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A request for correction of the drawings has been filed pursuant to Rule 139 EPC. A decision on the request will be taken during the proceedings before the Examining Division (Guidelines for Examination in the EPO, A-V, 3.).

(54) CONTROL METHOD AND ROOM HEATING AND COOLING SYSTEM

(57) A method for controlling a heating and/or cooling system (1) comprises controlling a thermal generator (4) of the system (1) and controlling a primary circulator (8) of the system (1) in a first adjustment mode, determining a reduced efficiency condition when a thermal generator power (P_gen) is lower than a lower limit power (P_x) of a desired lower power range (Px < P_gen <= Px_u) and the current primary water delivery temperature (T_flow_out) of the system (1) is higher than a primary water delivery target temperature (T_flow_setpoint), if the reduced efficiency system has been determined and the operating speed (rpm_pump) of the primary circulator is lower than an upper speed limit value (rpm_pump_limit), switching the control of the primary circulator (8) from the first adjustment mode to a second adjustment mode, in which the operating speed (rpm_pump) of the primary circulator is increased so that a thermal generator power (P_gen) increases and returns to the desired lower power range (Px < P_gen <= Px_u).

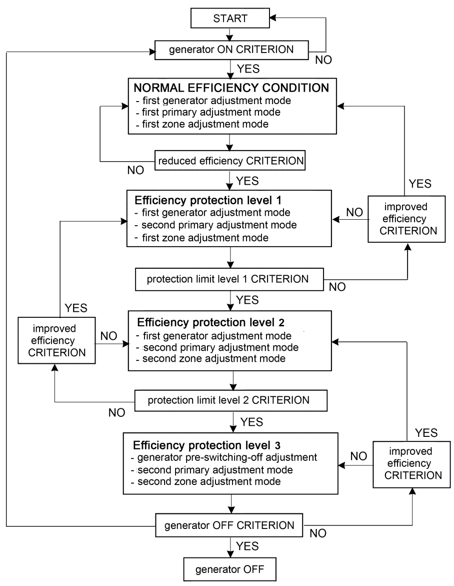

FIG. 3

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Description

[0001] The invention relates to a room heating and/or cooling / cooling system and to a method of controlling a room heating and/or cooling / cooling system.

Background art

[0002] A water-based heating and/or cooling system to provide hot sanitary water and/or heating and/or cooling a room comprises:

- a primary water circuit,
- a heating and/or cooling circuit system connected to the primary water circuit,
- a thermal heat and/or cooling generator, e.g., a heat pump, a combustion generator (gas boiler) or an electric generator, having a heat exchanger connected in the primary water circuit,
- one or more thermal heat and/or cold emitters and/or accumulators, e.g., a radiator, a radiant panel, a fan coil, etc., placed in the room to be heated and/or cooled, a sanitary hot water tank, a water buffer tank, connected in the heating and/or cooling circuit system,
- a primary circulator (e.g., a water pump) for:
- generating a primary water flow in the primary water circuit through the heat exchanger of the thermal generator, in which the primary water is heated or cooled,
- providing primary water from the heat exchanger of the thermal generator in the heating and/or cooling circuit system to supply said thermal emitters and/or accumulators to give or subtract heat to/from the room to be heated and/or cooled and/or to give heat to the sanitary water,
- returning primary water from the heating and/or cooling circuit system to the heat exchanger of the thermal generator,
- a control system, which actuates the thermal generator (controlling the operation, activation, switching-off, and power adjustment thereof) and (the activation, switching-off, and flow rate and head adjustment of) the circulators in the system (e.g., the primary circulator, the zone circulators).

[0003] The control system operates the thermal generator, the primary circulator, and the zone circulators, if present, as a function of the control parameters comprising one or more of an interior room temperature target value selectable by the user, a detected interior room temperature value, an external temperature value detected or communicated based on weather forecasts and/or depending on a sanitary water target temperature value set or selected by the user, a detected sanitary water temperature value, and a difference in the primary water temperature detected downstream and upstream of the heat exchanger of the thermal generator or between the delivery and return of heating zones.

[0004] It is known to determine, as a function of the aforesaid control parameters, a target temperature value (setpoint) of the primary delivery water downstream of the heat exchanger of the thermal generator (the target temperature value depends on the calculated delivery target temperature for the heating zones present), and to adjust the power of the thermal generator (e.g., the heat pump compressor frequency or the supply of fuel gas and combustion air of a gas boiler) to reach and maintain the target temperature (setpoint) of the primary delivery water.

[0005] Under certain conditions, the target temperature (setpoint) of the primary delivery water can be such that the power demanded from the thermal generator is less than the minimum operating power thereof, e.g., in case of very low demand for heating or cooling heat power during transient seasonal periods (autumn, spring).

[0006] Under these conditions, it is not possible to maintain the primary delivery water temperature setpoint stably when the thermal generator is on, but the detected primary delivery water temperature will systematically exceed the target temperature (setpoint) of the primary delivery water (either by excess, in case of heating, or by defect, in case of cooling), causing the thermal generator (e.g., the heat pump compressor or the burner of a gas boiler) to switch off and on alternately, known as "ON/-OFF cycle operation".

[0007] The ON/OFF cycle operation reduces the energy efficiency of the thermal generator, increases the wear of the construction components thereof (compressor, heat pump refrigerant circuit, electrical circuits and components, any type of actuators and components used in the construction of the generators) reducing the service life thereof, and also causes a lack of comfort due to periodic failure to reach the target temperature desired by the user.

[0008] Under other operating conditions of the heating and/or cooling system, the target temperature (setpoint) of the primary delivery water requires a power from the thermal generator either equal or very close to the minimum operating power thereof, resulting in continuous and prolonged operation, without ON/OFF cycle operations, but at minimum power.

[0009] Typically, in both modulable heat pumps and modulable gas boilers, the minimum operating power can be far from their optimal operating power with a maximum COP (Coefficient Of Performance). By way of example, in heat pumps, the maximum COP is typically obtained at about 2/3 of the maximum operating power.

[0010] However, in practice, it is not possible to simply "undersize" the thermal generators to reach a higher demanded power level more frequently, thus closer to the optimal operating power and farther away from the ON/OFF cycle operation condition or from prolonged operating condition at minimum power.

[0011] Conversely, the design power of the thermal generator is mainly determined by the need for hot sanitary water and/or the need for more power in the warm-up transients of the system, so that the minimum operating power is oversized compared to the heating/cooling needs of the room for most of the winter/summer period, thus being the cause of frequent ON/OFF cycle operation of the thermal generators, with particular criticality in heat pumps.

[0012] Therefore, for the explained reasons, it is desirable to reduce the occurrence of ON/OFF cycle operations and, in addition, to run the thermal generator for most of the time at a significantly higher power than the minimum operating power and then keep it off for longer idling intervals (in order to respect the target temperature settings by the user).

[0013] US9920967B2 describes a control system for a heating and cooling system which has two distinct modes of operation:

- an "on/off normal control" mode, in which the compressor is switched off and on at a first set of primary delivery water switching-off and switching-on threshold temperatures, and
- an "on/off restriction control" mode, in which the compressor is switched off and on at a second (different) set of primary delivery water switching-off and switching-on threshold temperatures,

where the control system switches from the normal mode to the restrictive mode when, in the normal mode, a repetition of ON/OFF cycle operation occurs with the compressor operating at the minimum frequency.

[0014] A further control mode of the thermal generator, known to the inventors (unpublished, inhouse knowledge) comprises:

- modulating the power of the thermal generator in order to reach a current primary water delivery temperature equal to the primary water target temperature and,
- when the power of the thermal generator is at a minimum power value for a preset time, e.g., 3 minutes, and the current delivery temperature remains above the delivery target temperature, the thermal generator is switched off,
- in case of power demand, the thermal generator is switched on again only after a preset minimum switching-off time or a preset minimum time between two consecutive generator switching-on events (timer against cycle operation) has elapsed, e.g., 10 minutes.

[0015] It is known to the inventors (unpublished, inhouse knowledge) that the primary circulator and, if provided, also further zone circulators, of the heating and/or cooling system are typically (but not only) controlled in rotational speed or conveyance speed depending on a target temperature difference between a delivery water temperature and a return water temperature of the primary water circuit (thermal generator) and of the zone water circuits (thermal emitters, radiators, hot sanitary water accumulators, etc.), e.g., of 5K in heat pumps.

[0016] It is also known to the inventors (unpublished, inhouse knowledge) that the primary circulator and, if provided, also further zone circulators, of the heating and/or cooling system are (but not only) controlled in rotational speed or conveyance speed depending on a target head (pressure difference) between a delivery pressure and a target suction pressure of circulated water, or depending on a target flow rate of circulated water.

[0017] Moreover, it is known to the inventors (unpublished, inhouse knowledge) that the zone circuits can be decoupled from the primary circuit of the thermal generator, by means of a hydraulic separator (intermediate buffer tank of capacity ranging from a few liters to tens/hundreds of liters).

Object of the invention

[0018] It is the object of the present invention to improve the method and system of controlling the heating and/or cooling system with the objective of increasing the energy efficiency and COP (Coefficient Of Performance) in addition to increasing the expected service life of the thermal generator.

[0019] It is a further object of the invention to improve the method and system of controlling the heating and/or cooling system to reduce the occurrence of conditions of ON/OFF cycle operations of the thermal generator.

[0020] It is a further object of the invention to improve the method and system of controlling the heating and/or cooling system to reduce the occurrence of prolonged and continuous periods of operation of the thermal generator at the minimum power limit thereof and thus with reduced energy efficiency.

[0021] These and other objects are achieved by a heating and/or cooling system according to claim 1 and by a method according to claim 13.

[0022] The dependent claims relate to advantageous and preferred embodiments.

Summary of the invention

[0023] According to an aspect of the invention, water-based heating and/or cooling system 1 for providing hot sanitary water and/or for heating and/or cooling a room comprises:

- a primary water circuit 2,
- a zone circuit system 3 connected to the primary water circuit 2,
- a thermal heat and/or cold generator 4, having a heat exchanger 5 connected in the primary water circuit 2,
- one or more thermal heat and/or cold emitters 6 and/or accumulators 7, connected in the zone circuit

system 3 in corresponding emission or accumulation zones 11 of the system 1,

- at least one primary circulator 8 for circulating a primary water flow in the primary water circuit 2 through the heat exchanger 5, and from the heat exchanger 5 in the zone circuit system 3 for supplying the thermal emitters 6 and/or accumulators 7, and returning the primary water from the zone circuit system 3 to the heat exchanger 5,
- an electronic control system 9 which:

  A) controls the thermal generator 4 and the primary circulator 8, and
  B) adjusts a power P_gen of the thermal generator 4 depending on a delivery target temperature T_flow_setpoint of the primary water downstream of the heat exchanger 5 and on a current temperature T_flow_out of the primary water detected downstream of the heat exchanger 5,
  C) in a primary adjustment mode, adjusts an operating speed rpm_pump of the primary circulator 8 depending on a primary water temperature difference target value delta_T_flow_setpoint and on a current primary water temperature difference delta_T_flow between the detected primary water delivery temperature T_flow_out and a current primary water return temperature T_flow_in detected upstream of the heat exchanger 5 (delta_T_flow = T_flow_out - T_flow_in),

wherein the control system 9 is configured to:

  D) determine a reduced efficiency condition (with risk of cycle operation and low COP) when the thermal generator power P_gen is lower (P_gen <= Px) than a lower limit power P_x of a desired lower power range (Px < P_gen <= Px_u) and the current primary water delivery temperature T_flow_out is higher than the primary water delivery target temperature T_flow_setpoint (T_flow_out > T_flow_setpoint + T_hyst_OFF),
  E) if the **reduced efficiency condition** has been determined and the operating speed rpm_pump of the primary circulator is lower than an upper speed limit value rpm_pump_limit, switch from the first primary adjustment mode to a second primary adjustment mode, in which the operating speed rpm_pump of the primary circulator is increased so that the thermal generator power P_gen increases and returns to the lower desired power range (Px < P_gen <= Px_u).

[0024] In the second primary adjustment mode, the aim of adjusting the operating speed of the primary circulator rpm_pump is no longer reaching and maintaining the primary water temperature difference target value delta_T_flow, but rather increasing and maintaining the power P_gen demanded from the thermal generator 4 above the lower power limit P_x and within the desired lower power range (Px < P_gen <= Px_u), in which range the coefficient of efficiency (COP) is considered acceptable.

[0025] Indeed, according to a not immediately intuitive consideration, the primary delivery water target temperature T_flow_setpoint being the same, increasing the primary delivery water rate reduces the current primary water temperature difference value delta_T_flow and therefore increases the thermal energy that can be transmitted from the thermal generator 4 to the rest of system 1 and the thermal energy that the system 1 can exchange with the environment, because the thermal emitters 6 and/or the thermal accumulators 7 will operate at a higher average temperature because of the current primary water temperature difference delta_T_flow being reduced as compared to the primary water target temperature difference delta_T_flow_setpoint.

[0026] According to a further aspect of the invention, a method for controlling a heating and/or cooling system 1, comprising:

- a primary water circuit 2,
- a zone circuit system 3 connected to the primary water circuit 2,
- a thermal heat and/or cold generator 4, having a heat exchanger 5 connected in the primary water circuit 2,
- one or more thermal heat and/or cold emitters 6 and/or accumulators 7, connected in the zone circuit system 3 in corresponding emission and accumulation zones 11 of the system 1,
- a primary circulator 8 for circulating a primary water flow in the primary water circuit 2 through the heat exchanger 5, and from the heat exchanger 5 in the zone circuit system 3 for supplying the thermal emitters 6 and/or accumulators 7, and returning the primary water from the zone circuit system 3 to the heat exchanger 5,

where said method comprises:

  A) controlling the thermal generator 4 and the primary circulator 8, and
  B) adjusting a power P_gen of the thermal generator 4 depending on a delivery target temperature T_flow_setpoint of the primary water downstream of the heat exchanger 5 and on a current temperature T_flow_out of the primary water detected downstream of the heat exchanger 5,
  C) in a primary adjustment mode, adjusting an operating speed rpm_pump of the primary circulator 8 depending on a primary water temperature difference target value delta_T_flow_setpoint and on a current primary water temperature difference delta_T_flow between the detected primary water de-

livery temperature T_flow_out and a current primary water return temperature T_flow_in detected upstream of the heat exchanger 5 (delta_T_flow = T_flow_out - T_flow_in),

D) determining a reduced efficiency condition (with risk of cycle operation and low COP) when the thermal generator power P_gen is lower (P_gen <= Px) than a lower limit power P_x of a desired lower power range (Px < P_gen <= Px_u) and the current primary water delivery temperature T_flow_out is higher than the primary water delivery target temperature T_flow_setpoint (T_flow_out > T_flow_setpoint + T_hyst_OFF),

E) if the reduced efficiency condition has been determined and the operating speed rpm_pump of the primary circulator is lower than an upper speed limit value rpm_pump_limit, switching from the first primary adjustment mode to a second primary adjustment mode, in which the operating speed rpm_pump of the primary circulator is increased so that the thermal generator power P_gen increases and returns to the lower desired power range (Px < P_gen <= Px_u).

Brief description of the figures

[0027] Further advantageous aspects of the invention will become apparent from the following description of some embodiments thereof, given by way of non-limiting example, with reference to the accompanying drawings, in which:

- figure 1 shows a heating and/or cooling system with a primary circulator and zone circulators according to an embodiment,
- figure 2 shows a heating and/or cooling system with only one primary circulator according to an embodiment,
- figures 3, 4, 5, 6 are flow charts of a method of controlling the heating and/or cooling system, according to embodiments,
- figure 7 graphically shows the determination of the reset integral and of the release integral as a condition for switching the thermal generator off and on.

Description of embodiments

[0028] With reference to the figures, a water-based heating and/or cooling system 1 for providing hot sanitary water and/or for heating and/or cooling a room comprises:

- a primary water circuit 2,
- a zone circuit system 3 connected to the primary water circuit 2,
- a thermal heat and/or cooling generator 4, e.g., a heat pump, a combustion generator (gas boiler) or an electric generator (resistive), having a heat exchanger 5 connected in the primary water circuit 2,
- one or more thermal heat and/or cold emitters 6 and/or accumulators 7, e.g., a radiator 6.1, a radiant panel 6.2, a fan coil 6.3, etc., placed in the room to be heated and/or cooled, a sanitary hot water tank 7.1, a hydraulic separator 7.2 or a water buffer tank 7.3, connected in the zone circuit system 3 in corresponding accumulation and emission zones 11 of the system 1,
- at least one primary circulator 8 (e.g., a water pump) for circulating a primary water flow in the primary water circuit 2 through the heat exchanger 5, in which a temperature change of the primary water occurs, and from the heat exchanger 5 in the zone circuit system 3 for supplying the thermal emitters 6 and/or thermal accumulators 7 in order to change the temperature in the emission and accumulation zones 11, and returning the primary water from the zone circuit system 3 to the heat exchanger 5.

[0029] The system 1 further comprises an electronic control system 9 which:

A) controls (e.g., the operation, activation, switching-off, and power adjustment of) the thermal generator 4 and (e.g., the activation, switching-off, and flow rate and/or head adjustment of) the primary circulator 8, and

B) adjusts a power P_gen of the thermal generator 4 depending on a delivery target temperature T_flow_setpoint of the primary water downstream of the heat exchanger 5 and on a current temperature T_flow_out of the primary water detected downstream of the heat exchanger 5,

C) in a primary adjustment mode, adjusts an operating speed rpm_pump of the primary circulator 8 depending on a primary water temperature difference target value delta_T_flow_setpoint and on a current primary water temperature difference delta_T_flow between the detected current primary water delivery temperature T_flow_out and a current primary water return temperature T_flow_in detected upstream of the heat exchanger 5 (delta_T_flow = T_flow_out - T_flow_in).

[0030] According to an aspect of the invention, the control system 9 is configured to:

D) determine a reduced efficiency condition (with risk of cycle operation and low COP) when the thermal generator power P_gen is lower (P_gen <= Px) than a lower limit power P_x of a desired lower power range (Px < P_gen <= Px_u) and the current primary water delivery temperature T_flow_out is higher than the primary water delivery target temperature T_flow_setpoint (T_flow_out > T_flow_setpoint + T_hyst_OFF),

E) if the **reduced efficiency condition** has been determined and the operating speed rpm_pump of the primary circulator is lower than an upper speed limit value rpm_pump_limit, switch from the first primary adjustment mode to a second primary adjustment mode, in which the operating speed rpm_pump of the primary circulator is increased so that the thermal generator power P_gen increases and returns to the lower desired power range (Px < P_gen <= Px_u).

Description of the adjustment of thermal generator power P gen

[0031] Under a normal efficiency condition, in a first adjustment mode of the thermal generator, the thermal generator power P_gen is adjusted (by the electronic control system 9) as a function of a primary water delivery target temperature value T_flow_setpoint downstream of the heat exchanger 5 of the thermal generator 4 and a current primary water delivery temperature value T_flow_out (detected) downstream of the heat exchanger 5 of the thermal generator 4, so that (with the aim that) the current primary delivery water temperature value T_flow_out corresponds to the primary delivery water target temperature value T_flow_setpoint (generator adjustment aim: T_flow_out = T_flow_setpoint), possibly within a tolerance range around T_flow_setpoint, for example predetermined.

Determination of the primary water delivery temperature target T flow setpoint

[0032] According to an embodiment, the control method or control system 9 determines the primary water delivery target temperature value T_flow_setpoint as a function of a current external temperature value T_ext, detected for example by an external temperature sensor 10 and/or transmitted to the control system 9 by means of a data connection. For example, the control system 9 comprises, or the control method uses, a temperature adjustment table or curve, selectable or settable by the installer or user, and which defines a relationship between the current external temperature T_ext and the primary water delivery target temperature T_flow_setpoint.

[0033] According to an embodiment, the control method or system 9 determines the primary water delivery target temperature value T_flow_setpoint as a function of one or more internal temperature values, i.e., current zone temperature values T_zone of at least one or more of the emission and/or accumulation zones 11, detected by respective one or more zone temperature sensors 12 and transmitted to the control system 9 by means of a data connection. For example, the control method or the control system 9 determines the primary water delivery target temperature value T_flow_setpoint (at least also) as a function of a difference value between a current zone temperature value T_zone (detected) and a threshold zone temperature value T_zone_threshold (selectable or settable by the user).

[0034] According to embodiments, the control method or system 9 determines the primary water delivery target temperature value T_flow_setpoint both as a function of the current external temperature value T_ext and as a function of the one or more current zone temperature values T_zone of the various zones present.

[0035] According to embodiments, the control method or system 9 uses a primary water delivery target temperature value T_flow_setpoint either fixed (factory setting) or settable by the user or installer.

Description of the first primary adjustment mode

[0036] In a normal efficiency condition or a protected efficiency condition (which will be described later), in a first primary adjustment mode, the control method or system 9 adjusts the operating speed rpm_pump of the primary circulator 8 as a function of a primary water temperature difference target value delta_T_flow_setpoint and a current primary water temperature difference value delta_T_flow between the current primary water delivery temperature T_flow_out detected (by means of a primary delivery water temperature sensor 13) downstream of the heat exchanger 5 of the thermal generator 4 and the detected current primary water return temperature T_flow_in (by means of a primary return water temperature sensor 14) upstream of the heat exchanger 5 of the thermal generator 4 (delta_T_flow = T_flow_out - T_flow_in), so that (with the aim that) the current primary water temperature difference value delta_T_flow matches the primary water temperature difference target value delta_T_flow_setpoint (primary adjustment aim: delta_T_flow = T_flow_out - T_flow_in = delta_T_flow_setpoint), possibly within a tolerance range, for example predetermined.

Determination of the primary water temperature difference target value delta T flow setpoint

[0037] According to an embodiment, the control method or system 9 determines the primary water delivery temperature difference target value delta_T_flow_setpoint as a function of one or more internal temperature values, i.e., current zone temperature values T_zone of at least one or more of the emission and/or accumulation zones 11, detected by respective one or more zone temperature sensors 12 and transmitted to the control system 9 by means of a data connection. For example, the control method or the control system 9 determines the primary water delivery temperature difference target value delta_T_flow_setpoint (at least also) as a function of a difference value between a current zone temperature value T_zone (detected) and a threshold zone temperature value T_zone_threshold (selectable or settable by the user).

[0038] According to embodiments, the control method or system 9 determines the primary water delivery temperature difference target value delta_T_flow_setpoint both as a function of the current external temperature value T_ext and as a function of the one or more current zone differences values T_zone.

[0039] According to embodiments, the control method or system 9 uses a primary water temperature difference target value delta_T_flow_setpoint either fixed (factory setting) or settable by the user or installer, e.g., a delta_T_flow_setpoint of 5K for radiant systems and/or 10K for systems with radiators.

System 1 with zone circulators 17

[0040] According to an embodiment, the primary water circuit 2 is connected to zone circuit system 3 by means of the interposition of a hydraulic separator 15 (a primary water tank in communication with the primary water circuit 2 and in communication with one or more zone circuits 16 of the zone circuit system 3) and one or more zone circuits 16 of the zone circuit system 3 with its own zone circulator 17 for the circulation of primary water towards the thermal emitters 6 and/or the thermal accumulators 7.

Description of the first zone adjustment mode

[0041] In a normal efficiency condition or a protected efficiency condition (which will be described later), in a first zone adjustment mode, the control method or system 9 adjusts an operating speed rpm_zone of the zone circulator 17 as a function of a zone flow temperature difference target value delta T zone_setpoint and a current zone flow temperature difference value delta_T_zone between a current zone delivery flow temperature T_zone_out of the primary water (detected in zone circuit 16 by means of a zone delivery flow temperature sensor 18) downstream of the hydraulic separator 15 and a current zone flow return temperature T_zone_in of the primary water (detected in the zone circuit 16 by a zone return flow temperature sensor 19) upstream of hydraulic separator 15 (delta_T_zone = T_zone_out - T_zone_in), so that (with the aim that) the current zone flow temperature difference value delta_T_zone corresponds to the zone flow temperature difference target value (zone adjustment aim: delta_T_zone = T_zone_out - T_zone_in = delta_T_zone_setpoint), possibly within a tolerance range, for example predetermined.

Determination of the zone flow temperature difference target value delta T zone setpoint

[0042] According to an embodiment, the control method or system 9 determines the zone flow temperature difference target value delta_T_zone_setpoint as a function of one or more internal temperature values, i.e., current zone temperature values T_zone of at least one or more of the emission and/or accumulation zones 11, detected by respective one or more zone temperature sensors 12 and transmitted to the control system 9 by means of a data connection. For example, the control method or the control system 9 determines the zone flow temperature difference target value delta_T_zone_setpoint (at least also) as a function of a difference value between a current zone temperature value T_zone (detected) and a threshold zone temperature value T_zone_threshold (selectable or settable by the user).

[0043] According to embodiments, the control method or system 9 determines the zone flow temperature difference target value delta T zone_setpoint both as a function of the current external temperature value T_ext and as a function of the one or more current difference values T_zone.

[0044] According to embodiments, the control method or system 9 uses a zone flow temperature difference target value delta_T_zone_setpoint either fixed (factory setting) or settable by the user or installer.

Determination of a reduced efficiency condition (risk of cycle operation or low energy efficiency)

[0045] Within this description, the term "reduced efficiency condition" denotes a situation of the system 1 in which the thermal generator 4 operates with a risk of cycle operation and/or undesirably low energy efficiency (COP).

[0046] The control method or system 9 verifies whether the thermal generator power P_gen (currently adjusted) is lower than or equal to a lower limit power P_x of a desired lower power range (or lower power dead band) (Px < P_gen <= Px_u) for efficient operation of the thermal generator 4 (criterion: P_gen <= Px) and if the current primary water delivery temperature T_flow_out is greater than the primary water delivery target temperature T_flow_setpoint, possibly with a hysteresis switching-off margin T_hyst_OFF, for example of T_hyst OFF = +1K (criterion: T_flow_out > T_flow_setpoint + T_hyst_OFF).

[0047] If the verification result is affirmative, the control method or system 9 determines the existence of a reduced efficiency condition.

Switching from the first primary adjustment mode to the second primary adjustment mode

[0048] According to an embodiment, if the reduced efficiency condition is determined (condition P_gen <= Px and T_flow_out > T_flow_setpoint + T_hyst_OFF), and the primary circulator operating speed rpm_pump of the primary circulator 8 is lower than a upper primary speed limit value rpm_pump_max, the control method or system 9 switches from the first primary adjustment mode to a second primary adjustment mode, increasing the operating speed of the primary circulator rpm_pump until an efficiency protection condition (understood as a COP safeguard and protection against cycle operations) is reached, in which the heat generator power P_gen is returned to the lower desired power range (Px < P_gen <= Px_u).

[0049] In the second primary adjustment mode, the aim of adjusting the operating speed of the primary circulator is no longer to reach and maintain the primary water temperature difference target value delta_T_flow, but rather to increase and maintain the thermal generator power P_gen above the lower limit power P_x and within the desired lower power range (Px < P_gen <= Px_u).

[0050] The switching is a first, second or nth level of efficiency protection of the system 1, depending on the sequence of steps of the control method.

[0051] For the same primary delivery water target temperature T_flow_setpoint, an increase in the primary delivery water rate reduces the current primary water temperature difference value delta_T_flow and thus increases the thermal energy that can be transmitted from the thermal generator 4 to the rest of system 1 and the thermal energy that the system 1 can exchange with the environment, because the thermal emitters 6 and/or the thermal accumulators 7 will operate at an averagely higher temperature because the current primary water temperature difference delta_T_flow being reduced compared to the primary water target temperature difference delta_T_flow_setpoint.

Switching from the first zone adjustment mode to the second zone adjustment mode

[0052] According to an embodiment, if the reduced efficiency condition (condition P_gen <= Px and T_flow_out > T_flow_setpoint + T_hyst_OFF) is determined, and the operating speed (rpm_zone) of the one or more zone circulators 17 (which are active if there is a request for heating or cooling that zone) is lower than an upper zone speed limit value rpm_zone_max (criterion rpm_zone < rpm_zone_max), the control system 9 switches from the first zone adjustment mode to a second zone adjustment mode, increasing the zone circulator operating speed rpm_zone until an efficiency protection condition is reached, in which the thermal generator power value P_gen has returned to the desired lower power range (Px < P_gen <= Px_u).

[0053] This switching is also a first, second or nth level of efficiency protection of the system 1, depending on the sequence of steps of the control method.

[0054] Similarly to the second primary adjustment mode, also the second zone adjustment mode, the aim of adjusting the operating speed of the zone circulator rpm_zone is no longer to reach and maintain the zone flow temperature difference target value delta_T_flow, but rather to increase and maintain the thermal generator power P_gen above the lower limit power P_x and within the desired lower power range (Px < P_gen <= Px_u).

[0055] For the same primary water delivery target temperature T_flow_setpoint, increasing the water flow rate in the zone circuits 16 reduces the current zone flow temperature difference value delta_T_zone and, as a result, increases the thermal energy transmissible to the system 1 and the thermal energy which the system 1 can exchange with the room, because the thermal emitters 6 will operate at a higher average temperature due to the delta_T_zone value being lower than the delta_T_zone_setpoint value.

[0056] According to an embodiment, the control method or system 9 switches from the first zone adjustment mode to the second zone adjustment mode only if the reduced efficiency condition is determined (P_gen <= Px and T_flow_out > T_flow_setpoint + T_hyst_OFF) and if the primary circulator operating speed rpm_pump is already adjusted to the predetermined rpm_pump_max primary speed upper limit (criterion rpm_pump >= rpm_pump_max).

[0057] This additional criterion makes it possible to determine that the method or system 1 is already in an efficiency protection condition (e.g., first level) but has reached the adjustment possibility limit, so the further (e.g., second) protection level is activated by switching from the first zone adjustment mode to the second zone adjustment mode.

Pre-switching-off adjustment of the thermal generator 4 without increasing the primary water delivery target temperature T flow setpoint

[0058] According to an embodiment, or according to a first pre-switching-off adjustment mode of the thermal generator 4, settable or selectable by the user or installer, for example by means of a user interface 20 of the control system 9,

if the reduced efficiency condition is determined (P_gen <= Px and T_flow_out > T_flow_setpoint + T_hyst OFF criterion), and the system 1 is already in the (maximum) efficiency protection condition (with no possibility of further increase in efficiency protection), i.e., when the operating speed of the primary circulator rpm_pump is already adjusted to a upper primary speed limit value (condition rpm_pump >= rpm_pump_max) and (only in the presence of zone circulators 17) the operating speed of the zone circulator(s) rpm_zone is already adjusted to a zone speed upper limit value rpm_zone_max (criterion rpm_zone >= rpm_zone_max),
then the method or control system 9:

- adjusts the thermal generator power P_gen to the lower limit power value Px (condition P_gen = Px) and allows an increase in the current primary water delivery temperature T_flow_out beyond the primary water delivery target temperature T_flow_setpoint (condition T_flow_out > T_flow_setpoint + T_hyst_OFF), keeping the primary circulator operating speed (rpm_pump) and the operating speed rpm_zone of the zone circulator(s) (only in presence of zone circulators 17) at maximum levels, and

- verifies one or a combination of several switching-off conditions chosen from the group consisting of:

  - reaching a predetermined reset integral limit value of the integral over time of the function (T_flow_out - T_flow_setpoint) of the difference between T_flow_out and T_flow_setpoint, starting from the instant in which T_flow_out exceeds T_flow_setpoint (or exceeds T flow setpoint+Reset integral_hyst, e.g., +1K),
  - reaching the predetermined reset integral limit value (see the listed point above) and, necessarily, a continuous switching-on time of the thermal generator t_on_gen has exceeded a predetermined minimum switching-on time value t_on_min,
  - the current primary water delivery temperature T_flow_out exceeds a predetermined admissible maximum delivery temperature value T_flow_max (T_flow_out >= T_flow_max),
  - absence of a power request signal,
  - in case of heating, the current zone temperature T_zone is higher than the upper threshold zone temperature T_zone_threshold (T_zone > T_zone_threshold) in all emission and/or accumulation zones 11,
  - in case of heating, the current external temperature T_ext is higher than the threshold external temperature T_ext_threshold (T_ext > T_ext threshold),
  - a continuous thermal generator switching-on time t_on_gen has exceeded a predetermined minimum switching-on time value t_on_min,

and switches off the thermal generator 4 if one or more of the switching-off conditions occur.

[0059] In the first pre-switching-off adjustment mode of the thermal generator 4, a temporary increase in the current primary delivery water temperature T_flow_out in primary water circuit 2 and also a (only temporary) reduction in the coefficient of efficiency (COP) is accepted.

Pre-switching-off adjustment of the thermal generator 4 with increase in the target value T flow setpoint

[0060] According to a further embodiment, or according to a second pre-switching-off adjustment mode of the thermal generator 4, settable or selectable by the user or installer, for example by means of the user interface 20 of the control system 9,

if the reduced efficiency condition is determined (P_gen <= Px and T_flow_out > T_flow_setpoint + T_hyst OFF criterion), and the system 1 is already in (maximum) efficiency protection condition (with no possibility of further increase in efficiency protection), i.e., when the operating speed of the primary circulator rpm_pump is already adjusted to an upper limit value of primary speed (condition rpm_pump >= rpm_pump_max) and (only in the presence of zone circulators 17) the operating speed of the zone circulator(s) rpm_zone is already adjusted to a zone speed upper limit value rpm_zone_max (criterion rpm_zone >= rpm_zone_max),
the control method or system 9:

- calculates an increased delivery target temperature value T_flow_setpoint_incr (T_flow_setpoint_incr = T_flow_setpoint + T _incr) as the sum of the primary water delivery target temperature value T_flow_setpoint and an increase value T_incr, variable in an increase range (0 K < T_incr < T_incr_max) predetermined or settable by the user or installer, e.g., 0 K < T_incr < T_incr max = 5K,
- uses, for the power control of thermal generator P_gen, the increased delivery target temperature value T_flow_setpoint_incr instead of the primary water delivery target temperature value T_flow_setpoint, so as to return to the efficiency protection condition, in which the thermal generator power value P_gen is returned to the lower desired power range (Px < P_gen <= Px_u),

maintaining the primary operating speed rpm_pump and (if a zone circulator 17 is provided) the zone operating speed rpm_zone at maximum levels, and verifies a chosen switching-off condition in the group consisting of:

- the increase value T_incr reaches the upper limit T _incr_max of the predetermined increase interval (0 K < T_incr < T_incr_max) (condition T _incr >= T _incr_max),
- the current primary water delivery temperature T_flow_out exceeds an admissible maximum increased target temperature value T_flow_setpoint_max (condition T_flow_out >= T_flow_setpoint_max = T_flow_setpoint + T_incr_max),
- reaching a predetermined reset integral limit value of the integral over time of the function (T_flow_out - T_flow_setpoin_incr) of the difference between the current primary water delivery temperature T_flow_out and the increased delivery target temperature T_flow_setpoint_incr,

starting from the instant in which the current primary water delivery temperature T_flow_out exceeds the increased delivery target temperature T_flow_setpoint_incr,

- the current primary water delivery temperature T_flow_out exceeds a predetermined admissible maximum delivery temperature value T_flow_max (T_flow_out >= T_flow_max),
- absence of a power request signal,
- in case of heating, the current zone temperature T_zone is higher than the upper threshold zone temperature T_zone_threshold (T_zone > T_zone_threshold) in all emission and/or accumulation zones 11,
- in case of heating, the current external temperature T_ext is higher than the threshold external temperature T_ext_threshold (T_ext > T_ext threshold),
- a continuous thermal generator switching-on time t_on_gen has exceeded a predetermined minimum switching-on time value t_on_min,

and switches off the thermal generator 4 if one or more than one switching-off condition occurs.

[0061] In this embodiment, the primary aim is to further delay a thermal generator switching-off (e.g., if the lower limit power Px also corresponds to a minimum deliverable power Pmin of thermal generator 4), in order to avoid the cycle operation of the thermal generator 4, and/or to keep the generator power P_gen above the lower limit power Px, at which the efficiency of the thermal generator is better than at lower powers.

[0062] In the second pre-switching-off adjustment mode of the thermal generator 4, the current zone temperature T_zone will increase faster than in the first switching-off mode.

[0063] The switching-off of the primary circulator 8 and (if provided) of the zone circulators 17 takes place after a post-circulation time t_post of e.g. 1 minute to 5 minutes, or 3 minutes, for example, from the switching-off of the thermal generator 4.

Condition of thermal generator (re)ignition

[0064] With the thermal generator 4 off, the control system verifies a condition of (re)ignition of the thermal generator 4 comprising, for example:

- presence of a power request signal, and
- reaching a predetermined release integral limit value of the integral over time of the function (T_flow_out - T_flow_setpoint) of the difference between the current primary water delivery temperature T_flow_out and the primary water delivery target temperature T_flow_setpoint, starting from the instant in which the current primary water delivery temperature (T_flow_out) drops under the primary water delivery target temperature (T_flow_setpoint), and/or
- a continuous thermal generator switching-off time t_off_gen has exceeded a predetermined minimum switching-off time value t_off_min, and/or
- an elapsed time between two consecutive switching-on events t_cic of the thermal generator 4 has exceeded a predetermined minimum cycle operation time value t_cic_min,
- the current primary water delivery temperature T_flow_out is lower than the primary water delivery target temperature value T_flow_setpoint, possibly including a switching-on hysteresis margin value T_hyst ON, for example of - 1 K (T_flow_out < T_flow_setpoint + T_hyst_ON),

and (re)ignites the thermal generator 4 if the (re)ignition condition occurs, or at least one or all of the (re)ignition conditions occur.

[0065] The (re)ignition of the primary circulator 8 and (if provided) of the zone circulators 17 occurs (with a possible time offset) together with the (re)ignition of the thermal generator 4.

Determination of an improved efficiency condition

[0066] If the system 1 is in the efficiency protection condition, for example in one of the conditions:

- first generator adjustment mode and second primary adjustment mode, or
- first generator adjustment mode and second primary adjustment mode and first zone adjustment mode, or
- first generator adjustment mode and second primary adjustment mode and second zone adjustment mode, or
- first generator adjustment mode and first primary adjustment mode and second zone adjustment mode,

the control method or system 9 verifies whether the power output of the thermal generator P_gen exceeds the upper limit of the desired lower power range Px_u (criterion: P_gen > Px_u) and the primary water delivery target temperature T_flow_setpoint exceeds the current detected primary water delivery temperature T_flow_out (criterion T_flow_setpoint >= T_flow_out), possibly for a switching waiting time t_com, for example predetermined, e.g., 1 minute to 5 minutes, e.g., 3 minutes.

[0067] If the verification result is affirmative, the control method or system 9 determines (the return to) an improved efficiency condition.

[0068] An improved efficiency condition, under efficiency protection condition, can occur, for example, in case of a change in the current zone temperature T_zone and/or in case of a change in the current external temperature T_ext.

Switching from the second primary adjustment mode to the first primary adjustment mode

[0069] In an embodiment, if the system 1 is in the second primary adjustment mode and (only if a zone circulator 17 is provided) in the first or second zone adjustment mode, then the control method or system 9 switches from the second primary adjustment mode to the first primary adjustment mode, by means of a reduction of the operating speed of the primary circulator rpm_pump until the current primary water temperature difference value delta_T_flow reaches or again exceeds the primary water target temperature difference value delta_T_flow_setpoint (criterion: delta_T_flow = T_flow_out - T_flow_in >= delta_T_flow_setpoint).

Switching from the second zone adjustment mode to the first zone adjustment mode

[0070] In an embodiment, if the system 1 is in the second zone adjustment mode and in the first or second primary adjustment mode and an improved efficiency condition is determined, then the control method or system 9 switches from the second zone adjustment mode to the first zone adjustment mode, by means of a reduction of the operating speed of the rpm_zone circulator until the current zone flow temperature difference value delta_T_zone reaches or again exceeds the zone flow temperature difference target value delta T zone_setpoint (condition delta_T_zone = T_zone_out - T_zone_in >= delta T zone_setpoint).

[0071] According to embodiments, if a primary circulator 8 and one or more zone circulators 17 are present, the switching of the control of the zone circulators 17 from the second zone adjustment mode to the first zone adjustment mode can occur before, after or concurrently with the switching of the control of the primary circulator 8 from the second primary adjustment mode to the first primary adjustment mode.

Generation of a power request signal

[0072] The control method or system 9 generates a power request signal from at least one of the emission and/or accumulation zones 11 depending on:

- a current zone temperature value T_zone (detected or transmitted) and a threshold zone temperature value T_zone_threshold (set or selected by the user) and/or
- a current external temperature value T_ext (detected or transmitted) and a threshold external temperature value T_ext_threshold (set or selected by the user).

[0073] For example, in case of heating, a power request signal from one of the emission and/or accumulation zones 11 is generated when:

- the current zone temperature value T_zone is lower than a lower threshold zone temperature value T_zone_threshold (T_zone < T_zone_threshold) and/or
- the current external temperature value T_ext is lower than a lower threshold external temperature value T_ext threshold (T_ext < T_ext_threshold).

[0074] For example, in case of cooling, a power request signal from one of the emission and/or accumulation zones 11 is generated when the current zone temperature value T_zone is higher than an upper threshold zone temperature value T_zone_threshold (T_zone > T_zone_threshold).

[0075] According to an embodiment, the system comprises a room thermostat (e.g., for each heating/cooling zone), and when the current zone temperature value T_zone exceeds the threshold zone temperature value T_zone_threshold (T_zone > T_zone_threshold condition) in all emission and/or accumulation zones of the system, no power request signal generation takes place and, therefore, the thermal generator is switched off and/or stays off.

List of reference signs

[0076]

system 1
primary water circuit 2
zone circuit system 3
thermal generator 4
heat exchanger 5
thermal emitters 6
radiator 6.1
radiant panel 6.2
fan coil 6.3,
thermal accumulators 7
sanitary hot water tank 7.1
hydraulic separator 7.2
water buffer tank 7.3
primary circulator 8
electronic control system 9
external temperature sensor 10
emission and/or accumulation zones 11
zone temperature sensors 12
primary delivery water temperature sensor 13
primary return water temperature sensor 14
hydraulic separator 15
zone circuits 16
zone circulator 17
zone delivery flow temperature sensor 18
zone return flow temperature sensor 19
user interface 20
thermal generator power P_gen
lower limit power P_x
desired lower power range Px < P_gen <= Px_u
upper limit of the desired lower power range Px_u
current external temperature T_ext

threshold external temperature T_ext_threshold
current zone temperature T_zone
zone threshold temperature value t_zone_threshold
primary water delivery target temperature T_flow_setpoint
current primary water delivery temperature T_flow_out
current primary water return temperature T_flow_in
maximum admissible delivery temperature value T_flow_max
primary water temperature difference target value delta_T_flow_setpoint
current primary water temperature difference value delta_T_flow
switching-off hysteresis margin T_hyst OFF
switching-on hysteresis margin T_hyst ON
increased delivery target temperature T_flow_setpoint_incr
increase value T_incr
current zone flow delivery temperature T_zone_out
current zone flow return temperature T_zone_in
zone flow temperature difference target value delta T zone_setpoint
current zone flow temperature difference value delta_T_zone
primary circulator operating speed rpm_pump
upper primary speed limit value rpm_pump_max
zone circulator operating speed rpm_zone
upper zone speed limit value rpm_zone_max
switching waiting time t_com
continuous thermal generator switching-on time t_on_gen
minimum switching-on time t_on_min
continuous switching-off time t_off_gen
time between two consecutive switching-on events t_cic
minimum cycle operation time t_cic_min
post-circulation time t_post

Claims

1. A heating and/or cooling system (1), comprising:

- a primary water circuit (2) with a zone circuit system (3),
- a thermal heat and/or cold generator (4), having a heat exchanger (5) connected in the primary water circuit (2),
- one or more thermal heat and/or cold emitters (6) and/or accumulators (7), connected in the zone circuit system (3) in corresponding emission or accumulation zones (11) of the system (1),
- at least one primary circulator (8) for circulating a primary water flow in the primary water circuit (2) through the heat exchanger (5), and from the heat exchanger (5) in the zone circuit system (3) for supplying the thermal emitters (6) and/or thermal accumulators (7), and returning the primary water from the zone circuit system (3) to the heat exchanger (5),
- an electronic control system (9) which:

A) controls the thermal generator (4) and the primary circulator (8), and
B) adjusts a power (P_gen) of the thermal generator (4) depending on a delivery target temperature (T_flow_setpoint) of the primary water downstream of the heat exchanger (5) and on a current temperature (T_flow_out) of the primary water detected downstream of the heat exchanger (5),
C) in a primary adjustment mode, adjusts an operating speed (rpm_pump) of the primary circulator (8) depending on:

- at least one primary water temperature or flow rate or pressure value, or
- a primary water temperature difference target value (delta_T_flow_setpoint) and a current primary water temperature difference value (delta_T_flow) between the current primary water delivery temperature (T_flow_out) and a current primary water return temperature (T_flow_in) detected upstream of the heat exchanger (5), wherein the control system (9) is configured to:

D) determine a reduced efficiency condition when the thermal generator power (P_gen) is lower than a lower limit power (P_x) of a desired lower power range (Px < P_gen <= Px_u) and the current primary water delivery temperature (T_flow_out) is higher than the primary water delivery target temperature (T_flow_setpoint),
E) if the reduced efficiency condition has been determined and the operating speed (rpm_pump) of the primary circulator is lower than an upper speed limit value (rpm_pump_limit), switch from the first primary adjustment mode to a second primary adjustment mode, wherein the operating speed (rpm_pump) of the primary circulator is increased so that the thermal generator power (P_gen) increases and returns to the lower desired power range (Px < P_gen <= Px_u).

2. A system (1) according to claim 1, comprising a hydraulic separator (15) interposed between the primary water circuit (2) and the zone circuit system (3), and one or more zone circuits (16) of the zone circuit system (3) each with an own zone circulator (17) for circulating the primary water towards the thermal emitters (6) and/or the thermal accumulators (7),

wherein, in a first zone adjustment mode, the control system (9) adjusts an operating speed (rpm_zone) of the zone circulator (17) as a function:

- of at least one temperature or flow rate or pressure value of the primary water in the zone circuit (16), or
- of a zone flow temperature difference target value (delta_T_zone_setpoint) and a current zone flow temperature difference value (delta_T_zone) between a current zone flow delivery temperature (T_zone_out) of the primary water detected downstream of the hydraulic separator (15) and a current zone flow return temperature (T_zone_in) of the primary water detected upstream of the hydraulic separator (15), and verifies the reduced efficiency condition,

wherein, if the reduced efficiency condition (P_gen <= Px and T_flow_out > T_flow_setpoint + T_hyst_OFF) is determined, and the operating speed (rpm_zone) of the one or more zone circulators (17) is lower than an upper zone speed limit value (rpm_zone_max), the control system (9) switches from the first zone adjustment mode to a second zone adjustment mode, increasing the zone circulator operating speed (rpm_zone) until the efficiency protection condition is reached, in which the thermal generator power value (P_gen) has returned to the desired lower power range (Px < P_gen <= Px_u).

3. A system (1) according to claim 2, wherein the control system (9) switches from the first zone adjustment mode to the second zone adjustment mode only if the operating speed (rpm_pump) of the primary circulator has reached a predetermined upper primary speed limit value (rpm_pump_max).

4. A system (1) according to claim 3, wherein, if the control system (9) determines the reduced efficiency condition (P_gen <= Px and T_flow_out > T_flow_setpoint + T_hyst_OFF), and the operating speed (rpm_pump) of the primary circulator has reached an upper primary speed limit value (rpm_pump_max) and the operating speed (rpm_zone) of the zone circulator(s) has also reached an upper zone speed limit value (rpm_zone_max), the control system (9):

- adjusts the thermal generator power (P_gen) to the lower limit power value (Px) and allows an increase in the current primary water delivery temperature (T_flow_out) beyond the primary water delivery target temperature (T_flow_setpoint) and keeps the primary circulator operating speed (rpm_pump) and the operating speed (rpm_zone) of the zone circulator(s) at maximum levels, and
- verifies a switching-off condition of the thermal generator (4),
- switches off the thermal generator (4) if the switching-off condition occurs.

5. A system (1) according to claim 1, wherein, if the control system (9) determines the reduced efficiency condition (P_gen <= Px and T_flow_out > T_flow_setpoint + T_hyst_OFF), and the operating speed (rpm_pump) of the primary circulator has reached an upper primary speed limit value (rpm_pump_max), the control system (9):

- adjusts the thermal generator power (P_gen) to the lower limit power value (Px) and allows an increase in the current primary water delivery temperature (T_flow_out) beyond the primary water delivery target temperature (T_flow_setpoint) and keeps the primary circulator operating speed (rpm_pump) at maximum level, and
- verifies a switching-off condition of the thermal generator (4), and
- switches off the thermal generator (4) if the switching-off condition occurs.

6. A system (1) according to claim 3, wherein, if the control system (9) determines the reduced efficiency condition (P_gen <= Px and T_flow_out > T_flow_setpoint + T_hyst_OFF), and the operating speed (rpm_pump) of the primary circulator has reached an upper primary speed limit value (rpm_pump_max) and the operating speed (rpm_zone) of the zone circulator(s) has also reached an upper zone speed limit value (rpm_zone_max), the control system (9):

- determines an increased delivery target temperature (T_flow_setpoint_incr) as the sum of the primary water delivery target temperature value (T_flow_setpoint) and an increase value (T_incr), and
- uses, for controlling the thermal generator power (P_gen), the increased delivery target temperature value (T_flow_setpoint_incr) instead of the primary water delivery target temperature value (T_flow_setpoint),

so as to return to the efficiency protection condition, where the power value (P_gen) of the thermal generator has returned to the desired

lower power range (Px < P_gen <= Px_u), and
- keeps the operating speed (rpm_pump) of the primary circulator and the operating speed (rpm_zone) of the zone circulator(s) at maximum levels, and
- verifies a switching-off condition of the thermal generator (4), and
- switches off the thermal generator (4) if the switching-off condition occurs.

7. A system (1) according to claim 1, wherein, if the control system (9) determines the reduced efficiency condition (P_gen <= Px and T_flow_out > T_flow_setpoint + T_hyst_OFF), and the operating speed (rpm_pump) of the primary circulator has reached an upper primary speed limit value (rpm_pump_max), the control system (9):

- determines an increased delivery target temperature (T_flow_setpoint_incr) as the sum of the primary water delivery target temperature value (T_flow_setpoint) and an increase value (T_incr), and
- uses, for controlling the thermal generator power (P_gen), the increased delivery target temperature value (T_flow_setpoint_incr) instead of the primary water delivery target temperature value (T_flow_setpoint),
so as to return to the efficiency protection condition, where the power value (P_gen) of the thermal generator has returned to the desired lower power range (Px < P_gen <= Px_u), and
- keeps the operating speed (rpm_pump) of the primary circulator at maximum level, and
- verifies a switching-off condition of the thermal generator (4),
- switches off the thermal generator (4) if the switching-off condition occurs.

8. A system (1) according to claim 4 or 5, wherein the switching-off condition is selected from the group consisting of:

- reaching a predetermined reset integral value of the integral over time of the function (T_flow_out - T_flow_setpoint) of the difference between the current primary water delivery temperature (T_flow_out) and the primary water delivery target temperature (T_flow_setpoint), starting from the instant in which the current primary water delivery temperature (T_flow_out) exceeds the primary water delivery target temperature (T_flow_setpoint),
- the current primary water delivery temperature (T_flow_out) exceeds a predetermined admissible maximum delivery temperature value (T_flow_max),
- absence of a power request signal,
- a continuous thermal generator switching-on time (t_on_gen) has exceeded a predetermined minimum switching-on time value (t_on_min).

9. A system (1) according to claim 6 or 7, wherein the switching-off condition is selected from the group consisting of:

- the current primary water delivery temperature (T_flow_out) exceeds an admissible maximum increased target temperature value (T_flow_setpoint_max),
- reaching a predetermined reset integral limit value by the integral over time of the function (T_flow_out - T_flow_setpoint_incr) of the difference between the current primary water delivery temperature (T_flow_out) and the increased delivery target temperature (T_flow_setpoint_incr), starting from the instant in which the current primary water delivery temperature (T_flow_out) exceeds the increased delivery target temperature (T_flow_setpoint_incr),
- the current primary water delivery temperature (T_flow_out) exceeds a predetermined admissible maximum delivery temperature value (T_flow_max),
- absence of a power request signal,
- a continuous thermal generator switching-on time (t_on_gen) has exceeded a predetermined minimum admissible switching-on time value (t_on_min).

10. A system (1) according to any one of the preceding claims,

wherein, if the system (1) is in the efficiency protection condition, and in the second primary adjustment mode,
the control system (9):

- verifies whether the thermal generator power (P_gen) exceeds the upper limit of the desired lower power range (Px_u) and the primary water delivery target temperature (T_flow_setpoint) exceeds the current primary water delivery temperature (T_flow_out) for a switching waiting time (t_com), and if yes, determines an improved efficiency condition, and
- if the improved efficiency condition has been determined, switches from the second primary adjustment mode to the first primary adjustment mode, by means of a reduction of the operating speed (rpm_pump) of the primary circulator.

11. A system (1) according to claim 2 or any one of the

claims dependent on claim 2, wherein, if the system (1) is in the efficiency protection condition, and in the second zone adjustment mode,
the control system (9):

- verifies whether the thermal generator power (P_gen) exceeds the upper limit of the desired lower power range (Px_u) and the primary water delivery target temperature (T_flow_setpoint) exceeds the current primary water delivery temperature (T_flow_out) for a switching waiting time (t_com), and if yes, determines an improved efficiency condition, and
- if the improved efficiency condition has been determined, switches from the second zone adjustment mode to the first zone adjustment mode, by means of a reduction of the operating speed (rpm_zone) of the zone circulator.

12. A system (1) according to claim 11, wherein the switching of the control of the zone circulators (17) from the second zone adjustment mode to the first zone adjustment mode occurs:

- prior to the switching of the control of the primary circulator (8) from the second primary adjustment mode to the first primary adjustment mode, or
- after the switching of the control of the primary circulator (8) from the second primary adjustment mode to the first primary adjustment mode, or
- together with the switching of the control of the primary circulator (8) from the second primary adjustment mode to the first primary adjustment mode.

13. A method for controlling a heating and/or cooling system (1), comprising:

- a primary water circuit (2) with a zone circuit system (3),
- a thermal heat and/or cold generator (4), having a heat exchanger (5) connected in the primary water circuit (2),
- one or more thermal heat and/or cold emitters (6) and/or accumulators (7), connected in the zone circuit system (3) in corresponding emission or accumulation zones (11) of the system (1),
- at least one primary circulator (8) for circulating a primary water flow in the primary water circuit (2) through the heat exchanger (5), and from the heat exchanger (5) in the zone circuit system (3) for supplying the thermal emitters (6) and/or accumulators (7), and returning the primary water from the zone circuit system (3) to the heat exchanger (5),

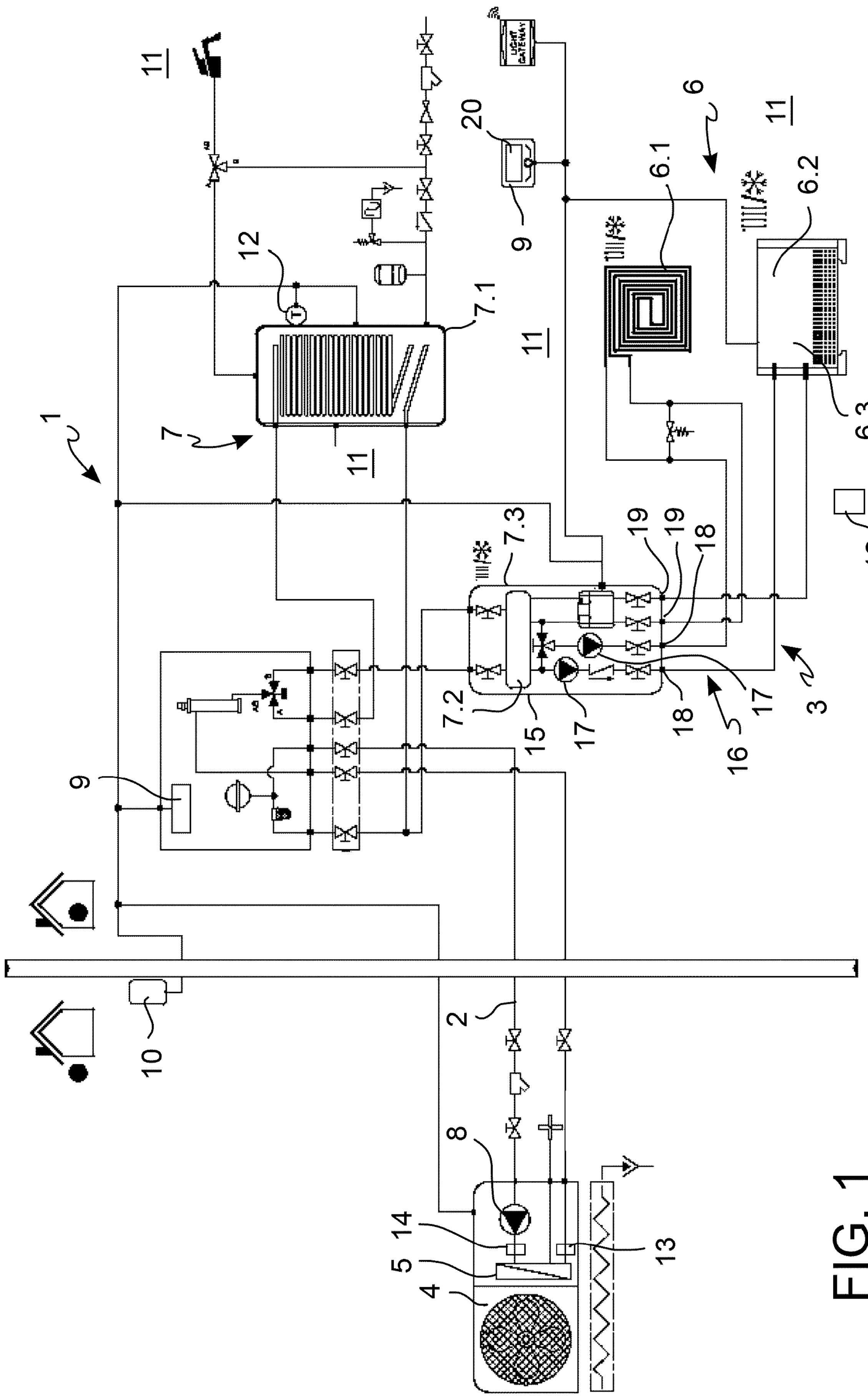
wherein the method comprises:

A) controlling the thermal generator (4) and the primary circulator (8), and
B) adjusting a power (P_gen) of the thermal generator (4) depending on a delivery target temperature (T_flow_setpoint) of the primary water downstream of the heat exchanger (5) and on a current temperature (T_flow_out) of the primary water detected downstream of the heat exchanger (5),
C) in a primary adjustment mode, adjusting an operating speed (rpm_pump) of the primary circulator (8) depending on:

- at least one temperature value or flow rate value or pressure value of the primary water, or
- a primary water temperature difference target value (delta_T_flow_setpoint) and a current primary water temperature difference value (delta_T_flow) between the current primary water delivery temperature (T_flow_out) and a current primary water return temperature (T_flow_in) detected upstream of the heat exchanger (5),

characterized by the steps of:

D) determining a reduced efficiency condition when the thermal generator power (P_gen) is lower than a lower limit power (P_x) of a desired lower power range (Px < P_gen <= Px_u) and the current primary water delivery temperature (T_flow_out) is higher than the primary water delivery target temperature (T_flow_setpoint),
E) if the reduced efficiency condition has been determined and the operating speed (rpm_pump) of the primary circulator is lower than an upper speed limit value (rpm_pump_limit), switching from the first primary adjustment mode to a second primary adjustment mode, in which the operating speed (rpm_pump) of the primary circulator is increased so that the thermal generator power (P_gen) increases and returns to the desired lower power range (Px < P_gen <= Px_u).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LIGHT GATEWAY

FIG. 1

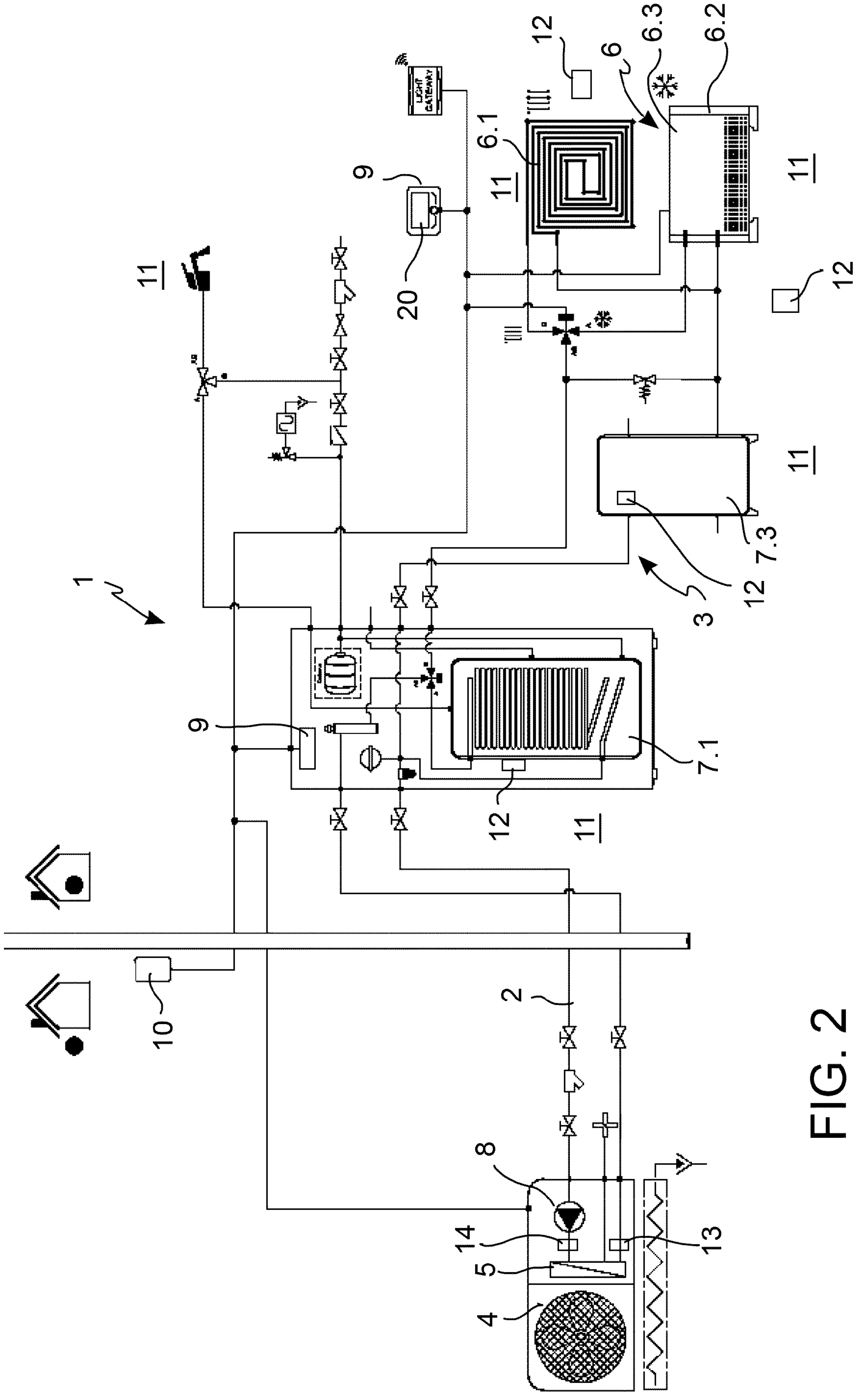

FIG. 2

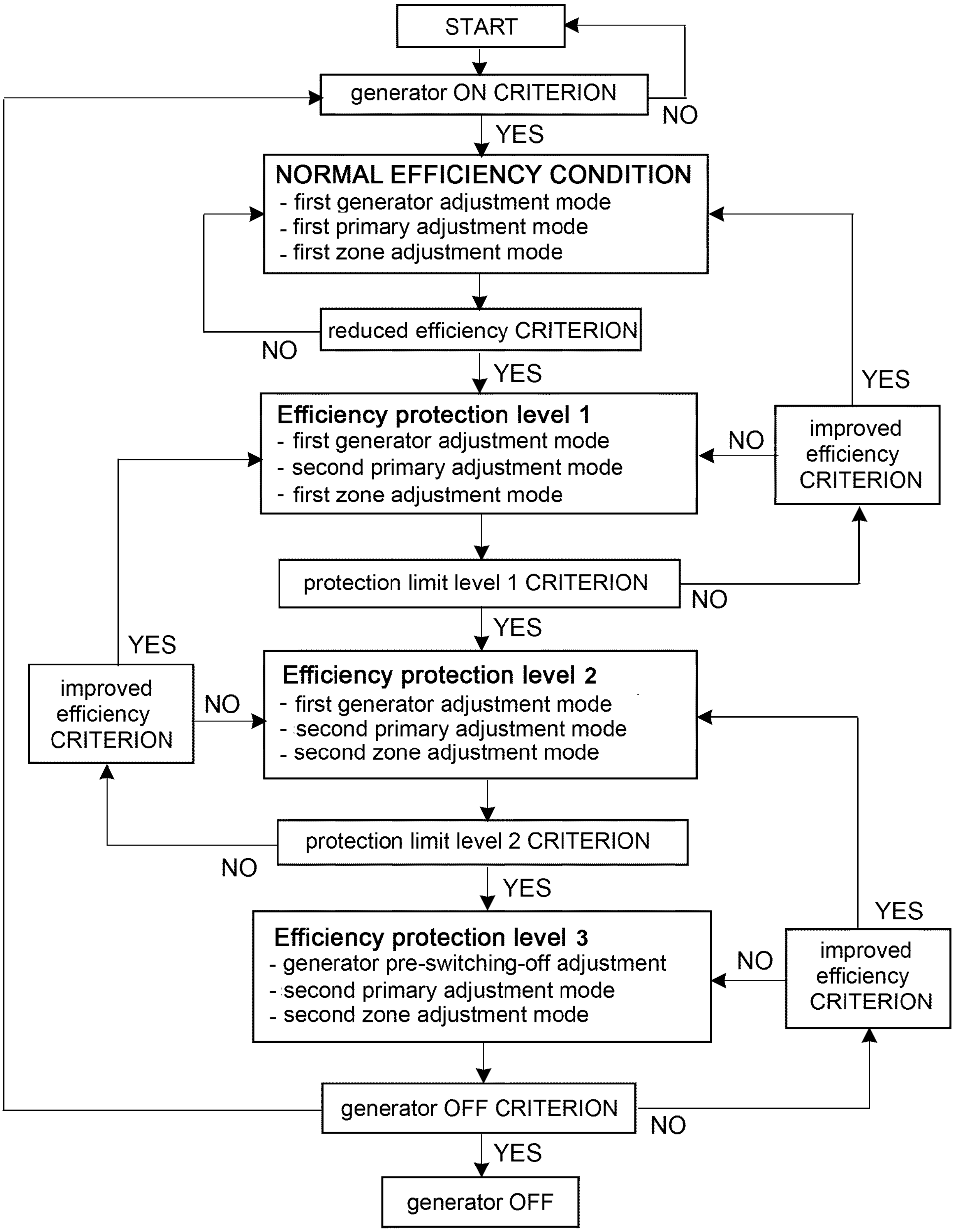
START
generator ON CRITERION
NO
YES
NORMAL EFFICIENCY CONDITION
- first generator adjustment mode
- first primary adjustment mode
- first zone adjustment mode
reduced efficiency CRITERION
NO
YES
Efficiency protection level 1
- first generator adjustment mode
- second primary adjustment mode
- first zone adjustment mode
improved efficiency CRITERION
YES
NO
protection limit level 1 CRITERION
NO
YES
Efficiency protection level 2
- first generator adjustment mode
- second primary adjustment mode
- second zone adjustment mode
improved efficiency CRITERION
YES
NO
protection limit level 2 CRITERION
NO
YES
Efficiency protection level 3
- generator pre-switching-off adjustment
- second primary adjustment mode
- second zone adjustment mode
improved efficiency CRITERION
YES
NO
generator OFF CRITERION
NO
YES
generator OFF

FIG. 3

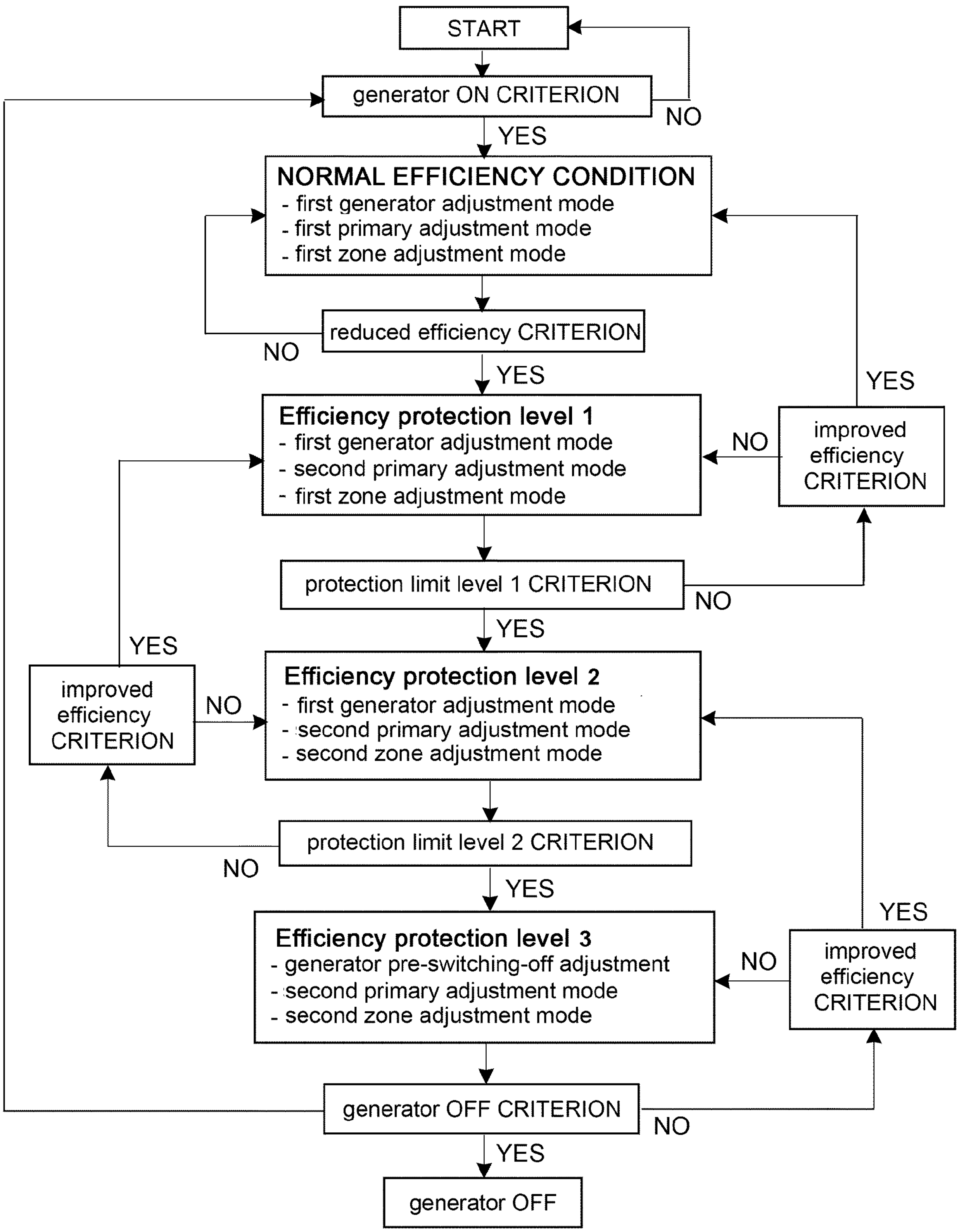
START
generator ON CRITERION
NO
YES
NORMAL EFFICIENCY CONDITION
- first generator adjustment mode
- first primary adjustment mode
- first zone adjustment mode
reduced efficiency CRITERION
NO
YES
Efficiency protection level 1
- first generator adjustment mode
- second primary adjustment mode
- first zone adjustment mode
YES
improved efficiency CRITERION
NO
protection limit level 1 CRITERION
NO
YES
Efficiency protection level 2
- first generator adjustment mode
- second primary adjustment mode
- second zone adjustment mode
YES
improved efficiency CRITERION
NO
protection limit level 2 CRITERION
NO
YES
Efficiency protection level 3
- generator pre-switching-off adjustment
- second primary adjustment mode
- second zone adjustment mode
YES
improved efficiency CRITERION
NO
generator OFF CRITERION
NO
YES
generator OFF

FIG. 4

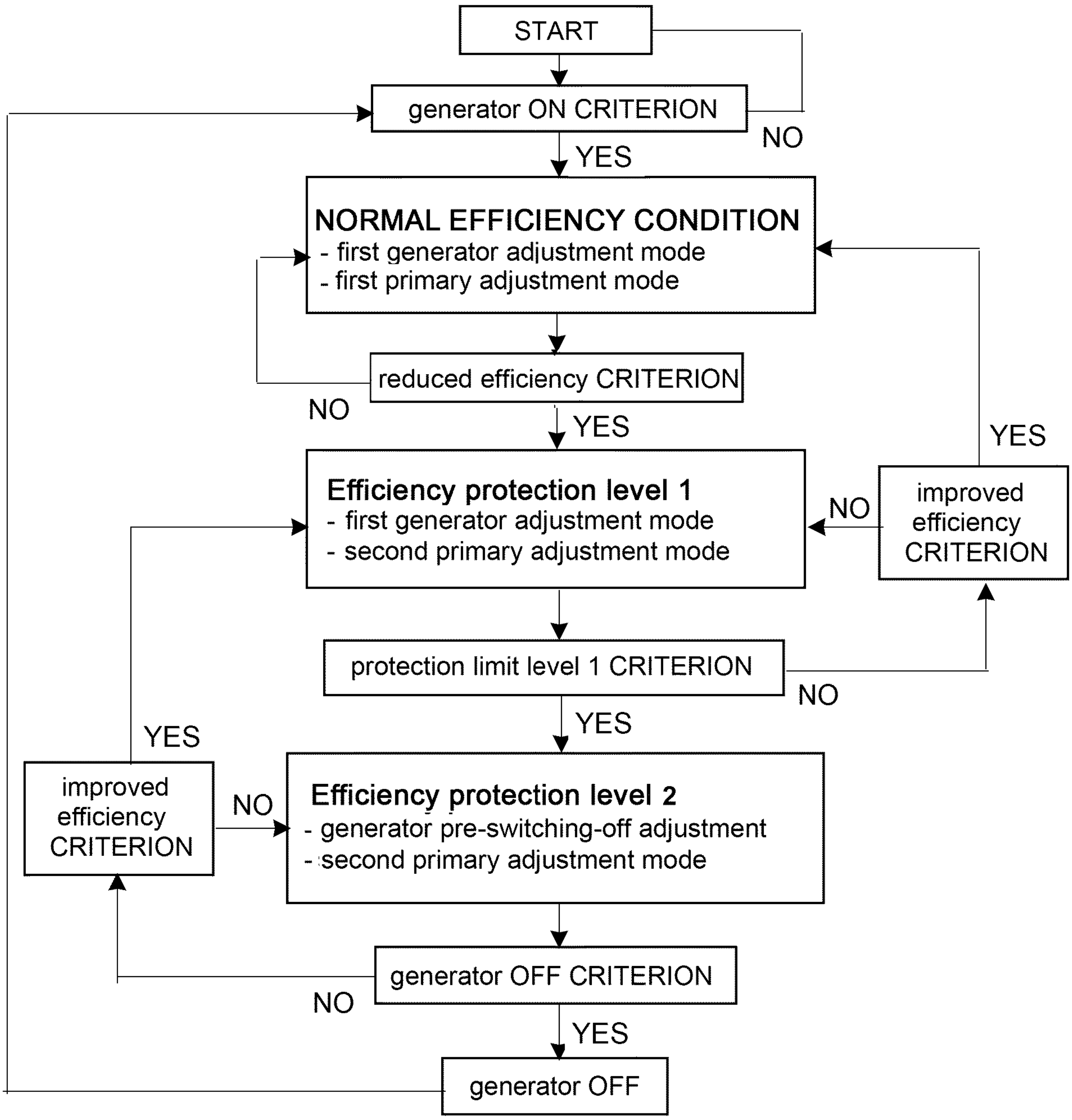
START
generator ON CRITERION
NO
YES
NORMAL EFFICIENCY CONDITION
- first generator adjustment mode
- first primary adjustment mode
reduced efficiency CRITERION
NO
YES
YES
Efficiency protection level 1
- first generator adjustment mode
- second primary adjustment mode
NO
improved efficiency CRITERION
protection limit level 1 CRITERION
NO
YES
YES
improved efficiency CRITERION
NO
Efficiency protection level 2
- generator pre-switching-off adjustment
- second primary adjustment mode
generator OFF CRITERION
NO
YES
generator OFF

FIG. 5

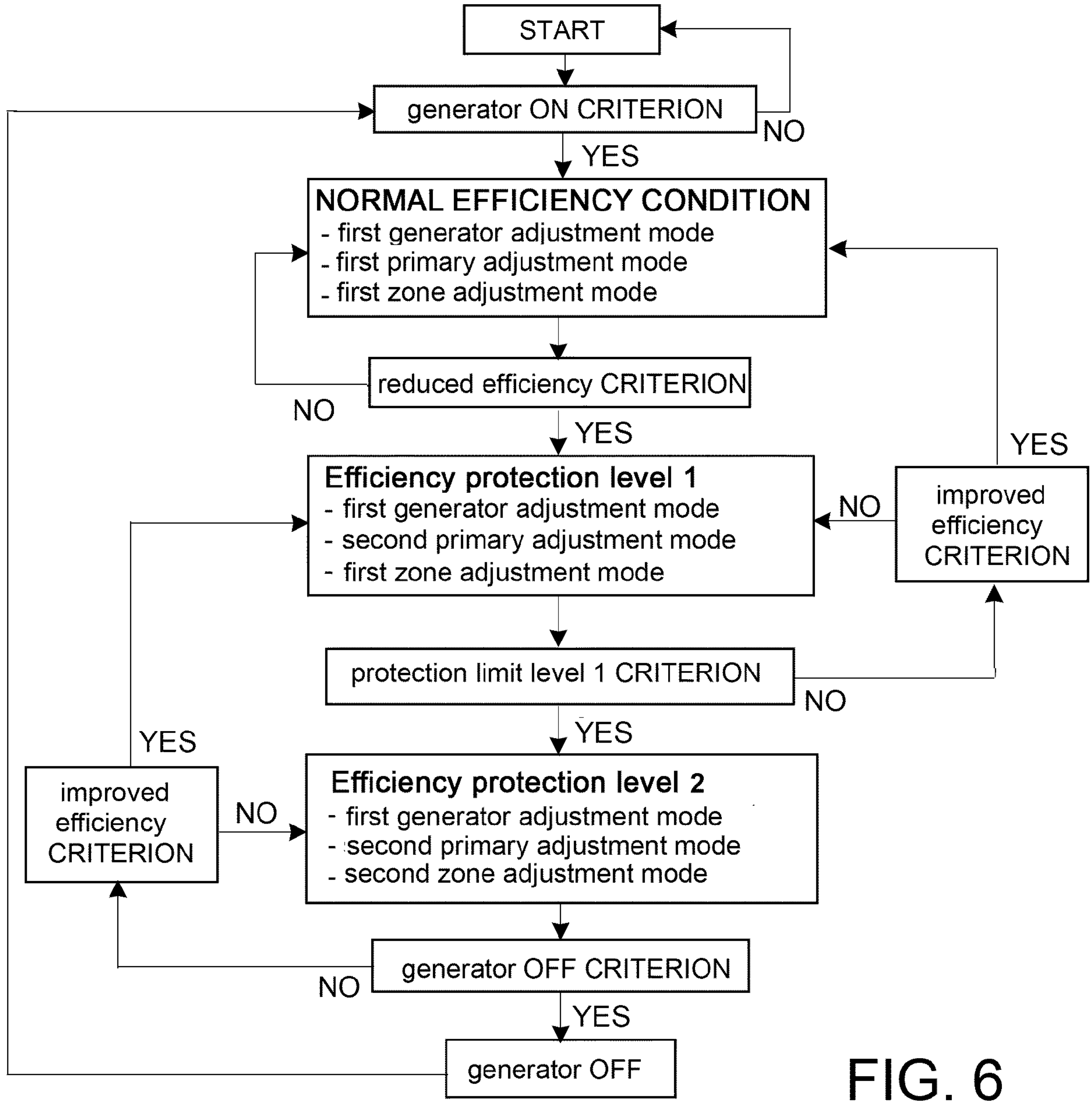
START
generator ON CRITERION
NO
YES
NORMAL EFFICIENCY CONDITION
- first generator adjustment mode
- first primary adjustment mode
- first zone adjustment mode
reduced efficiency CRITERION
NO
YES
Efficiency protection level 1
- first generator adjustment mode
- second primary adjustment mode
- first zone adjustment mode
NO
improved efficiency CRITERION
YES
protection limit level 1 CRITERION
NO
YES
Efficiency protection level 2
- first generator adjustment mode
- second primary adjustment mode
- second zone adjustment mode
improved efficiency CRITERION
YES
NO
generator OFF CRITERION
NO
YES
generator OFF

FIG. 6

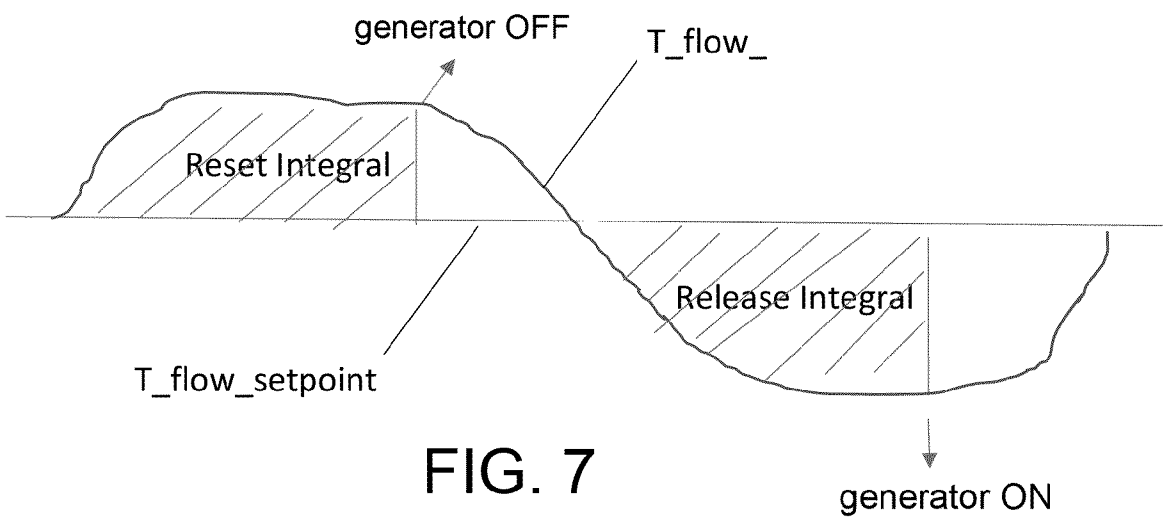
generator OFF
T_flow_
Reset Integral
Release Integral
T_flow_setpoint
generator ON

FIG. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 24 20 6205

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	DE 43 12 808 A1 (STIEBEL ELTRON GMBH & CO KG [DE]) 27 October 1994 (1994-10-27) * columns 1-3; figures 1, 2 * -----	1-13	INV. F24D3/18 F24D17/02 F24D19/10 F24F5/00 F24D3/10 F24H15/156 F24H15/174 F24H15/215 F24H15/219 F24H15/238 F24H15/242 F24H15/34 F24H15/355 F24H15/375 F24H15/223 F24H15/254 F24H15/258
A	EP 3 450 875 B1 (DAIKIN IND LTD [JP]; RINNAI KK [JP]) 2 June 2021 (2021-06-02) * the whole document * -----	1-13	
A	US 2017/219219 A1 (MILLER KEITH A [US] ET AL) 3 August 2017 (2017-08-03) * the whole document * -----	1-13	
A	EP 2 159 495 B1 (HONEYWELL TECHNOLOGIES SARL [CH]) 15 November 2017 (2017-11-15) * the whole document * -----	1-13	
			TECHNICAL FIELDS SEARCHED (IPC)
			F24D F24F F24H

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	20 February 2025	Schwaiger, Bernd

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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20-02-2025

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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