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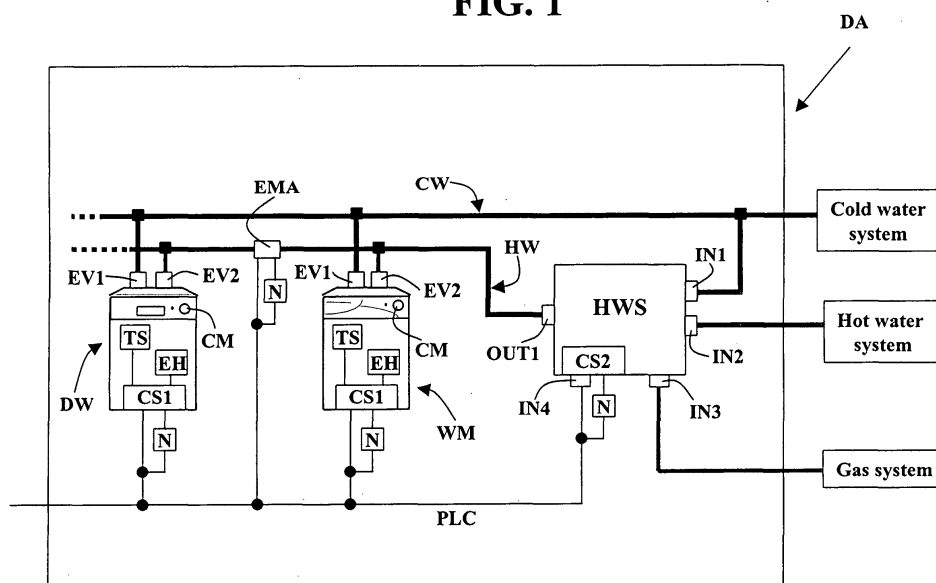
(54) **Method and system for the optimal exploitation of thermal energy available in the form of hot water**

(57) In a domestic environment (DA) there is present a hot-water distribution system (HW) to which there is connected at least one electrical household appliance (WM, DW). The hot water is introduced into the distribution system (HW) by means of a respective supply apparatus (HWS), and the operating cycle of the electrical household appliance (WM, DW) entails the use of a working amount of hot water at a working temperature. The control system (SC1) of the electrical household appliance is operative for:

ter available in the first distribution system (HW);
 b) drawing into the electrical household appliance (WM, DW) a mass of hot water compatible with the temperature and the working amount associated to the operating cycle selected for the electrical household appliance (WM, DW);
 c) modifying the operating cycle of the electrical appliance (WM, DW) according to the amount of heat introduced into the appliance itself, understood as the product of the mass and the temperature of the water taken in by the distribution system (HW).

a) detecting the value of the temperature of the wa-

FIG. 1



Description

Field of the invention

[0001] The present invention relates to the theme of energy saving and regards a method and a system for optimal exploitation of thermal energy possibly available in the form of hot water.

Description of the prior art

[0002] Various household' appliances use hot water for carrying out their function adequately; such appliances are laundry washing machines, dish-washers, machines for preparing coffee and beverages, steam vacuum-cleaners, etc. Some of said appliances, even though they carry within them appropriate electrical means for heating water, are provided with a specific inlet for cold water and another inlet for the possible hot water available in a water piping of the domestic environment; such is the case, for example, of some models of washing machines and dish-washers. This type of product, for which in the past there was a request only on certain markets (such as on the English and German markets, where dwellings are normally provided with a dual water-supply system capable of supplying cold water and hot water simultaneously), is progressively spreading also to many other markets. Exploitation by an electrical household appliance of the above-mentioned dual water-supply option is currently governed by the corresponding control system in such a way as to achieve the following two objectives:

- search for the right compromise between the exploitation of thermal energy of the hot water available in the domestic environment and the need to prevent possible damage caused by an excessive temperature of the hot water introduced into the electrical household appliance; and
- adjustment of the duration of the operating cycle of the electrical household appliance according to the amount of hot water introduced.

[0003] A specific example which regards the pursuit of the first objective referred to above can be provided by a washing machine. In this case, in order to prevent delicate fabrics from possibly being damaged by the intake of excessively hot water into the machine, typically cold water is first taken in and this is followed by intake of hot water in a precautionary amount. The said precautionary intake is envisaged so that, even in the most unfavourable case, where the hot water taken in is at the maximum temperature compatible with the water-supply system (for example 60°C), the temperature resulting from mixing with the cold water already present in the tank will not exceed a given limit value (for example 40°C), which is deemed not dangerous for the most delicate garments.

[0004] As a result of such a precautionary approach, which is basically adopted by all current electromechanical and electronic control systems of electrical household appliances which use water, it follows, however, that the amount of hot water taken in proves to be, in general, much smaller than the optimal amount that would have guaranteed maximum energetic efficiency, the criterion of which is represented by the minimum use of water heated locally by supplying electric power to one or more heating elements present within the electrical household appliance.

[0005] Also the pursuit of the second objective referred to above may be exemplified with reference to a washing machine. In the case of intake, into a washing machine, of water that has already been heated, it in fact becomes necessary to increase accordingly the duration of the washing cycle of the machine, the purpose being to compensate for the fact that, as a result of the introduction of hot water into the tank of the machine, the time necessary for reaching the working temperature envisaged by the washing cycle is shorter than the time associated to heating of the water within the machine. Said reduction of duration could in fact jeopardize the effectiveness of the result of the operating cycle of the washing machine on account of a lower mechanical action exerted on the laundry.

[0006] To enable a better understanding of the above concept, consider, purely by way of non-limiting example, that in a domestic washing machine the step of heating of the water is characterized by a non-negligible duration, corresponding to approximately one minute per degree centigrade. In this case, assuming that it is necessary to heat the water from an initial temperature of 15°C to a final temperature of 60°C, approximately 45 minutes are required, during which the process of mechanical removal of dirt by means of appropriate alternating movements of the drum of the washing machine is activated. Assuming then that water already heated to the final temperature of 60°C is introduced into the washing machine, the period of 45 minutes associated to internal heating is ruled out. Consequently, the reduction in the heating time caused by the introduction of water that is already hot would limit the global effectiveness of the washing process, since the mechanical action determined, during the step of heating of the water, by rubbing of the washing caused by the alternating rotation of the drum of the washing machine would no longer exist. For this reason all current washing-machine control systems envisage, in the case of intake of hot water, the addition of a given fixed period during which there is performed the movement of the drum required for compensating for the reduced mechanical action for removal of dirt resulting from the shorter time taken for bringing the water up to the temperature envisaged by the washing program selected by the user.

[0007] The choice of a fixed compensation time constitutes, however, a possible critical factor because it does not take into account the effective value of the tem-

perature of the cold water and the hot water present in the respective water-supply systems; nor does it take into account in general the type of fabric and the amount of dirt. Consequently, it does not pursue the optimal condition whereby, with a minimum washing time, there is guaranteed an adequate removal of dirt. In fact, assuming a long compensation time, there is obtained an excessively long washing process which is not appreciated by the user. On the other hand, assuming a compensation time that is too short, the risk is an inadequate removal of dirt.

Purpose of the invention

[0008] The purpose of the present invention is to overcome the aforesaid drawbacks of the prior art by means of a method that will enable complete exploitation of the availability of hot water in an environment, in particular in a domestic environment, to be obtained by an electrical appliance, in particular an electrical household appliance, and, at the same time, will guarantee the maximum effectiveness of operation of said appliance.

Summary of the invention

[0009] According to the present invention, the aforesaid purpose is achieved thanks to a method for optimal exploitation of thermal energy possibly available in the form of hot water, in which the control system of an electrical appliance using water is capable of:

- determining the value of temperature of the hot water made available to the electrical appliance by a water-supply system supplied with hot water;
- using the maximum possible amount of said hot water that is compatible with the value of working temperature and with the level of water envisaged by the operating cycle that a user has set for the electrical appliance; and
- adapting, according to the amount of heat introduced into the electrical appliance, the operating cycle set and possibly the value of other significant parameters of said cycle so as to guarantee optimal performance.

Brief description of the drawings

[0010] Further purposes, characteristics and advantages of the invention will emerge from the ensuing description with reference to the annexed drawings, which are provided purely by way of non-limiting example, and in which:

- Figure 1 is a schematic representation of a system made up of electrical household appliances according to the invention present in a domestic environment and connected to a water-supply system capable of supplying simultaneously cold water and

hot water, the hot water being produced by a generic hot-water source external to the household appliances themselves;

- Figure 2 is a flowchart that illustrates the process of intake of the water within an electrical household appliance which forms part of the system according to the invention;
- Figure 3 is a flowchart that illustrates the process of intake, according to the invention, of the hot water used by an electrical household appliance to carry out an operating cycle selected by the user;
- Figure 4 is a schematic representation of a system of electrical household appliances according to the invention, similar the one illustrated in Figure 1, in which the hot-water source is a gas-fired boiler;
- Figure 5 is a flowchart that illustrates, in the context of a preferred embodiment of the invention, the modalities of interaction between the control system of an electrical household appliance and that of a gas-fired boiler during the process of intake of hot water within the household appliance itself;
- Figure 6 is a schematic representation of a system of electrical household appliances according to the invention, similar to the one illustrated in Figure 1, in which the hot-water source is an electric boiler;
- Figure 7 is a schematic representation of a system for "smart" management of power absorption comprising electrical household appliances capable of exploiting in an optimal way the hot water possibly present in a domestic environment, according to the invention; and
- Figure 8 is a flowchart that illustrates a process for managing absorption of electric power by electrical household appliances capable of exploiting hot water in an optimal way according to the invention, which refers to the system illustrated in Figure 7.

Detailed description of the invention

[0011] According to the invention, a method is proposed aimed at enabling an electrical appliance, in particular an electrical household appliance, equipped with an appropriate electronic control system, to use in an optimal manner the hot water possibly available in the environment in which the appliance is installed, for the purpose of performing its function in the most effective and economic manner possible. The use of said method enables the maximum benefit to be obtained when, in the environment where the electrical appliances concerned are located, there are present systems for hot-water production external to the appliance itself. Some non-limiting examples of said alternative systems are the following:

- a hot-water generating system based upon the use of gas (gas-fired domestic boiler, instantaneous gas-fired water-heater, etc.);
- availability of hot water supplied by an external util-

ity (hot water produced by thermo-electric power stations, incinerators, etc.);

- a hot-water generating system based upon the use of solar panels;
- a hot-water generating system based upon the use of photovoltaic cells;
- a hot-water generating system that, albeit using electricity, is based upon optimal exploitation of hours of low demand in which the cost of electric power is minimum; this is the case, for example, of high-capacity electric boilers with high thermal insulation which are activated prevalently at night.

[0012] Since in order to achieve the objectives of the present invention it is sufficient to assume the presence of a hot-water distributor appropriately connected to a water-supply system, an in-depth analysis of the aforesaid alternative systems for hot-water production will be omitted.

[0013] Where not otherwise specified, by the generic term of "electrical appliance" is meant any of the appliances that, in order to be able to carry out their function adequately, require a certain amount of water heated up to a working temperature, designated in what follows by T_W , which is pre-set on the basis of the operating program selected by a user. Likewise, by the generic term of "hot-water source", designated in what follows by HWS, is meant a device, an apparatus or a system designed for supplying hot water, heated according to procedures that are generally different from ordinary ones, based upon the use of electrical-heating means proper to an electrical appliance. In the sequel of the present description there will initially be described the general outline of the invention and subsequently some of its possible practical applications.

General outline of the invention

[0014] Figure 1 illustrates, in general terms, a system of electrical household appliances for implementation of the method according to the invention. Figure 1 is a schematic representation of a domestic environment, designated as a whole by DA, in which there are present two water-supply circuits: a circuit dedicated to the supply of hot water, designated by HW, and a circuit dedicated to the supply of cold water, designated by CW. The cold-water circuit CW is supplied by the normal water mains, whilst the hot-water circuit HW is supplied by a purposely provided hot-water source, designated by HWS.

[0015] Connected to the aforesaid two water-supply circuits CW, HW are, purely by way of non-limiting example, two electrical household appliances, namely a laundry washing machine designated by WM and a dish-washer designated by DW; the two electrical household appliances WM, DM are each provided with two inlets for the water, controlled, respectively, by a solenoid valve for the cold water, designated by EV1, and

by a solenoid valve for the hot water, designated by EV2. In both of the electrical household appliances WM, DW the water inlets are governed by respective control systems, designated by CS1 via the aforesaid solenoid valves EV1, EV2.

[0016] The hot-water source HWS may be any one of the following:

a) a gas-fired boiler equipped with an inlet IN1 for the cold water from the mains supply, an inlet IN3 for the gas that supplies the internal burner of the boiler, an input IN4 for the electricity necessary for supplying the control system for the apparatus of the hot-water source HWS, and an outlet OUT1 for the hot water connected to the corresponding water-supply circuit HW;

b) a gas-fired water-heater equipped with an inlet IN1 for the cold water from the mains, an inlet IN3 for the gas that supplies the internal burner of the water-heater, an input IN4 for the electricity necessary for supplying the control system of the apparatus of the hot-water source HWS, and an outlet OUT1 for the hot water connected to the corresponding water-supply circuit HW;

c) a high-capacity electric water-heater with thermal insulation equipped with an inlet IN1 for the cold water from the mains, an input IN4 for the electricity necessary for supplying the control system of the apparatus of the hot-water source HWS and its internal heating elements (consisting of electrical resistors), and an outlet OUT1 for the hot water connected to the corresponding water-supply circuit HW;

d) a hot-water distributor equipped with an inlet IN2 for the hot water, supplied by an appropriate external system (represented for example by a solar-panel or photovoltaic-cell water-supply system, or by a remote-heating water-supply system), an input IN4 for the electricity necessary for supplying the control system of the apparatus of the hot-water source HWS, and an outlet OUT1 for the hot water, connected to the corresponding water-supply circuit HW.

[0017] Of course, in the case where the hot-water source HWS is a boiler or a gas-fired water-heater (cases a and b), it will not be provided with the inlet IN2; in the case, instead, where the hot-water source HWS is an electric water-heater (case c), it will not be provided with the inlets IN2 and IN3; finally, in the case where the hot-water source HWS is simply a distributor (case d), it will not be provided with the inlets IN1 and IN3.

[0018] The generic hot-water source HWS is equipped, according to the invention, with a respective electronic control system CS2. The control systems CS1 of the electrical household appliances WM, DW and the control system CS2 of the hot-water source HWS are able to connect up to the mains by means of

respective communication nodes, designated by N, which are in themselves known and contain within them the communication protocol and the information transceiver.

[0019] The communication network necessary for exchange of information from the hot-water source HWS to the electrical household appliance WM, DW is designated by PLC; said network PLC preferably consists of the same electrical network as that of the domestic environment DA, and transmission of information is based upon the so-called power-line-carrier technique. There may, however, be used for the purpose any other communication network, either wired or wireless (for example a radio-frequency communication network), whether standard or proprietary, without thereby departing from the scope of the present invention. Likewise, the communication protocol used may be of any type, whether standard or proprietary.

[0020] The two electrical household appliances WM, DW have all the commonly known components necessary for their operation (for example, with reference to the washing machine WM: a washing tank, a rotating drum for containing the washing, a motor for producing rotation of the drum, a dispenser of washing-agents, etc.; with reference to the dish-washer DW: a washing tank, one or more rack-type baskets for the dishes, a pump for circulation of the washing water, a dispenser of washing-agents, etc.); included among these components are:

- control means, designated in the figure by CM, for example in the form of push-buttons or knobs, for the selection of the programs for operation of the electrical household appliance WM, DW, and for the possible setting of specific operating parameters (such as, for example, the amount of the load of washing or of dishes, the working temperature T_W , etc.); and
- electrical means for heating the water, designated by EH, typically made up of one or more electrical resistors.

[0021] The method according to the invention is based upon the knowledge, by the control system CS1 of the electrical appliance WM, DW concerned, of the value of the temperature T_H of the hot water generated or controlled by the external hot-water source HWS, and is characterized by the following three steps:

Step 1: determination of the value of the temperature T_H of the hot water that the electrical appliance WM, DW can take in from the corresponding water-supply system HW, as supplied by the external hot-water source HWS;

Step 2: intake of the maximum possible amount of hot water compatible with the mode of operation of the electrical appliance WM, DW, i.e., with the temperature and the level of the water associated to the

cycle or program selected by the user via the control means CM; and

Step 3: adjustment of the duration of the operating cycle, and of other possible significant parameters thereof, in accordance with the amount of heat introduced (represented by the product of the mass of the hot water and the temperature T_H thereof), in order to guarantee optimal performance by the appliance WM, DW.

[0022] The aforesaid three steps of the method according to the invention are described in detail in what follows:

STEP 1: detection of the temperature T_H of the hot water supplied by the external hot-water source HWS to the electrical appliance WM, DW.

As has been said, according to the invention, the information corresponding to the value of the temperature T_H is necessary to the control system CS1 of each electrical appliance WM, DW in order to be able to maximize the intake of hot water. For this purpose there are envisaged, according to the invention, two different situations:

- the case where the information corresponding to the temperature T_H is supplied to the control system CS1 of the electrical appliance WM, DW by an external measuring device; and
- the case where it is the control system CS1 of the appliance WM, DW that determines, via a direct or indirect measurement, the value of said temperature T_H .

In the first case, the information regarding the temperature T_H can be supplied directly by the control system CS2 of the hot-water source HWS, on request from the control system CS1 of the electrical appliance WM, DW, via the communication network PLC. Alternatively, this information is measured by a specific measuring apparatus, designated by EMA in Figure 1, which is capable of communicating with the control system CS1, directly or else via the communication network PLC itself, by means of a respective node N, as represented in the figure. In the second case, the temperature T_H can be measured directly by the control system CS1 of the electrical appliance WM, DW via its appropriate sensor means, not indicated, set in contact with the water at input to the solenoid valves EV1, EV2. Alternatively, the information regarding the temperature T_H can be obtained indirectly via measurements of the temperature of the mixed water introduced into the electrical household appliance WM, DW according to the procedure that will hereinafter be described with reference to Figure 3.

The preferred mode of implementation of the invention is the one in which the value of the tem-

perature T_H is sent directly by the control system CS2 of the hot-water source HWS, on request from the control system CS1 of the electrical appliance WM, DW, via the communication network PLC. In the case where the electrical appliance WM, DW and/or the hot-water source HWS are not connected to the communication network, the preferred mode according to the invention is, instead, the one based upon the indirect measurement of the temperature T_H obtained via measurements of the temperature of the mixed water introduced into the appliance WM, DW according to the modes indicated in Figure 3, described hereinafter and performed using the customary temperature sensor, designated by TS in Figure 1, with which the appliance itself is typically equipped.

STEP 2: intake of the maximum amount possible of hot water in a way compatible with the mode of operation of the electrical appliance WM, DW.

The temperature T_W of the hot water necessary for the electrical appliance WM, DW for its own operation is a parameter known to the respective control system CS1 and depends upon the settings made by the user via the means CM (type of program or specific working temperature set); on the other hand, as explained previously in relation to Step 1, the value of the temperature T_H of the water supplied by the external hot-water source HWS is, according to the invention, brought to the knowledge of the control system CS1.

According to the invention, the control system CS1, which is in possession of the said two data regarding temperature, is able to maximize the intake of hot water in relation to the value of T_H with respect to T_W , according to the existence of one of the following three situations:

Case 1: $T_H > T_W$

Case 2: $T_H = T_W$

Case 3: $T_H < T_W$

According to the invention:

- in Case 1, the control system CS1 of the electrical appliance WM, DW manages an appropriately mixed intake of hot water and cold water in such a way as to maximize the amount of hot water introduced;
- in Case 2, the control system CS1 manages an intake just of hot water; and
- in Case 3, the control system CS1 asks the external hot-water source HWS to heat the water up to the desired temperature T_W , and then to proceed to an intake just of hot water via the water-supply system HW.

Assuming that, with reference to Case 3, the external hot-water source HWS were not in a con-

dition to heat the water further, the control system CS1 of the appliance WM, DW, according to the invention, completes the heating, employing its own internal electrical means EH.

The aforesaid process of intake of the water into an electrical appliance according to the invention is illustrated in detail in Figures 2 and 3, where, by way of non-limiting example, reference will be made to a washing machine WM.

In particular, Figure 2 describes the control logic that the system CS1 uses for handling the general process of intake of water into the washing machine WM. Figure 3 describes, instead, in detail the intake of hot water drawn in from the hot-water supply system HW, as supplied by the external hot-water source HWS. According to the flowchart of Figure 2, starting from the initial condition represented by the block 100, control passes to block 101, which is a test block for verifying the availability or otherwise of a hot-water source HWS within the domestic environment DA in which the washing machine WM is installed.

If a hot-water source HWS is not available, control is transferred to block 102, which manages the normal procedure of intake of the cold water from the mains, by means of the solenoid valve EV1, and concludes the process, transferring control to the end block 114. Otherwise, control passes to block 103, which is a test block that verifies whether the control system CS2 of the hot-water source HWS is able to communicate or otherwise with the control system CS1 of the washing machine WM via the communication network PLC.

If the control system CS2 of the hot-water source HWS is not able to communicate, control passes to block 104, which is a test block that verifies the presence or otherwise of a device for measuring the temperature of the hot water, such as the device EMA, which is external to the washing machine WM and is capable of communicating with the control system CS1 of the latter via the communication network PLC.

If the presence of a device EMA external to the washing machine WM capable of measuring the temperature of the hot water and of communicating the value of said measurement to the control system CS1 of the washing machine itself is not detected, control proceeds to the step of indirect measurement of the temperature of the hot water, represented by block 105. and described, according to the invention, by the flowchart of Figure 3, which will be analysed in detail in what follows. Control is then transferred to the end block 114.

If the answer of the test of block 103 or, alternatively, that of block 104 is positive, then the value T_H of the temperature of the hot water is to be considered known and acquired by the control system CS1 of the washing machine WM, and control pass-

es to block 106.

Block 106 is a test block, which verifies whether the temperature T_H of the hot water available outside the washing machine WM is too high or not with respect to the desired value T_W . If the temperature T_H is higher than the desired value T_W , control passes to block 113, in which the procedure of intake of the mixed water is executed in accordance with the flowchart of Figure 3, as will be described in detail in what follows. Control is then transferred to the end block 114. If the temperature T_H is not higher than the desired value T_W , control passes to block 107, which is a test block that verifies whether the value of T_H is equal to the desired value T_W .

If T_H is equal to T_W , control is again transferred to block 113 and, after execution of the procedure of intake of the hot water described by the flowchart of Figure 3, passes to the end block 114. If, instead, T_H is lower than T_W , control is transferred to block 108, which is a test block that verifies whether the hot-water source HWS is able or not to heat further its own water, utilizing the appropriate internal means EH. If the hot-water source HWS is not able to heat further its own water, control is again transferred to block 113 and then to the end block 114, according to what has already been described above; otherwise, control passes to block 109.

Block 109 is a request block, through which the control system CS1 of the washing machine WM asks the control system CS2 of the hot-water source HWS to activate its own internal-heating means in order to increase the temperature of the water. Block 109, once said step of heating of the water has been activated, transfers control to block 110, which is a test block that verifies whether the desired temperature T_W has been reached or not. If the temperature T_H is lower than the desired value T_W , control is transferred to block 111, which confirms the state of activation of the means for heating the water of the hot-water source HWS and then again transfers control to block 110, which, in turn, again passes control to block 111, remaining in the wait loop until the outcome of the test of block 110 is positive.

When the outcome of the test of block 110 is positive, control is transferred to block 112, which deactivates the internal-heating means of the hot-water source HWS and then transfers control to block 113, which, as has already been described previously, executes the procedure of intake of hot water described by the flowchart of Figure 3 and then passes control definitively to the end block 114.

The flowchart of Figure 2 just described regards the general process of intake of the water into an electrical appliance, in the case in point a washing machine WM; as already anticipated above, the details of the intake of the hot water drawn in from the

external hot-water source HWS are, instead, represented by the flowchart of Figure 3 described hereinafter.

According to the flowchart of Figure 3, starting from by the initial condition represented by block 200, control passes to block 201, which is a test block that verifies the knowledge or otherwise of the value of T_H by the control system CS1 of the washing machine WM. If T_H is not known, it is determined via the procedure described by the six blocks that go from 202 to 207, and, for this purpose, control is transferred to the initial block 202. Otherwise, control passes to block 208, which is a test block that verifies whether the temperature T_H of the hot water is higher or otherwise than the desired temperature T_W .

Block 202 provides for the intake of an appropriate known amount of cold water M_C and then transfers control to block 203, which, after a brief step of thermal stabilization, measures the temperature T_C of the cold water taken in using the sensor TS provided in the washing machine WM, and then transfers control to block 204. Block 204 provides for the intake of an appropriate known amount of hot water M_H and then transfers control to block 205. Block 205 provides for mixing the water via rotation of the drum of the washing machine WM and waits for thermal stabilization; then it transfers control to block 206, which, after measuring the temperature T_M of the mixed water by means of the sensor TS, passes to block 207.

Block 207 carries out indirect calculation of the temperature T_H of the hot water of the external hot-water source HWS, given the known values of M_H , M_C , T_C and T_M , according to the following formula:

$$T_H = T_M + (T_M - T_C) * M_C / M_H$$

which derives from the equality of the amount of heat associated to the total mass of mixed water $M_C + M_H$ at the temperature T_M and the sum of the amount of heat associated, respectively, to the mass M_C of the cold water at the temperature T_C and to the mass M_H of the hot water at the temperature T_H :

$$(M_C + M_H) * T_M = M_C * T_C + M_H * T_H$$

Once the value of T_H has been determined, block 207 transfers control to the test block 208, which verifies whether T_H is higher or not than the desired temperature T_W . If T_H is higher than T_W , control passes to block 209; otherwise, control is transferred to block 211.

Block 209 carries out the intake of an amount of cold water proportional to the difference between

T_H and T_W so as to obtain, via the subsequent intake of hot water performed by block 210, a final temperature of the mixture corresponding to the desired value T_W . Then control is transferred to the end block 216.

Block 211 is a test block that verifies whether T_H is equal or otherwise to T_W . If T_H is equal to T_W , control passes once again to block 210, where there occurs the intake of hot water up to the desired level, and then to the end block 216. If, instead, T_H is lower than T_W , control is transferred to block 212, which carries out intake of hot water up to the desired level and then transfers control to block 213.

With block 213 there starts the step of heating of the water within the electrical appliance, for the purpose of bringing the temperature T_H up to the desired value T_W . For this purpose, block 213 activates the heating elements EH inside the washing machine WM and then transfers control to block 214.

Block 214 is a test block, which keeps the internal heating of the water, i.e., the resistor EH, activated via block 213 until T_H reaches the desired value T_W , which causes passage of control to block 215. Block 215 interrupts the process of heating of the water inside the washing machine WM and then definitively transfers control to the end block 216.

STEP 3: adjustment of the duration of the operating cycle of the electrical appliance WM, DW, and of other possible significant parameters of the cycle itself, according to the amount and temperature T_H of the hot water introduced, for the purpose of guaranteeing an optimal performance by the appliance itself.

According to the invention, the duration of the operating cycle of the electrical appliance, and other possible significant parameters of the cycle, are updated by the respective control system CS1 according to the amount of heat introduced, represented by the total mass of hot water at the temperature T_H that has been taken in, and of the type of operating cycle selected by the user via the control means CM.

In the specific case of a washing machine WM, said updating regards the duration of the washing step and any other possible significant parameters of the washing cycle, such as, for example, the cadence of rotation of the drum and the corresponding speed. Since in the specific case of a washing machine or dish-washer the rate of flow of water through the solenoid valves typically employed is substantially constant and independent of the mains water pressure, the amount of hot water introduced at the temperature T_H is proportional to the total time of opening of the solenoid valve of the hot water EV2.

Consequently, in the specific case of the duration of the washing step, the amount of increase in

said duration can be calculated by the control system CS1 of the washing machine WM as a function of the temperature T_H , the total time t_{ev2} of activation of the hot-water solenoid valve EV2, and the type of washing program WP selected by the user, according to a relation of the type:

Increase in duration of washing step =

$$F_d(T_H, t_{ev2}, WP)$$

where F_d is a function contained in the data memory of the microcontroller of the control system CS1 of the washing machine WM, appropriately expressed in mathematical form or else more simply in tabular form. Purely by way of non-limiting example, said function F_d can be in general expressed in the following mathematical form:

$$y = a + bx$$

where: y is the increase in the value of the duration of the operating cycle WP of the appliance; a and b are constants which depend upon the type of appliance and the type of operating cycle and can be stored in an appropriate table addressed by the type of program selected; and x is the amount of heat introduced via intake of the hot water.

[0023] In the specific case of the washing machine WM, should the user have for example selected, via the control means CM, the fast-washing option, the values of a and b will be such as to limit as much as possible the increase in the duration of the cycle. In this case, the control system CS1 will act prevalently, according to the invention, upon the cadence of washing and possibly also on the speed of rotation of the drum, instead of upon the duration of the cycle. In particular, if the user has chosen to minimize the duration of the cycle, compensation of the lower effectiveness of the washing operation due to the shorter duration of the cycle will be achieved by increasing the washing cadence, i.e., the duration of the step of rotation of the drum with respect to that of pause, and possibly also the speed of rotation of the drum itself.

[0024] In any case, irrespective of the details regarding the type of corrective function adopted and the type and number of significant parameters of the operating cycle concerned in the correction, an important aspect of the invention regards the fact that adjustment of said parameters is not of a fixed type, according to the current state of the art, but is managed by an appropriate function that takes into account the type of appliance, its operating cycle or program and the amount of heat introduced into the appliance in the form of hot water at the temperature T_H drawn from an appropriate external

source.

[0025] Moreover, in the specific case where the electrical appliance is represented by a washing machine, another important feature of the invention regards the fact that the introduction of hot water supplied by an external source enables reduction of the global duration of the washing cycle, since the washing performance is in any case guaranteed by an appropriate increase in the washing cadence, and possibly in the speed of rotation of the drum, according to the amount of heat introduced.

[0026] The latter feature is deemed particularly advantageous above all in the case where the washing machine is equipped with a very efficient motor, which will enable high washing cadences to be sustained without encountering problems of overheating of the motor. An example of efficient motor for washing machines is represented by a three-phase asynchronous motor driven by an inverter-type control system, which, starting from a d.c. voltage drawn from the domestic single-phase a.c. electrical system via a diode rectifier bridge, generates three symmetrical phases with controlled voltage and frequency using modulation techniques and control algorithms in themselves known.

[0027] The use of a motor of this sort in a washing machine, combined with the use of hot water as previously described, enables a reduction in the duration of the washing process without impairing the performance, since it enables an increase in the washing energy so as to compensate for the negative effects of the reduction in the duration of the cycle caused by the absence of heating of the water within the washing machine itself. Much the same applies also for the dish-washer, where a more efficient motor for the respective washing pump enables an increase in the pressure of the water in the rotating spray-nozzles, thus increasing the effectiveness of the washing process.

[0028] The invention has been described previously with reference to a generic hot-water source HWS, according to the general diagram of Figure 1. In what follows some specific examples of application will be described, which implement the operating method described above.

First specific example of application

[0029] A first important practical application of the present invention is illustrated in Figure 4, where the same reference numbers as those of Figure 1 are used for indicating elements that are technically equivalent to the ones previously described. Consequently, Figure 4 represents a domestic environment DA equipped with a first cold-water supply system CW, supplied with the cold water from the mains, and a second hot-water supply system HW supplied by the hot water produced by a purposely provided gas-fired boiler, designated by GF, which thus implements the hot-water source HWS of Figure 1.

[0030] Also in the case of Figure 4, connected to the

aforesaid water-supply systems CW, HW are two electrical household appliances, namely, a dish-washer DW and a washing machine WM, each of which is provided with a dual attachment for the water controlled by its own control system CS1 via the solenoid valve EV1 for the cold water and the solenoid valve EV2 for the hot water.

[0031] The control systems CS1 of the electrical household appliances WM, DW and the control system CS2 of the boiler GF are of an electronic type, are based upon a microcontroller, and are characterized by the possibility of network connection via respective communication nodes N, which incorporate a network protocol suited to the purpose.

[0032] The preferred communication network, designated by PLC, is represented by the domestic electrical network itself, and the bi-directional transmission of information is based upon the power-line-carrier technique. The preferred communication protocol is LonTalk, classified as American standard EIA-709, and the transceiver, or power-line modem, is the PLT-22 device produced by the American firm Echelon.

[0033] The type of communication network and the type of protocol adopted can, however, be any whatsoever, provided that they are suited for the domestic environment. For example, there can be used a radio-frequency network, or else a network based upon a twisted pair, and the protocol can be the European one known as EHS (European Home System) of the Konnex association, or else the Japanese one known as Echonet, or else once again the American one known as CEBus, without thereby departing from the scope of the present invention.

[0034] The control system CS2 of the boiler GF is consequently capable of communicating with the respective control systems CS1 of the two electrical appliances DW and WM and, in particular, it can supply at any moment, upon request from DW or WM, the current value of the temperature T_H of the hot water present in the boiler GF.

[0035] The mode of communication, according to the invention, between the control system CS1 of the appliance DW and/or the appliance WM and the control system CS2 of the boiler GF is described schematically in the flowchart of Figure 5, which represents, purely by way of non-limiting example, the dialogue between the washing machine WM and the boiler GF.

[0036] With reference to the aforesaid Figure 5, the start block 300 transfers control to block 301, through which the control system CS1 of the washing machine WM asks the control system CS2 of the boiler GF the value T_H of the temperature of the hot water present therein.

[0037] Once the value of T_H has been received, control passes to the test block 302, in which the control system CS1 of the washing machine WM verifies whether T_H is higher or not than the temperature T_W required by the washing program WP selected by the user via the control means CM.

[0038] If T_H is higher than T_W , control is transferred

to block 309, where the control system CS2 of the washing machine WM carries out the procedure of mixed intake of the water, already described previously with reference to Figure 3, and then transfers control to the end block 310. Otherwise, control passes to the test block 303, in which equality or otherwise between T_H and T_W is verified.

[0039] If T_H is equal to T_W , control passes again to block 309 and then to the end block 310. Otherwise, instead, in the case where T_H is lower than T_W , control is transferred to block 304, where the control system CS1 of the washing machine WM asks the control system CS2 of the boiler GF to increase the temperature of its water until the desired value T_W is reached.

[0040] Once the request has been made, control passes to block 305, in which the control system CS2 of the boiler GF starts heating up the water, activating its own internal gas burner, and then transfers control to the test block 306, which verifies whether the required temperature T_W has been reached.

[0041] If T_H is lower than T_W , the control system CS2 of the boiler GF continues heating up the water via block 307 and returns to the preceding test block 306, remaining in a wait loop until T_H has reached the value T_W required by the control system CS1 of the washing machine WM.

[0042] If instead T_H is equal to T_W , the control system CS2 of the boiler GF interrupts heating of the water via block 308 and then transfers control to the control system CS1 of the washing machine, which, via block 309, executes the procedure of intake of the hot water, and then the operation is concluded with the end block 310.

[0043] The application of Figure 4 just described is deemed extremely advantageous in view of the fact that there exist markets, such as, for example, the Italian one, where domestic heating is prevalently based upon the use of gas-fired boilers.

Second specific example of application

[0044] A second practical application of the present invention, illustrated in Figure 6, is similar to the one just described, but with the difference that in this case the hot-water source HWS of Figure 1 is represented by a high-capacity electric boiler EH with high thermal insulation. This application regards above all the markets in which the cost of electricity is competitive with the cost of gas.

[0045] The detailed description of the operation of the system of Figure 6 (to which the flowchart of Figure 5 also applies, provided that the reference GF is substituted by EB) is omitted, in so far as it basically coincides with that of Figure 4 described above.

Third specific example of application

[0046] A third practical application, which is particularly important according to the invention, is illustrated

schematically in Figure 7, in which the same reference numbers as those of the previous figures are adopted and which represents a domestic environment DA equipped with a system capable of levelling out the total electric power absorption of the various appliances, which are network-connected according to the modalities already described with reference to Figures 1, 4 and 6, for the purpose of preventing the maximum limit allowed by the contract for supply of electric power from being exceeded.

[0047] The above system for levelling out the global consumption of electric power absorbed by a domestic environment is a system of a distributed type, and in particular as described in the document EP-A-0 727 668, possibly with the respective improvements referred to in the documents WO-A-00 52806 and WO-A-01 01542, the relevant teachings of which are here incorporated for reference.

[0048] According to the technical solution described in EP-A-0 727 668, and in the other documents cited, each electrical appliance is capable of self-regulation, at every instant, of its own current absorption on the basis of the effective availability of power at that instant; this information is supplied by an appropriate power meter installed upstream of the electrical system and connected to the communication network itself.

[0049] The aforesaid power meter, represented in Figure 7 upstream of the electrical system (which functions, as has been said, also as communication network PLC) of the domestic environment and designated by PMS (power-metering system), may coincide with a latest-generation electric meter or else may be a purposely designed stand-alone metering device, installed immediately downstream of a traditional electric meter.

[0050] In Figure 7, in addition to the power-metering system PMS, the following household appliances are represented: an electric oven EO, a refrigerator RE, a freezer FR, a set of electrical appliances not equipped with a network-connectable control system (for example: a hair-drier, an iron, one or more lamps for lighting), and the three electrical household appliances according to the invention represented by a washing machine WM, a dish-washer DW and a gas-fired boiler GF.

[0051] According to the teachings of EP-A-0 727 668 and of WO-A-00 52806, each network-connected electrical appliance, i.e., EO, RE, WM, DW, receives constantly or at variable intervals from the power-metering system PMS, which is also connected to the network PLC itself, the information of the effective power available instant by instant and, on the basis of said information, adapts its own absorption of power according to criteria of priority, for example as described in detail in WO-A-01 01542, providing its own contribution so that the total power absorption of the entire domestic environment will in no case exceed the maximum value according to the contract of supply (note that the control system CS2, even though it is able to receive information regarding the available power, does not need to ad-

just the absorption of electric power of the boiler GF, in so far as said absorption is negligible and practically non-influential; in general terms, for the purposes of implementation of the invention, to the hot-water source there can be assigned a maximum priority of operation).

[0052] Taking into consideration, purely by way of example, the practical case in which the power according to contract is 3 kW, as is in actual fact the case of the majority of Italian dwellings, and the fact that within the domestic environment there are present: a 2.8-kW oven EO, a 2.2-kW washing machine DW and a 2.5-kW dishwasher DW, it is evident that the simultaneous activation of any two of these three electrical household appliances causes tripping of the current limiter, which, for safety reasons, cuts off supply of electric power when the absorbed power constantly exceeds the maximum value allowed by the contract of supply.

[0053] In the case described by the prior documents cited above, the oven EO, the priority of which is typically higher than that of the washing machine WM and the dishwasher DW, normally performs its function without any limitations of power, whereas the washing machine WM and the dishwasher DW interrupt heating of their own washing water by deactivating their internal resistors EH, the power of which is respectively 2 kW and 2.4 kW, but continue their operating cycle maintaining active the motor (200 W) that rotates the drum of the washing machine and the pump (100 W) that produces outflow of water under pressure from the nozzles of the dishwasher, respectively. This means that the problem of interruption of the electric power supply caused by tripping of the current limiter is solved but that, at the same time, the washing machine WM and the dishwasher DW must accept the compromise of continuing to wash using water at a temperature lower than the one envisaged by the program WP selected by the user, with a consequent drop in the washing performance.

[0054] By adding to the teachings of the aforementioned prior documents those of the present invention, it is possible to solve also this latter problem, in so far as the water can be heated, upon request from the appliances WM and DW, by the gas-fired boiler GF without the need for the two appliances WM, DW to use their own heating resistors EH, as described previously.

[0055] Consequently, according to a further important aspect of the present invention, the teachings of EP-A-0 727 668, WO-A-00 52806 and WO-A-01 01542 can be further improved, enabling a very efficient system of power levelling to be achieved such as not to impair in any way the washing performance of the appliances WM and DW.

[0056] Finally, Figure 8 describes the process of absorption of electric power by the control system CS1 of the electrical household appliances WM, DW, which are able to manage the hot water according to the present invention, via a flowchart that expresses the criteria whereby the strategy for heating the washing water is decided upon on a time-by-time basis.

[0057] In particular, with reference to the flowchart of Figure 8, the start block 400 transfers control to the test block 401, which verifies the need or otherwise for the household appliance WM, DW to use hot water to carry out properly the washing cycle requested by the user via the control means CM.

[0058] If the household appliance WM or DW is executing a program WP that does not require hot water, control is definitively transferred to the end block 408; otherwise, control passes to the test block 402, which, in accordance with the teachings of EP-A-0 727 668, verifies whether there exists the possibility of carrying out internal heating of the water using the electrical heating elements EH with which the electrical household appliance itself is provided.

[0059] If the electric power available, the information regarding which is supplied by the power-metering system PMS of Figure 7 according to what is described above, is such as to enable activation of the internal means EH for heating of the water without exceeding the limit of power according to contract of supply, then the control passes to block 403. Otherwise, it is transferred to block 407, which executes, according to the invention, the procedure of intake of the hot water supplied by the external source GF of Figure 7 and then definitively transfers control to the end block 408.

[0060] Block 403 is a test block, which verifies whether it is advantageous or not for the electrical appliance WM or DW, to heat the water, utilizing its own internal heating means EH even when there is available electric power adequate for the purpose. If it is advantageous as compared to gas, for example, justified by a low cost of the electric power during certain hours of the day (periods of low demand for electric power), then control is transferred to block 404, which starts the process of internal heating of the water. Otherwise control goes back to block 407, which executes, according to the invention, the procedure of intake of the hot water supplied by the external source GF, as has been described previously, and then definitively transfers control to the end block 408.

[0061] Block 404 activates internal heating means EH of the electrical household appliance WM, DW and then transfers control to the test block 405, which verifies whether the temperature T_W envisaged by the washing program WP chosen by the user via the means CM has been reached or not.

[0062] If the temperature T_W envisaged by the washing program has not been reached, control returns again to block 40, which, after confirming activation of the internal resistors EH of the electrical household appliance WM, DW, passes control to the test block 405, remaining in wait loop until said temperature has been reached.

[0063] Once the desired temperature T_W has been reached, control passes from block 405 to block 406, which, after deactivating the process of internal heating of the water, definitively transfers control to the end block 408.

Fourth specific example of application

[0064] Finally, a fourth application derives from the fact that, in the specific case of a washing machine or of a dish-washer, the introduction of hot water supplied by an external source enables, according to the invention, reduction of the global duration of the washing cycle, and from the fact that performance of the washing process can in any case be guaranteed by an appropriate increase, according to the amount of heat introduced, in the cadence of washing of the washing machine and in the pressure of the water in the rotating spray-nozzles of the dish-washer.

[0065] The implementation consists therefore in proposing new models of washing machines and dish-washers equipped with high-efficiency motors, for example three-phase motors based upon asynchronous motors or motors with permanent magnets driven by inverter-type control systems, and with washing programs of short duration, in which a major recovery of time is linked to the use of hot water taken from an external source according to the invention. This meets the growing need of the market, which is increasingly asking for washing machines and dish-washers capable of carrying out ultra-fast washing cycles, at the same time guaranteeing satisfactory levels of performance.

Conclusions

[0066] From the foregoing description, the characteristics of the present invention emerge clearly, as likewise there emerge clearly the advantages thereof. As has been seen, in fact, the proposed method enables an electrical appliance to use, in an optimal manner, the hot water possibly available in the environment in which it is installed in order to carry out its own function in the most effective and economic way possible.

[0067] An example of particularly advantageous application of the invention is provided when there is present in a domestic environment a gas-fired boiler equipped with an appropriate electronic control system capable of communicating with electrical appliances that use hot water, for example washing machines and dish-washers, which are in turn equipped with an electronic control system having appropriate means for network connection.

[0068] A further example of advantageous application of the invention regards the case where one or more electrical appliances that use hot water are elements of a system for the management of electric-power absorption, and the corresponding control systems are capable of appropriately metering their own absorption for preventing the total maximum limit allowed by the contract of supply from being exceeded, according to the procedure described in the European patent application EP-A1-0 727 668.

[0069] The present invention has been described with particular reference to a domestic environment in which

there are present electrical household appliances equipped with control systems the functions of which have been illustrated in the present document also with the aid of drawings and flowcharts. It is, however, clear that the principles of the invention are applicable to any other environment in which there are present electrical appliances of any kind that make use of hot water for carrying out their function properly and that envisage the possibility of drawing in said water from an appropriate external source.

Claims

1. A method for the exploitation of thermal energy in an environment (DA), in particular a domestic environment, in which there is present a first hot-water distribution system (HW), to which there is operatively connected at least one electrical appliance (WM, DW), which is able to use hot water, namely an electrical household appliance, the electrical appliance (WM, DW) comprising an inlet (EV2) for intake of hot water from the first distribution system (HW), a control system (CS1) and control means (CM) for selection of an operating cycle of the electrical appliance (WM, DW), wherein hot water is introduced into the first distribution system (HW) by means of a respective supply apparatus (HWS) and the operating cycle of the electrical appliance (WM, DW) involves the use of a working amount of hot water at a working temperature (T_W), the method being **characterized in that** it comprises the following steps:

- a) determining the value of the temperature (T_H) of the water available in the first distribution system (HW), being introduced into the latter by the supply apparatus (HWS);
- b) drawing into the electrical appliance (WM, DW), from the first distribution system (HW), a mass of hot water compatible with the working temperature (T_W) and with the working amount associated to an operating cycle selected via the control means (CM);
- c) adjusting the operating cycle of the electrical appliance (WM, DW) in function of the amount of heat introduced into the appliance itself and of the type of operating cycle selected via the control means (CM), the amount of heat introduced being understood as the product of the mass and the temperature (T_H) of the water taken into the electrical appliance (WM, DW) from the first distribution system (HW).

2. The method according to Claim 1, in which for the purposes of the execution of Step a), the information relating to the value of the temperature (T_H) of the water available in the first distribution system

(HW) is supplied to the control system (CS1) of the electrical appliance (WM, DW) by measurement means (EMA, CS2) external to the appliance itself, in particular by a control system (CS2) of the supply apparatus (HWS), via a communication network (PLC).

3. The method according to Claim 1, in which, for the purposes of execution of Step a), the information relating to the value of the temperature (T_H) of the water available in the first distribution system (HW) is obtained from the control system (CS1) of the electrical appliance (WM, DW) via a direct or indirect measurement.

4. The method according to Claim 4, in which:

- the environment (DA) has a second system for distribution of cold water (CW);
- the electrical appliance (WM, DW) comprises an inlet (EV1) for intake of cold water from the second distribution system (CW); and
- the value of the temperature (T_H) of the water available in the first distribution system (HW) is determined indirectly by the control system (CS1) of the electrical appliance (WM, DW) on the basis of measurements made by a temperature sensor (TS) of the appliance itself,

the value of the temperature (T_H) of the water available in the first distribution system (HW) being in particular determined by means of a procedure that comprises the following steps:

- intake of a first given amount of cold water (M_C) from the second distribution system (CW) and measurement of the its temperature (T_C);
- intake of a second given amount of hot water (M_H) from the first distribution system (HW);
- measurement of the temperature (T_M) of the mixture of water ($M_C + M_H$) formed by the first and the second given amounts of water (M_C , M_H); and
- indirect calculation of the value of the temperature (T_H) of the hot water available in the first distribution system (HW) on the basis of the values of the first given amount (M_C), of the second given amount (M_H), of the temperature (T_C) of the cold water and of the temperature (T_M) of the mixture of water ($M_C + M_H$).

5. The method according to Claim 1, in which, for the purposes of execution of Step b), the control system (CS1) of the electrical appliance (WM, DW) determines the volume of the mass of hot water to be drawn therein in relation to the value of the temperature (T_H) of the water available in the first distribution system (HW) with respect to the working tem-

perature (T_W) associated to the operating cycle selected via the control means (CM).

6. The method according to Claim 5, in which the environment (DA) has a second system for distribution of cold water (CW), the electrical appliance (WM, DW) comprises an inlet (EV1) for intake of cold water from the second distribution system (CW) and, if the temperature (T_H) of the water available in the first distribution system (HW) is higher than the working temperature (T_W), the control system (CS1) of the electrical appliance (WM, DW) manages a mixed intake of hot water and of cold water up to the working amount from the first distribution system (HW) and from the second distribution system (CW), respectively, where in particular:

- the mixed intake comprises intake of an amount of cold water proportional to the difference between the value of the temperature (T_H) of the water available in the first distribution system (HW) and the value of the working temperature (T_W), to obtain, via a subsequent intake of hot water, a mixture of water having a final temperature corresponding to the working temperature (T_W), and/or
- if the temperature (T_H) of the water available in the first distribution system (HW) is congruent with the working temperature (T_W), the control system (CS1) of the electrical appliance (WM, DW) manages an intake of just hot water from the first distribution system (HW) up to the working amount, and/or
- if the temperature (T_H) of the water available in the first distribution system (HW) is lower than the working temperature (T_W), the control system (CS1) of the electrical appliance (WM, DW) asks the supply apparatus (HWS) to heat up to the working temperature (T_W) the water to be introduced into the first distribution system (HW), and then proceeds to an intake of just hot water from the latter up to the working amount, or else, in the case where the supply apparatus of the hot-water source (HWS) is not in a condition to heat up further the water to be introduced into the first distribution system (HW), the control system (CS1) of the appliance (WM, DW) issues a command for heating the working amount of water taken in up to the working temperature (T_W), employing electrical-heating means (EH) within the appliance itself.

7. The method according to Claim 1, in which, for the purposes of execution of Step c), the control system (CS1) of the electrical appliance (WM, DW) modifies the duration of the operating cycle and possibly other significant parameters thereof, where in particular:

- the electrical appliance is a washing appliance (WM, DW) and the adjustment of the operating cycle regards the duration of a step of washing of a washing cycle, and/or
 - the electrical appliance is a laundry washing machine (WM), and the adjustment of the operating cycle comprises both the reduction of the duration of a washing cycle and the increase of the cadence or movement of washing, and/or
 - the electrical appliance is a dish-washer (DW) and the adjustment of the operating cycle comprises both the reduction of the duration of a washing cycle and the increase of the washing pressure, and/or
 - the intake of water into the electrical household appliance (WM, DW) from the first distribution system (HW) is controlled by means of a valve (EV2) at a substantially constant flow rate, and the duration of the operating cycle is modified by the control system (CS1) of the electrical appliance (WM, DW) as a function of the temperature (T_H) of the water available in the first distribution system (HW), of the total time (t_{ev2}) of activation of the valve (EV2), and of the type of operating cycle selected by the control means (CM).
8. The method according to Claim 1, in which:
- in the environment (DA) there are provided one or more electrical apparatuses (EO, RE) connected to a communication network (PLC) together with the electrical appliance (WM, DW);
 - the electrical apparatuses (EO, RF) and the electrical appliance (WM, DW) are operative for self-regulating their own current absorption on the basis of the availability of electric power in the environment (DA);
 - a measuring device (PMS) makes available, on the communication network (PLC), information representing the electric power available;
 - the control system (CS1) of the electrical appliance (WM, DW) verifies the need to use hot water for executing the operating cycle selected via the control means (CM) and where this need exists,
 - if the electric power available is sufficient, the control system (CS1) of the electrical appliance (WM, DW) issues a command for intake of the working amount of water and for heating it up to the working temperature (T_W), employing electrical-heating means (EH) present within the appliance (WM, DW),
 - if the electric power available is not sufficient, the control system (CS1) of the electrical appliance (WM, DW) manages intake of the working amount of hot water from the first distribution system (HW).
9. The method according to Claim 8, in which the control system (CS1) of the electrical appliance (WM, DW) evaluates whether:
- to heat the water, employing its own electrical-heating means (EH) even when the electric power available is sufficient; or else
 - to carry out intake of hot water from the first distribution system (HW).
10. A system for managing thermal energy in an environment (DA), for the implementation of the method according to one or more of the preceding claims, in which the supply apparatus (HWS) is selected in the group consisting of:
- a gas-fired water heater (GF) equipped with a cold-water inlet (IN1), a gas-supply inlet (IN3), an electrical-supply input (IN4) and an outlet (OUT1) for hot water connected to the first distribution system (HW);
 - an electric water heater (EB) equipped with a cold-water inlet (IN1), an electrical-supply input (IN4), and an outlet (OUT1) for hot water connected to the first distribution system (HW); and
 - a hot-water distributor (HWS) equipped with an inlet (IN2) for hot water coming from an external source, an electrical-supply input (IN4), and a hot-water outlet (OUT1) connected to the first distribution system (HW).
11. An electrical appliance (WM, DW), which is able to use hot water, in particular an electrical household appliance, for use with the method or the system according to one or more of the preceding claims, comprising an inlet (EV2) for intake of hot water from the first distribution system (HW), an electronic control system (CS1), control means (CM) for selection of an operating cycle of the electrical appliance (WM, DW), electrical water-heating means (EH), and temperature-sensor means (TS) for detecting the temperature of the water.
12. A supply apparatus of hot water (HWS), in particular a gas-fired water heater (GF), an electric water heater (EB) or a distributor (HWS) of hot water coming from an external source, for use in the method or in the system according to one or more of the preceding claims, the apparatus comprising an outlet (OUT1) for introducing hot water into the first distribution system (HW) and an electronic control system (CS2).
13. A method for controlling operation of an electrical appliance (WM, DW), which can be connected to a hot-water distribution system (HW), the operation

entailing the use of a working amount of hot water at a working temperature (T_W) and being configurable according to a plurality of operating programs, the method being **characterized in that**, following upon start-up of an operating program, the following operations are envisaged: 5

a) determining the value of the temperature (T_H) of the water available in the distribution system (HW) ; 10

b) drawing into the electrical appliance (WM, DW), from the distribution system (HW), a mass of hot water compatible with the operating program set under way, i.e., with the respective amount of hot water and working temperature (T_W); and 15

c) varying automatically one or more operating parameters of the operating program set under way, according to the amount of heat introduced into the electrical appliance (WM, DW), understood as the product of the mass and the temperature of the water taken into the electrical appliance (WM, DW) from the first distribution system (HW). 20

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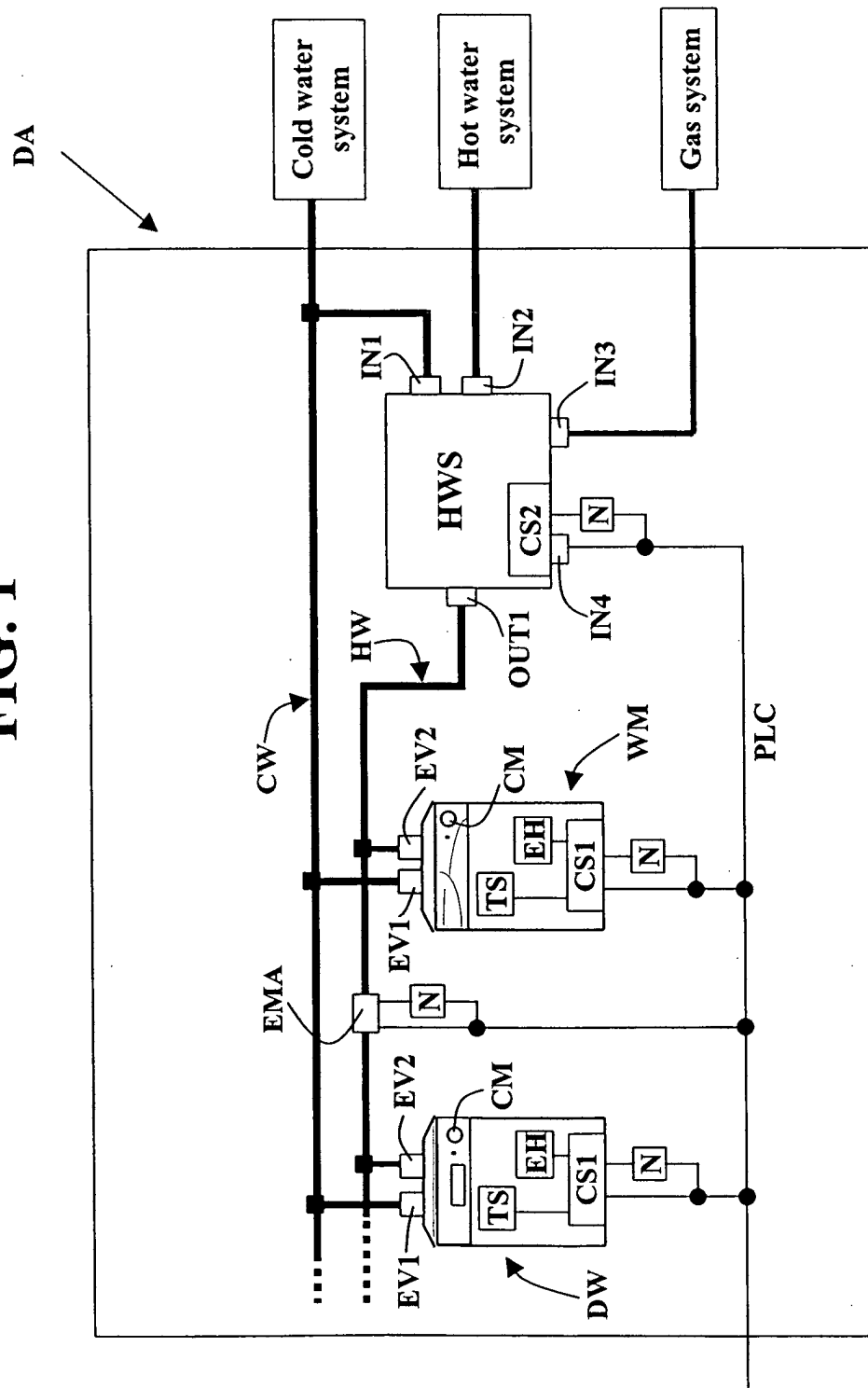
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FIG. 1



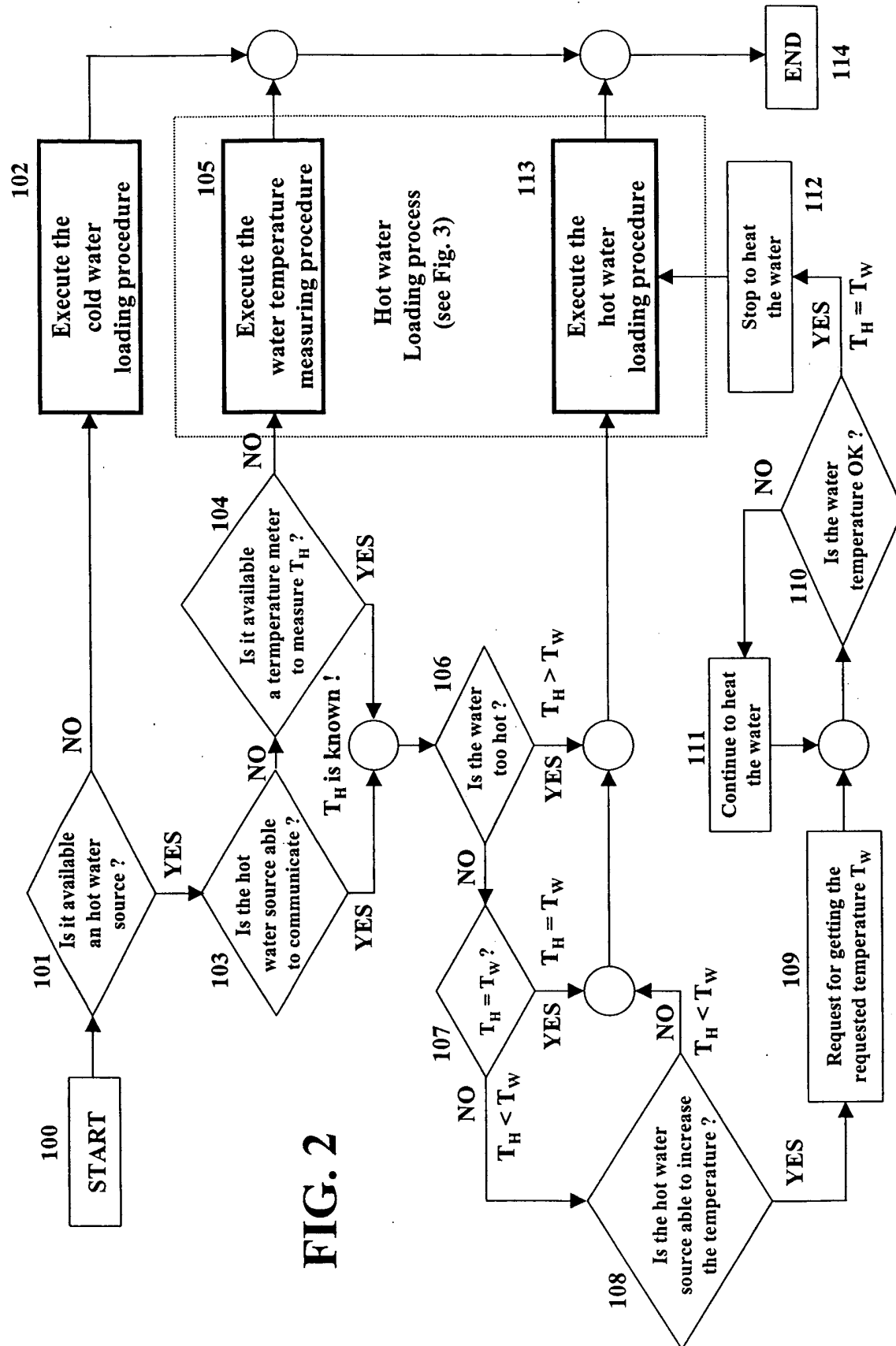


FIG. 3

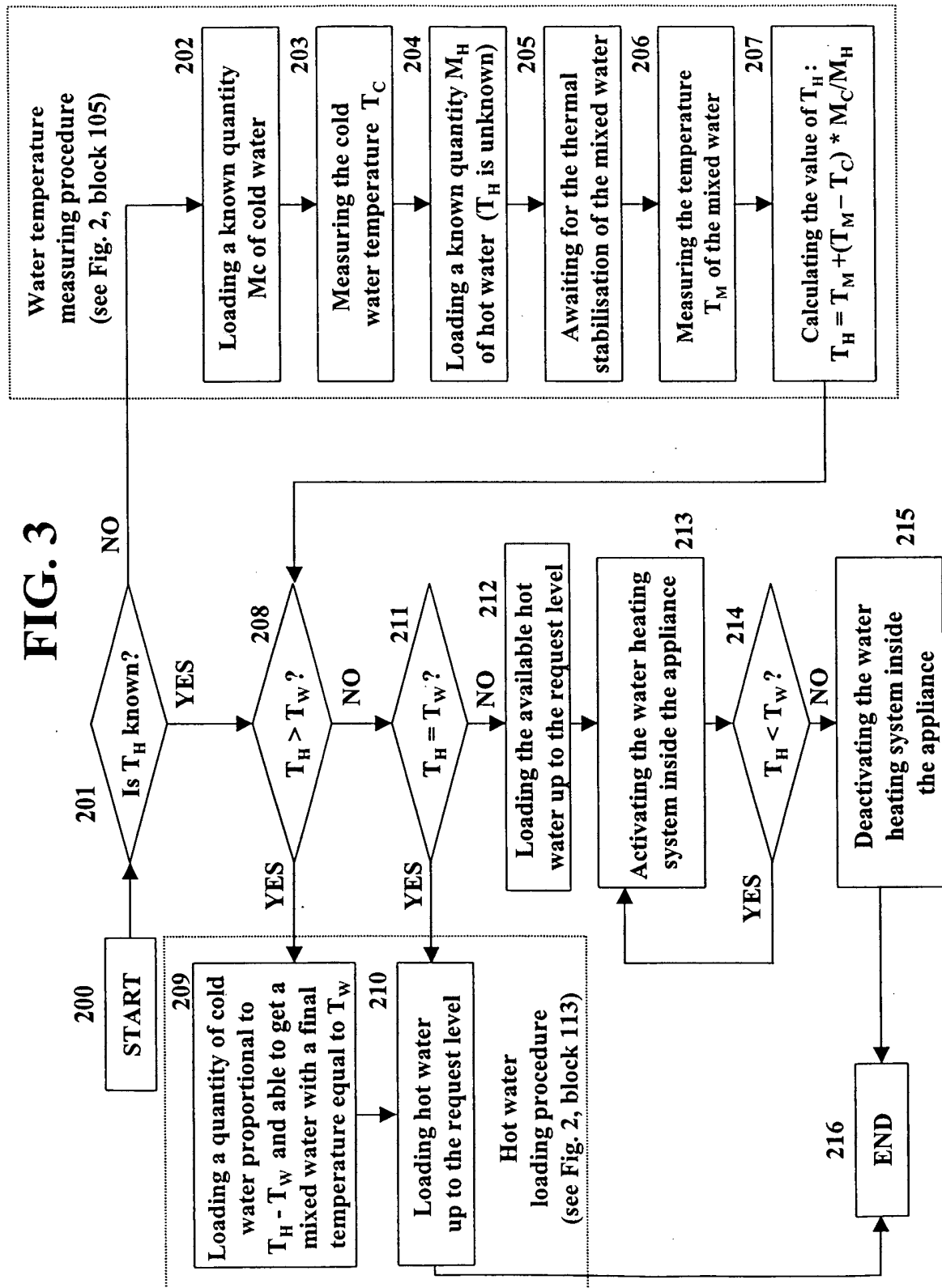
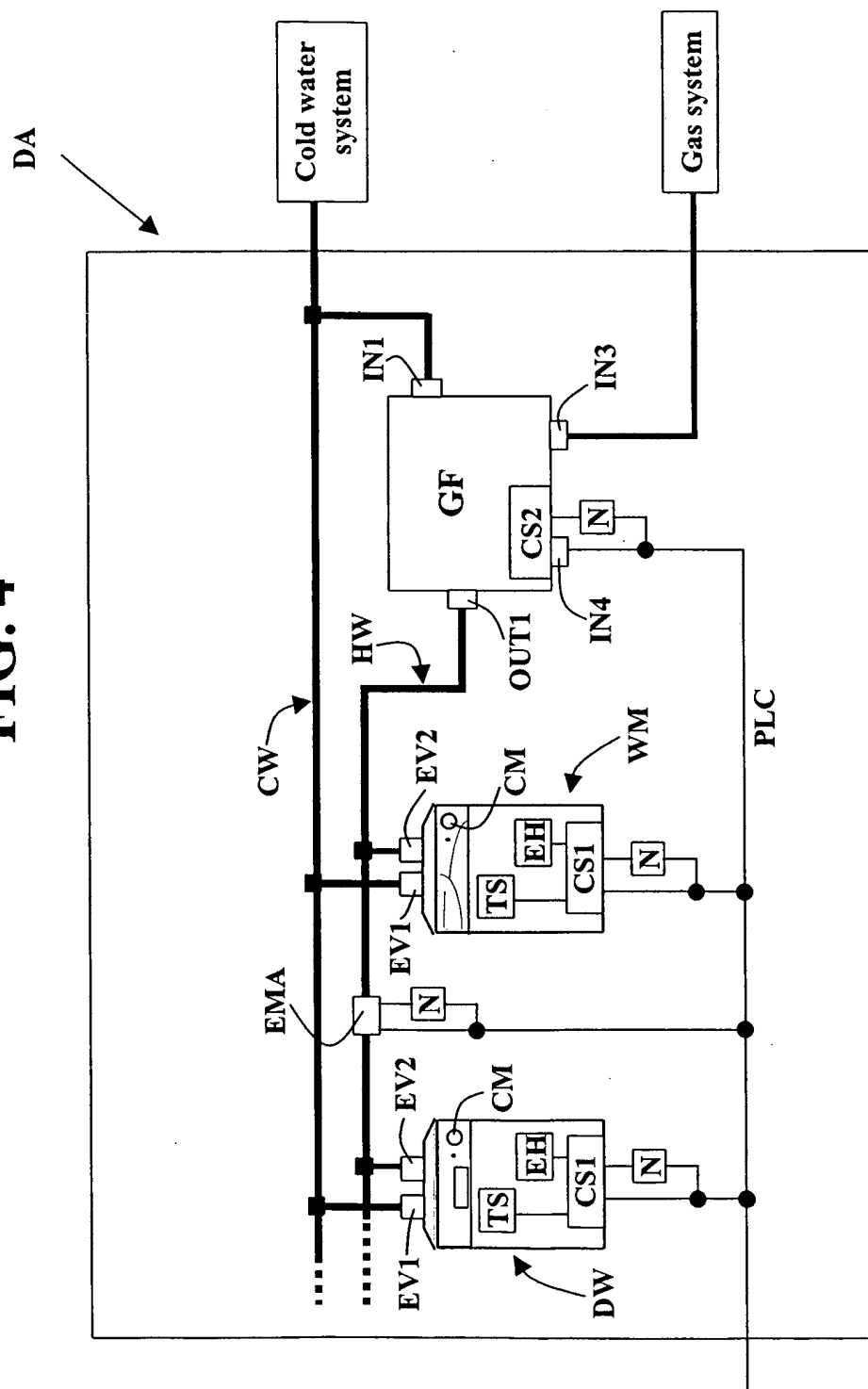


FIG. 4



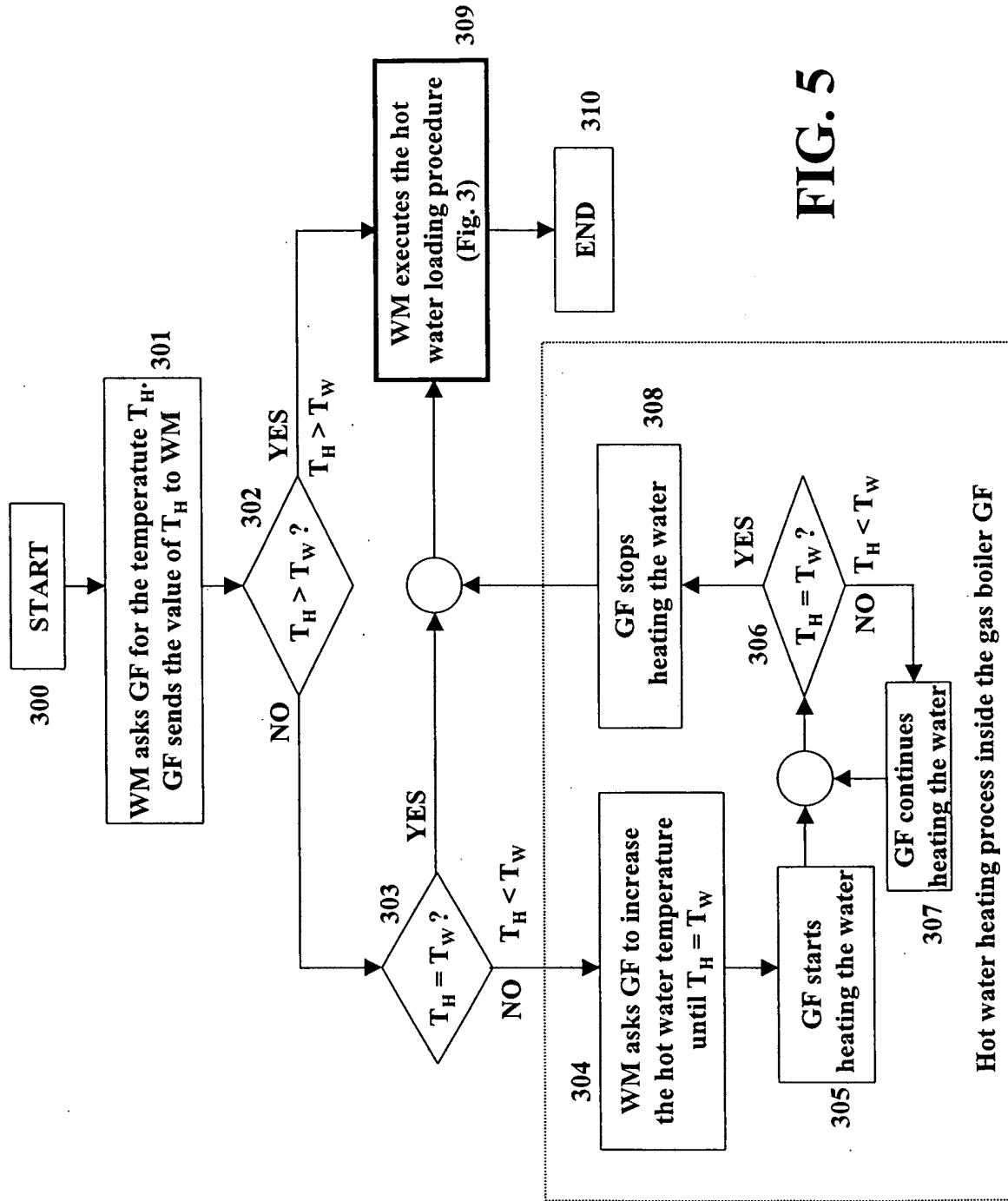


FIG. 5

FIG. 6

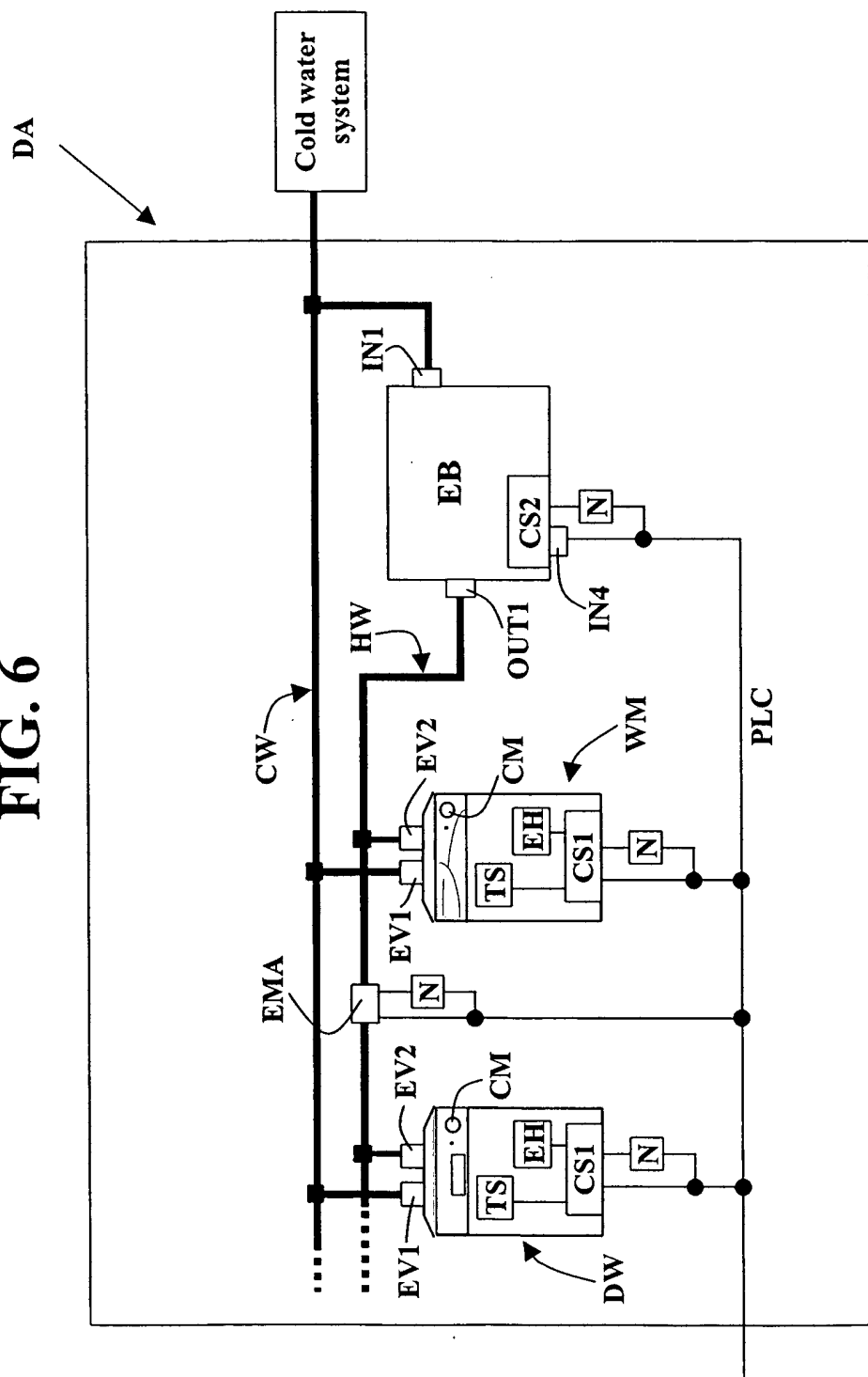


FIG. 7

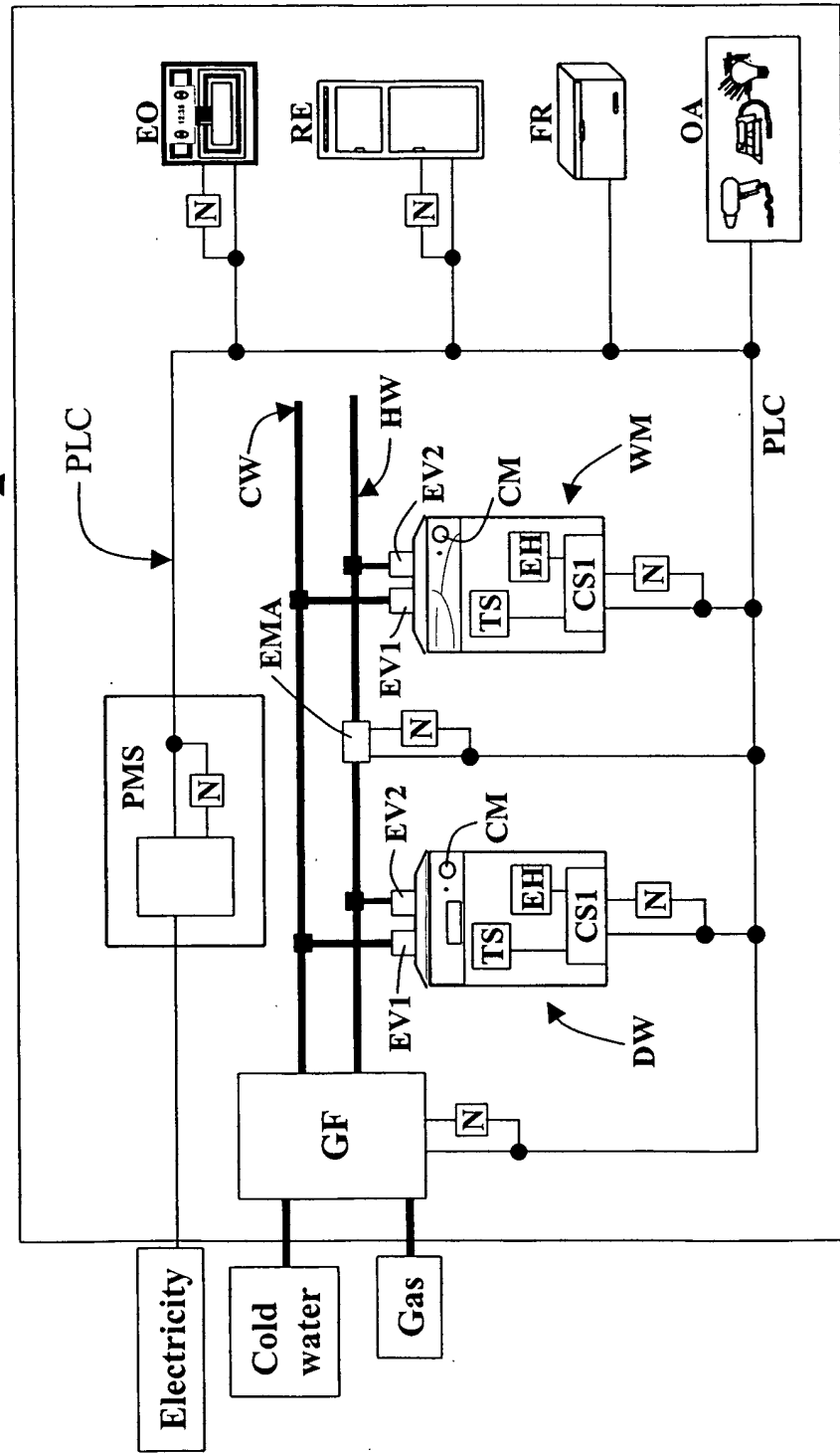


FIG. 8

