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(54) **ELECTRONIC THERMAL-PROTECTOR FOR ELECTRIC WATER BOILERS**

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PROTECTEUR THERMOELECTRONIQUE POUR CHAUFFE-EAU ELECTRIQUES

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(56) References cited:
NL-A- 8 501 754 US-B1- 6 246 831

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Description

[0001] This invention relates to regulation and safety control devices for electric water boilers. Electric water boilers have two devices that control the temperature of the water contained in the tank.

[0002] One is a regulating thermostat (hereinafter also referred to as the heat regulator). Its task is that of adjusting the temperature by maintaining the water boiler's temperature at the t.r value set either by the manufacturer and/or by the user; of course, any regulation range made available to the user prevents that dangerous temperatures can be reached.

[0003] The other device is a thermal-protector thermostat (hereinafter referred to as the thermal-protector). Its task is that of providing thermal protection by cutting off the power supply to the electrical resistances if the monitored temperature reaches an intermediate cut-off value of t.i ranging between the temperature values that can be reached during normal operation and the maximum value of t.s envisaged by Safety Regulations. In general, this may take place only if the regulating thermostat has suffered a failure; for instance, if the setting is not correct or if its electrical contacts are welded and can no longer open. However, it is also possible that an anomalous situation such as, for instance, the lack of water in the tank, may lead to sudden increases in temperature that activate the thermal-protector even though the regulating thermostat is in perfect condition.

[0004] The accuracy of the regulating thermostat is extremely important, not so much in terms of comfort but for the purpose of limiting consumption; given the same mean temperature in the water boiler over a given period, the sharper the variations in the actual temperature owing to its inaccurate control are, the greater the loss of heat, as proven experimentally. From this point of view it is a matter of fact that the most precise electro-mechanical thermostats are those using a bulb sensor followed by a rod sensor and then by those whose sensor is composed of a bi-stable bimetallic foil. Electronic thermostats are by far the best, generally using an NTC as sensor, that not only provides for an accurate regulation which could not be otherwise reached with electro-mechanical thermostats, but they also offer many other advantages such as the ease in controlling them with a microprocessor, by means of which the operating time and temperatures as well as other functions can be programmed. While electro-mechanical thermostats cut off the power supply to the electrical resistances by physically opening an electrical contact, electronic thermostats act by stopping the passage of current through a semiconductor device (the TRIAC), which, in turn, can be arranged directly in series along the circuit of the electrical resistances if the required amperage is low enough or by commanding the opening of a relay, which, in turn, disconnects the circuit of the resistances. Nonetheless, the safety regulations do not require that the regulating thermostat physically disconnect the phases of an electric circuit.

[0005] The bipolar physical disconnection of both ends of the electrical circuit of the resistances is commanded by the thermal-protector thermostat; on the other hand, no particular degree of accuracy is required for the activation temperature, as the tolerance values of the less sensitive sensors like those with a bi-stable bimetallic foil are capable of being activated at cut-off temperatures t.i much higher than the regulation temperature t.r yet well below the maximum permissible temperatures t.s. Hitherto, the thermal-protector thermostat in water boilers has always been of the electro-mechanical type with an extremely simple mechanism; in general it is of the type containing the well-known bi-stable bimetallic disks as sensor/actuator device. When the set temperature is reached, the thermal-protector thermostat irreversibly opens the two (or three) power supply phases; the resetting of the contacts is possible in most models to restart the water boiler when the overtemperature is not the result of malfunctions affecting the regulating thermostat, but the reset device must be accessed only by a maintenance technician, thereby constituting the inconvenience that the resetting of the water boiler always requires the intervention of the technical servicing department, even if the cause of the block was absolutely accidental.

[0006] For the sake of compact and easy assembly, the electro-mechanical regulating thermostat and the thermal-protector thermostat are often lodged in the same casing; but this does not mean that they are not two independent devices, each having its own sensor, its own mechanism for opening the electrical contacts and finally its own electrical contacts. In conclusion, safety requires that the two thermostats must each have their own "electro-mechanical logic".

[0007] As for the electronic regulating thermostats, their use has been limited up to now to higher level products, considering the impossibility of eliminating the costs for the electro-mechanical thermal-protector, which, among other things, is usually quite difficult to include in the same casing with the electronic thermostat. While the most widespread type of thermal-protector is the one with bimetallic foil, it must be lodged as close as possible to the zone whose temperature must be monitored, i.e. the zone in which the operating temperature can be high enough to damage the electronic devices even in normal operating conditions.

[0008] The document NL 8 501 754 A shows an electronic device for the thermal regulation and thermal protection of storage water heater that is put in blocked status not only when a given temperature is exceeded but even in case an anomalous operation of the temperature sensors is noticed. The blocked status is obtained by switching off the heating with the opening of a bi-status relay while an RC network prevents from going in blocked status due to anomalies of short length. Once put in blocked status, the device does not keep memory of the detected failures so that it could accept an indefinite number of resetting actions even in dangerous situations. Such a device, although representing a progress, is so

conceived that, as expressly specified, still it must provide the device that restores the normal operating conditions accessible only to the maintenance technicians as the previous electromechanical security devices. This is a drawback, because the maintenance technicians must be called whenever the water heater is put in blocked status even if this is not due to failures.

[0009] The main purpose of this invention is that of allowing the user to reset regular water boiler operation when it is blocked by the thermal-protector even avoiding dangerous situations. Another purpose of this invention is that of specifying the means by which to obtain a single control device capable of acting, at minimum, as regulating thermostat and thermal-protector in an electric water boiler.

[0010] Another purpose of this invention is that of specifying the means by which to allow the said single control device to use a single operating logic, i.e. a single hardware device and a single software device, at least for the control of the heat regulator and thermal-protector functions. Another purpose of this invention is that of assigning to the said single control device further information, programming and control functions which are not related to either the heat regulation or thermal protection.

[0011] According to the invention, these and other purposes are achieved by means of a control device including a combination of suitable electronic and electro-mechanical means which function according to appropriate methods.

[0012] The invention shall now be illustrated with regard to a number of preferred yet non-exclusive variants in the following description as well as in the drawing and attached claims, which constitute an integral part of the invention's description.

[0013] A number of preferred variants of the invention are now illustrated.

[0014] Fig. 1, the sole illustration attached to this description, schematically illustrates an electronic and electro-mechanical control device R according to the invention.

[0015] With regard to the figure, R indicates a control device which, taken as a whole, has the functions of heat regulator and thermal-protector; 1 is an electrical power circuit powering, via the connection terminals 2.1, the electrical resistances 2 that heat the water; 3 indicates a regulation relay whose opening/closing controls the power supply to the resistances 2 to maintain the water at the temperature set during regular operation; 4 indicates two safety relays (or, alternatively, a single relay with a double micro-switch) which the control device R opens should it detect any operating malfunction incompatible with the safety regulations; 5 indicates two possible fuses which are arranged in series with said relays 4 and which protect the contacts of the relays 4 against overcurrents which would lead to their sticking.

[0016] Control device R comprises one or two temperature sensors 6, preferably of the NTC type or in any case of a type fit to transmit temperature signals that can

be interpreted by electronic devices; of the two sensors 6, one is dedicated to the control of the set regulation temperature t.r and the other to the control of the cut-off temperature t.i; however, consistent with the requirements of the relevant regulations and with the points in which said regulation temperature t.r and cut-off temperature t.i must or can be detected, a single sensor 6 can be used both for the information relating to the heat regulation and for the thermal protection; at least a second sensor 6 can be useful for auxiliary functions not relating to heat regulation and to thermal protection such as, for instance, and according to known methods, the estimation of the mean temperature and the energy content of the water boiler, which can be easily inferred if the water temperature in two different duly chosen zones are known.

[0017] Control device R also comprises a microprocessor 7 equipped with specific software to perform, at minimum, the following tasks:

- receive and interpret signals from the sensors 6;
- if there are no operating malfunctions, command the relay 3 via the command cable 3.1 to modulate the thermal power to be supplied to the water via the resistances 2 to maintain the temperature around the set regulation temperature t.r value;
- if there are operating malfunctions, force the opening of the relays 4 via the command cable 4.1 to cut off both power supply phases of the resistances 2.

[0018] Among other things, the operating malfunctions that can be identified by the microprocessor 7 include not only the detection of overtemperatures signalled by the sensors 6, but also the failure of said sensors owing to an interruption or short-circuit signalled by an infinite, null or absurd value of their electrical resistor, i.e. outside the range of possible values for the intact sensors 6.

[0019] The control device R comprises also a hardware circuit 8 which acts as a supervisor (commonly called and well-known as the system "watch-dog"); it monitors the proper functioning of the microprocessor 7 and it opens the relays 4 by means of the command circuits 4.2, if anomalous behaviour is detected in the microprocessor 7 or in other essential or auxiliary devices including the control device R. As regards the said watch-dog 8, which functions according to known techniques and methods, it shall not be mentioned any further below, as it is implicitly inferred that it can supervise the control of any function within the limits provided by the current state of the art.

[0020] It must be borne in mind that today's technologies for the manufacturing of electronic equipment providing for the possible redundancy of logic circuits and monitoring methods by means of hardware circuits which act as watch-dogs, at least with regard to the proper performance of the main functions, make it possible to obtain extremely reliable devices, which can be entrusted with safety functions, as is acknowledged and accepted by

the relevant Regulatory Bodies.

[0021] If one of the relays 4 opens as a result of a detected malfunction, automatic closure by the control device cannot occur once the malfunction has been eliminated: only a manually operated resetting device 9 can command their closing. However, the said reset command is accepted by the safety system only when the microprocessor 7 ascertains that the malfunction causing the opening of the relays 4 no longer subsists. In other words, if, for instance, there is an accidental increase in the temperature, the reset command and the subsequent closing of the relays 4 is accepted, but only once the temperature is back to normal; on the contrary, if, by way of example, the malfunction consists in the irreversible failure of a sensor, it is not possible to restore normal conditions and hence the reset command continues to be rejected by the microprocessor 7. As known, electro-mechanical thermal-protectors are also provided with a reset command to reset the thermostat once the malfunction has been eliminated; it comprises a pushbutton, which, once pressed, acts directly on the electrical contacts by closing them; pressing the pushbutton, however, may force the closing of said contacts even though the malfunction is still in progress. For this reason, the said pushbutton is lodged in a place which cannot be accessed by the user and it is protected by a cover which can be opened with a special tool so that only an authorized repair technician can activate it. On the contrary, as stated above, according to this invention, since the reset command is rejected and it does not have any effect if the malfunction is still in progress, the user can nonetheless gain access to the command with the advantage that there is no need to call the technical servicing department to reset the water boiler when there has been no failure but just a temporary and reversible malfunction.

[0022] However, the control device R may also be designed to be able to take into account and memorize the number of reset commands it has accepted and limit the maximum possible number of resets to a set value beyond which it rejects any other command. Therefore, even a temporary and reversible malfunction may require the intervention of the technical servicing department if it occurs too often, hence indicating that there is a recurring problem that needs to be identified and resolved.

[0023] For this reason, too, the control device R can include the presence of a non-volatile memory 10 such as an EEPROM, i.e. a memory which is not deleted if there is no power and which saves with an appropriate code all the anomalies detected and/or the number of resets accepted; said memory 10 can also save data not relating to the heat regulation and thermal protection, but which are nonetheless useful in performing the aforementioned auxiliary functions:

[0024] In conclusion, a display 11 may also be furnished, providing the user with information on the status of the water boiler with regard to both the heat regulation and thermal protection functions and to the auxiliary functions.

[0025] Another difference not only in terms of means but also of method or, rather, of the operating logic compared to the current electro-mechanical heat regulation and thermal protection devices is, as stated above, that the latter always have two independent devices even when they are lodged in the same casing; in other words, they each follow their own mechanical logic. Instead, the control device R has a single "electronic logic", even though it is redundant for safety reasons and it includes both a software and hardware component, comprising the watch-dog 8. Said "electronic logic" is not composed of specific parts dedicated to heat regulation, thermal protection and to the auxiliary functions. Regardless of whether there is more than one temperature sensor 6, for the sake of compliance with regulations or of measuring the temperature in several points, their signals are received by a single unit which performs various functions depending on the cases: as long as the temperature levels are normal, the "electronic logic" of the control device R controls the operation of the regulation relay 3 or, in other words, it carries out the heat regulation procedure; once the cut-off temperature t_i is exceeded or if there are other malfunctions, the same control device R opens both safety relays 4, namely, it starts the thermal protection procedure by blocking the water boiler; in the meantime, the "electronic logic" of the control device R can also perform other auxiliary information or programming functions, and so on.

[0026] The advantage is clearly that the control device R provides for the development of non-essential functions which are however useful for programming and other purposes with only negligible additional costs.

[0027] Other embodiments are possible for the control device R and a few non-exhaustive examples are provided below.

[0028] The safety relays 4 can be either of the Normally Closed or Normally Opened type, as they both can be safely opened or kept opened by the control device R in case of anomalous conditions.

[0029] The cut-off device 3, as in the case of current electronic regulating thermostats, may have a TRIAC instead of a relay.

[0030] As it is provided with relays that can perform a number of cycles greater than those envisaged during the life of a water boiler (for instance, 300.000 cycles at the state of the art), the regulation relay 3 can be eliminated and its function can be assigned to either one or both of the safety relays 4. In said case the safety provided by the control device R can be further improved by adding one or more of the following functions or devices:

- the aforementioned fuses 5 can be included;
- in heat regulation mode, it is possible and sufficient to command alternately the opening of just one of the two relays 4 so that the wear of their contacts proceeds evenly and that the possibility of 2 x 300.000 open-close cycles for the electrical resistances 2 are guaranteed for the purpose of heat reg-

ulation;

- once the number of cycles approaches the maximum value envisaged, the control device R can be blocked by opening the relays 4 definitively;
- failure to open a contact of one of the relays 4 can be detected by the control device R in various ways by means of electrical or thermal signals (for instance, by detecting that there was a drop in the voltage at the ends of the electrical resistances 2 or that, despite the open command, the temperature continues to rise) with the subsequent immediate and non-resettable opening of the other relay 4.

[0031] As for the relays 4, provided that the relevant regulations consent to it, they can be replaced by a TRI-AC.

[0032] In conclusion, it should be pointed out that, with the due modifications, the foregoing refers to a two-phase current and can hence be applied also to three-phase systems with the electrical resistances connected in a delta or star layout.

Claims

1. Control device (R) for the heat regulation and thermal protection functions in electric water boilers, comprising

- at least one sensor (6) for the measurement of the tank water's temperature;
- an electric power circuit (1) supplying, by means of connection terminals (2.1), electric resistances (2) for the heating of the tank's water;
- means (3.1; 4.1) to control a cut-off device (3; 4) whose opening/closing controls the power supply to the resistances (2) to maintain the water at the regulation temperature (t.r.) set during regular operating;
- means (4.1; 4.2) to stop, in case of operating anomalies, the heat regulation process by opening microswitches of safety relays (4) to cut off the power at both of said connection terminals (2.1) of said electric resistances (2); said safety relays (4) consisting either of two relays (4) with a single microswitch or of a single relay (4) with a double microswitch and said operating anomalies consisting in
 - reaching of a cut-off temperature (t.i.) by the tank water greater than the regulation temperature (t.r.) yet lower than the safety temperature (t.s),
 - and/or anomalous functioning of one or more of said sensors (6);
- a manually operated resetting device (9) to reset the heat regulation procedure if stopped ow-

ing to said operating anomalies;

- an electronic logic (7, 8, 9, 10) to provide at least for the control of said heat regulation and thermal protection means;

characterized by the fact that the reset command is accepted by the safety system only when a microprocessor (7) belonging to the electronic logic (7, 8, 9, 10) ascertains that the malfunction causing the opening of the relays (4) no longer subsists.

2. Control device (R) according to the previous claim 1 **characterized by** the fact that said manually operated resetting device (9) is capable of resetting the heat regulation procedure only up to a set maximum number of resets.

3. Control device (R) according to the claims 1 or 2 **characterized by** the fact that said electronic logic (7, 8, 9, 10) is expressed at least in part by means of software instructions saved in a microprocessor (7).

4. Control device (R) according to any of the previous claims 1 to 3

characterized by the fact that a permanent memory (10) such as an EEPROM, is envisaged in which at least the information relating to operating malfunctions can be logged.

5. Control device (R) according to any of the previous claims

characterized by the fact that said cut-off device (3; 4) to control the power supply in order to maintain the water at the regulation temperature (t.r.) is a TRIAC (3).

6. Control device (R) according to any of the previous claims from 1 to 4

characterized by the fact that said cut-off device (3; 4) whose opening/closing controls the power supply to maintain the water at the regulation temperature (t.r.) is a regulation relay (3; 4).

7. Control device (R) according to claim 6 **characterized by** the fact that

- said safety relays (4) consist of two safety relays (4) with a single microswitch,
- said regulation relay (3; 4) coincides with one of said two safety relays (4),
- said safety relay (4), which also provides for heat regulation, is of a type capable of performing a number of cycles equal at least to those envisaged for the water boiler's life.

8. Control device (R) according to the previous claim 6, **characterized by** the fact that

- said safety relays (4) consist of two safety relays (4) with a single microswitch,
- said regulation relay (3; 4) coincides, alternately, with one of two said safety relays (4),
- said safety relays (4) are of a type capable of performing a number of cycles equal at least to half of those envisaged for the water boiler's life.

9. Control device (R) according to the previous claims 7 or 8

characterized by the fact that

the same control device (R) can count said number of cycles by memorizing them in said permanent memory (10) and is programmed to open said two relays (4) so that it cannot be reset once a set number of cycles is reached.

10. Control device (R) according to the previous claims 4 or 7

characterized by the fact that

the control device (R) can detect the failure to open of said safety relay (4) used also for heat regulation and be set to actuate the subsequent immediate non-resettable opening of the other of said two safety relays (4).

11. Control device (R) according to any of the previous claims 1 to 10

characterized by the fact that

a hardware logic circuit (8) performing the functions of a watch-dog is further envisaged,

- which is capable of detecting, according to the state of the art, one or more performance anomalies of said microprocessor (7) and other system components,
- and which is equipped with means (4.2) to stop, in case of operating anomalies, the heat regulation procedure by opening the microswitches of the safety relays (4).

12. Control method for the heat regulation and thermal protection functions in electric water boilers comprising

- sensing the tank water's temperature,
- supplying electric power for the heating of the tank's water,
- controlling said electric power supply to maintain the water at the regulation temperature (t.r.) set during regular operating,
- detecting possible operating anomalies
- cutting off said electric power in case of said detected operating anomalies,
- manually attempting to operate the resetting

of the heat regulation procedure **characterized by** the fact that

said manual resetting of the heat regulation procedure is accepted provided that said operating anomalies no longer subsist.

13. Control method according to the previous claim 12. **characterized by** the fact that

the number of said operated manual reset is counted and memorized and by the fact that further manually operated resets are rendered impossible when said number of resets exceeds a maximum possible value, said manual resetting of the heat regulation procedure being possible only for a given number of times.

14. Control method according to the previous claim 12 **characterized by** the fact that

the wearing of the microswitches (3; 4) used for the heat regulation procedure is monitored by counting the number of times that said microswitches (3; 4) are actuated and by the fact that, once a set number of actuations is exceeded,

- the thermal protection is activated,
- while the manual resetting of the heat regulation procedure is deactivated.

15. Control method according to the previous claim 12 **characterized by** the fact that

when one of the two safety relays (4) is used for heat regulation and in case said safety relay (4) does not respond to an opening command,

- the other safety relay (4) is immediately opened,
- while the manual resetting of the heat regulation procedure is deactivated.

16. Control method according to the previous claim 12 **characterized by** the fact that

the correctness of the operations carried out by the control system is monitored and the water boiler is shut off if said operations are considered as incorrect.

Patentansprüche

1. Steuergerät (R) für die Funktionen der Wärmeregulierung und des thermischen Schutzes in elektrischen Heißwasserboilern, bestehend aus

- mindestens einem Sensor (6) für die Messung der Temperatur des Wassers des Tanks;
- einem elektrischen Stromkreis (1), der durch

Anschlussklemmen (2.1), elektrische Widerstände (2) für die Aufheizung des Wassers des Tanks sorgt;

- Mitteln (3.1; 4.1) zur Steuerung einer Abschaltvorrichtung (3; 4), deren Öffnen /Schließen die Stromversorgung der Widerstände (2) steuert, um das Wasser auf der Regulierungstemperatur (R.T.), die während des regulären Betriebs eingestellt ist, zu halten;

- Mitteln (4.1; 4.2), um im Falle von Funktionsstörungen die Wärmeregulierung durch das Öffnen von Mikroschaltern von Sicherheitsrelais (4) zu stoppen, um die Stromzuführung an den beiden besagten Anschlussklemmen (2,1) der elektrischen Widerstände (2) zu unterbrechen; wobei die genannten Sicherheitsrelais (4) entweder aus zwei Relais (4) mit einem Mikroschalter oder einem einzelnen Relais (4) mit einem Doppel-Mikroschalter bestehen und die besagten Betriebsstörungen aus

- dem Erreichen von einer Abschalttemperatur (A.T.) des Wassers im Tank, die höher als die Regulierungstemperatur (R.T.) aber dennoch niedriger als die Sicherheitstemperatur (S.T.) ist,

- und / oder anormalem Funktionieren eines oder mehrerer der genannten Sensoren (6) bestehen;

- einer manuell betätigten Rückstelleinrichtung (9) zum Rückstellen des Prozesses der Wärmeregulierung, wenn dieser aufgrund der besagten Funktionsstörungen gestoppt ist;

- einer elektronischen Logikschaltung (7, 8, 9, 10), um zumindest für die Kontrolle der besagten Mittel zur Wärmeregulierung und des thermischen Schutzes zu sorgen;

gekennzeichnet durch die Tatsache, dass der Reset-Befehl von dem Sicherheitssystem nur dann akzeptiert wird, wenn ein Mikroprozessor (7) aus der elektronischen Logikschaltung (7, 8, 9, 10) feststellt, dass die Funktionsstörung, die die Öffnung der Relais (4) verursacht, nicht länger besteht.

2. Steuergerät (R) nach dem vorhergehenden Anspruch 1,

gekennzeichnet durch die Tatsache, dass die besagte handbetätigte Rückstelleinrichtung (9) in der Lage ist, den Prozess der Wärmeregulierung nur bis zu einer festgelegten maximalen Anzahl von Rückstellungen zurückzusetzen.

3. Steuergerät (R) gemäß den Ansprüchen 1 oder 2, **gekennzeichnet durch** die Tatsache, dass die besagte elektronische Logikschaltung (7, 8, 9, 10) zumindest teilweise **durch** in einem Mikropro-

zessor (7) gespeicherte Software-Anleitungen ausgedrückt wird.

4. Steuergerät (R) nach einem der vorhergehenden Ansprüche 1 bis 3,

gekennzeichnet durch die Tatsache, dass ein permanenter Speicher (10), wie ein EEPROM, vorgesehen ist, in dem mindestens die Informationen in Bezug auf Betriebsstörungen aufgezeichnet werden können.

5. Steuergerät (R) nach einem der vorhergehenden Ansprüche,

gekennzeichnet durch die Tatsache, dass die besagte Abschaltvorrichtung (3, 4) zur Kontrolle der Stromversorgung, um das Wasser auf der Regulierungstemperatur (R.T.) zu halten, ein TRIAC (3) ist.

6. Steuergerät (R) nach einem der vorhergehenden Ansprüche 1 bis 4,

gekennzeichnet durch die Tatsache, dass die besagte Abschaltvorrichtung (3, 4), deren Öffnen / Schließen die Stromversorgung steuert, um das Wasser auf der Regulierungstemperatur (R.T.) zu halten, ein Regulier-Relais (3, 4) ist.

7. Steuergerät (R) nach dem Anspruch 6, **gekennzeichnet durch** die Tatsache, dass

- die besagten Sicherheitsrelais (4) aus zwei Sicherheitsrelais (4) mit einem Mikroschalter bestehen,

- das besagte Regulier-Relais (3, 4) mit einem der zwei besagten Sicherheitsrelais (4) zusammenfällt,

- das besagte Sicherheitsrelais (4), das auch für die Wärmeregulierung sorgt, derart beschaffen ist, dass es in der Lage ist, eine Anzahl von Zyklen durchzuführen, die mindestens denjenigen entspricht, die für die Lebensdauer des Wasserboilers vorgesehen sind.

8. Steuergerät (R) nach dem vorhergehenden Anspruch 6,

gekennzeichnet durch die Tatsache, dass

- die besagten Sicherheitsrelais (4) aus zwei Sicherheitsrelais (4) mit einem Mikroschalter bestehen,

- das besagte Regulier-Relais (3, 4) abwechselnd mit einem der beiden genannten Sicherheits-Relais (4) zusammenfällt,

- die besagten Sicherheitsrelais (4) derart beschaffen sind, dass sie eine Anzahl von Zyklen ausführen können, die mindestens der Hälfte derjenigen entspricht, die für die Lebensdauer des Wasserboilers vorgesehen sind.

9. Steuergerät (R) nach den vorhergehenden Ansprüchen 7 oder 8,
gekennzeichnet durch die Tatsache, dass dieses Steuergerät (R) die genannte Anzahl der Zyklen zählen kann, wobei diese in dem erwähnten permanenten Speicher (10) gespeichert werden, und programmiert ist, um die zwei besagten Relais (4) zu öffnen, so dass es nicht zurückgestellt werden kann, sobald eine bestimmte Anzahl von Zyklen erreicht ist.
10. Steuergerät (R) nach den vorhergehenden Ansprüchen 4 oder 7,
gekennzeichnet durch die Tatsache, dass das Steuergerät (R) das Öffnungsversagen des besagten Sicherheitsrelais (4) erkennen kann, das auch für die Wärmeregulierung verwendet wird, und eingestellt werden kann, um die anschließende sofortige nicht rückstellbare Öffnung des anderen der besagten zwei Sicherheitsrelais (4) zu betätigen.
11. Steuergerät (R) nach einem der vorhergehenden Ansprüche 1 bis 10,
gekennzeichnet durch die Tatsache, dass zudem eine Hardware-Logikschaltung (8), die die Watchdog-Funktionen ausübt, vorgesehen ist,
- die in der Lage ist, nach dem Stand der Technik, eine oder mehrere Leistungsanomalien des besagten Mikroprozessors (7) und anderer Systemkomponenten festzustellen,
 - und die mit Mitteln (4.2) ausgestattet ist, um den Prozess der Wärmeregulierung im Falle von Betriebsstörungen **durch** Öffnen der Mikroschalter der Sicherheitsrelais (4) zu stoppen.
12. Steuerungsverfahren für die Funktionen der Wärmeregulierung und des Wärmeschutzes in elektrischen Wasserkochern mit
- Erfassung der Temperatur des Wassers des Tanks,
 - Stromversorgung für die Aufheizung des Wassers des Tanks,
 - Steuerung der besagten Stromversorgung, um das Wasser auf der Regulierungstemperatur (R.T.), die während des regulären Betriebs eingestellt ist, zu halten,
 - Feststellung etwaiger Betriebsstörungen
 - Unterbrechung der Stromzuführung bei den besagten festgestellten Betriebsstörungen,
 - manueller Versuch, die Rückstellung des Prozesses der Wärmeregulierung zu betätigen, **gekennzeichnet durch** die Tatsache, dass
- die besagte manuelle Rückstellung des Prozesses der Wärmeregulierung angenommen wird, vorausgesetzt, dass die besagten Funktionsstörungen

nicht mehr bestehen.

13. Steuerungsverfahren nach dem vorherigen Anspruch 12,
gekennzeichnet durch die Tatsache, dass die Anzahl der besagten manuell betriebenen Rückstellungen gezählt und gespeichert wird, und **durch** die Tatsache, dass weitere manuelle Rückstellungen unmöglich gemacht sind, wenn die besagte Anzahl von Rückstellungen einen möglichen Maximalwert überschreiten. die besagte manuelle Rückstellung des Prozesses der Wärmeregulierung nur für eine bestimmte Anzahl von Malen möglich ist.
14. Steuerungsverfahren nach dem vorhergehenden Anspruch 12,
gekennzeichnet durch die Tatsache, dass der Verschleiß der Mikroschalter (3; 4), die für den Prozess der Wärmeregulierung verwendet werden, **durch** Zählung der Häufigkeit, mit der die besagten Mikroschalter (3; 4) betätigt werden, überwacht wird und **durch** die Tatsache, dass, sobald eine eingestellte Anzahl von Betätigungen überschritten ist,
- der thermische Schutz aktiviert wird,
 - während die manuelle Rückstellung des Prozesses der Wärmeregulierung deaktiviert wird.
15. Steuerungsverfahren nach dem vorhergehenden Anspruch 12,
gekennzeichnet durch die Tatsache, dass, wenn eines der zwei Sicherheitsrelais (4) zur Wärmeregulierung verwendet wird und das besagte Sicherheitsrelais (4) nicht auf einen Öffnungsbefehl reagieren sollte,
- das andere Sicherheitsrelais (4) sofort geöffnet wird,
 - während die manuelle Rückstellung des Prozesses der Wärmeregulierung deaktiviert wird.

16. Steuerungsverfahren nach dem vorhergehenden Anspruch 12,
gekennzeichnet durch die Tatsache, dass die Richtigkeit der **durch** die Steuerung durchgeführten Vorgänge überwacht und der Boiler abgeschaltet wird, wenn die besagten Operationen als falsch betrachtet werden.

Revendications

1. Un dispositif de contrôle (R) pour la régulation thermique et les fonctions de protection thermique dans un chauffe-eau électrique, comprenant
- au moins un capteur (6) pour la mesure de la

température de l'eau du réservoir;

- un circuit d'alimentation électrique (1) qui alimente par le biais de bornes de connexion (2.1), des résistances électriques (2) pour chauffer l'eau du réservoir;

- des moyens (3.1; 4.1) pour contrôler un dispositif de coupure (3; 4) dont l'ouverture/fermeture contrôle l'alimentation électrique aux résistances (2) pour maintenir l'eau à sa température de régulation (t.r.) sélectionnée au cours du fonctionnement normal;

- des moyens (4.1; 4.2) pour arrêter, en cas d'anomalies de fonctionnement, le procédé de régulation en ouvrant les micro-rupteurs des relais de sécurité (4) pour couper l'alimentation électrique aux deux susdites bornes de connexions (2.1) des susdites résistances électriques (2); lesdits relais de sécurité (4) étant constitués soit de deux relais (4) avec un seul micro-rupteur soit d'un unique relais (4) avec un double micro-rupteur et les susmentionnées anomalies de fonctionnement étant les suivantes:

- la température de coupure (t.i.) du réservoir d'eau a atteint une valeur plus élevée de la température de réglage (t.r.) même si encore plus basse de la température de sécurité (t.s),

- et/ou un fonctionnement anormal d'un ou plusieurs des susdits capteurs (6);

- un dispositif de réinitialisation actionné manuellement (9) pour réinitialiser la procédure de régulation de la température si désactivée à cause des susmentionnées anomalies de fonctionnement;

- une logique électronique (7, 8, 9, 10) préposée au moins au contrôle des susdits moyens de régulation de la température et de protection thermique;

caractérisé par le fait que

la commande de réinitialisation est acceptée par le système de sécurité seulement après qu'un microprocesseur (7) faisant partie du circuit électronique logique (7, 8, 9, 10) a vérifié que l'anomalie qui a déterminé l'ouverture des relais (4) n'existe plus.

2. Dispositif de contrôle (R) conformément à la précédente revendication 1,

caractérisé par le fait que

le susdit dispositif de réinitialisation commandé manuellement (9) est capable de réinitialiser la procédure de régulation de la température seulement jusqu'à un nombre maximum déterminé de réinitialisations.

3. Dispositif de contrôle (R) conformément aux reven-

dications 1 ou 2,

caractérisé par le fait que

la susdite logique électronique (7, 8, 9, 10) fonctionne, au moins en partie, par le biais d'un logiciel sauvegardé dans un microprocesseur (7).

4. Dispositif de contrôle (R) conformément à chacune des précédentes revendications de 1 à 3,

caractérisé par le fait que

une mémoire permanente (10) comme une EEPROM, est prévue dans laquelle au moins les informations concernant les anomalies de fonctionnement peuvent être enregistrées.

5. Dispositif de contrôle (R) conformément à chacune des précédentes revendications,

caractérisé par le fait que

le susdit dispositif de coupure (3; 4) pour contrôler l'alimentation électrique dans le but de maintenir l'eau à la température de régulation (t.r.) est un TRIAC (3).

6. Dispositif de contrôle (R) conformément à chacune des précédentes revendications de 1 à 4,

caractérisé par le fait que

le susdit dispositif de coupure (3; 4) dont l'ouverture/fermeture contrôle l'alimentation électrique pour maintenir l'eau à la température de régulation (t.r.) est un relais de régulation (3; 4).

7. Dispositif de contrôle(R) conformément à la revendication 6,

caractérisé par le fait que

- le susdit relais de sécurité (4) se compose de deux relais de sécurité (4) avec un seul micro-rupteur,

- le susdit relais de sécurité (3; 4) est un des deux susdit relais de sécurité (4),

- le susdit relais de sécurité (4), lequel se charge aussi de la régulation de la température, est d'un type capable d'effectuer un nombre de cycles égal au moins à ceux qui sont prévus pendant la durée de vie du chauffe-eau.

8. Dispositif de contrôle(R) conformément à la revendication 6,

caractérisé par le fait que

- le susdit relais de sécurité (4) se compose de deux relais de sécurité (4) avec un seul micro-rupteur,

- le susdit relais de régulation (3; 4) coïncide, alternativement, avec un des deux susdit relais de sécurité(4),

- le susdit relais de sécurité (4) le susdit relais de sécurité (4) sont d'un type capable d'effectuer un nombre de cycles égal au moins à la moitié

de ceux qui sont prévus pendant la durée de vie du chauffe-eau.

9. Dispositif de contrôle (R) conformément aux précédentes revendications 7 ou 8, 5
caractérisé par le fait que
 le même dispositif de contrôle (R) peut comptabiliser ledit nombre de cycles et les mémorisant dans la susdite mémoire permanente (10) et est programmée de façon à ouvrir les susdits deux relais (4) qui ne peuvent plus être réinitialisés dès qu'on a atteint le nombre de cycles déterminé. 10

10. Dispositif de contrôle (R) conformément aux précédentes revendications 4 ou 7, 15
caractérisé par le fait que
 le dispositif de contrôle (R) peut détecter l'ouverture manquée du susdit relais de sécurité (4), utilisé aussi pour la régulation de la température, et activer la conséquence, immédiate ouverture, qui ne peut pas être réinitialisée de l'autre des susdit relais de sécurité (4). 20

11. Dispositif de contrôle (R) conformément à chacun des précédentes revendications de 1 à 10, 25
caractérisé par le fait que
 un circuit logique matériel (8) assurant une fonction de chien de garde est en plus prévu,

 - lequel est capable de détecter, conformément à la technique actuelle, une ou plusieurs anomalies de fonctionnement du susdit microprocesseur (7) et d'autres composants du système, 30
 - et qui est équipé avec des moyens (4.2) pour arrêter, en cas d'anomalies de fonctionnement, la procédure de régulation de la température en ouvrant les micro-rupteurs des relais de sécurité (4). 35

12. Méthode de contrôle pour les fonctions de régulation de la température et de protection thermique dans le chauffe-eau électrique comprenant 40

 - détection de la température du réservoir d'eau, 45
 - alimentation électrique pour chauffer l'eau du réservoir,
 - contrôle de ladite alimentation électrique pour maintenir l'eau à la température de régulation (t.r.) sélectionnée pendant le fonctionnement normal, 50
 - détection de possibles anomalies de fonctionnement
 - coupure de la susdite alimentation électrique en cas des susdites anomalies de fonctionnement, 55
 - tentative manuelle d'activer la réinitialisation de la procédure de régulation de la température**caractérisé par le fait que** ladite réinitialisation

manuelle de la procédure de régulation de la température est acceptée à condition que les susdites anomalies de fonctionnement n'existent plus.

13. Méthode de contrôle conformément à la précédente revendication 12, 10
caractérisé par le fait que
 le nombre des susdites réinitialisations opérées manuellement est comptabilisé et mémorisé et **par le fait que** les réinitialisations ultérieures opérées manuellement sont rendues impossibles lorsque le susdit nombre de réinitialisations dépasse la valeur maximale possible ladite opération de réinitialisation manuelle de la procédure de régulation de la température étant possible seulement pour un certain nombre de fois.

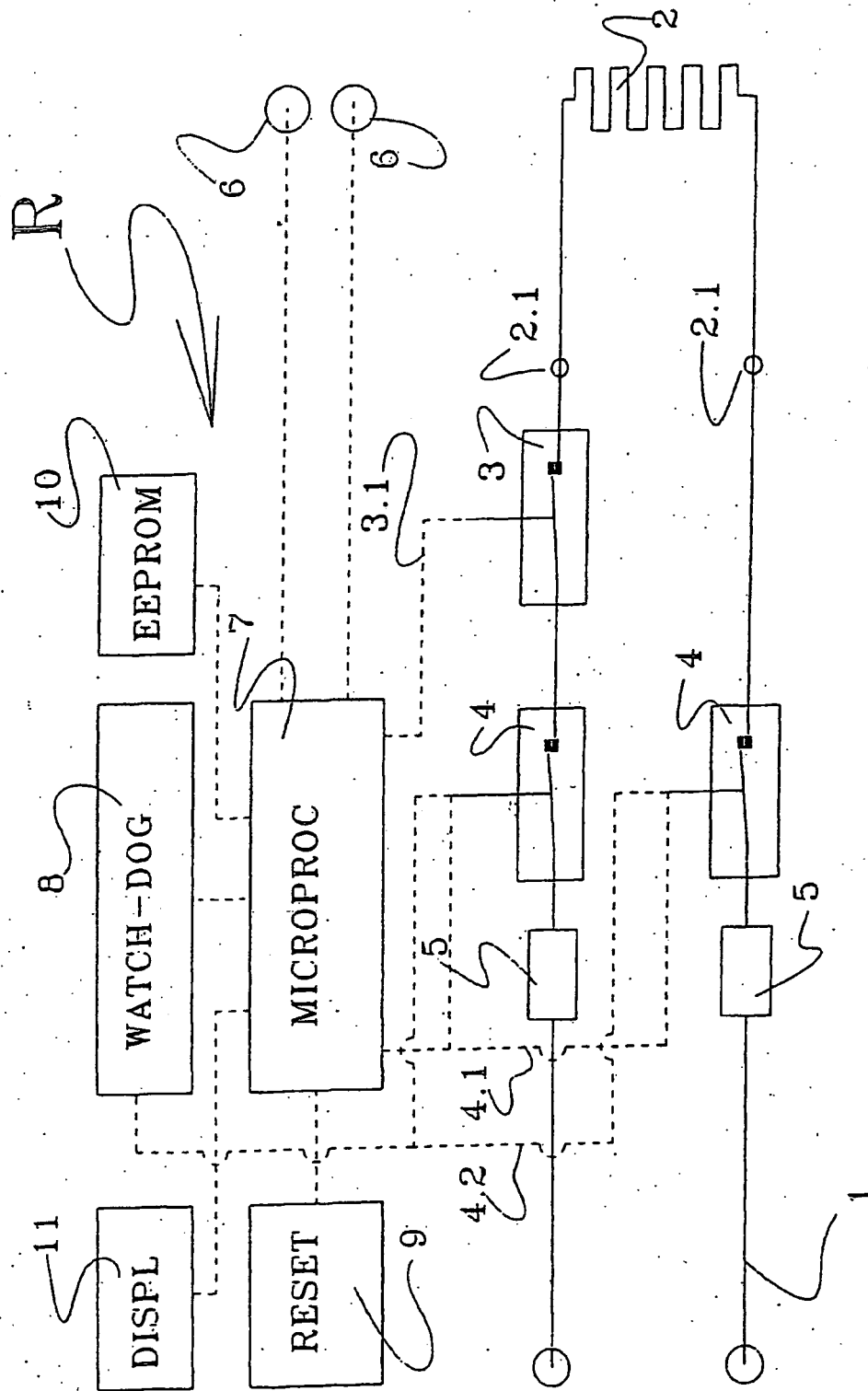
14. Méthode de contrôle conformément à la précédente revendication 12, 20
caractérisé par le fait que
 l'usure du micro-rupteur (3 ; 4) utilisé pour la procédure de régulation de la température est surveillée en comptabilisant le nombre de fois que les susdits micro-rupteurs (3 ; 4) sont actionnés
et par le fait que, dès que le nombre prédéterminé d'activation est dépassé,

 - la protection thermique est activée,
 - en même temps la réinitialisation manuelle de la procédure de régulation de la température est désactivée.

15. Méthode de contrôle conformément à la précédente revendication 12, 35
caractérisé par le fait que
 lorsqu'un des deux relais de sécurité (4) est utilisé pour la régulation de la température et en cas que ledit relais de sécurité (4) ne répond pas à une commande d'ouverture,

 - l'autre relais de sécurité (4) est immédiatement ouvert,
 - en même temps la réinitialisation manuelle de la procédure de régulation de la température est désactivée.

16. Méthode de contrôle conformément à la précédente revendication 12, 50
caractérisé par le fait que
 le bon déroulement des opérations effectuées par le système de contrôle est surveillé et le chauffe-eau est éteint si lesdites opérations sont considérées incorrectes. 55



Fi^o 1

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- NL 8501754 A [0008]