preset temperature T_{set} required for ensuring the service should be, also considering that it may be highly variable according to the days of the week; as a consequence, even where the preset temperature T_{set} is adjustable by the user, it is often kept at much higher values than those actually required day by day.

[0005] The document JP-A-61 110840 teaches how to reduce such thermal dispersions, predetermining the necessary quantity of hot water in the storage tank according to the quantities which was used in the past by the user.

[0006] Said document discloses a controlling device suitable for properly pre-setting the starting time of the heating element of the water heater, by means of a temperature sensor (placed in the lower part of the tank) for checking the storage temperature and of a plurality of sensors (located in the upper part of the tank) for detecting the quantity of remaining hot water.

[0007] The solution disclosed in this document JP-A-61 110840 is suitable to determine the target temperature of the water necessary for the next day, also decreasing the quantity of remaining hot water in the tank; however a plurality of sensors are implied, far away from the economical and practical possibility of use in a water heater.

[0008] It is also known that in some countries, especially in countries where electrical energy is produced from nuclear sources, there is the possibility of taking advantage of time bands of electrical energy supply at reduced rate. Such rates by time bands will become increasingly widespread in the future.

[0009] Where energy rates for household purpose are

differentiated by time bands, the houses are provided with information instruments and means that allow knowing the start and end time of said time bands and of course, counting the consumptions recorded in each band at the different rates.

[0010] It is also known that the methane distribution network, at least in certain zones, is overloaded in certain periods, for example during room heating; as a consequence, it is not excluded that sooner or later, methane suppliers may activate rate policies aimed at encouraging the postponement of consumptions, delaying them to certain low consumption time bands, as it happens with electrical energy.

[0011] In the description of this invention, hereinafter, "energy supply network" means without distinction both the supply of electrical energy and of methane, whereas "heating element" means without distinction both the group of electrical resistances of an electrical water heater and the combustion unit of a gas water heater.

[0012] The method according to the invention, hereinafter called "ECO method", usefully applies to both electrical and gas storage water heaters.

[0013] The main object of the ECO method is to reduce thermal energy dispersions, being equal the temperature of water made available to the user at the time of the first expected use.

[0014] A further object of the ECO method is to take advantage of the energy time bands at reduced rate.

[0015] A further object of the ECO method consists in preventing overloads in the household methane or electrical energy distribution network at the beginning of the reduced rate bands, when other appliances that activate at that time are connected to the same network.

[0016] A further object of the ECO method is to adjust the water temperature, automatically adjusting it to the actual user's requirements.

[0017] These and other objects are achieved with the method and control as defined in claims 1 or 18.

Figure 1a shows different possible distributions of time bands at reduced rates.

Figure 1b shows the period of supply of the heating elements of a storage water heater, respectively without ECO method (continuous line) and with ECO method (discontinuous line), in particular according to the "Delay" function and with reference to the reduced rate 5h shown in Fig. 1a.

Figure 1c shows the thermal profile of the water contained in the storage water heater, without the ECO method (continuous line) and with the ECO method (discontinuous line), in particular according to the "Delay" function.

Figure 2 shows an operating example of the storage water heater with the ECO method, according to the "Optimisation" function.

[0018] The ECO method allows reducing consumptions by thermal dispersion acting according to two main

procedures, each envisaging multiple variants.

[0019] The execution of such two procedures requires the water heater to be piloted by an electronic control provided with means suitable at least for performing the following functions:

- calculating the passing of time;
- receiving or having pre-stored information on the start and end time of the time bands at reduced rate;
- receiving information on the water temperature inside the water heater;
- storing the preset and/or read and/or calculated data;
- processing calculations from received or stored data;
- activating/deactivating the water heating element based on the calculations processed and on the temperature of the water itself.

[0020] The first function, hereinafter called "Delay", is intended to carry out the heating of the appliance to the preset temperature T.set during the time band at reduced rate, but postponing the complete heating as much as possible, so that it may end just before the end of such time band at reduced rate (the so-called peak-off period).

[0021] The second function, hereinafter called "Optimisation", optimises the maintenance temperature automatically reducing the preset value T.set if the water heater is not usually used at full capacity thereof, that is, if the user has set a temperature T.set unusually high for his/her actual uses.

[0022] The ECO method may be activated/deactivated by pressing a simple key, for example located on the front of the generic storage water heater, or the Delay and Optimisation functions may be activated independently of each other, only one or both.

[0023] The Delay function shall now be described in greater detail.

[0024] The water heater electronic control monitors the energy supply network to identify the current rate type.

[0025] According to a version of the Delay function, the electronic control has the water heating speed v.r pre-stored, according to the model of water heater it is installed on; in fact, such speed is known knowing the electrical power P.w, the thermal dispersions Q.d and the thermal capacity C of the water heater model in question. It is noted, however, that such speed may be considered as valid only if a certain approximation is accepted, that is, if we set aside the fact that, according to the type of each model in operation:

- the thermal power of the heating element P.w is variable for tolerances of execution of the electrical resistances and for fluctuations, considerable as well, of the actual mains voltage beyond the nominal value, or for variations of the gas calorific power;
- also the actual thermal dispersions Q.d are variable for tolerances of execution of the insulating layer and according to the temperature of the room where the

appliance is installed;

- the thermal capacity C is variable according to the amount of scale deposited on the electrical resistances and on the rod of the adjustment thermostat.

[0026] According to this first version of the Delay function, then, the electronic control at the beginning of a band at reduced rate F.rid, starts a heating step F.2 during which:

- it detects the initial water temperature T.2 inside the water heater;
- reads in its memory:
 - the pre-stored water heating speed v.r,
 - and the pre-stored time of end of the band at reduced rate F.rid;
- it calculates the heating time range Dt.2 required to heat the water from the temperature T.2 to the preset temperature T.set;
- it activates the heating element in advance on the time range Dt.2 compared to the known time of end of the band at reduced rate F.rid, so that the preset temperature T.set is reached at the same time as the end of said band at reduced rate F.rid.

[0027] By delaying the water heating to the last possible time, while performing it entirely within the time band at reduced rate, besides taking advantage of such rate there is the dual advantage of:

- avoiding possible power absorption peaks at the beginning of the band at reduced rate F.rid, if multiple appliances are all connected to the same energy supply network and all are set so as to activate at the beginning of the reduced rate without delaying the operation thereof;
- reducing thermal dispersions thanks to the fact that water heating is delayed as much as possible.

[0028] According to a useful additional version of the Delay function, said heating step F.2, suitable for reaching the preset temperature T.set starting from said initial temperature T.2, is preceded by a preheating step F.1.

[0029] According to such version, the electronic control enables the activation of the heating of the water heater with a delay time D.tr (for example, D.tr = 30 minutes) relative to the beginning of the band at reduced rate F.rid, so as to prevent said possible initial power absorption peaks.

[0030] Once the delay time D.tr has elapsed, only a preheating is allowed wherein from the initial temperature T.1, the water heater is made to reach a stand-by temperature T.sb, generally much lower than the water temperature set by the user T.set and preferably equal or close to the useful temperature T.u which, for example, is equal to 45 °C. The electronic control records the actual

time Dt.1 of preheating from the initial temperature T. 1 to the stand-by temperature T.sb.

[0031] At this point the electronic control, the initial T.1 and stand-by T.sb temperatures and the actual time Dt.1 of the first preheating step F.1 being known, is capable of calculating the actual heating speed v.r of the water heater in those specific operating conditions and replacing the data optionally pre-stored with the new updated value.

[0032] The preheating step F. 1 as described offers the advantages of:

- avoiding said possible power absorption peaks,
- but at the same time if the stand-by temperature T.sb is set substantially equal to the useful temperature T.u, providing a satisfactory amount of water usable for hygienic use almost immediately after the beginning of the time band F.rid, while limiting the thermal dispersions,
- and finally, determining with good precision the actual heating speed v.r at the current conditions.

[0033] The heating step F.2 for reaching the preset temperature T.set follows, exactly as already described above, wherein of course:

- the initial temperature T.2 substantially coincides, except for a slight cooling for thermal dispersions, with the stand-by temperature T.sb reached at the end of the preheating step F.1,
- and the heating speed v.r used is that stored in the previous preheating step F.1. Said recalculation of the heating speed v.r may be carried out for each subsequent preheating step F. 1 so as to always keep its value updated.

[0034] The Delay function allows money saving as it activates the water heater during the band at reduced rate F.rid and energy saving, thanks to the keen-witted use of times within such band.

[0035] There may be cases wherein the electronic control is instructed not to carry out the preheating step F.1, even if it is activated by the user, and to switch directly to the heating step F.2.

[0036] By way of an example, the electronic control may ignore the preheating step F.1 if:

- based on the initial temperature T.1 and on the pre-stored heating speed v.r, it calculates that the delay time D.tr + the time required to heat from the initial temperature T.1 to the preset temperature T.set is more than the duration of the band at reduced rate,
- and/or the initial temperature T.1 is higher than the useful temperature T.u,
- and/or the temperature difference between the preset temperature T.set and the useful temperature T.u is more than a predetermined preset value (for example $> 40^{\circ}\text{C}$), where the latter condition is a

practical and very simplified method to decide if there is time to perform the above preheating step F.1.

[0037] The Optimisation function shall now be described in detail.

[0038] In known storage water heaters, the water temperature maintenance value T.set, even if it is adjustable by the user, is normally unchanged with the time of the day and the day of the week.

[0039] According to the Optimisation function, said maintenance value T.set is optimised according to the actual water usage, making it variable according to the day of the week, and optionally for each day, according to the time, so as to keep into account the different water uses that there may be on holidays and working days, or more in general, also the time and in a different manner for each day of the week.

[0040] To this end, according to the Optimisation function, for each day of the week GG and at the end of consecutive periods of time Pt that cover the entire day, the storage temperature value T.acc and the maintenance value T.set are checked, for the same period of time of the same day of the next week, and such maintenance value T. set is changed or kept unchanged according to the storage temperature T.acc found.

[0041] More precisely, the maintenance value T.set is:

- increased if a storage temperature T.acc found is below the useful temperature T.u by a negative amount $\Delta T.dif$,
- reduced if a storage temperature T.acc found is higher than the useful temperature T.u by a positive amount $\Delta T.ecc$,
- unchanged if the storage temperature T.acc found is within the range between $(T.u + \Delta T.ecc)$ and $(T.u - \Delta T.dif)$.

[0042] The procedure described above may be performed in various more or less accurate manners.

[0043] According to a first manner, said consecutive periods of time Pt consist in a single period of 24 hours. That is, the storage temperature T.acc is monitored at the time of usage end h.set of each day, wherein "h.set" means the time when the water heater daily use ends. Such usage end time h.set may be pre-stored in the electronic control and usually, it is a late evening time.

[0044] In order to understand for each day of the week which the actual usage end time h.set is, a time monitoring is useful: when only a slight temperature drop due to thermal dispersions is sensed from one hour to the next one, this means that no hot water was used within that time range.

[0045] Therefore, the time monitoring allows detecting the profile of daily uses, as a general rule different every day of the week, and thus store the actual usage end time h.set of each day as the last time of the day after which no temperature drops are sensed if not due to thermal dispersions.

[0046] The actual usage end time h.set of each day is then stored in place of the previous values.

[0047] At this point, if at the usage end time h.set the storage temperature T.acc is higher than the useful temperature T.u by a positive amount $\Delta T.ecc$, this means that the preset temperature T.set may be reduced by the same positive amount $\Delta T.ecc$, without absolutely affecting the user requirements.

[0048] On the contrary, if at the usage end time h.set the storage temperature T.acc is below the useful temperature T.u, by a negative amount $\Delta T.dif$, this indicates that the user was not able to obtain the expected uses and that therefore, the preset temperature T.set must be increased at least by the same negative amount $\Delta T.dif$, even if this is not necessarily sufficient to meet the user requirements.

[0049] This being said, the following variation to the Optimisation function is possible:

- the electronic control has stored, for each day of the week from 1 to 7, a value of the preset temperature T.set and of the usage end time h.set;
- by a number of days GG equal to seven, the storage temperature T.acc is controlled at the specific usage end time h.set of each day;
- if for each day of the consecutive GG days the storage temperature T.acc is higher than the useful temperature T.u by a positive amount $\Delta T.ecc$, the preset temperature T.set is reduced by an amount equal to the positive amount $\Delta T.ecc$ or by a predetermined amount ΔT ;
- on the contrary, if for each day of the consecutive GG days the storage temperature T.acc is less than the useful temperature T.u by a negative amount $\Delta T.dif$, the preset temperature T.set of that day is increased by an amount at least equal to the negative amount $\Delta T.dif$ or by a predetermined amount ΔT .

[0050] As an alternative to a number of sampling days GG equal to 7, it is possible to consider a number of sampling days GG equal to a multiple of seven, whereas for the optional change of the preset temperature T.set, the mean value of the storage temperatures T.acc sensed on the same day of the week is taken into account, that is, the generic day GG, day GG + 7 and so on.

[0051] Said procedure may be carried out periodically for even consecutive sequences of days, in order to check any changes in the user's habits.

[0052] As another alternative, the storage temperature value T.acc considered is that resulting from the mobile average of samplings made in the last SS weeks, where for example the number of weeks SS is equal to two.

[0053] As regards the actual usage end time h.set for each day of the week, as may be sensed by the above time monitoring, this may be continuously updated too, according to the same methods just described for the determination of the storage temperature T.acc. Without departing from the scope of the invention, the Optimisa-

tion function may envisage the following simplified procedure, at least as regards the methods for changing the preset temperature T.set.

[0054] According to such version, the Optimisation function:

- does not change the temperature set T.set if at the usage end time h.set, the storage temperature T.acc is comprised within two minimum T.s.min and maximum T.s.max thresholds;
- decreases the temperature set T.set only if at the usage end time h.set, the storage temperature T.acc is higher than said predetermined maximum threshold T.s.max;
- increases the temperature set T.set only if at the usage end time h.set, the storage temperature T.acc is lower than said predetermined minimum threshold T.s.min;
- wherein in particular, said decrease or increase of the preset temperature T.set is a fixed value,
- and wherein, in particular, said minimum predetermined threshold T.s.min is equal for example to 35 °C, said maximum predetermined threshold T.s.max is equal for example to 45 °C and said decrease or increase of the preset temperature T.set is equal for example to 10 °C.

[0055] Another simplifying version may relate to the definition of the usage end time h.set which, instead of being preset for every day of the week or being calculated by studying the profile of daily usage, may consist in the time of start of the time band at reduced rate.

[0056] A further version may consist in the fact that in order to optimise the maintenance temperature automatically varying the preset value T.set, the electronic control performs a monitoring of the storage temperature T.acc at multiple times of each day rather than only at the usage end time h.set of each day, at which the daily use of the water heater ends, as already described in detail.

[0057] Said last version of the monitoring therefore allows measuring a more detailed profile of daily uses, as it is capable of controlling the storage temperature T.acc every "H" hours within a day, for example every hour or every 4/6 hours, and consequently proceeding to the variation of the preset temperature T.set for each period Pt expiring at the H-teenth hour.

[0058] As described above, in particular, for each period Pt, the electronic control proceeds to a reduction of the preset temperature T.set if the storage temperature T.acc is higher than a maximum predetermined threshold T.s.max, whereas it proceeds to an increase of the preset temperature T.set if the storage temperature T.acc is less than a minimum predetermined threshold T.s.min. On the contrary, it keeps the temperature T.set unchanged if such storage temperature T.acc is comprised between said minimum threshold T.s.min and maximum threshold T.s.max.

[0059] By way of an example and without any limiting

purpose, said reduction or increase of the preset temperature T.set is equal to 1-2 °C, whereas said minimum predetermined threshold T.s.min is still equal to 35 °C and said maximum predetermined threshold T.s.max is still equal to 45 °C.

[0060] The Optimisation function as described is capable of building a different profile of the preset water maintenance temperature T.set for each day of the week.

[0061] In general, without departing from the scope of the invention, the sampling days GG, rather than being 7 or a multiple of 7 are only one or a generic number M of days.

[0062] In general, therefore, the number of sampling days is equal to GG or a multiple M.GG, where GG is equal to 1 or 7.

[0063] The number of sampling days GG or M.GG may be predetermined by the manufacturer or it may be set by the user.

[0064] However, nothing prevents a very simplified version wherein the sampling days GG, rather than being 7 or a multiple of 7 are 1 or "a multiple of 1", or still the sampling may be performed not in days but hours, meaning that no difference is made between days of the week, and any consecutive sampling days are only used to sense the average value or the minimum value of storage temperatures T.acc.

[0065] In general, therefore, the number of sampling days is equal to GG or a multiple M.GG, where GG is equal to 1 or 7, or the sampling does not take place in hours.

Claims

1. Method for the management of water temperature in a storage water heater, comprising the functions of:

- calculating the passing of time;
- receiving information on the water temperature inside said water heater;
- storing the preset and/or read and/or calculated data;
- processing calculations from received or stored data;
- activating/deactivating the water heating based on the calculations processed and on the temperature of the water itself;
- storing, by a number (H) of consecutive periods of time (Pt) that cover the entire day and for a period of consecutive days (GG; M.GG), values of water maintenance temperature (T.set);
- said management method envisaging a function of reduction of energy consumption, wherein a variation of the maintenance temperature (T.set) stored is carried out by at least a first step wherein the temperature value (T.acc) of the storage (T.acc) is checked for a period of

consecutive days (GG; M.GG) and at the end (h.set) of said consecutive time periods (Pt);

characterised in that

said variation of the maintenance temperature (T.set) stored is further carried out by at least the following steps:

- according to a second step, a value regarded as representative of said storage temperature (T.acc) is compared with the predetermined temperature deemed useful (T.u) for hygienic use;

- according to a third step, for each of said consecutive time periods (Pt), said water maintenance temperature stored (T.set) is changed, alternately carrying out:

- a reduction if said storage temperature (T.acc) is higher than said useful temperature (T.u; T.s.max) by a predetermined positive amount (ΔT_{ecc}),

- an increase if said storage temperature (T.acc) is lower than said useful temperature (T.u; T.s.min) by a predetermined negative amount (ΔT_{dif}).

2. Method for the management of water temperature in a water heater according to claim 1,

characterised in that

said consecutive periods of time (Pt) consist in a single period of 24 hours.

3. Method of management according to claim 2,

characterised in that

said end (h.set) of said single 24 hour period substantially coincides with the end (h.set) of use of the water heater in the day.

4. Method of management according to claim 2,

characterised in that

said end (h.set) is predetermined by the user.

5. Method of management according to claim 2,

characterised in that

said end (h.set) is taken as coinciding with the time of start of a time band at reduced rate.

6. Method of management according to claim 2,

characterised in that

- monitoring of the storage temperature (T.acc) is carried out during the whole day,
- and said end (h.set) is made to coincide with the last time of the day after which no substantial drops of said storage temperature (T.acc) are sensed.

7. Method of management according to claim 2,

characterised in that

- monitoring of the storage temperature (T.acc) is carried out during multiple days representative of the same day of the week,
- the last end (h.set) after which no substantial drops of said storage temperature (T.acc) are sensed is sensed for each of said days,
- and said end (h.set) is made to coincide, for that day of the week, with the average of said last moments (h.set).
8. Method of management according to any previous claim,
characterised in that
said temperature value deemed representative of the storage temperature (T.acc) is the actual storage temperature value (T.acc) sensed during the execution of said first step.
9. Method of management according to any previous claim except 8,
characterised in that
said temperature value deemed representative of the storage temperature (T.acc) is the mean of the storage temperature value (T.acc) sensed during multiple repeated executions of said first step.
10. Method of management according to any previous claim,
characterised in that
said predetermined reference temperature (T.u; T.s.max) above which said reduction of said water maintenance temperature (T.set) is carried out is the predetermined useful temperature (T.u).
11. Method of management according to any previous claim except 10,
characterised in that
said predetermined reference temperature (T.u; T.s.max) above which said reduction of said water maintenance temperature (T.set) is carried out is a predetermined maximum threshold temperature (T.s.max).
12. Method of management according to the previous claim,
characterised in that
said maximum threshold temperature (T.s.max) is equal to 45 °C.
13. Method of management according to any previous claim,
characterised in that
said predetermined reference temperature (T.u; T.s.min) above which said increase of said water maintenance temperature (T.set) is carried out is the predetermined useful temperature (T.u).
14. Method of management according to any previous claim except 13,
characterised in that
said predetermined reference temperature (T.u; T.s.min) above which said increase of said water maintenance temperature (T.set) is carried out is a predetermined minimum threshold temperature (T.s.min).
15. Method of management according to the previous claim,
characterised in that
said minimum threshold temperature (T.s.min) is equal to 35 °C.
16. Method of management according to any previous claim,
characterised in that
said increases or reductions of said water maintenance temperature (T.set) are equal to 10 °C.
17. Method of management according to any previous claim except 16,
characterised in that
- said increases or reductions of said water maintenance temperature (T.set) are equal to 1-2 °C.
- and said consecutive periods of time (Pt) that cover a whole day are more than one.
18. Electronic control for carrying out the method according to claims 1-17 provided with means suitable for
- calculating the passing of time;
- receiving information on the water temperature inside a water heater;
- storing the preset and/or read and/or calculated data;
- processing calculations from received or stored data;
- activating/deactivating a heating element of the water contained in a storage water heater based on the calculations processed and on the temperature of the water itself;
characterised in that it is possible to carry out methods for heating said water heater according to one or more of the previous claims.
19. Storage water heater using an electronic control according to claim 18.
20. Storage water heater implementing functions according to one or more of the heating methods of claims from 1 to 17.

Patentansprüche

1. Verfahren zur Regelung der Wassertemperatur in einem Heißwasserspeicher, umfassend folgende Funktionen:

- Berechnen des Zeitablaufs;
- Empfangen von Informationen über die Wassertemperatur im Heißwasserspeicher;
- Speichern der voreingestellten und/oder gemessenen und/oder berechneten Daten;
- Verarbeiten von Berechnungen anhand der empfangenen oder gespeicherten Daten;
- Aktivieren/Deaktivieren des Erhitzens des Wassers, basierend auf den verarbeiteten Berechnungen und auf der Wassertemperatur;
- Speichern anhand einer Anzahl (H) an aufeinanderfolgenden Zeiträumen (Pt), die den gesamten Tag abdecken, und für einen Zeitraum aufeinanderfolgender Tage (GG; M.GG) von Werten der Wassererhaltungstemperatur (T.set);

wobei dieses Regelungsverfahren zur Reduzierung des Energieverbrauchs dient, wobei eine Änderung der gespeicherten Erhaltungstemperatur (T.set) durch mindestens einen ersten Schritt durchgeführt wird, wobei der Temperaturwert (T.acc) der Speicherung (T.acc) für einen Zeitraum aufeinanderfolgender Tage (GG; M.GG) und am Ende (h.set) der aufeinanderfolgenden Zeiträume (Pt) geprüft wird;

dadurch gekennzeichnet, dass

die Änderung der gespeicherten Erhaltungstemperatur (T.set) zudem durch mindestens folgende Schritte ausgeführt wird:

- Gemäß einem zweiten Schritt wird ein Wert, der als repräsentativ für die Speichertemperatur (T.acc) betrachtet wird, mit der vorgegebenen Temperatur verglichen, die als nützlich (T.u.) für die hygienische Verwendung eingestuft wird.
- Gemäß einem dritten Schritt wird diese gespeicherte Wassererhaltungstemperatur (T.set) für jeden der aufeinanderfolgenden Zeiträume (Pt) geändert, wobei alternativ Folgendes ausgeführt wird:

- eine Reduzierung um eine vorgegebene positive Menge (ΔT_{ecc}), wenn die Speichertemperatur (T.acc) höher ist als die nützliche Temperatur (T.u.; T.s.max),
- eine Erhöhung um eine vorgegebene negative Menge (ΔT_{dif}), wenn die Speichertemperatur (T.acc) niedriger ist als die nützliche Temperatur (T.u.; T.s.min).

2. Verfahren zur Regelung der Wassertemperatur in einem Heißwasserspeicher nach Anspruch 1,

dadurch gekennzeichnet, dass

die aufeinanderfolgenden Zeiträume (Pt) aus einem einzigen Zeitraum von 24 Stunden bestehen.

3. Verfahren zur Regelung nach Anspruch 2, **dadurch gekennzeichnet, dass** das Ende (h.set) des einzelnen 24-Stunden-Zeitraums im Wesentlichen mit dem Ende (h.set) der Nutzung des Heißwasserspeichers am Tag zusammenfällt.

4. Verfahren zur Regelung nach Anspruch 2, **dadurch gekennzeichnet, dass** das Ende (h.set) vom Nutzer vorgegeben ist.

5. Verfahren zur Regelung nach Anspruch 2, **dadurch gekennzeichnet, dass** das Ende (h.set) als zusammenfallend mit dem Zeitpunkt des Beginns einer Zeitspanne zu reduzierten Kosten betrachtet wird.

6. Verfahren zur Regelung nach Anspruch 2, **dadurch gekennzeichnet, dass**

- die Überwachung der Speichertemperatur (T.acc) während des ganzen Tags durchgeführt wird
- und dass das Ende (h.set) so festgelegt wird, dass es mit dem letzten Zeitpunkt des Tages zusammenfällt, nach dem keine wesentlichen Reduzierungen der Speichertemperatur (T.acc) mehr gemessen werden.

7. Verfahren zur Regelung nach Anspruch 2, **dadurch gekennzeichnet, dass**

- die Überwachung der Speichertemperatur (T.acc) über mehrere Tage durchgeführt wird, die repräsentativ für denselben Tag in der Woche sind,
- dass das letzte Ende (h.set), nach dem keine wesentlichen Reduzierungen der Speichertemperatur (T.acc) mehr gemessen werden, für jeden dieser Tage gemessen wird
- und dass das Ende (h.set) so festgelegt wird, dass es für den betreffenden Wochentag mit dem Durchschnitt der letzten Zeitpunkte (h.set) zusammenfällt.

8. Verfahren zur Regelung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der Temperaturwert, der als repräsentativ für die Speichertemperatur (T.acc) eingestuft wird, die Ist-Speichertemperatur (T.acc) ist, die während der Ausführung des ersten Schritts gemessen wird.

9. Verfahren zur Regelung nach einem der vorherge-

- henden Ansprüche mit Ausnahme von Anspruch 8, **dadurch gekennzeichnet, dass** der Temperaturwert, der als repräsentativ für die Speichertemperatur (T.acc) eingestuft wird, der Mittelwert der Speichertemperatur (T.acc) ist, die während mehrerer wiederholter Ausführungen des ersten Schritts gemessen wird.
10. Verfahren zur Regelung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die vorgegebene Referenztemperatur (T.u.; T.s.max), oberhalb derer die Reduzierung der Wassererhaltungstemperatur (T.set) durchgeführt wird, die vorgegebene nützliche Temperatur (T.u.) ist.
11. Verfahren zur Regelung nach einem der vorhergehenden Ansprüche mit Ausnahme von Anspruch 10, **dadurch gekennzeichnet, dass** die vorgegebene Referenztemperatur (T.u.; T.s.max), oberhalb derer die Reduzierung der Wassererhaltungstemperatur (T.set) durchgeführt wird, eine vorgegebene maximale Schwellentemperatur (T.s.max) ist.
12. Verfahren zur Regelung nach dem vorhergehenden Anspruch, **dadurch gekennzeichnet, dass** die maximale Schwellentemperatur (T.s.max) gleich 45 °C ist.
13. Verfahren zur Regelung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die vorgegebene Referenztemperatur (T.u.; T.s.min), oberhalb derer die Erhöhung der Wassererhaltungstemperatur (T.set) durchgeführt wird, die vorgegebene nützliche Temperatur (T.u.) ist.
14. Verfahren zur Regelung nach einem der vorhergehenden Ansprüche mit Ausnahme von Anspruch 13, **dadurch gekennzeichnet, dass** die vorgegebene Referenztemperatur (T.u.; T.s.min), oberhalb derer die Erhöhung der Wassererhaltungstemperatur (T.set) durchgeführt wird, eine vorgegebene Mindestschwellentemperatur (T.s.min) ist.
15. Verfahren zur Regelung nach dem vorhergehenden Anspruch, **dadurch gekennzeichnet, dass** die Mindestschwellentemperatur (T.s.max) gleich 35 °C ist.
16. Verfahren zur Regelung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Erhöhungen oder Reduzierungen der Wass-
- erhaltungstemperatur (T.set) gleich 10°C sind.
17. Verfahren zur Regelung nach den vorhergehenden Ansprüchen mit Ausnahme von Anspruch 16, **dadurch gekennzeichnet, dass**
- die Erhöhungen oder Reduzierungen der Wassererhaltungstemperatur (T.set) gleich 1 bis 2 °C sind
 - und dass die aufeinanderfolgenden Zeiträume (Pt), die einen ganzen Tag abdecken, mehr als einer sind.
18. Elektronische Steuerung zur Durchführung des Verfahrens nach den Ansprüchen 1 bis 17, versehen mit Mitteln, die geeignet sind zum
- Berechnen des Zeitablaufs;
 - Empfangen von Informationen über die Wassertemperatur in einem Heißwasserspeicher;
 - Speichern der voreingestellten und/oder gemessenen und/oder berechneten Daten;
 - Verarbeiten von Berechnungen anhand der empfangenen oder gespeicherten Daten;
 - Aktivieren/Deaktivieren eines Heizelements des in einem Heißwasserspeicher enthaltenen Wassers, basierend auf den verarbeiteten Berechnungen und auf der Wassertemperatur;
- dadurch gekennzeichnet, dass** die Möglichkeit besteht, Verfahren zum Erhitzen des Heißwasserspeichers nach einem oder mehreren der vorhergehenden Ansprüche durchzuführen.
19. Heißwasserspeicher, nutzend eine elektronische Steuerung nach Anspruch 18.
20. Heißwasserspeicher, aufweisend Funktionen nach einem oder mehreren der Erhitzungsverfahren nach den Ansprüchen 1 bis 17.
- Revendications**
1. Procédé de gestion de la température de l'eau dans un chauffe-eau à accumulation, comportant les fonctions de:
- calculer le temps passé;
 - recevoir des informations sur la température de l'eau à l'intérieur dudit chauffe-eau;
 - mémoriser les données configurées à l'avance et/ou lues et/ou calculées;
 - effectuer des calculs à partir des données reçues ou mémorisées ;
 - activer/désactiver le chauffage de l'eau en fonction des calculs effectués et de la température de ladite eau;

- mémoriser, pour un nombre (H) de périodes de temps consécutives (Pt) qui couvrent toute la durée de la journée et pour une période de jours consécutifs (GG; M.GG), des valeurs de la température (T.set) de maintien de l'eau; ledit procédé de gestion prévoit une fonction de réduction des consommations d'énergie, comportant l'application d'une variation de la température mémorisée (T.set) de maintien à travers au moins un premier passage pendant lequel on contrôle, pour une période de jours consécutifs (GG; M.GG) ainsi qu'à la fin (h.set) de ces périodes de temps consécutives (Pt), la valeur de température (T.acc) de l'accumulation;
- caractérisé par le fait que**
ladite variation de la température mémorisée (T.set) de maintien est ultérieurement appliquée à travers au moins les passages suivants:
- d'après un deuxième passage, on compare une valeur considérée représentative de ladite température d'accumulation (T.acc) à la température prédéterminée jugée utile (T.u) pour les usage hygiéniques;
 - d'après un troisième passage, pour chacune desdites périodes de temps consécutives (Pt) on procède à la variation de ladite température mémorisée (T.set) de maintien de l'eau, en appliquant, alternativement:
 - une réduction si ladite température d'accumulation (T.acc) est supérieure à ladite température utile (T.u; T.s.max) d'une quantité en excès déterminée (ΔT_{ecc}),
 - une augmentation si ladite température d'accumulation (T.acc) est inférieure à ladite température utile (T.u; T.s.min) d'une quantité en défaut déterminée (ΔT_{dif}).
2. Procédé de gestion de la température de l'eau dans un chauffe-eau selon la revendication 1, **caractérisé par le fait que** ces périodes de temps consécutives (Pt) consistent en une période unique de 24 heures.
3. Procédé de gestion selon la revendication 2, **caractérisé par le fait que** ce terme (h.set) de cette période unique de 24 heures coïncide pratiquement avec le terme (h.set) d'utilisation du chauffe-eau dans la journée.
4. Procédé de gestion selon la revendication 2, **caractérisé par le fait que** ledit terme (h.set) est prédéterminé par l'utilisateur.
5. Procédé de gestion selon la revendication 2, **caractérisé par le fait que** ledit terme (h.set) est supposé coïncider avec le moment de début d'une tranche horaire à tarif réduit.
6. Procédé de gestion selon la revendication 2, **caractérisé par le fait que**
- un suivi de la température d'accumulation (T.acc) est effectué tout le long de la journée,
 - et ce terme (h.set) est fait coïncider avec le dernier moment de la journée après lequel on ne constate aucune baisse significative de ladite température d'accumulation (T.acc).
7. Procédé de gestion selon la revendication 2, **caractérisé par le fait que**
- un suivi de la température d'accumulation (T.acc) est effectué pendant plusieurs jours représentatifs du même jour de la semaine,
 - on relève, pour chacun de ces jours, le dernier terme (h.set) après lequel on ne constate aucune baisse significative de ladite température d'accumulation (T.acc),
 - et ce terme (h.set) est fait coïncider, pour ce jour de la semaine, avec la moyenne de ces derniers moments (h.set).
8. Procédé de gestion selon n'importe quelle revendication précédente, **caractérisé par le fait que** ladite valeur de température considérée comme représentative de la température de l'accumulation (T.acc) est la valeur effective de température de l'accumulation (T.acc) relevée au cours de l'exécution dudit premier passage.
9. Procédé de gestion selon n'importe quelle revendication précédente, 8 non comprise, **caractérisé par le fait que** ladite valeur de température considérée comme représentative de la température de l'accumulation (T.acc) est la moyenne des valeurs de température de l'accumulation (T.acc) relevées au cours de plusieurs exécutions répétées de ce premier passage.
10. Procédé de gestion selon n'importe quelle revendication précédente, **caractérisé par le fait que** ladite température prédéterminée de référence (T.u; T.s.max) au-dessus de laquelle est appliquée la réduction de cette température (T.set) de maintien de l'eau est la température prédéterminée utile (T.u).
11. Procédé de gestion selon n'importe quelle revendication précédente, 10 non comprise, **caractérisé par le fait que** ladite température prédéterminée de référence (T.u; T.s.max) au-dessus de laquelle est appliquée la réduction de ladite température (T.set) de maintien de

- l'eau est une température prédéterminée de limite maximum (T.s.max).
12. Procédé de gestion selon la revendication précédente, **caractérisé par le fait que** ladite température prédéterminée de limite maximum (T.s.max) est égale à 45 °C. 5
13. Procédé de gestion selon n'importe quelle revendication précédente, **caractérisé par le fait que** ladite température prédéterminée de référence (T.u; T.s.min) au-dessous de laquelle est appliquée l'augmentation de cette température (T.set) de maintien de l'eau est la température prédéterminée utile (T.u). 10 15
14. Procédé de gestion selon n'importe quelle revendication précédente, 13 non comprise, **caractérisé par le fait que** ladite température prédéterminée de référence (T.u; T.s.min) au-dessous de laquelle est appliquée l'augmentation de ladite température (T.set) de maintien de l'eau est une température prédéterminée de limite minimum (T.s.min). 20 25
15. Procédé de gestion selon la revendication précédente, **caractérisé par le fait que** ladite température prédéterminée de limite minimum (T.s.min) est égale à 35 °C. 30
16. Procédé de gestion selon n'importe quelle revendication précédente, **caractérisé par le fait que** ces augmentations ou réductions de ladite température (T.set) de maintien de l'eau sont égales à 10 °C. 35
17. Procédé de gestion selon n'importe quelle revendication précédente, 16 non comprise, **caractérisé par le fait que**
- lesdites augmentations ou réductions de ladite température (T.set) de maintien de l'eau sont égales à 1- 2 °C, 45
 - et lesdites périodes de temps consécutives (Pt) qui couvrent toute une journée sont en nombre supérieur à une. 50
18. Contrôle électronique pour l'application du procédé selon les revendications de la 1 à la 17, équipé de systèmes aptes à:
- calculer le temps passé; 55
 - recevoir des informations sur la température de l'eau dans un chauffe-eau;
 - mémoriser les données configurées à l'avance
- et/ou lues et/ou calculées;
- effectuer des calculs à partir des données reçues ou mémorisées;
 - activer/désactiver un élément de chauffage de l'eau contenue dans un chauffe-eau à accumulation en fonction des calculs effectués et de la température de cette eau;
- caractérisé par** le fait de pouvoir appliquer des méthodes de chauffage dudit chauffe-eau selon une ou plusieurs revendications précédentes.
19. Chauffe-eau à accumulation utilisant une commande électronique selon la revendication 18.
20. Chauffe-eau à accumulation mettant en oeuvre des fonctions selon une ou plusieurs méthodes de chauffage des revendications de 1 à 17.

Fig. 1a

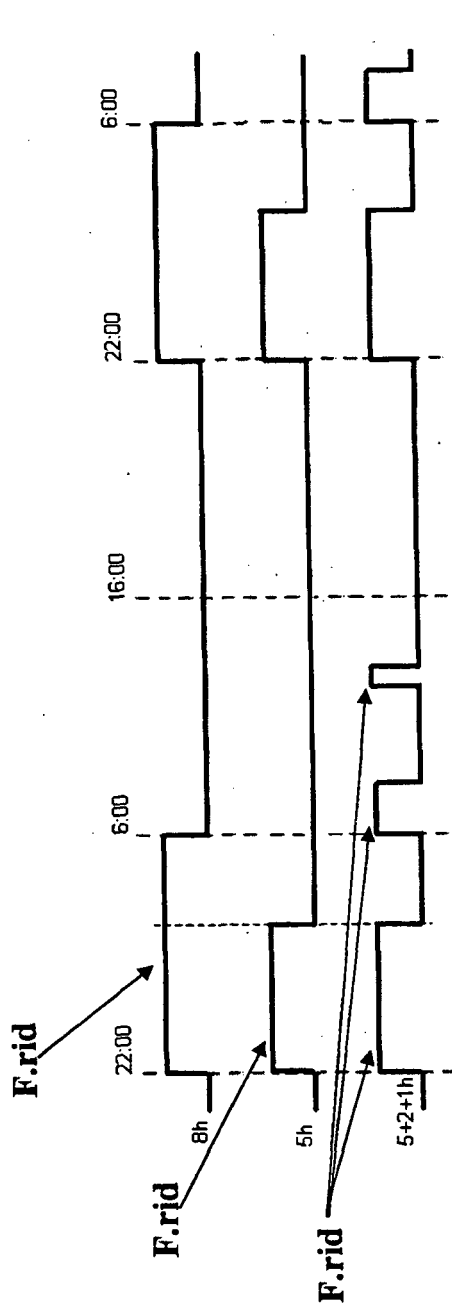


Fig. 1b

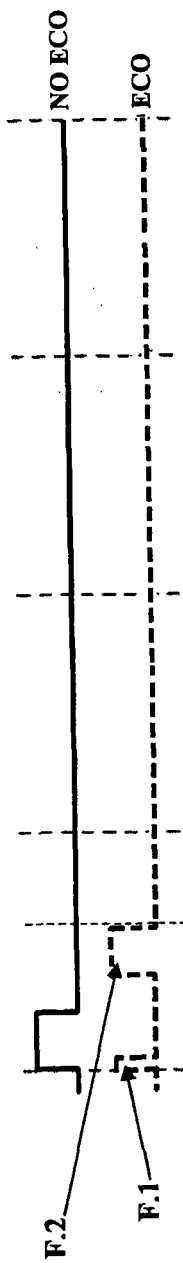
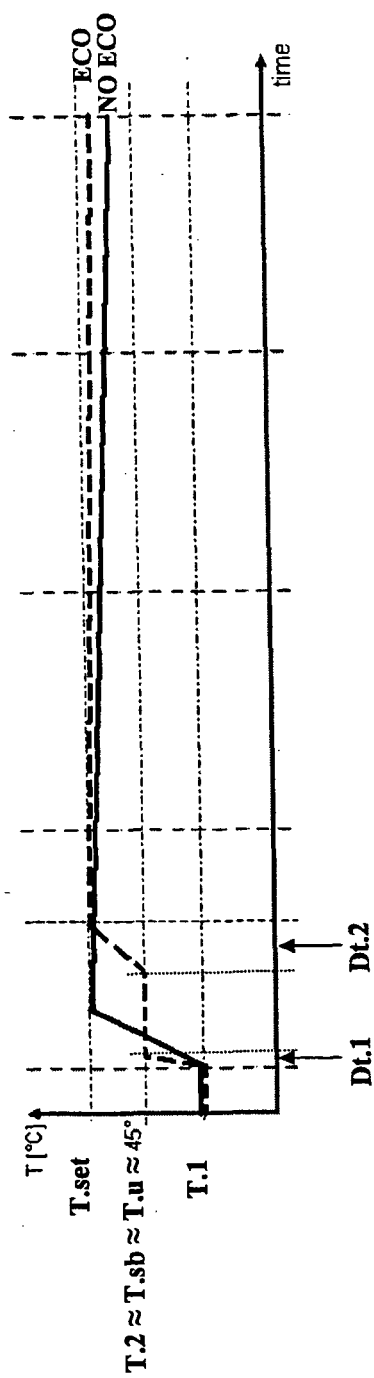


Fig. 1c



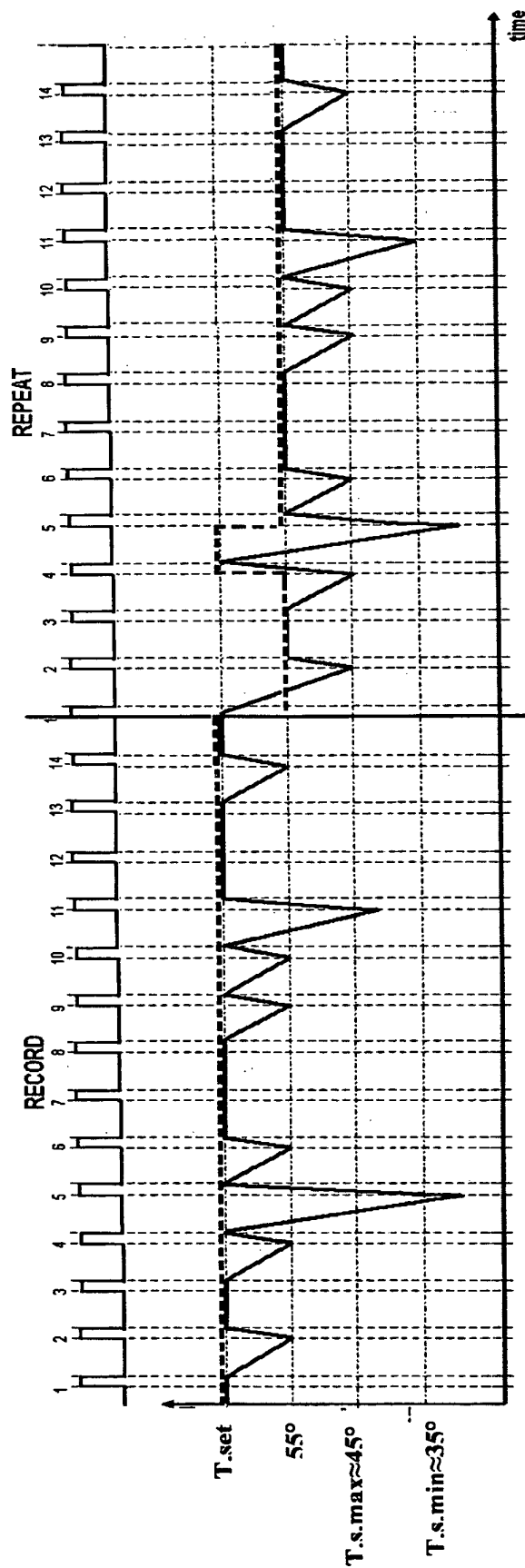


Fig. 2

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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