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(71) Applicant: **R.B.M. S.p.A.**
25060 Polaveno (BS) (IT)

(72) Inventor: **BOSSINI, Guido**
25060 POLAVENO (BS) (IT)

(74) Representative: **Studio Torta S.p.A.**
Via Viotti, 9
10121 Torino (IT)

(54) METHOD FOR CONTROLLING A RADIANT PLATFORM AND RELATED RADIANT PLATFORM

(57) Method for controlling a radiant platform, the radiant platform (1) comprising a plurality of self-regulating electrical circuits (2), said plurality comprising at least a first circuit (i) and a second circuit (*i*+1), the method comprising the step of sequentially activating the circuits (2), wherein the second circuit (*i*+1) is activatable consecutively to the first circuit (i) and the activation of the second circuit (*i*+1) is subject to a verification of exceeding a limit power.

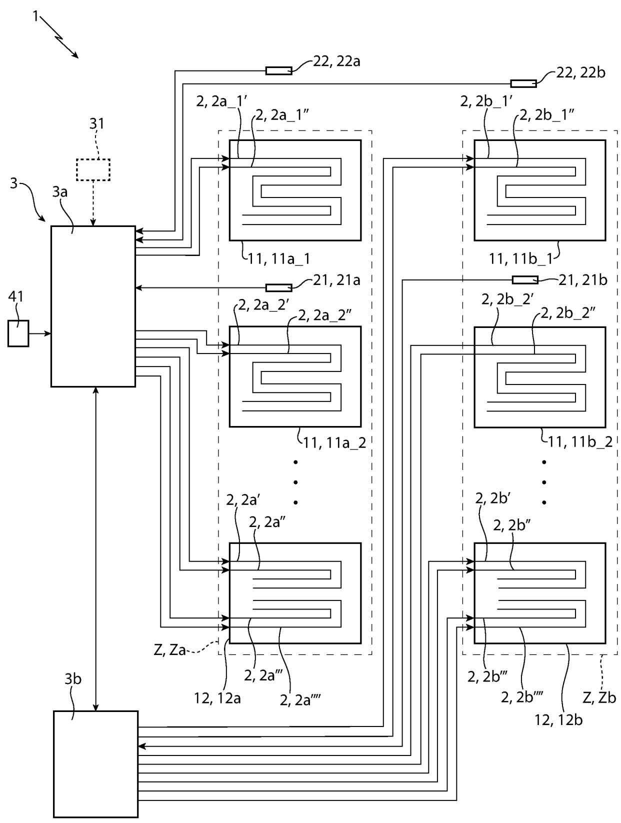

FIG. 1

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Description

Cross reference to related Patent Applications

[0001] This patent application claims priority from Italian patent application no. 102023000019827 filed on September 26, 2023, the entire disclosure of which is incorporated herein by reference.

Technical field

[0002] The present invention relates to a method for controlling a radiant platform and the related radiant platform.

Background art

[0003] As is known, radiant platforms are used, for example, for heating large volume spaces, such as places of worship, and environments that are not permanently inhabited, such as dehors or marquees, including temporary or emergency ones, where the installation of a conventional heating system is technically unfeasible or not sustainable from an energy point of view.

[0004] A radiant platform comprises a plurality of self-regulating electrical circuits, which must be electrically powered. The power absorption of the circuits varies over time, depends on several factors and is difficult to predict. Therefore, controlling the radiant platform is not trivial.

[0005] A purpose of the present invention is to provide a method for controlling a radiant platform, which allows the above problems to be overcome.

Disclosure of the invention

[0006] The aforementioned purpose is achieved by a method as claimed in claim 1.

[0007] The present invention further relates to a radiant platform as claimed in claim 9.

Brief description of the drawings

[0008] For a better understanding of the present invention, a preferred embodiment is described hereinafter, by way of non-limiting example and with reference to the accompanying drawings, wherein:

- Figure 1 is a schematic view of a radiant platform according to the present invention; and
- Figure 2 is a flow chart of a method according to the present invention.

Detailed description of the invention

[0009] With reference to Figure 1, there is indicated by 1 a radiant platform according to the present invention.

[0010] Platform 1 comprises a plurality of self-regulating electrical circuits 2 and a control system 3.

[0011] Conveniently, each circuit 2 is a radiant floor heating circuit. In particular, circuit 2 is formed by a PTC ("Positive Temperature Coefficient") semiconductor cable, which is self-regulating and self-modulating, i.e. having a conductive matrix with a resistivity that increases with temperature, such that current absorption decreases as the temperature increases until an equilibrium temperature is reached at which the current absorption reaches its minimum value.

[0012] With each activation of circuit 2, i.e. when circuit 2 is electrically powered, the electrical absorption of circuit 2 has an initial peak value which rapidly decreases over time. Fluctuations in the peak value depend on the starting temperature and the time during which circuit 2 has not been electrically powered.

[0013] Preferably, platform 1 comprises a plurality of first areas 11. Each first area 11 comprises at least two circuits 2. Control system 3 is configured to sequentially activate a circuit 2 of each first area 11 and subsequently to sequentially activate another circuit 2 of each first area 11.

[0014] Conveniently, each first area 11 is a panelled area, i.e. it comprises at least one panel, which can be heated by the respective circuits 2.

[0015] Preferably, circuits 2 of the first area 11 have substantially equal power absorption to each other, and preferably substantially equal length to each other. In other words, circuits 2 of first areas 11 are substantially the same as each other. Preferably, first areas 11 have an equal number of circuits 2 to each other. Therefore, first areas 11 have a total power absorption, i.e. the power absorption when all their circuits 2 are active, which is substantially equal to each other.

[0016] Preferably, platform 1 comprises a second area 12. Second area 12 comprises at least two circuits 2. Each circuit 2 of second area 12 has a lower power absorption than circuits 2 of first areas 11. Control system 3 is configured to sequentially activate circuits 2 of second area 12 after having activated circuits 2 of first areas 11.

[0017] Conveniently, second area 12 is a panelled area, i.e. it comprises at least one panel, which can be heated by the respective circuits 2.

[0018] Preferably, circuits 2 of second area 12 have substantially equal power absorption to each other, and preferably substantially equal length to each other. In other words, circuits 2 of second area 12 are substantially the same as each other. Conveniently, the number of circuits 2 of second area 12 is greater than the number of circuits 2 of each first area 11. Preferably, second area 12 has a total power absorption, i.e. the power absorption when all its circuits 2 are active, substantially equal to the total power absorption of each first area 11. Conveniently, the length of each circuit 2 of second area 12 is less than the length of each circuit 2 of each first area 11.

[0019] Conveniently, platform 1 comprises at least a first temperature sensor 21 configured to produce a first signal indicative of a first temperature of platform 1.

Control system 3 is configured to receive the first signal from first sensor 21 and to sequentially activate circuits 2 on the basis of the first signal.

[0020] Preferably, platform 1 comprises a plurality of thermal zones Z. Each thermal zone Z comprises a respective first sensor 21 and a plurality of first areas 11.

[0021] In particular, first sensor 21 is a floor temperature sensor configured to detect the temperature of the respective thermal zone Z wherein it is inserted. Therefore, each thermal zone Z is associated with the respective first signal, produced by the respective first sensor 21 and indicative of the respective first temperature.

[0022] Preferably, each thermal zone Z comprises a respective second area 12, i.e. the number of second areas 12 is equal to the number of thermal zones Z.

[0023] Conveniently, control system 3 comprises a main control unit 3a configured to directly control a first thermal zone Za of the plurality of thermal zones, and a respective auxiliary control unit 3b for each further thermal zone Zb in addition to first thermal zone Za. Each auxiliary control unit 3b is connected to the respective thermal zone Zb and main control unit 3a, and main control unit 3a is configured to control each further thermal zone Zb via the respective auxiliary control unit 3b.

[0024] Preferably, platform 1 comprises at least a second temperature sensor 22 configured to produce a second signal indicative of a second temperature of an environment associated with platform 1. Control system 3 is configured to receive the second signal from second sensor 22 and to sequentially activate circuits 2 on the basis of the second signal.

[0025] Preferably, each thermal zone Z comprises a respective second sensor 22, which is a room temperature sensor configured to detect the temperature of the environment associated with the respective thermal zone Z. In other words, for each thermal zone Z, the first temperature relates to thermal zone Z and the second temperature relates to the environment associated with thermal zone Z. Alternatively, there is only one second sensor 22, i.e. it is common to all thermal zones Z.

[0026] Conveniently, main control unit 3a is configured to receive signals to start or stop platform 1 from an electronic device 31 connected to main control unit 3a via cable or wirelessly. For example, electronic device 31 is a smartphone or tablet provided with an application for remote control of platform 1, a manual control panel or an interface with a thermal building management system (BMS).

[0027] Main control unit 3a is further configured to receive signals from an external multimeter 41 configured to detect an instantaneous power absorbed by platform 1, i.e. the instantaneous power absorbed by all circuits 2 of platform 1.

[0028] The embodiment illustrated in Figure 1 is described in detail hereinafter.

[0029] Platform 1 comprises two thermal zones Z, namely first thermal zone Za and further thermal zone Zb.

[0030] Each thermal zone Za, Zb comprises a respective first sensor 21a, 21b and a respective second sensor 22a, 22b.

[0031] Control system 3 comprises main control unit 3a, configured to directly control first thermal zone Za, and auxiliary control unit 3b for further thermal zone Zb.

[0032] Auxiliary control unit 3b is connected to further thermal zone Zb and main control unit 3a, and main control unit 3a is configured to control further thermal zone Zb via auxiliary control unit 3b.

[0033] First thermal zone Za comprises n_a first areas 11a_1, 11a_2, ..., 11a_n_a, arranged aligned with one other in this order, and further thermal zone Zb comprises n_b first areas 11b_1, 11b_2, ..., 11b_n_b, arranged aligned with one other in this order and parallel to the n_a first areas of first thermal zone Za. In general, n_a is greater than or equal to two and n_b is greater than or equal to two. For example, n_a is equal to n_b i.e. first thermal zone Za and further thermal zone Zb have the same number of first areas 11.

[0034] Each first area 11 has two circuits 2, which have substantially equal power absorption and substantially equal length to each other.

[0035] In particular:

- first area 11a_1 of first thermal zone Za has two circuits 2a_1', 2a_1" , first area 11a_2 of first thermal zone Za has two circuits 2a_2', 2a_2", ..., first area 11a_n_a (not illustrated) of first thermal zone Za has two circuits 2a_n_a', 2a_n_a" ; and
- first area 11b_1 of further thermal zone Zb has two circuits 2b_1', 2b_1'', first area 11b_2 of further thermal zone Zb has two circuits 2b_2', 2b_2", ..., first area 11b_n_b (not illustrated) of further thermal zone Zb has two circuits 2b_n_b' , 2b_n_b".

[0036] The two circuits 2 of each first area 11 are arranged in a serpentine pattern with parallel straight sections and curved end sections, wherein each end section is configured to connect two consecutive straight sections of the respective circuit 2.

[0037] First thermal zone Za comprises a respective second area 12a and further thermal zone Zb comprises a respective second area 12b.

[0038] Each second area 12 has four circuits 2, which have substantially equal power absorption and substantially equal length to one another. The power absorption of each circuit 2 of second area 12 is substantially half the power absorption of each circuit 2 of each first area 11, and the length of each circuit 2 of second area 12 is substantially half the length of each circuit 2 of each first area 11.

[0039] In particular:

- second area 12a of first thermal zone Za has four circuits 2a' , 2a", 2a‴, 2a⁗, wherein circuits 2a', 2a" are associated with a first portion of second area 12a, near first area 11a_n_a, and circuits 2a‴, 2a⁗ are associated with a second portion of second area

12a; and

- second area 12b of further thermal zone Zb has four circuits 2b' , 2b'', 2b''', 2b'''', wherein circuits 2b', 2b" are associated with a first portion of second area 12b, near first area 11b_n_b, and circuits 2b''', 2b'''' are associated with a second portion of second area 12b.

[0040] The two circuits 2 of each portion of each second area 12 are arranged in a serpentine pattern with parallel straight sections and curved end sections, wherein each end section is configured to connect two consecutive straight sections of the respective circuit 2.

[0041] With reference to first thermal zone Za, main control unit 3a is configured to:

- sequentially activate one circuit 2 of each first area 11, in particular sequentially activate 2a_1', 2a_2', ..., 2a_n_a';
- subsequently, sequentially activate the other circuit 2 of each first area 11, in particular sequentially activate 2a_1", 2a_2", ..., 2a_n_a" ; and
- subsequently, sequentially activate circuits 2 of second area 12, preferably by sequentially activating one circuit of each portion of second area 12, in particular by sequentially activating 2a' e 2a''', and subsequently sequentially activating the other circuit of each portion of second area 12, in particular by sequentially activating 2a" and 2a''''.

[0042] Conveniently, in order to allow uniform use of circuits 2, the order of activation of circuits 2 is partially reversed each time platform 1 is started.

[0043] In particular, at the consecutive start-up of platform 1 to the one just described, main control unit 3a is configured to:

- sequentially activate one circuit 2 of each first area 11, in particular sequentially activate 2a_1", 2a_2'' , ..., 2a_n_a";
- subsequently, sequentially activate the other circuit 2 of each first area 11, in particular sequentially activate 2a_1', 2a_2', ..., 2a_n_a'; and
- subsequently, sequentially activate circuits 2 of second area 12, preferably by sequentially activating one circuit of each portion of second area 12, in particular by sequentially activating 2a'' e 2a'''', and subsequently sequentially activating the other circuit of each portion of second area 12, in particular by sequentially activating 2a' and 2a'''.

[0044] What has just been described with reference to first thermal zone Za applies by analogy to further thermal zone Zb, replacing "a" with "b" in each reference sign.

[0045] The present invention further relates to a method for controlling a radiant platform 1 comprising a plurality of self-regulating electrical circuits 2, wherein said plurality comprises at least a first circuit and a second circuit. The method comprises the step of activating circuits 2 sequentially, wherein the second circuit is activatable consecutively to the first circuit and the activation of the second circuit is subject to a verification of exceeding a limit power *P_lim.*

[0046] Conveniently, the first circuit and the second circuit belong to the same thermal zone Z and are activatable consecutively, i.e. there is no third circuit of such thermal zone Z which is activatable between the first circuit and the second circuit.

[0047] For example, with reference to first thermal zone Za:

- the first circuit is circuit 2a_1' and the second circuit is circuit 2a_2' which is activatable consecutively to first circuit 2a_1';
- the first circuit is circuit 2a_1" and the second circuit is circuit 2a_2" which is activatable consecutively to first circuit 2a_1" ;
- the first circuit is circuit 2a' and the second circuit is circuit 2a" which is activatable consecutively to first circuit 2a';
- the first circuit is circuit 2a" and the second circuit is circuit 2a'''' which is activatable consecutively to first circuit 2a".

[0048] Preferably, the verification of exceeding the limit power *P_lim* comprises a first verification step, wherein it is verified that an estimated absorbed power does not exceed the limit power *P_lim,* and a second verification step, wherein it is verified that an actual absorbed power does not exceed the limit power *P_lim.*

[0049] In particular, the first verification step is theoretical as the limit power *P_lim* is compared with an estimated absorbed power, and the second verification step is practical as the limit power *P_lim* is compared with an actual absorbed power. The estimated absorbed power comprises the estimated power absorbed by the second circuit, which is calculated on the basis of the power actually absorbed by the first circuit, while the actual absorbed power comprises the power actually absorbed by the second circuit. Indeed, the first verification step occurs before the activation of the second circuit, while the second verification step occurs after the activation of the second circuit.

[0050] Conveniently, the first verification step comprises the steps of:

- detecting an instantaneous power absorbed *P_ass* by the plurality of circuits 2;
- adding the instantaneous power absorbed *P_ass* and a maximum power absorbed by the first circuit, obtaining the estimated absorbed power; and
- verifying that a first condition is met, the first condition being met if the estimated absorbed power is less than or equal to the limit power *P_lim.*

[0051] In particular, the instantaneous power absorbed

P_ass is the sum of the power absorbed by all circuits 2 of platform 1 that are active.

[0052] Preferably, the method comprises the steps of:

- iteratively executing the first verification step if the first condition is not met, two consecutive iterations being spaced temporally by a first predetermined time interval Δt_1; and
- activating the second circuit as soon as the first condition is met or after a first predetermined number of iterations.

[0053] In particular, the first predetermined time interval Δt_1 between two consecutive iterations allows the instantaneous absorbed power P_ass (and thus the estimated absorbed power) to decrease as circuits 2 are formed by PTC semiconductor cables. For example, the first predetermined time interval Δt_1 has a duration of five seconds, and the first predetermined number of iterations is twelve.

[0054] Optionally, the method comprises a step of generating a pre-alarm if the first condition is not met after the first predetermined number of iterations. Such pre-alarm is generated immediately before activating the second circuit. In other words, the pre-alarm is a signalling that does not interrupt the method, i.e. it does not prevent the activation of the second circuit.

[0055] Conveniently, the second verification step comprises the steps of:

- detecting a power absorbed by the plurality of circuits 2 after the activation of the second circuit, obtaining the actual absorbed power P_ass; and
- verifying that a second condition is met, the second condition being met if the actual absorbed power P_ass is less than or equal to the limit power P_lim.

[0056] Preferably, the step of detecting the actual absorbed power P_ass is executed after a second predetermined time interval Δt_2 from the activation of the second circuit.

[0057] In particular, waiting for the second predetermined time interval Δt_2 before measuring the actual absorbed power P_ass allows to tolerate, during such interval, any exceeding of the power limit P_lim due to the initial peak for the activation of the second circuit. For example, the second predetermined time interval Δt_2 has a duration of one second.

[0058] Conveniently, the method comprises a routine if the second condition is not met, wherein the routine comprises the steps of:

- deactivating the second circuit;
- waiting for a third predetermined time interval Δt_3;
- activating the second circuit; and
- executing the second verification step.

[0059] In particular, waiting for the third predetermined time interval Δt_3 between the deactivation and activation of the second circuit allows the decrease of the actual absorbed power P_ass as circuits 2 are formed by PTC semiconductor cables. For example, the third predetermined time interval Δt_3 has a duration of five seconds.

[0060] Preferably, the method comprises the steps of:

- iteratively executing the routine if the second condition is not met; and
- generating an alarm if the second condition is not met after a second predetermined number of iterations.

[0061] Preferably, the alarm is a signalling that interrupts the method, i.e. prevents the activation of the second circuit, and requires manual intervention. For example, the second predetermined number of iterations is twelve.

[0062] Conveniently, the limit power P_lim is defined in such a way that at least one circuit 2 of platform 1 is activated. In other words, the limit power P_lim is such that, when only one circuit 2 of platform 1 is active, the power absorbed by such circuit 2, detected after the second predetermined time interval Δt_2 for the above reasons, is not greater than the limit power P_lim.

[0063] The method is exemplified in the flow chart of Figure 2, wherein the first circuit is referred to as the circuit *i* and the second circuit is referred to as the circuit *i* + 1.

[0064] For simplicity, it is assumed that the circuit *i* and the circuit *i* + 1 belong:

- to respective first areas of the same thermal zone Z, e.g. circuit *i* belongs to first area 11a_1 and circuit *i* + 1 belongs to first area 11a_2; or
- to the second area of the same thermal zone Z, e.g. circuit *i* and circuit *i* + 1 belong to second area 12a.

[0065] The method is described starting with a situation wherein circuit *i* is active and power P_max_i, i.e. the maximum power absorbed by circuit *i*, is stored.

[0066] In the first verification step, the instantaneous power absorbed P_ass by the plurality of circuits 2 is determined, the estimated absorbed power $P\_ass + P\_max_i$ is obtained, and the first condition $P\_ass + P\_max_i \leq P\_lim$ is verified.

[0067] If the first condition is met, i.e. if the estimated absorbed power $P\_ass + P\_max_i$ is less than or equal to the limit power P_lim, circuit *i* + 1 is activated and P_max_{i+1}, i.e. the maximum power absorbed by circuit *i* + 1, is stored.

[0068] If the first condition is not met, i.e. if the estimated absorbed power $P\_ass + P\_max_i$ is greater than the limit power P_lim, the first verification step is performed iteratively, wherein two consecutive iterations are spaced temporally by the first predetermined time interval Δt_1. As soon as the first condition is met or after the first predetermined number of iterations, the circuit *i* + 1 is activated and P_max_{i+1}. i.e. the maximum power absorbed by the circuit $i + 1$, is stored. If the first condition is not met after the first predetermined number of iterations, the pre-alarm is generated immediately before activating the circuit i+1.

[0069] After activating the circuit $i + 1$, the second predetermined time interval Δt_2 is waited and then the second verification step is executed. In particular, the power absorbed by the plurality of circuits 2 after activating the circuit $i + 1$ is detected, obtaining the actual absorbed power *P_ass,* and the second condition $P\_ass \leq P\_lim$ is verified.

[0070] If the second condition is met, i.e. if actual absorbed power *P_ass* is less than or equal to limit power *P_lim,* then $i \leftarrow i + 1$ (i. e. *i* takes the value $i + 1$) and there is a return to first step of the method, i.e. circuit *i* (which is now circuit $i + 1$) is active and power P_max_i (which is now power P_max_{i+1}) is stored. In other words, if the second condition is met, circuit $i + 1$ is kept active and the method is iterated. This is equivalent to stating that circuit $i + 1$ (i.e. the second circuit) in one iteration of the method is circuit *i* (i.e. the first circuit) in the subsequent iteration of the method.

[0071] If the second condition is not met, i.e. if actual absorbed power *P_ass* is greater than limit power *P_lim,* the following routine is executed:

- the circuit $i + 1$ is deactivated;
- the third predetermined time interval Δt_3 is waited;
- circuit $i + 1$ is activated; and
- the second verification step is executed.

[0072] The routine is executed iteratively if the second condition $P\_ass \leq P\_lim$ is not met. If the second predetermined number of iterations is reached, the alarm is generated, i.e. the alarm is generated if the second conditionand $P\_ass \leq P\_lim$ is not met after the second predetermined number of iterations of the routine.

[0073] It is worth noting that the method of Figure 2 is valid, subject to one modification, also in the particular case where circuit *i* belongs to the (last) first area 11 and circuit $i + 1$ belongs to the second area 12 of the same thermal zone Z, e.g. circuit *i* is circuit 2a_n_a' of first area 11a_n_a and circuit $i + 1$ is circuit 2a' of second area 12a. In such a case, in the first verification step, the estimated absorbed power is $P\_ass + P\_max_i/2$ and thus the first condition is $P\_ass + P\_max_i/2 \leq P\_lim$, as the power absorption of circuit $i + 1$ (which belongs to second area 12) is substantially half of the power absorption of circuit *i* (which belongs to first area 11).

[0074] In use, the method is implemented by control system 3.

[0075] In particular, control system 3 starts the method as main control unit 3a receives signals from electronic device 31, or automatically, e.g. in a time-controlled manner (preferably on the basis of the time slot).

[0076] Control system 3 can control platform 1 in different ways, depending on the presence and possible use of first sensor 21 and second sensor 22.

[0077] For example, control system 3 can activate circuits 2 sequentially, according to the described method, until the limit power *P_lim* is reached. In such a case, neither first sensor 21 nor second sensor 22 are required.

[0078] In particular, main control unit 3a can sequentially activate circuits 2 of first thermal zone Za, and each auxiliary control unit 3b can sequentially activate circuits 2 of the respective thermal zone Zb. Conveniently, main control unit 3a receives signals from multimeter 41 and each auxiliary control unit 3b, which in turn receives signals from main control unit 3a.

[0079] Using first sensor 21 and/or second sensor 22, control system 3 can activate circuits 2 as a function of jointly the power limit *P_lim,* as described above, and the temperature, as described in detail hereinafter.

[0080] Using first sensor 21 of each thermal zone Z, control system 3 can sequentially activate circuits 2, according to the described method, until a desired temperature of the respective thermal zone Z is reached.

[0081] In particular, as the first signal of each first sensor 21 is indicative of the respective first temperature relative to the respective thermal zone Z, the first signal can be compared with a respective first reference signal, indicative of the desired temperature of the respective thermal zone Z, and circuits 2 of the respective thermal zone Z can be activated until the first signal and the respective first reference signal are substantially equal, i.e. the respective thermal zone Z has substantially reached the desired temperature.

[0082] For each thermal zone Z, if the temperature of thermal zone Z, detected by the respective first sensor 21, is higher than the desired temperature, circuits 2 of thermal zone Z are sequentially deactivated, e.g. in the same order as they were activated, until the first signal and the respective first reference signal are substantially equal.

[0083] Using second sensor 22, control system 3 can sequentially activate circuits 2, according to the described method, until a desired temperature of the environment associated with platform 1 is reached.

[0084] Preferably, using second sensor 22 of each thermal zone Z, control system 3 can sequentially activate circuits 2, according to the described method, until a desired temperature of the environment associated with the respective thermal zone Z is reached.

[0085] In particular, as the second signal of each second sensor 22 is indicative of the respective second temperature relative to the environment associated with the respective thermal zone Z, the second signal can be compared with a respective second reference signal, indicative of the desired temperature of the environment associated with the respective thermal zone Z, and circuits 2 of the respective thermal zone Z can be activated until the second signal and the respective second reference signal are substantially equal, i.e. the environment associated with the respective thermal zone Z has substantially reached the desired temperature.

[0086] For each thermal zone Z, if the temperature of the environment associated with thermal zone Z, detected by the respective second sensor 22, is higher than the desired temperature of the environment associated with thermal zone Z, circuits 2 of thermal zone Z are sequentially deactivated, e.g. in the same order as they were activated, until the second signal and the respective second reference signal are substantially equal.

[0087] The number of elements of platform 1 of the illustrated embodiment can be generalised.

[0088] For example, the number of circuits 2 of each first area 11 can be n (not necessarily $n = 2$ as in the illustrated embodiment), the number of circuits 2 of each second area 12 can be $m > n$ (not necessarily $m = 4$ as in the illustrated embodiment). In such a case, the power absorption of each circuit 2 of second area 12 is substantially n/m times the power absorption of each circuit 2 of each first area 11, and preferably the length of each circuit 2 of second area 12 is substantially n/m times the length of each circuit 2 of each first area 11.

[0089] Furthermore, the number of thermal zones Z can be k (not necessarily $k = 2$ as in the illustrated embodiment). In such a case, the number of further thermal zones Zb (and thus the number of auxiliary control units 3b) is $k - 1$, the number of first sensors 21 is k, and the number of second sensors 22 is preferably k.

[0090] From an examination of the characteristics of the method and platform 1, the advantages of the present invention are evident.

[0091] In particular, the sequential activation of circuits 2, subject to verification that the limit power has been exceeded, allows efficient control of platform 1. Indeed, the activation of circuit 2 is temporally spaced out. Furthermore, the exceeding of the limit power is verified both before and after the activation of each circuit 2 via a theoretical and practical verification, respectively.

[0092] The method can be applied iteratively, for each pair of circuits 2 that are activatable consecutively.

[0093] Platform 1 with its plurality of first areas 11 allows a modular approach, both structurally and functionally. Indeed, first areas 11 can be arranged aligned and circuits 2 of first areas 11 are activated sequentially, improving thermal homogeneity. Furthermore, circuits 2 of second areas 12 allow fine tuning, as they have a lower power absorption than circuits 2 of first areas 11 and are activated after them.

[0094] Platform 1 with the plurality of thermal zones Z allows to further improve the control, as each thermal zone Z is associated with the respective first temperature, detected by the respective first sensor 21, which can be used to implement closed-loop control on the basis of the temperature of the respective thermal zone Z. Furthermore, each further thermal zone Zb in addition to first thermal zone Za is controlled by the respective auxiliary control unit 3b, which in turn is controlled by main control unit 3a which receives signals from multimeter 41 and thus knows the instantaneous power absorbed by all circuits 2 of platform 1. The temperature of the environment associated with each thermal zone Z, detected via the respective second sensor 22, can be used to implement closed-loop control on the basis of the temperature of the environment associated with the respective thermal zone Z.

[0095] Finally, it is clear that modifications and variants can be made to platform 1 without departing from the scope of protection defined by the claims.

Claims

1. Method for controlling a radiant platform, the radiant platform (1) comprising a plurality of self-regulating electrical circuits (2), said plurality comprising at least a first circuit (i) and a second circuit ($i + 1$), the method comprising the step of sequentially activating the circuits (2), wherein the second circuit ($i + 1$) is activatable consecutively to the first circuit (i) and the activation of the second circuit ($i + 1$) is subject to a verification of exceeding a limit power.

2. Method as claimed in claim 1, wherein the verification of exceeding the limit power comprises a first verification step, wherein it is verified that an estimated absorbed power does not exceed the limit power, and a second verification step, wherein it is verified that an actual absorbed power does not exceed the limit power.

3. Method as claimed in claim 2, wherein the first verification step comprises the steps of:

   - detecting an instantaneous power absorbed by the plurality of circuits (2);
   - adding the instantaneous power absorbed and a maximum power absorbed by the first circuit (i), obtaining the estimated absorbed power; and
   - verifying that a first condition is met, the first condition being met if the estimated absorbed power is less than or equal to the limit power.

4. Method as claimed in claim 3, comprising the steps of:

   - iteratively executing the first verification step if the first condition is not met, two consecutive iterations being spaced temporally by a first predetermined time interval (Δt_1); and
   - activating the second circuit ($i + 1$) as soon as the first condition is met or after a first predetermined number of iterations.

5. Method as claimed in any of claims 2 to 4, wherein the second verification step comprises the steps of:

   - detecting a power absorbed by the plurality of circuits (2) after the activation of the second

circuit (i + 1), obtaining the actual absorbed power; and
- verifying that a second condition is met, the second condition being met if the actual absorbed power is less than or equal to the limit power.

6. Method as claimed in claim 5, wherein the step of detecting the actual absorbed power is executed after a second predetermined time interval (Δt_2) from the activation of the second circuit (i + 1).

7. Method as claimed in claim 6, comprising a routine if the second condition is not met, the routine comprising the steps of:

- deactivating the second circuit (i + 1);
- waiting for a third predetermined time interval (Δt_3);
- activating the second circuit (i + 1); and
- executing the second verification step.

8. Method as claimed in claim 7, comprising the steps of:

- iteratively executing the routine if the second condition is not met; and
- generating an alarm if the second condition is not met after a second predetermined number of iterations.

9. Radiant platform comprising a plurality of self-regulating electrical circuits (2) and a control system (3) configured to implement the method as claimed in any of the preceding claims.

10. Platform as claimed in claim 9, comprising a plurality of first areas (11), each first area (11) comprising at least two electrical circuits (2), the control system (3) being configured to sequentially activate one electrical circuit (2) of each first area (11) and subsequently to sequentially activate another electrical circuit (2) of each first area (11).

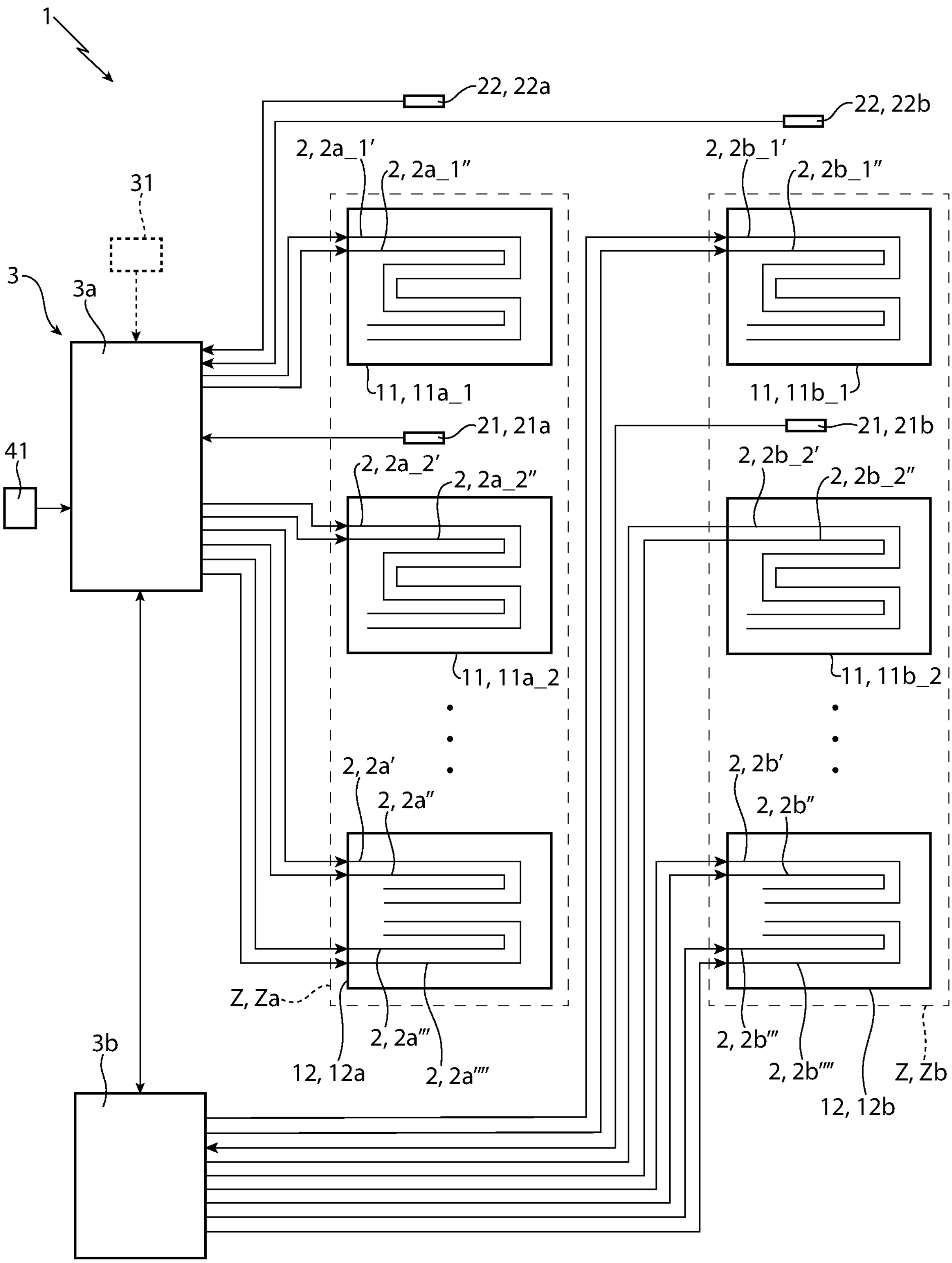
11. Platform as claimed in claim 10, comprising a second area (12), the second area (12) comprising at least two electrical circuits (2) having a lower power absorption with respect to the electrical circuits (2) of the first areas (11), the control system (3) being configured to sequentially activate the electrical circuits (2) of the second area (12) after having activated the electrical circuits (2) of the first areas (11).

12. Platform as claimed in claim 10 or 11, comprising at least a first temperature sensor (21) configured to produce a first signal indicative of a first temperature of the platform (1), the control system (3) being configured to receive the first signal from the first sensor (21) and to sequentially activate the electrical circuits (2) on the basis of the first signal.

13. Platform as claimed in claim 12, comprising a plurality of thermal zones (Z), each thermal zone (Z) comprising a respective first sensor (21) and a plurality of said first areas (11).

14. Platform as claimed in claim 13, wherein the control system (3) comprises a main control unit (3a) configured to directly control a first thermal zone (Za) of the plurality of thermal zones (Z), and a respective auxiliary control unit (3b) for each further thermal zone (Zb) in addition to said first thermal zone (Za), each auxiliary control unit (3b) being connected to the respective thermal zone (Zb) and the main control unit (3a), the main control unit (3a) being configured to control each further thermal zone (Zb) via the respective auxiliary control unit (3b) .

15. Platform as claimed in any of claims 10 to 14, comprising at least a second temperature sensor (22) configured to produce a second signal indicative of a second temperature of an environment associated with the platform (1), the control system (3) being configured to receive the second signal from the second sensor (22) and to sequentially activate the electrical circuits (2) on the basis of the second signal.


1
22, 22a
22, 22b
31
2, 2a_1′
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2, 2b_1′
2, 2b_1″
3
3a
11, 11a_1
11, 11b_1
21, 21a
21, 21b
41
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2, 2a_2″
2, 2b_2′
2, 2b_2″
11, 11a_2
11, 11b_2
2, 2a′
2, 2a″
2, 2b′
2, 2b″
Z, Za
2, 2a‴
12, 12a
2, 2a⁗
2, 2b‴
2, 2b⁗
Z, Zb
12, 12b
3b

FIG. 1

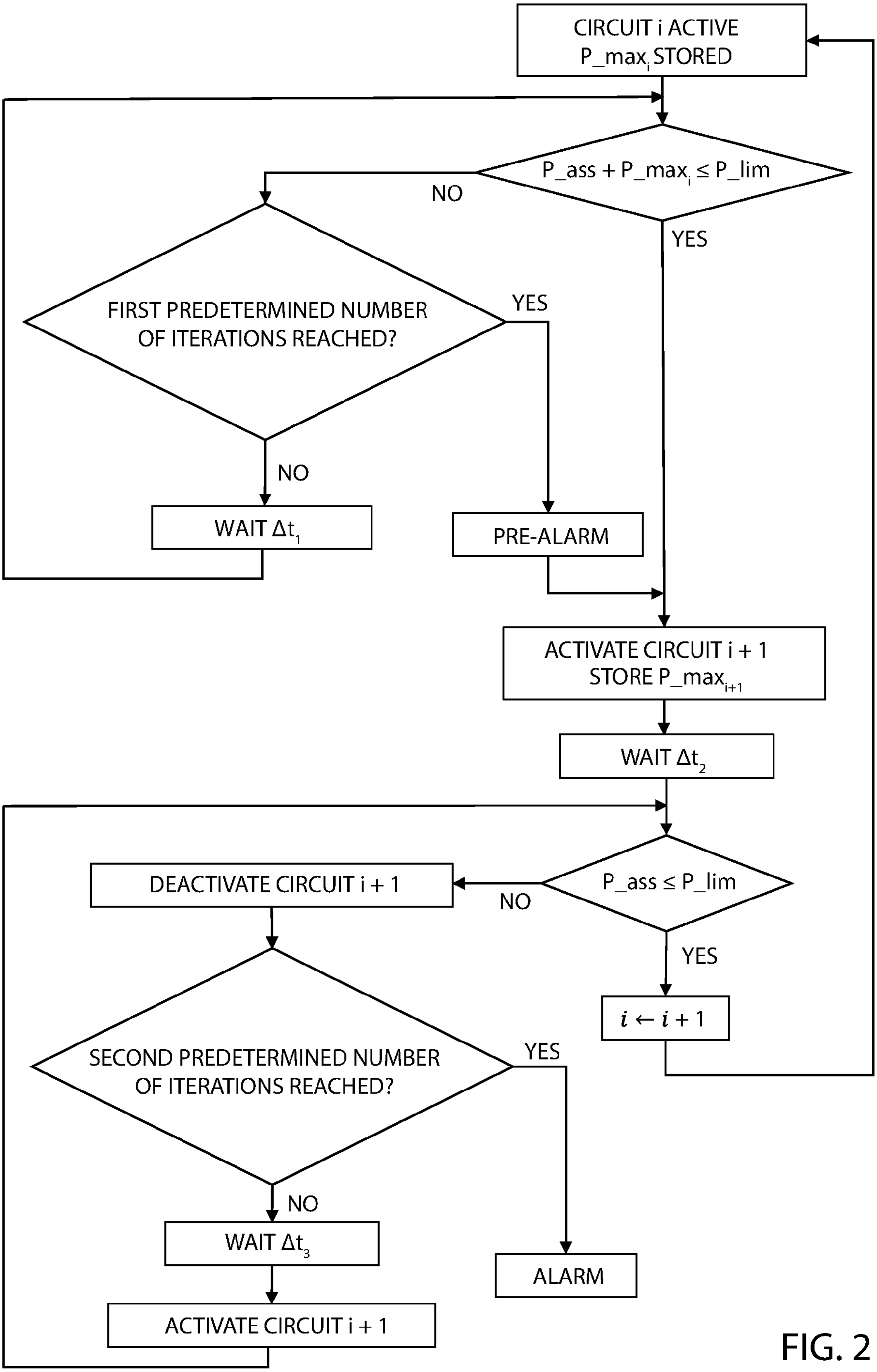
CIRCUIT i ACTIVE
P_max_i STORED
P_ass + P_max_i ≤ P_lim
NO
YES
FIRST PREDETERMINED NUMBER OF ITERATIONS REACHED?
YES
NO
WAIT Δt_1
PRE-ALARM
ACTIVATE CIRCUIT i + 1
STORE P_max_i+1
WAIT Δt_2
DEACTIVATE CIRCUIT i + 1
P_ass ≤ P_lim
NO
YES
i ← i + 1
SECOND PREDETERMINED NUMBER OF ITERATIONS REACHED?
YES
NO
WAIT Δt_3
ALARM
ACTIVATE CIRCUIT i + 1

FIG. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 24 20 2111

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			H05B

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
Munich	21 January 2025	de la Tassa Laforgue

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21-01-2025

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