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(54) SYSTEM, APPARATUS AND METHOD FOR THERMAL CONTROL, PREFERABLY FOR DOMESTIC ENVIRONMENTS, CONFIGURED TO MANAGE HEATING AND/OR COOLING EQUIPMENT BELONGING TO DIFFERENT TYPES OF THERMAL SOURCES INDEPENDENT FROM EACH OTHER

(57) A thermal control system, preferably for domestic environments, configured to manage the following independent heating and/or cooling equipment: radiant equipment (1), preferably with radiators or on the floor, connected to a gas boiler (2), or electrical equipment (3) with thermal diffusers (3) connected to an air-to-air heat pump (8); comprising a control unit (4) configured to:
- detect an initial internal temperature and a subsequent temperature of one or more internal environments (10) by means of one or more detectors positioned inside one or more of said internal environments (10);
- compare said detected internal initial and subsequent temperature with one or more predefined temperature thresholds;
- generate a first and a second activation command configured to activate a heating or cooling equipment and to modify the selection thereof as a function of the subsequent temperature.

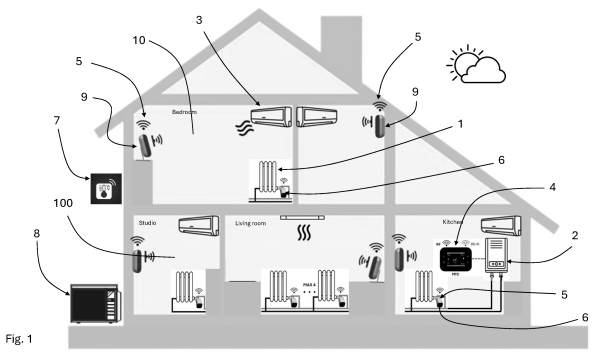


Fig. 1

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Description

Technical field

[0001] The present invention relates to a system, apparatus and method for thermal control, preferably for domestic environments, configured to manage heating and/or cooling equipment belonging to different types of thermal sources independent from each other.

[0002] In particular, the present invention falls within the field of the thermal management of different and independent sources (not already integrated in a hybrid system), often belonging to different manufacturers, which are installed in the same domestic environment, or in several environments (e.g. several rooms) that make up the same domestic macro-environment (e.g. house) such as, for example, a radiator or floor heating supplied by a gas boiler and a reversible air-to-air heat pump heating/cooling system.

Prior art

[0003] To date, different types of heating for domestic environments are known, some of which are of particular interest, indicated below:

- radiant equipment, preferably on the floor or wall, connected to a gas boiler, and managed by a thermostat installed on the wall;
- electrical equipment of the air-to-air heat pump type with thermal diffusers, preferably air/air (split), which are capable of producing hot or cold air and can usually be activated by means of a remote control;
- integrated hybrid systems comprising both a gas boiler and a heat pump (air-to-water) to heat the water inside the ducts of the radiant equipment.

[0004] In this context, usually the only known systems capable of offering integrated management of heat sources are integrated or separate hybrid systems, made by the same manufacturer, which already comprise control logic optimised so as to select the most convenient heat source (boiler or heat pump) at a certain time, rather than the most efficient, etc... as a function of a predefined algorithm.

[0005] As an alternative to these hardly widespread hybrid systems, most domestic environments have a gas boiler heating system or central heating system and a separate air conditioning system (air/air heat pumps) with indoor units (split).

[0006] During the winter season, users use a (more or less advanced) thermostat to control the heating and, if necessary, manually manage the splits by turning them on as desired to supplement or alternate the radiant heating by means of a gas boiler (autonomous or centralised).

[0007] However, the manual split management is obviously not optimised and does not respond to any predefined logic.

[0008] For example, there are times when it is more convenient (for example from an economic point of view) to use the splits rather than the gas boiler, but this logic is often ignored by users. At other times it is more convenient to heat the environments by means of the gas boiler as it has a more effective heating power, especially at low outdoor ambient temperatures. That is, to date there are no systems that integrate the use of the boiler, or central heating, and the splits as a function of predefined logic. This integration is often further problematic as the systems are not configured to "communicate" with one another and are from different manufacturers (therefore the respective control units respond to different logic and commands).

[0009] Furthermore, there is also the problem of ensuring adequate environmental comfort for the user due to the following situations that arise:

- the diffusion of heat with the air of the splits is not equivalent to the heat radiated by means of radiator heating;
- splits are not present in all rooms/environments, but only in some; therefore, reaching certain temperatures in some environments could be more difficult;
- some heating systems reduce humidity more than others, therefore, in order to maintain the environment at a certain degree of humidity, it is necessary to weigh the choice between one heating system and another.

Objects of the present invention

[0010] In this situation, the object of the present invention is to make a thermal control system, apparatus and method which obviates the aforementioned drawbacks.

[0011] It is an object of the present invention to make a thermal control system, apparatus and method that allows to efficiently integrate the use of heating and/or cooling equipment belonging to mutually different and independent types of thermal sources.

[0012] It is an object of the present invention to make a thermal control system, apparatus and method which is capable of optimising the user's comfort of perceiving the heat of humidity and ventilation inside one or more of the environments in question.

[0013] The indicated objects are substantially achieved by a thermal control system, apparatus and method according to what is described in the appended claims.

Description of the figures

[0014] Further features and advantages of the present invention will become more apparent from the de-

tailed description of a thermal control system, apparatus and method, in which:

- Figure 1 illustrates a control system, apparatus and method according to the present invention applied to a house comprising several domestic environments;
- Figure 2 illustrates an embodiment variant of the control scheme of the control system, apparatus and method according to the present invention; and
- Figure 3 illustrates a diagram relating to a Wi-Fi communication with a cloud server of the control system and method according to the present invention.

Detailed description of one or more embodiments according to the present invention

[0015] With reference to the accompanying figures, a thermal control system is schematically represented in two embodiment variants, preferably for domestic environments, configured to manage heating and/or cooling equipment belonging to one of the following types of mutually independent heat sources (and often from different manufacturers):

- radiant equipment 1, preferably with radiators or on the floor, connected to a gas boiler 2, or
- electrical equipment 3, preferably thermal diffusers (e.g. split), connected to a reversible air-to-air heat pump for the emission of a flow of hot or cold air.

[0016] It should be noted that the system is of the "multi-zone" type, i.e. the radiant equipment 1 and the electrical equipment 3 are arranged in a plurality of internal environments 10. For example:

- radiant equipment arranged in each internal environment 10, and separately controllable "by zone";
- electrical equipment 3 arranged in a plurality of internal environments (not necessarily in all) in which at least some internal environments 10 have both an electrical equipment 3 and radiant 1 equipment.

[0017] The system comprises a control unit 4 (MTC in Figures 1 and 2) configured to:

- detect an initial internal temperature of a plurality of internal environments 10 by means of a plurality of detectors (temperature detectors 5) respectively positioned inside said internal environments 10;
- compare said initial internal temperature detected for said plurality of internal environments with respective predefined temperature thresholds (also defined as "setpoints") for said plurality of internal environments;
- generate a first activation command configured to activate the radiant equipment 1 or the electrical equipment 3 or both so as to increase / decrease the temperature inside each of said internal environments to reach said respective predefined temperature thresholds.

[0018] It should be noted that the first activation command consists of one or more signals which, for example, are:

- on/off electrical signal or command through the "OpenTherm" communication bus to activate the gas boiler 2 connected to the radiant equipment 1 and a signal to activate, as the case may be, the valves associated with the opening of a radiator or a zone of a floor system, as will be better explained below; and/or
- infrared or RF (radio frequency) signal to activate an ON/OFF signal or command through a Wi-Fi channel to a cloud to which the electrical equipment 3 comprising said diffusers 3 (split) connected to a heat pump 8 are connected.

[0019] Advantageously, as will be better explained below, the activation of the boiler 2 or of the splits 3 based on the internal temperatures and the setpoints occurs intelligently by means of the control logic of the control unit 4, which is configured to determine the selection of the equipment mainly as a function of the multi-parameter environmental comfort condition determined for each environment.

[0020] Any additional criteria, such as energy efficiency, energy cost or the presence of renewable sources (e.g. photovoltaic systems), are considered in a subordinate and compatible manner with respect to the comfort condition, so as to optimise the overall operation of the system without compromising the required comfort level.

[0021] Such logic can also take into account external parameters, such as the external temperature detected by a device preferably connected in RF to the control unit 4, or obtained from web services based on the geolocation of the system, or still communicated by the heat pump or by sensors associated with the boiler 2, for example by means of OpenTherm bus.

[0022] In accordance with the present invention, the control unit 4 is further configured to:

- detect a subsequent temperature (with respect to the initial temperature) inside each of said internal environments 10, following said initial temperature detection;
- verify if said detected subsequent temperature approaches or deviates from said one or more predefined temperature thresholds;
- detect a degree of internal humidity of said plurality of internal environments 10 by means of a plurality of humidity detectors respectively associated with

said internal environments 10;
- compare said degree of humidity detected for said plurality of internal environments with respective predefined humidity thresholds for each internal environment 10;
- detect a ventilation level inside said plurality of internal environments 10 by means of ventilation regulators associated with said thermal diffusers 3;
- compare said ventilation level detected for said plurality of internal environments with respective predefined ventilation thresholds for each internal environment 10.

[0023] Based on this verification, calculate a multi-parameter environmental comfort condition (or as a function of several parameters) of a plurality of said environments based on:

◦ said verification if said detected subsequent temperature approaches or deviates from said one or more predefined temperature thresholds;
◦ said comparison of said degree of humidity detected for said plurality of internal environments with respective predefined humidity thresholds;
◦ said comparison of said ventilation level detected for said plurality of internal environments with respective predefined ventilation thresholds.

[0024] It should be noted that the selection and activation of the heating and/or cooling equipment 1, 3 is not based exclusively on a comparison with a reference temperature or on energy criteria, but on a dynamic multi-parameter comfort condition that jointly takes into account the temperature, its evolution over time, humidity and ventilation.

[0025] In particular, the control unit 4 is configured to perform said calculation of the environmental comfort condition for each environment 10 and is configured to assign a value within a predefined comfort range (e.g. from 1 to 10) as a function of said comparisons and verification. That is, the comfort condition is defined by comparing:

- ventilation level with a predefined reference threshold (e.g. if ventilation is too strong, it is necessary to lower the fan);
- humidity level with a predefined reference threshold (e.g. if it is too humid, it is necessary to activate the electrical equipment 3);
- temperature with respect to a predefined reference threshold to increase or decrease the temperature (e.g. by activating the electrical equipment 3).

[0026] Furthermore, the control unit 4 is further configured to:

- compare said comfort condition value with a target comfort value,
- generate a second activation command for the radiant equipment 1 or for the electrical equipment 3 or for both, as a function of said comparison of said comfort condition value with a target comfort value, to alternatively:

◦ modify the previously chosen heating and/or cooling equipment,
◦ maintain the previously chosen equipment, but modify:

▪ the predefined temperature threshold to be reached, and
▪ the predefined humidity threshold,
▪ the predefined ventilation threshold;

◦ maintain the previously chosen equipment, but also activate the other equipment in parallel, to strengthen or speed up the cooling or heating effect.

[0027] That is, said environmental comfort condition refers to a condition in which at least the following measured parameters detected fall within a certain predefined range:

- degree of humidity;
- temperature distribution in the various rooms of the house;
- the user's perception of the temperature;
- presence or absence of air generated by the ventilation of the thermal diffusers 3;
- ....

[0028] In particular, the control unit 4 is configured to calculate said comfort condition also based on whether or not said temperature detector 5 is arranged in the same environment where said heating and/or cooling equipment is also operative.

[0029] Therefore, the control unit 4 is pre-programmed with data concerning the position of the heating and/or cooling equipment with respect to the environments (e.g. rooms) and the position of the temperature detectors 5.

[0030] It is thereby possible to verify whether or not one or more temperature detectors 5 are arranged in the same room where a heating and/or cooling equipment (e.g. split) is present.

[0031] It should be noted that the temperature detectors 5 can comprise:

- temperature sensors 5 distributed in the various rooms;
- temperature sensors 5 present inside the control unit 4;
- sensors 5 contained in valve actuators 6 (e.g. motorized actuators for thermostated valves - hereinafter also called "valve actuators") of said equip-

ment that detect the ambient temperature at said equipment.

[0032] That is, the environmental comfort condition is defined as a dynamic and multi-parametric function that jointly depends on a functional combination of the following parameters:

- an initial temperature detected in a given environment 10;
- a subsequent temperature detected, adapted to describe the evolution of the temperature over time;
- a degree of humidity detected in the environment;
- a ventilation level associated with the thermal diffusers 3.

[0033] That is, the comfort condition does not derive from a simple independent evaluation of the individual parameters, but from a functional combination thereof which is adapted to represent the overall environmental perception, in which the variation of the temperature over time is correlated with humidity and ventilation to determine the dynamic behaviour of the system.

[0034] In particular, the control unit 4 is configured to:

- evaluate the variation between initial temperature and subsequent temperature, determining:
    - a heating/cooling rate,
    - a deviation with respect to the setpoint;
- combine this information with:
    - the comparison between detected humidity and humidity threshold,
    - the comparison between detected ventilation and ventilation threshold;
- determine an overall comfort function representative of the user's environmental perception.

[0035] Preferably, said comfort function:

- does not depend exclusively on the instantaneous temperature,
- but takes into account the thermal dynamics of the environment (temperature trend),
- as well as the interaction between temperature, humidity and ventilation.

[0036] Thereby, the system overcomes the limits of traditional thermostatic systems, in which the control is based solely on the instantaneous temperature.

[0037] It should further be noted that the control unit 4 is configured to control temperature, humidity and ventilation of each internal environment 10 independently with respect to respective temperature, humidity and ventilation thresholds that can be different and managed differently and independently of one another.

[0038] That is, the control system is configured to operate according to an advanced multi-zone logic, in which each internal environment 10 is managed functionally independently with respect to the other environments.

[0039] In particular, the control unit 4 is configured to:

- associate with each internal environment 10 a dedicated set of:
    - temperature detectors 5,
    - humidity detectors,
    - ventilation parameters,
    - specific reference thresholds;
- elaborate a distinct and independent comfort condition for each environment 10;
- generate separate activation commands for each environment 10, such as to allow a differentiated adjustment of the equipment 1, 3 present in the respective zones.

[0040] Thereby, the system achieves a distributed control in which:

- a first zone can be heated by means of radiant equipment 1,
- a second zone can be heated by means of electrical equipment 3,
- a third zone can envisage combined operation,

without the operational choices of one zone directly affecting the others.

[0041] With regard to radiant equipment 1, it should be noted that the present invention is applicable to the various cases involving the management of heating/cooling of internal environments in which:

- the radiant equipment 1, if it consists of radiators, comprises valve actuators 6 for managing the flow of hot water in the radiator itself. In this case, the temperature detection can be followed by sensors 5 mounted on board said valve actuators 6; and/or
- the radiant equipment 1, if it consists of a floor system, comprises electric actuators configured to command the opening or closing of a respective hydraulic circuit of the floor system. In this case, the presence of a sensor mounted in the room or environment is necessary for temperature detection.

[0042] In both cases mentioned above relating to radiant equipment 1, each activation command consists of:

an electrical signal that commands the boiler;

a further electrical signal that commands the valve actuators 6 of the radiators and/or the electrical actuators of the floor system.

[0043] Furthermore, the thermal control system according to the present invention can also comprise any gateway devices 9 configured to connect, preferably wirelessly (for example in RF - radio frequency), to the control unit 4 to receive said first and second activation command and to transmit it to the diffusers 3 by means of infrared or wirelessly or by means of wire. Preferably, if such gateway devices 9 are configured to transmit said commands to the speakers by means of infrared, the gateway device 9 faces the diffusers.

[0044] In particular, the control unit 4 or the gateway devices 9 can comprise an infrared transmission unit aimed at emulating a remote control for activating the thermal diffusers 3 (split). In this case, the control unit 4 or the gateway device 9 transduces the contents of said activation commands into infrared commands that activate the thermal diffusers 3 within reach.

[0045] Alternatively, the gateway devices 9 comprise an actuator configured to send a wired signal for the activation of the thermal diffusers 3 (split).

[0046] According to a further alternative, the control unit 4 comprises a Wi-Fi module configured to communicate, preferably through a cloud server, with said thermal diffusers 3 if the latter are provided with a connection to the network capable of receiving signals from the network. That is, as better illustrated in Figure 3, the communication by means of Wi-Fi envisages that the control unit 4 forwards a command to the cloud server, which receives the command and generates a corresponding control signal of the diffuser 3 which in turn is connected to the network and to the cloud server (for example by means of a connection module to the internet).

[0047] In the embodiment shown in Figure 1, the gateway devices 9 also mount a temperature sensor 5 on board to measure the temperature inside the room.

[0048] In the alternative embodiment shown in Figure 2, the gateway devices 9 do not mount a temperature sensor 5, but only act as a gateway. In this case, the gateway devices 9 are connected to the respective diffuser 3 in a "wired" manner (i.e. with electric wire) and the diffuser 3 is of the on/off type. The temperature sensor 5 is defined by a different device mounted inside the same room (sleeping area) and configured to communicate with the control unit 4 so as to transmit data relating to the temperature of the room. This figure represents a particular case of installation that falls within the present invention.

[0049] As already stated, the thermal control system is multi-zone.

[0050] In this latter case, the control system manages a plurality of environments 10 in each of which there is a temperature detector 5 (single or integrated in a valve actuator or integrated in a gateway device) and one of the heating and/or cooling equipment. In this case, the control unit 4 is configured to generate said control signals so as to separately control the heating/cooling of each environment 10 by means of the radiant equipment 1 or by means of the electrical equipment 3 or by means of an integrated combination of the two types of equipment.

[0051] According to an aspect envisaged by the present invention, the control unit 4 is configured to generate said first activation command and/or said second activation command to simultaneously activate said radiant equipment 1 and said electrical equipment 3 according to an integrated mode that follows predefined logic to efficiently optimise the system.

[0052] Furthermore, the control unit 4 is configured to generate said first activation command and/or said second activation command for said radiant equipment 1 or said electrical equipment 3 or both according to predefined logic, compatibly and as a function of said comfort condition, which favour:

- renewable energy sources;
- the lowest energy consumption sources.

[0053] In accordance with another aspect of the present invention, the thermal control system further comprises one or more humidity measurement sensors of said one or more internal environments 10. Such humidity sensors can be associated with said temperature detectors 5 so as to detect, in the same zone, temperature and also humidity, or can be integrated inside said electrical equipment 3 (split). The aforesaid comfort condition is also defined by a comparison of humidity between said detected humidity values with respect to a predefined humidity threshold. Therefore, the control unit 4 is configured to generate said second activation command for the radiant equipment 1 or for the electrical equipment 3 or for both as a function of said humidity comparison.

[0054] In addition, the ventilation achieved by said electrical equipment 3 is also adjusted by the control unit as a function of said detected comfort condition.

[0055] Preferably, the thermal control system further comprises an external probe 7 connected to the control unit 4 and configured to transmit an external temperature and/or humidity value. The control unit 4 is configured to generate said command signals also as a function of said external temperature and/or humidity value measured by the external probe 7.

[0056] In particular, the external temperature and/or humidity measured by the probe 7 are relevant for determining the intervention thresholds of the heat pump. Preferably, both the external temperature and humidity values are relevant in that the temperature can be influenced by humidity. For example, at the same external temperature, if the humidity is high, the behaviour of the heat pump in terms of efficiency is different (for example, at low temperatures with a lot of humidity it

may be necessary, first of all, to remove frost from the machine before operating it, thus causing a delay in the operation of the system).

[0057] In accordance with a further aspect of the present invention, the control unit 4 is configured to detect the correct operation of said thermal diffusers 3 (split) by means of said one or more temperature detectors 5. In particular, the control unit 4 is configured to:

- compare the temperature trend detected in a certain environment, after the activation of said electrical equipment 3, with an expected temperature trend for that environment;
- generate an alarm signal if said detected temperature trend deviates from said expected temperature trend;
- generate said second activation command to modify the operation of said electrical equipment 3 as a function of said comparison and the generation of said alarm signal.

[0058] Furthermore, the control unit 4 is configured not only to detect the correct operation of said thermal diffusers 3 (split) by means of said one or more temperature detectors 5, but also to evaluate whether one or more of said diffusers 3 has a trend such as to be able to reach one or more of said setpoints.

[0059] In fact, if the control unit 4 detects that the time to reach a desired temperature by means of one or more diffusers 3 is too high (e.g. greater than a predefined period of time), the control unit 4 is configured to activate the radiant equipment 1 in superposition to the diffusers 3 or alternatively thereto.

[0060] In addition to the above, the control unit 4 is configured to generate a third activation command that determines an adjustment of the ventilation and/or automatic oscillation of the fins of the diffusers 3 (for example, in some environments they allow to better diffuse the air), and/or activation of the "turbo"/"powerful" feature as a function of the comparison between said comfort condition and said one target comfort condition (for example, if an immediate or faster temperature change is desired). In general, the control unit 4 is configured to generate said third activation command as a function of predefined time periods (e.g. time of day) so as to activate said adjustment of the ventilation and/or automatic oscillation of the fins, and/or activation of the "turbo"/"powerful" feature as a function of a predefined time period.

[0061] In addition, said third command signal can be used to silence the diffusers 3 (for example in the bedroom so as not to disturb at night) or to modify other parameters of the same diffusers 3.

[0062] This third command signal can also be propagated by the control unit 4 through said gateway devices 9 described above.

[0063] It should further be noted that the control unit 4, according to the present invention, indeed defines a thermostat that detects the internal temperature (or the temperatures of the various environments in the event of multi-zone control) by means of which said first, second and third activation commands are generated. Therefore, as shown in Figure 2, the thermostat 11 (crossed out with an "X" in the figure) is replaced by the control unit 4.

[0064] It should further be noted that the thermal control system according to the present invention can comprise one or more independent temperature sensors 5. The control unit 4 by means of which said first, second and third activation commands are generated can integrate said sensor or it is operatively connected wirelessly to one or more independent temperature sensors for receiving detections of the temperature measured in the room in which it/they are installed.

[0065] According to a further aspect of the present invention, the control unit 4 is configured to selectively activate one or more heating and/or cooling equipment as a function of the comfort condition determined for each environment 10.

[0066] More precisely, the control unit 4 is configured to determine, for each environment 10, a dynamic and independent selection of the equipment 1, 3 to be activated as a function of the deviation from the target comfort condition and of the variation dynamics of the environmental parameters, allowing differentiated operating configurations between the different zones.

[0067] In particular, for each zone, the control unit 4 is configured to:

- independently select:
  - the radiant equipment 1,
  - the electrical equipment 3 (split),
  - or a combination thereof;
- generate separate activation commands for each equipment, as a function:
  - of the value of the comfort condition,
  - of the deviation with respect to a target comfort condition.

[0068] In particular:

- in a first zone only one split 3 can be activated;
- in a second zone, only the boiler 2 can be activated by means of radiant equipment 1;
- in a third zone both equipment can be activated in a combined manner;

all independently between the different zones.

[0069] Preferably, the selection of the equipment occurs based on:

- energy efficiency,
- speed of achieving comfort,

- local environmental conditions (temperature, humidity, ventilation),
- temperature variation dynamics.

[0070] A further object of the present invention is a thermal control apparatus comprising:

at least one radiant heating and/or cooling equipment, preferably with radiators or on the floor, connected to a gas boiler 2;
at least one electrical equipment 3 with thermal diffusers 3 connected to a heat pump 8 of the air/-air type;
the control system described above for managing said at least one radiant heating and/or cooling equipment and said at least one electrical equipment 3 with thermal diffusers 3.

[0071] Lastly, an object of the present invention is a thermal control method which is directly derived from what is disclosed above in relation to the control system, to which full reference is made hereinbelow.

[0072] The method comprises the following operating steps:

- detecting an initial internal temperature of a plurality of internal environments 10 by means of a plurality of detectors respectively positioned inside said internal environments 10;
- comparing said initial internal temperature detected for said plurality of internal environments with respective predefined temperature thresholds for said plurality of internal environments;
- generating a first activation command configured to activate the radiant equipment 1 or the electrical equipment 3 or both so as to increase / decrease the temperature inside each of said internal environments to reach said respective predefined temperature thresholds.

[0073] The method further comprises the following further operating steps:

- detecting a subsequent temperature inside each of said internal environments 10, following said initial temperature detection;
- verifying if said detected subsequent temperature approaches or deviates from said one or more predefined temperature thresholds;
- detecting a degree of internal humidity of said plurality of internal environments 10 by means of a plurality of humidity detectors respectively associated with said internal environments 10;
- comparing said degree of humidity detected for said plurality of internal environments with respective predefined humidity thresholds for each internal environment 10;
- detecting a ventilation level inside said plurality of internal environments 10 by means of ventilation regulators associated with said thermal diffusers 3;
- comparing said ventilation level detected for said plurality of internal environments with respective predefined ventilation thresholds for each internal environment 10;
- calculating a multi-parameter environmental comfort condition of a plurality of said environments based on:
  - ◦ said verification if said detected subsequent temperature approaches or deviates from said one or more predefined temperature thresholds;
  - ◦ said comparison of said degree of humidity detected for said plurality of internal environments with respective predefined humidity thresholds;
  - ◦ said comparison of said ventilation level detected for said plurality of internal environments with respective predefined ventilation thresholds;
- performing said calculation of the environmental comfort condition for each environment 10 and assigning a value within a predefined comfort range as a function of said comparisons and verification;
- comparing said comfort condition value with a target comfort value,
- generating a second activation command for the radiant equipment 1 or for the electrical equipment 3 or for both, as a function of said comparison of said comfort condition value with a target comfort value, to alternatively:
  - ◦ modify the previously chosen heating and/or cooling equipment,
  - ◦ maintain the previously chosen equipment, but modify:
    - ▪ the predefined temperature threshold to be reached, and
    - ▪ the predefined humidity threshold,
    - ▪ the predefined ventilation threshold;
  - ◦ maintain the previously chosen equipment, but also activate the other equipment in parallel, to strengthen or speed up the cooling or heating effect.

[0074] The present invention achieves the stated objects.

[0075] In particular, the present invention allows to achieve an integrated management of different and independent heating systems which are not created integrated. It is therefore a system that allows heating systems to be integrated together so as to optimise re-

sources and achieve an after-sales integration of equipment that is not designed to communicate with each other.

[0076] The integration occurs by means of the control unit 4 which forwards commands to both the gas heating system and the splits so as to achieve an alternative or integrated operation depending on needs.

[0077] Furthermore, the present invention allows to optimize the heating comfort since often temperature and humidity detectors 5 and/or heating systems are not present in all rooms and therefore the perception of the heat may differ from what is expected by the user.

[0078] Advantageously, the system is configured so that:

- the determination of the comfort condition,
- the selection of equipment,
- the generation of activation commands

occurs completely independently for each environment 10. It follows that:

- each zone constitutes an autonomous logic control unit,
- the system achieves decentralised control while maintaining centralised management by means of the control unit 4.

Claims

1. A thermal control system, preferably for domestic environments, configured to manage heating and/or cooling equipment belonging to one of the following types of heat sources independent from each other: radiant equipment (1), preferably with radiators or on the floor, connected to a gas boiler (2), or electrical equipment (3) with thermal diffusers (3) connected to an air-to-air heat pump (8), comprising:

a control unit (4) configured to:

- detect an initial internal temperature of a plurality of internal environments (10) by means of a plurality of detectors respectively positioned inside said internal environments (10);
- compare said initial internal temperature detected for said plurality of internal environments with respective predefined temperature thresholds for said plurality of internal environments;
- generate a first activation command configured to activate the radiant equipment (1) or the electrical equipment (3) or both so as to increase / decrease the temperature inside each of said internal environments to reach said respective predefined temperature thresholds;

characterised in that said control unit (4) is further configured to:

- detect a subsequent internal temperature of each of said internal environments (10), following said initial temperature detection so as to determine the evolution of the temperature over time;
- verify if said detected subsequent temperature approaches or deviates from said one or more predefined temperature thresholds;
- detect a degree of internal humidity of said plurality of internal environments (10) by means of a plurality of humidity detectors respectively associated with said internal environments (10);
- compare said degree of humidity detected for said plurality of internal environments with respective predefined humidity thresholds for each internal environment (10);
- detect a ventilation level inside said plurality of internal environments (10) by means of ventilation regulators associated with said thermal diffusers (3);
- compare said ventilation level detected for said plurality of internal environments with respective predefined ventilation thresholds for each internal environment (10);
- calculate a dynamic multi-parameter environmental comfort condition of a plurality of said environments based on:

  ◦ said verification if said detected subsequent temperature approaches or deviates from said one or more predefined temperature thresholds so as to determine the evolution of the temperature over time;
  ◦ said comparison of said degree of humidity detected for said plurality of internal environments with respective predefined humidity thresholds;
  ◦ said comparison of said ventilation level detected for said plurality of internal environments with respective predefined ventilation thresholds;

wherein said control unit (4) is configured to perform said calculation of the environmental comfort condition for each environment (10) and is configured to assign a value within a predefined comfort range

as a function of said comparisons and verification; said control unit (4) being further configured to:
- compare said comfort condition value with a target comfort value so as to determine the deviation of the environmental comfort condition with respect to a target comfort condition,
- generate a second activation command for the radiant equipment (1) or for the electrical equipment (3) or for both, as a function of said comparison of said comfort condition value with a target comfort value, to alternatively:

◦ modify the previously chosen heating and/or cooling equipment,
◦ maintain the previously chosen equipment, but modify:

▪ the predefined temperature threshold to be reached, and
▪ the predefined humidity threshold,
▪ the predefined ventilation threshold;

◦ maintain the previously chosen equipment, but also activate the other equipment in parallel, to strengthen or speed up the cooling or heating effect.

2. The thermal control system according to claim 1, wherein said control unit (4) is configured to control temperature, humidity and ventilation of each internal environment (10) independently with respect to respective temperature, humidity and ventilation thresholds which can be different and managed differently and independently of one another.

3. The thermal control system according to any one of the preceding claims, **characterised in that** it comprises valve actuators (6) interposed along said radiant equipment to regulate a flow of heating liquid thereof, wherein said valve actuators (6) comprise sensors that detect the temperature of the environment in which they are installed; said control unit (4) being configured to receive a temperature signal from said valve actuators (6) that define one or more of said temperature detectors (5).

4. The thermal control system according to any one of the preceding claims, wherein said control unit (4) is configured to generate said first activation command and/or said second activation command to simultaneously activate said radiant equipment (1) and said electrical equipment (3).

5. The thermal control system according to any one of the preceding claims, wherein said control unit (4) is configured to generate said first activation command and/or said second activation command for said radiant equipment (1) or said electrical equipment (3) or both according to predefined logic that takes into account renewable energy sources, as a function of the determined comfort condition.

6. The thermal control system according to any one of the preceding claims, wherein said control unit (4) is configured to generate said first activation command and/or said second activation command for said radiant equipment (1) or said electrical equipment (3) or both according to predefined logic that takes into account energy consumption as a function of the determined comfort condition.

7. The thermal control system according to any one of the preceding claims, **characterised in that** said control unit (4) is configured to detect the correct operation of said thermal diffusers (3) by means of said one or more detectors; said control unit (4) being configured to:

- compare the temperature trend detected in a certain environment, after the activation of said electrical equipment (3), with an expected temperature trend for that environment;
- generate an alarm signal if said detected temperature trend deviates from said expected temperature trend.

8. The thermal control system according to any one of the preceding claims, **characterised in that** said control unit (4) is configured to generate a third activation command for said diffusers (3) which determines an adjustment of the ventilation and/or automatic oscillation of the fins, and/or activation of the "turbo"/"powerful" feature as a function of the comparison between said comfort condition and said one target comfort condition, said control unit (4) being configured to generate said third activation command as a function of predefined time periods so as to activate said adjustment of the ventilation and/or automatic oscillation of the fins, and/or activation of the "turbo"/"powerful" feature as a function of said predefined time period.

9. The thermal control system according to any one of the preceding claims, **characterised in that** it comprises an external probe (7) connected to the control unit (4) and configured to transmit an external temperature and/or humidity value to said control unit (4); said control unit (4) being configured to generate said control signals also as a function of said external temperature and/or humidity value measured by the external probe (7) so as to deter-

mine the intervention thresholds of the heat pump (8), which supplies said thermal diffusers (3), efficiently.

10. A thermal control apparatus, comprising:

at least one radiant heating and/or cooling equipment, preferably with radiators or on the floor, connected to a gas boiler (2);
at least one heat pump-type electrical equipment (8) with thermal diffusers (3), preferably air-to-air;

characterised in that it comprises a control system according to any one of claims 1 to 9 configured to manage said at least one radiant heating and/or cooling equipment and said at least one heat pump-type electrical equipment (8) with thermal diffusers (3).

11. A thermal control method, preferably for domestic environments, configured to manage heating and/or cooling equipment belonging to one of the following types of independent heat sources: radiant equipment (1), preferably with radiators or on the floor, connected to a gas boiler (2), or electrical equipment (3) with thermal diffusers (3) connected to an air-to-air heat pump (8), comprising the following operating steps:

- detecting an initial internal temperature of a plurality of internal environments (10) by means of a plurality of detectors respectively positioned inside said internal environments (10);
- comparing said initial internal temperature detected for said plurality of internal environments with respective predefined temperature thresholds for said plurality of internal environments;
- generating a first activation command configured to activate the radiant equipment (1) or the electrical equipment (3) or both so as to increase / decrease the temperature inside each of said internal environments to reach said respective predefined temperature thresholds

characterised in that it comprises the following further operating steps:

- detecting a subsequent internal temperature of each of said internal environments (10), following said initial temperature detection so as to determine the evolution of the temperature over time;
- verifying if said detected subsequent temperature approaches or deviates from said one or more predefined temperature thresholds;
- detecting a degree of internal humidity of said plurality of internal environments (10) by means of a plurality of humidity detectors respectively associated with said internal environments (10);
- comparing said degree of humidity detected for said plurality of internal environments with respective predefined humidity thresholds for each internal environment (10);
- detecting a ventilation level inside said plurality of internal environments (10) by means of ventilation regulators associated with said thermal diffusers (3);
- comparing said ventilation level detected for said plurality of internal environments with respective predefined ventilation thresholds for each internal environment (10);
- calculating a dynamic multi-parameter environmental comfort condition of a plurality of said environments based on:

◦ said verification if said detected subsequent temperature approaches or deviates from said one or more predefined temperature thresholds so as to determine the evolution of the temperature over time;
◦ said comparison of said degree of humidity detected for said plurality of internal environments with respective predefined humidity thresholds;
◦ said comparison of said ventilation level detected for said plurality of internal environments with respective predefined ventilation thresholds;

- performing said calculation of the environmental comfort condition for each environment (10) and is configured to assign a value within a predefined comfort range as a function of said comparisons and verification;
- comparing said comfort condition value with a target comfort value so as to determine the deviation of the environmental comfort condition with respect to a target comfort condition,
- generating a second activation command for the radiant equipment (1) or for the electrical equipment (3) or for both, as a function of said comparison of said comfort condition value with a target comfort value, to alternatively:

◦ modify the previously chosen heating and/or cooling equipment,
◦ maintain the previously chosen equipment, but modify:

▪ the predefined temperature thresh-

old to be reached, and

- the predefined humidity threshold,
- the predefined ventilation threshold;

◦ maintain the previously chosen equipment, but also activate the other equipment in parallel, to strengthen or speed up the cooling or heating effect.

Fig. 1

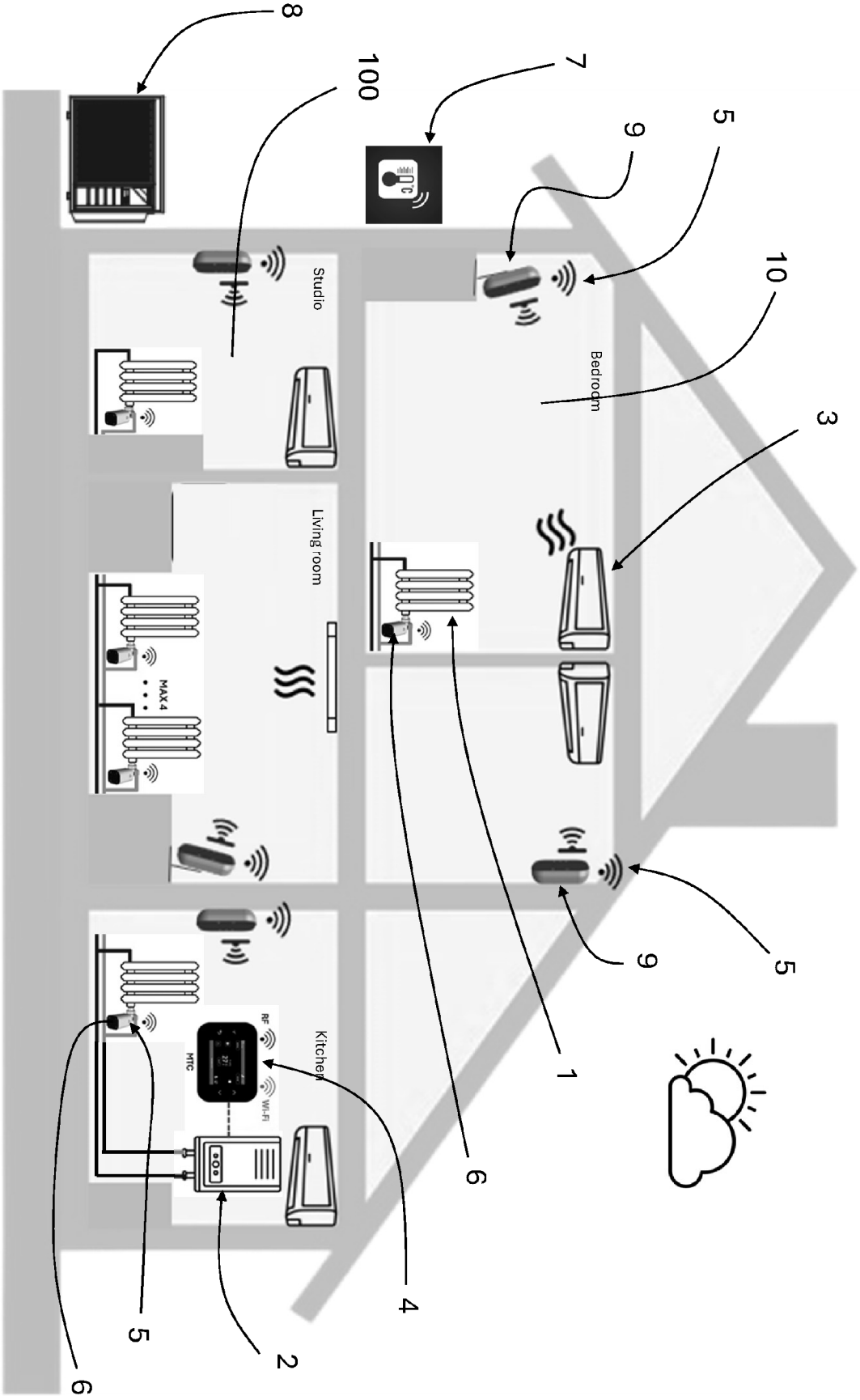

8
100
7
9
5
10
3
Studio
Bedroom
Living room
MAX 4
Kitchen
RF
MTC
Wi-Fi
1
6
4
5
2
6
9
5

Fig. 2

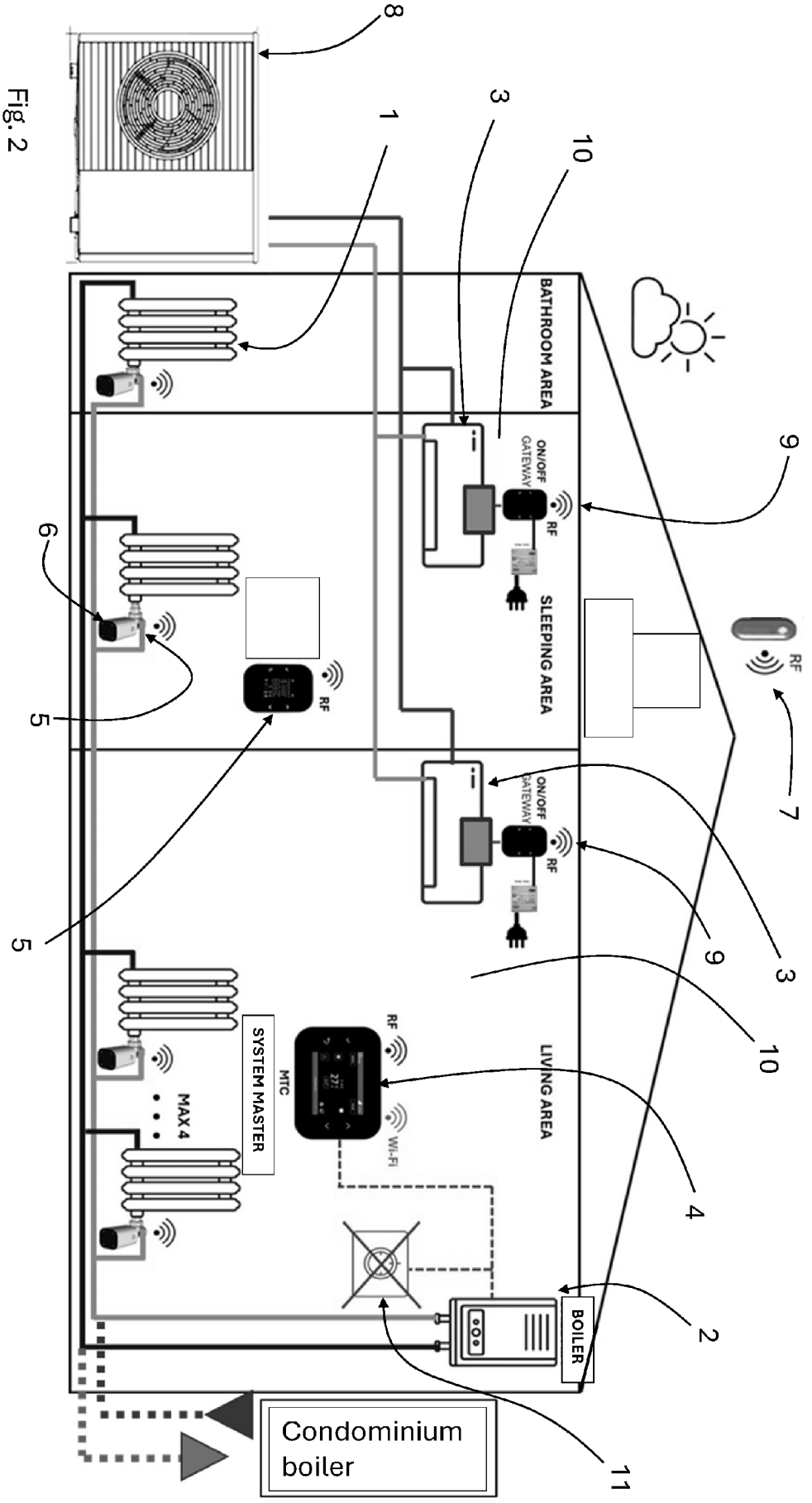
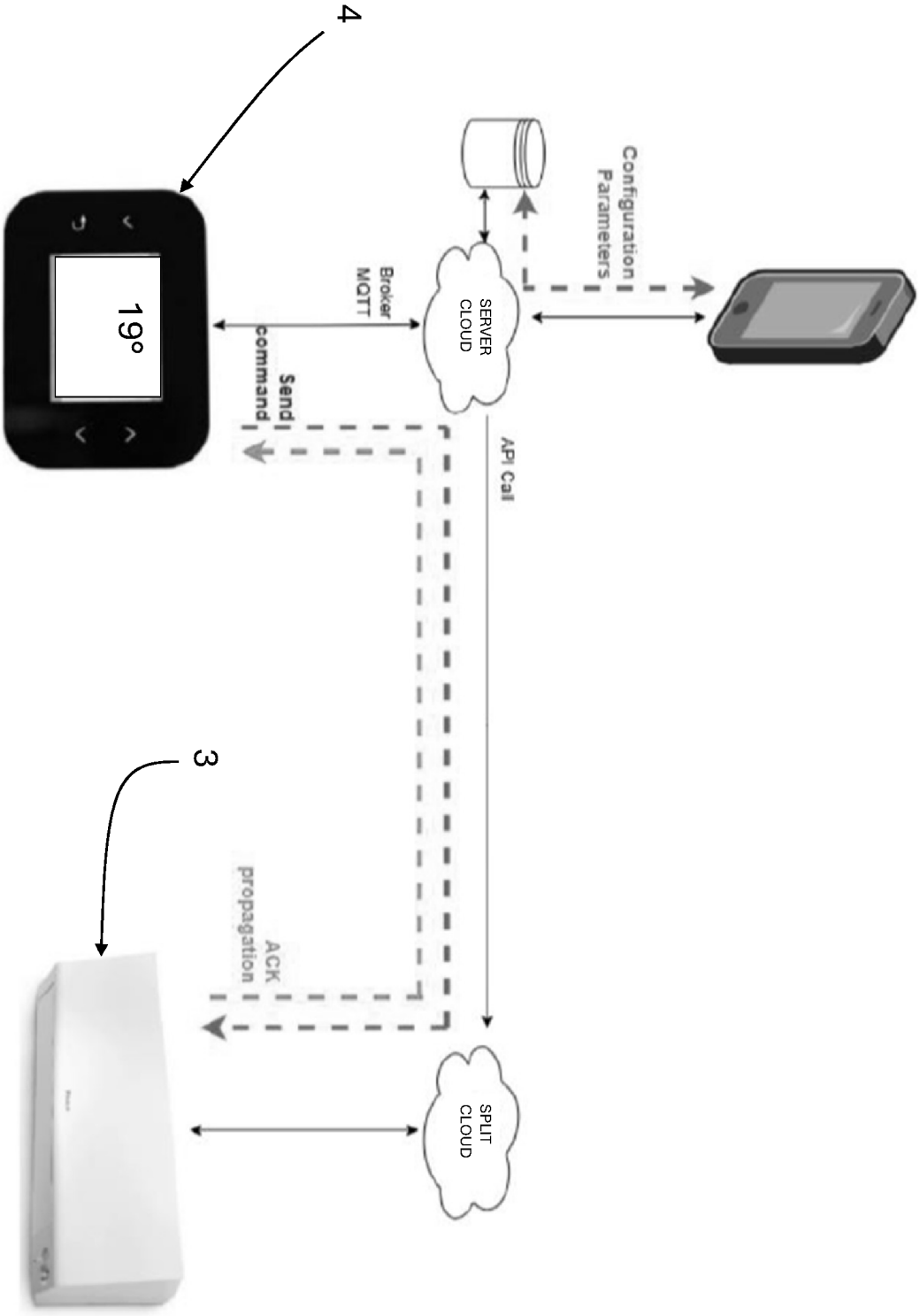

8
1
3
10
BATHROOM AREA
ON/OFF GATEWAY
RF
9
SLEEPING AREA
6
5
RF
7
5
3
9
10
LIVING AREA
MTC
SYSTEM MASTER
MAX 4
RF
Wi-Fi
4
2
BOILER
Condominium boiler
11

Fig. 3


4
19°
Broker
MQTT
SERVER
CLOUD
Configuration
Parameters
Send
command
API Call
3
ACK
propagation
SPLIT
CLOUD

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EUROPEAN SEARCH REPORT

Application Number
EP 26 17 2806

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Place of search	Date of completion of the search	Examiner
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