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(54) METHOD AND SYSTEM FOR PRECONDITIONING PARTS OF A RAILWAY VEHICLE, AND RELATED RAILWAY VEHICLE

(57) Method (100) and system (200) for preconditioning parts of a railway vehicle (1) comprising an on-board power generation system (10), comprising at least:
- (110): starting-up the railway vehicle (1) or at least parts thereof;
- (120): connecting a power storage unit (20) to a power conversion system (30), said power storage unit (20) and said power conversion system (30) being installed on board of the railway vehicle (1);
- (130): supplying at least part of the power conversion system (30) by discharging energy pre-stored in the power storage unit (20), the pre-stored energy being discharged with a level of power below a first predetermined power threshold;
- (140): heating-up the power storage unit (20) via the power conversion system (30);
- (150): starting pre-heating at least part of the power generation system (10) via the power conversion system (30);
- (160): when the pre-heated at least part of the power generation system (10) reaches a predetermined start-up temperature, and advantageously the power storage unit (20) reaches a predetermined minimal charging temperature, starting-up power generation by the power generation system (10);
- (170): when at least part of the power generation system (10) reaches a predetermined operating temperature, centralizing power sourcing of the railway vehicle (1) or parts thereof to the power generation system (10).

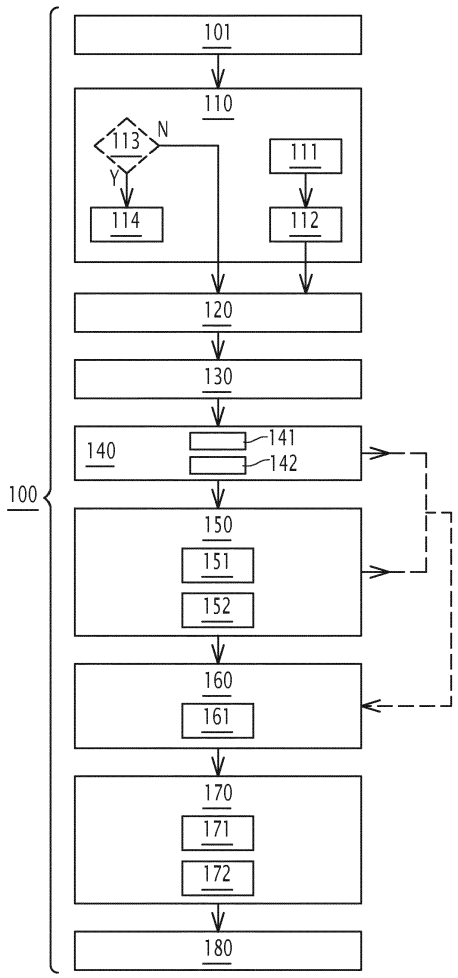

FIG.1

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Description

[0001] The present invention relates in general to energy management in railway vehicles, and in particular to a method and a system for preconditioning components or parts of a railway vehicle when the vehicle is initially started up and has to get ready for its duty service along a railway line.

[0002] As known, almost all modern railway vehicles are provided with a so-called pre-conditioning function which allows initiating, manually or via a pre-programmed timer, a start-up phase during which various subsystems of the vehicles, as well as the interior compartments for passengers, are pre-heated to a desired temperature.

[0003] In this way, railway vehicles can be ready to start service at due time, without undesired delays, and avoiding uncomfortable conditions, e.g. for passengers.

[0004] In order to fulfill such task, the pre-conditioning phase requires an amount of energy which must be available immediately when the start-up phase is initiated.

[0005] Such requirement may represent a quite demanding technical task in some applications, in particular when dealing with railways vehicles powered by a certain type of power generation sources installed on board.

[0006] A typical example of such sources is represented by modern hydrogen-powered trains which exploit fuel cell systems, installed on-board of the railway vehicles, in order to produce the amount of energy required for performing due service.

[0007] In particular, in such cases, during a start-up condition, indicated often as a cold start, e.g. when a train is restarted after a certain parking time, components of the power system, such as fuel cells, may be at temperatures which are below their minimum start-up operating temperatures; as a consequence, the actual voltages can be significantly lower than the normal ones, and for example in the case of fuel cell systems, the process of injecting fuel and/or oxidant into the fuel cells, thus starting the energy generation process, may take a considerable amount of time until voltage levels reach the normal operating conditions.

[0008] As a matter of fact, it is evident the need of having proper starting up procedure capable of balancing contrasting goals and facing different operative scenarios.

[0009] For example, in order to optimize operating performances, the preconditioning phase should be carried in such a way that a vehicle reaches the ready-for-operating status as quickly as possible; on the other end, the preconditioning phase should not result in too high demand for the power generation system thus risking damaging any component thereof.

[0010] Further, the curve of power initially needed during the preconditioning phase can vary substantially case by case, in connection with the specific application, for instance in relation to the external environmental conditions, duration of the resting period of the specific vehicle, et cetera.

[0011] To cope with this issue, some solutions foresee the use of additional components such as heaters which, even if bringing some beneficial effects, are not fully efficient and effective, in particular, if heaters are fed by the power system itself.

[0012] Indeed, in such cases, the positive impact of heaters would be minimal, especially at a cold-start-up of the power generation system where available power should be provided to it rather than the contrary.

[0013] Therefore, it is quite evident the need of having railway vehicles further improved to face such technical issues and solve at least partially, some of the above-indicated drawbacks and operational inconvenient.

[0014] Hence, it is a main aim of the present invention to provide a solution for preconditioning parts of a railway vehicle offering substantial improvements over known solutions, in particular as regard to the capability of efficiently manage power and equipment already available on-board of a railway vehicle without the need of installing additional components.

[0015] Within the scope of this aim, an object of the present invention is to provide a solution for preconditioning parts of a railway vehicle which is capable of better balancing the need of preconditioning a railway vehicle before it starts its duty service in the shortest amount of time possible and without forcing, at the same time, components to work in operative conditions that could undermine their integrity.

[0016] Yet a further object of the present invention is to provide a solution for preconditioning parts of a railway vehicle which is highly reliable, easy to realize and at competitive costs.

[0017] This aim, these objects and others which will become apparent hereinafter are achieved by a method for preconditioning parts of a railway vehicle comprising an on-board power generation system, the method being characterized in that it comprises at least the following phases:

(a): starting-up the railway vehicle or at least parts thereof;

(b): connecting a power storage unit to a power conversion system, said power storage unit and said power conversion system being installed on board of the railway vehicle;

(c): supplying at least part of the power conversion system by discharging energy pre-stored in the power storage unit, the pre-stored energy being discharged with a level of power below a first predetermined power threshold;

(d): heating-up the power storage unit via the power conversion system;

(e): starting pre-heating at least part of the power generation system via the power conversion system;

(f): when the pre-heated at least part of the power generation system reaches a predetermined start-up temperature, and advantageously the power storage unit reaches a predetermined minimal charging

temperature, starting-up power generation by the power generation system;
(g): when at least part of the power generation system reaches a predetermined operating temperature, centralizing power sourcing of the railway vehicle or parts thereof to the power generation system.

[0018] The above-mentioned aim and objects of the present invention are also achieved by a system for preconditioning parts of a railway vehicle, comprising at least:

- a power generation system adapted to generate power for supplying the railway vehicle;
- a power storage unit installed on board of the railway vehicle;
- a power conversion system installed on board of the railway vehicle and suitable to be connected with said power storage unit and said power generation system;
- an on-board control unit which is configured at least to:
- starting-up the railway vehicle or at least parts thereof;
- connecting the power storage unit to the power conversion system;
- causing discharging energy pre-stored in the power storage unit for supplying at least part of the power conversion system, the pre-stored energy being supplied to the power conversion system with a level of power below a first predetermined power threshold;
- heating-up the power storage unit via the power conversion system;
- starting pre-heating at least part of the power generation system via the power conversion system;
- starting-up power generation by the power generation system when the power generation system reaches a predetermined start-up temperature and advantageously the power storage unit reaches a predetermined minimal charging temperature;
- when the power generation system reaches a predetermined operating temperature, centralizing power sourcing of the railway vehicle or parts thereof to the power generation system.

[0019] The above-mentioned aim and objects of the present invention are also achieved by a railway vehicle characterized in that it comprises a system as above indicated, and in particular as described hereinafter and defined in the appended relevant claims.

[0020] Further characteristics and advantages will become apparent from the description of some preferred but not exclusive exemplary embodiments of a system and a method according to the present disclosure, illustrated only by way of non-limitative examples with the accompanying drawings, wherein:

Figure 1 is a flow chart schematically illustrating a method for preconditioning parts of a railway vehicle according to the present invention;
Figure 2 is block diagram schematically illustrating a system for preconditioning parts of a railway vehicle according to the present invention;
Figure 3 is a view showing of a railway vehicle comprising a fuel cell system, in accordance with an exemplary embodiment of the present invention.

[0021] It should be noted that in the detailed description that follows, identical or similar components, either from a structural and/or functional point of view, have the same reference numerals, regardless of whether they are shown in different embodiments of the present disclosure; it should also be noted that in order to clearly and concisely describe the present disclosure, the drawings may not necessarily be to scale and certain features of the disclosure may be shown in somewhat schematic form.

[0022] Further, when the term "adapted" or "arranged" or "configured" or "shaped", is used herein while referring to any component as a whole, or to any part of a component, or to a combination of components, it has to be understood that it means and encompasses correspondingly either the structure, and/or configuration and/or form and/or positioning.

[0023] In particular, for electronic and/or software means, each of the above listed terms means and encompasses electronic circuits or parts thereof, as well as stored, embedded or running software codes and/or routines, algorithms, or complete programs, suitably designed for achieving the technical result and/or the functional performances for which such means are devised.

[0024] A method and a system, according to the invention, for conditioning parts of a railway vehicle comprising a power generation system installed on-board, are schematically illustrated in figures 1 and 2, and therein indicated by the overall reference numbers 100 and 200, respectively.

[0025] The method 100 and system 200 according to the present invention are particularly suitable for use with railways vehicles comprising fuel cell systems as on-board-power generation devices, and therefore they will be described hereinafter by making specific reference to such preferred configuration, without intending in any way to limit the possible application with other types of suitable on-board power generation devices.

[0026] An illustrative example of such type of railway vehicles is illustrated in figure 3, where there is depicted a train 1, hereinafter referred to as the railway vehicle 1, comprising a fuel cell system, indicated in figure 2 by the reference number 10. The fuel cell system 10 comprises, inter alia, a fuel tank 11 containing hydrogen, and one or more stacks of fuel cells 12 electrically connected in series or in parallel to each other.

[0027] As well known to those skilled in the art, and therefore not described herein in details, during operations, fuel cells 12 are supplied with a fuel gas that con-

tains hydrogen, and an oxidation gas, e.g. air, that contains oxygen.

[0028] The electrochemical reaction of such gases in the fuel cell generates electric power, used to supply and make the railway vehicle 1 autonomous during at least part of its daily service, as well other by-products, e.g. process water, usually discharged out.

[0029] As illustrated in figure 1, the method 100 according to the present invention comprises at least the following phases:

- 110: starting-up the railway vehicle 1 or at least parts thereof;
- 120: connecting a power storage unit to a power conversion system.

[0030] In particular, as illustrated in figure 2, and according to a possible embodiment of the system 200 according to the invention, the power storage unit, schematically indicated by the reference number 20, is installed on board of the railway vehicle 1; the power storage unit 20 is suitable to be connected to and supplied by the power generation system 10, and comprises for instance one or more rechargeable traction batteries.

[0031] In turn, the power conversion system, schematically indicated by the reference number 30 is also installed on board of the railway vehicle 1; it is suitable to be connected with the power storage unit 20 and the power generation system 10 and comprises at least a DC link 31 and an auxiliary inverter 32.

[0032] The method 100 comprises also at least the following phases:

- 130: supplying at least part of the power conversion system 30 by discharging energy pre-stored in the power storage unit 20, e.g. in the traction batteries, the pre-stored energy being discharged with a level of power below a first predetermined power threshold. In this case, for example, the traction batteries are connected to an intermediate circuit (not illustrated) of the power conversion system 30, to which the auxiliary inverter 32 is connected immediately afterward;
- 140: heating-up the power storage unit 20 via the power conversion system 30. In this way, the temperature of the rechargeable batteries rises and, consequently, it raises also the power available from the batteries themselves;
- 150: starting pre-heating at least part of the power generation system 10, e.g. of the fuel cells 12, via the power conversion system 30;
- 160: when the pre-heated at least part of the power generation system 10 reaches a predetermined start-up temperature, and advantageously the power storage unit 20 reaches a predetermined minimal charging temperature, starting-up power generation by the power generation system 10; and
- 170: when at least part of the power generation system 10 reaches a predetermined operating temperature, centralizing power sourcing of the railway vehicle 1 or parts thereof to the power generation system 10 itself.

[0033] According to a possible embodiment, schematically represented in figure 1 by dotted lines, advantageously the steps of heating-up 140 the power storage unit 20 and of starting pre-heating 150 at least part of the power generation system 10 are run in parallel and in step 160, when the pre-heated at least part of the power generation system 10 reaches a predetermined start-up temperature and the power storage unit 20 reaches a predetermined minimal charging temperature, the power generation by the power generation system 10 is started-up;

[0034] According to a possible embodiment, when the power storage unit 20 comprises the mentioned rechargeable traction batteries 20, the phase 140 of heating-up the power storage unit 20 comprises the following steps:

- 141: initiating circulation of water within the rechargeable traction batteries 20; and
- 142: heating up the circulating water, at least for an initial interval of time from the instant circulation is initiated, via power provided by the power storage unit 20 through the power conversion system.

[0035] In one possible embodiment, the method 100 according to the invention comprises a further phase 180 of heating one or more internal areas of the railway vehicle 1 up to a target temperature. In particular, the phase 180 of heating one or more internal areas of the railway vehicle 1 comprises activating a heating system of the railway vehicle 1, schematically indicated in figure 3 by the reference number 3, and supplying the heating system 3 via power generated by the power generation system 10.

[0036] For example, the above-mentioned internal areas can be one or more compartments 2 adapted to receive passengers, and the heating system 3 can be part of a conditioning system used on board of the vehicle 1, e.g. its HVAC system comprising inter alia an electrical heater.

[0037] In this way, relevant and selected parts of the railway vehicle 1 are suitably preconditioned, and thus the railway vehicle 1 is ready to start its operative service along a railway line.

[0038] To this end, in order to further improve efficiency and timeliness, in the method 100 according to the invention, the phase 110 of starting-up the railway vehicle 1 or at least parts thereof comprises the following steps:

- 111: a first step of pre-calculating a time at which starting-up the railway vehicle 1 or at least parts thereof. This time is for instance calculated based on a scheduled time at which the railway vehicle 1

has to initiate its operating service on a railway line, and on one or more information related to the actual environmental temperature outside the railway vehicle 1, and the actual temperature of one or more selected parts of the railway vehicle 1. These selected parts can comprise for example, the actual temperature of at least some parts of the fuel cell system 10, e.g. of its fuel cells, of the interior areas 2, of the power storage unit 20, et cetera.

[0039] In particular, this time can be pre-calculated for example via a software module of a control unit 40, which can be installed on-board of the railway vehicle 1 itself and be part of the system 200, as schematically represented in figure 2.

[0040] Then, the phase 110 comprises a following step 112 of automatically starting-up the railway vehicle 1 or at least parts thereof at the pre-calculated time.

[0041] Alternatively, starting up of the railway vehicle 1 or at least parts thereof at the pre-calculated time can be performed by an operator, e.g. manually.

[0042] Further, according to a possible embodiment of the method 100, and as illustrated in figure 1, the phase 110 of starting-up the railway vehicle 1 or at least parts thereof comprises also the following steps:

- 113: checking the presence of faults at least within the power generation system 10, for example of the fuel cells 11 ; and, in the affirmative case,
- 114: switching off the railway vehicle 1 or any part thereof already started up.

[0043] In this way, thanks to this pre-diagnostic check, it is possible to identify any possible technical issue and to intervene as early as possible, preventing, to the extent possible, the onset of further and more relevant damages.

[0044] In one possible embodiment of the method 100 according to the invention, the phase 140 of heating-up the power storage unit 20 via the power conversion system 30 comprises sourcing the on-board power storage unit 20 with alternating current power, supplied for example by the auxiliary inverter 32, making available power for instance at 400VAC.

[0045] Alternatively, the power storage unit 20 can be heated by providing a series of pulses, or power sourcing a dedicated HVAC system or in any other suitable way.

[0046] According to an embodiment, and as illustrated in figure 1, in particular when the power generation 10 comprises a fuel cell system, the phase 150 of starting pre-heating comprises the following steps:

- a first step 151 of initiating circulation of a fluid, e.g. water which is usually already present within the fuel cell system 10; and then
- a second step 152 of heating up the circulating fluid, e.g. water, at least for an initial interval of time from the instant circulation is initiated, via power provided by the power storage unit 20 through the power conversion system.

[0047] According to a possible embodiment of the method 100, and as illustrated in figure 1, the phase 160 of starting-up power generation by the power generation system 10 includes a step 161 of continuing heating at least part of the power generation system 10 via the power conversion system (30) while the power generation by the power generation system 10 is started-up.

[0048] In one possible embodiment of the method 100, and as illustrated in figure 1, the phase 170 of centralizing power sourcing of the railway vehicle 1 or parts thereof to the power generation system 10, comprises a first step 171 of switching-off the ongoing heating of at least part of the power generation system 10 carried out via the power conversion system 30.

[0049] According to this embodiment, the phase 170 of centralizing comprises a second step 172 of commuting the power storage unit 20 from a discharging mode to a recharging mode and then recharging the power storage unit 20 with power generated by the power generation system 10.

[0050] When the railway vehicle 1 is parked somewhere, e.g. in a station or a depot, and there is available an additional source of power (not illustrated) external to the railway vehicle 1, then the method 100 according to the invention comprises a phase 101 of keeping at least some parts of the railway vehicle 1 at a desired temperature by means of the power storage unit and at least until the external power source is powering the railway vehicle 1.

[0051] In this way, when the railway vehicle 1 or parts thereof are started up at phase 110, the duration of the whole preconditioning by executing the various phases previously describe, can be reduced.

[0052] As illustrated in figure 2, in addition to the power generation system 10 adapted to generate power for supplying the railway vehicle 1, to the power storage unit 20, and to the power conversion system 30, the system 200 according to the invention, comprises at least one control unit, e.g. the previously mentioned control unit 40, which is in particular configured to carry out and/or to cause to carry out the method 100 as previously described.

[0053] In particular, the control unit 40 can comprise any type of processor or processor-based device commercially available and adapted for the scope, which is suitably programmed with software and in case accompanied by suitable circuitry, in order to carry and/or to cause carry out at least:

- starting-up the railway vehicle 1 or at least parts thereof;
- connecting the power storage unit 20 to the power conversion system 30;
- discharging energy pre-stored in the power storage unit 20 for supplying at least part of the power conversion system 30, the pre-stored energy being sup-

plied to the power conversion system 30 with a level of power controlled to be below a first predetermined power threshold;

- heating-up the power storage unit 20 via the power conversion system 30;
- starting pre-heating at least part of the power generation system 10 via the power conversion system 30;
- starting-up power generation by the power generation system 10 when the power generation system 10 reaches a predetermined start-up temperature and advantageously the power storage unit 20, heated by the power conversion system 30 itself, reaches a predetermined minimal charging temperature;
- when the power generation system 10 reaches a predetermined operating temperature, centralizing power sourcing of the railway vehicle 1 or parts thereof to the power generation system 10.

[0054] Clearly, the control unit 40 is suitable to carry out and/or cause to carry out each and any of the previously described phases and related steps of the method 100.

[0055] Further, according to possible embodiments, as schematically illustrated in figure 2, the system 200 comprises one or more sensors 50 for detecting the actual temperature of at least parts of the power generation system 10, and/or of the power storage unit 20, and/or of internal areas of the railway vehicle 1, such as the compartments 2, and/or the environmental temperature outside the railway vehicle 1 itself.

[0056] In the exemplary embodiment schematically illustrated in figure 2, the system 200 comprises a first temperature sensor 50 for detecting the actual temperature of at least parts of the power generation system 10, e.g. the fuel cells 12, a second temperature sensor 50 for detecting the actual temperature of at least part of the power storage unit 20, e.g. of the rechargeable traction batteries, a third temperature sensor 50 for detecting the actual temperature of one or more of the internal areas of the railway vehicle 10, such as the compartments 2, and a fourth temperature sensor 50 for detecting the environmental temperature outside the railway vehicle 1 itself.

[0057] In addition or in alternative to temperature sensors 50, the system 200 can comprise one or more different sensors, e.g. voltage sensors for detecting and allowing monitoring the level of actual voltage and/or power, at one or more of the components of the system 200, e.g. of the power generation system 10, of the power storage unit 20, et cetera.

[0058] Hence, it is evident from the foregoing description that the method 100, system 200 and related railway vehicle 1 according to the present invention allow achieving the intended aim and objects since preconditioning of a railway vehicle can be executed timely, properly balancing the need of duration and that of not risking the integrity of the various components.

[0059] These results are achieved according to a solution which manages the energy available on-board, without requiring the use of external power sources.

[0060] The method 100, system 200 and railway vehicle 1 thus conceived are susceptible of modifications and variations, all of which are within the scope of the inventive concept as defined in particular by the appended claims; for example, in relation to the specific application, some of the components, e.g. of parts or the whole control unit 40 can be positioned remotely, or there could be more than one control unit for sharing in coordination the various tasks and functionalities beforehand described.

[0061] All the details may furthermore be replaced with technically equivalent elements.

Claims

1. A method (100) for preconditioning parts of a railway vehicle (1) comprising an on-board power generation system (10), the method (100) being **characterized in that** it comprises at least the following phases:

   - (110): starting-up the railway vehicle (1) or at least parts thereof;
   - (120): connecting a power storage unit (20) to a power conversion system (30), said power storage unit (20) and said power conversion system (30) being installed on board of the railway vehicle (1);
   - (130): supplying at least part of the power conversion system (30) by discharging energy prestored in the power storage unit (20), the prestored energy being discharged with a level of power below a first predetermined power threshold;
   - (140): heating-up the power storage unit (20) via the power conversion system (30);
   - (150): starting pre-heating at least part of the power generation system (10) via the power conversion system (30);
   - (160): when the pre-heated at least part of the power generation system (10) reaches a predetermined start-up temperature, and advantageously the power storage unit (20) reaches a predetermined minimal charging temperature, starting-up power generation by the power generation system (10);
   - (170): when at least part of the power generation system (10) reaches a predetermined operating temperature, centralizing power sourcing of the railway vehicle (1) or parts thereof to the power generation system (10).

2. A method (100) for preconditioning parts of a railway vehicle (1) according to claim 1, wherein it further comprises the phase of:

- (180): heating one or more internal areas (2) of the railway vehicle (1) up to a target temperature.

3. A method (100) for preconditioning parts of a railway vehicle (1) according to claim 2, wherein said phase (180) of heating one or more internal areas (2) of the railway vehicle (1) comprises activating a heating system (3) of the railway vehicle (1) and supplying said heating system (3) via power generated by the power generation system (10).

4. A method (100) for preconditioning parts of a railway vehicle (1) according to anyone of the preceding claims, wherein said phase (160) of starting-up power generation by the power generation system (10) includes a sub-step (161) of continuing heating at least part of the power generation system (10) via the power conversion system (30) while power generation by the power generation system (10) is started-up.

5. A method (100) for preconditioning parts of a railway vehicle (1) according to anyone of the preceding claims, wherein said phase (170) of centralizing power sourcing of the railway vehicle (1) or parts thereof to the power generation system (10) comprises a first step (171) of switching-off the heating of at least part of the power generation system (10) carried out via the power conversion system (30).

6. A method (100) for preconditioning parts of a railway vehicle (1) according to claim 5, wherein said step (170) of centralizing power sourcing of the railway vehicle (1) or parts thereof comprises a second step (172) of commuting the power storage unit (20) from a discharging mode to a recharging mode and recharging the power storage unit (20) with power generated by the power generation system (10).

7. A method (100) for preconditioning parts of a railway vehicle (1) according to anyone of the preceding claims, wherein said power generation system (10) comprises a fuel cell system (10), and wherein said phase (150) of starting pre-heating comprises the following steps:

- (151): initiating circulation of water within the fuel cell system (10); and
- (152): heating up the circulating water, at least for an initial interval of time from the instant circulation is initiated, via power provided by the power storage unit (20) through the power conversion system.

8. A method (100) for preconditioning parts of a railway vehicle (1) according to anyone of the preceding claims, wherein said power storage unit (20) comprises rechargeable traction batteries (20), and wherein said phase (140) of heating-up the power storage unit (20) comprises the following steps:

- (141): initiating circulation of water within the rechargeable traction batteries (20); and
- (142): heating up the circulating water, at least for an initial interval of time from the instant circulation is initiated, via power provided by the power storage unit (20) through the power conversion system.

9. A method (100) for preconditioning parts of a railway vehicle (1) according to anyone of the preceding claims, wherein said phase (140) of heating-up the power storage unit (20) via the power conversion system (30) comprises sourcing the on-board power source (20) with alternating current power.

10. A method (100) for preconditioning parts of a railway vehicle (1) according to anyone of the preceding claims, wherein said phase (110) of starting-up the railway vehicle (1) or at least parts thereof comprises the following steps:

- (111): pre-calculating a time at which starting-up the railway vehicle (1) or at least parts thereof based on a scheduled time at which the railway vehicle has to start operating service, and on one or more of the actual environmental temperature outside the railway vehicle (1) and the actual temperature of one or more selected parts of the railway vehicle (1); and
- (112): automatically starting-up the railway vehicle (1) or at least parts thereof at the pre-calculated time.

11. A method (100) for preconditioning parts of a railway vehicle (1) according to anyone of the preceding claims, wherein it comprises the phase (101) of keeping at least some parts of the railway vehicle (1) at a desired temperature by means of the power storage unit and at least until an available external power source is powering the railway vehicle (1).

12. A system (200) for preconditioning parts of a railway vehicle (1), comprising at least:

- a power generation system (10) adapted to generate power for supplying the railway vehicle (1);
- a power storage unit (20) installed on board of the railway vehicle (1);
- a power conversion system (30) installed on board of the railway vehicle (1) and suitable to be connected with said power storage unit (20) and said power generation system (10);

- an on-board control unit (40) which is configured at least to:
- starting-up the railway vehicle (1) or at least parts thereof;
- connecting the power storage unit (20) to the power conversion system (30);
- causing discharging energy pre-stored in the power storage unit (20) for supplying at least part of the power conversion system (30), the pre-stored energy being supplied to the power conversion system (30) with a level of power below a first predetermined power threshold;
- heating-up the power storage unit (20) via the power conversion system (30);
- starting pre-heating at least part of the power generation system (10) via the power conversion system (30);
- starting-up power generation by the power generation system (10) when the power generation system (10) reaches a predetermined start-up temperature and advantageously the power storage unit (20) reaches a predetermined minimal charging temperature;
- when the power generation system (10) reaches a predetermined operating temperature, centralizing power sourcing of the railway vehicle (1) or parts thereof to the power generation system (10).

13. A system (200) for preconditioning parts of a railway vehicle (1) according to claim 12, wherein said power generation system comprises a fuel cell system (10), said power conversion system (30) comprises at least a DC link (31) and an auxiliary inverter (32), and said power storage unit (20) comprises one or more rechargeable traction batteries.

14. A system (200) for preconditioning parts of a railway vehicle (1) according to claim 12 or 13, wherein it comprises one or more sensors (50) for detecting the actual temperature of the power generation system (10), and/or of the power storage unit (20), and/or of internal areas of the railway vehicle (1), and/or the environmental temperature outside the railway vehicle (1).

15. A railway vehicle (1) **characterized in that** it comprises a system (200) according to one or more of the claims 12 to 14.

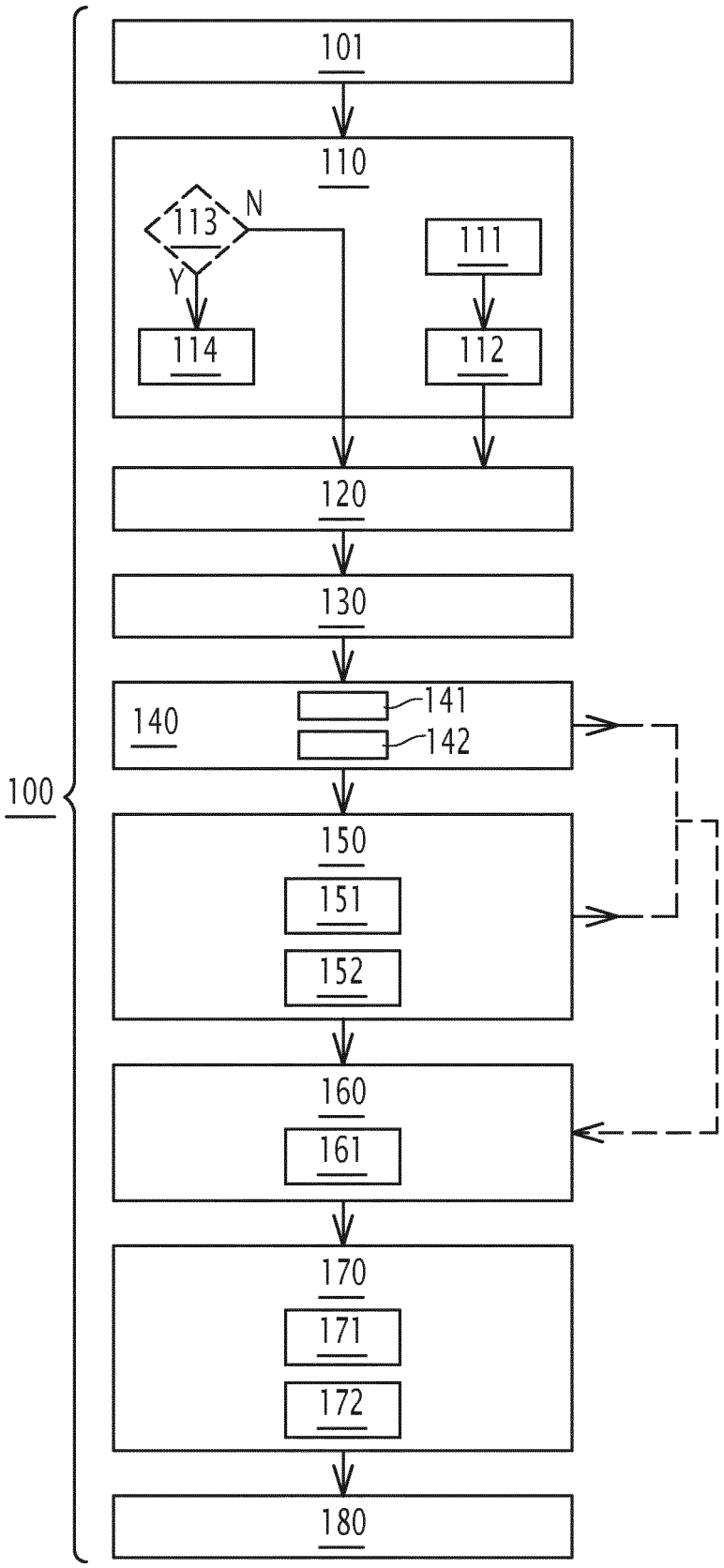
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FIG.1

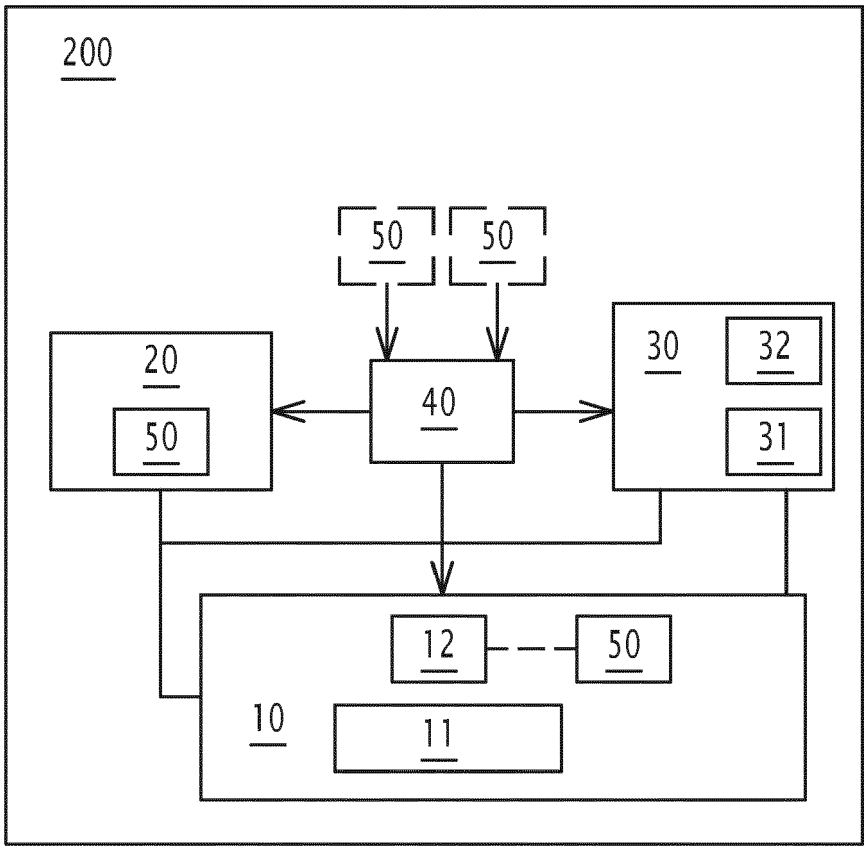

FIG.2

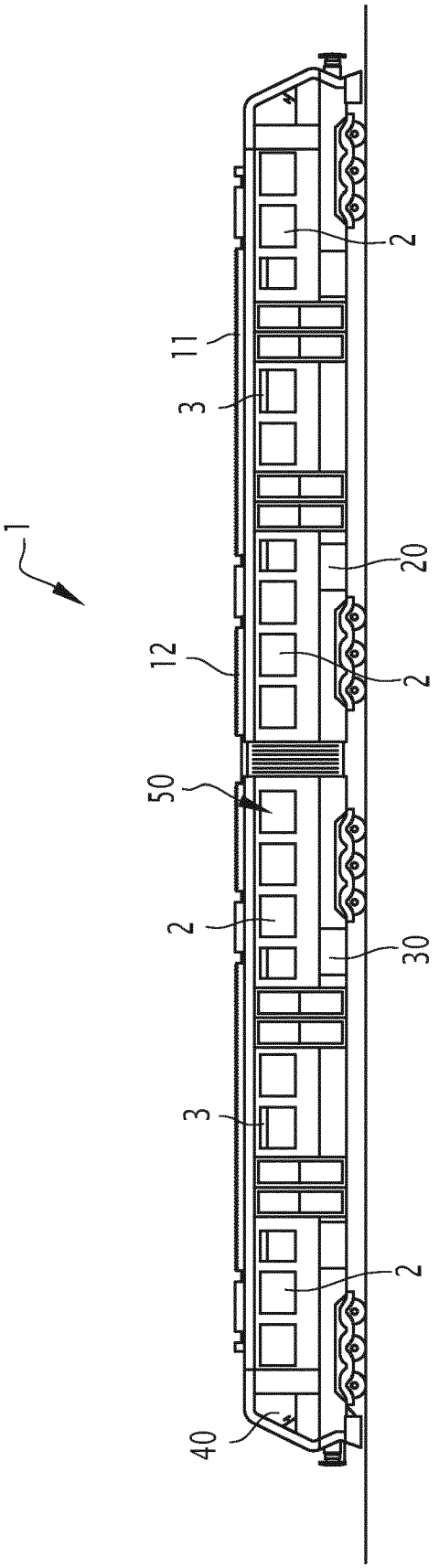

FIG.3

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EUROPEAN SEARCH REPORT

Application Number
EP 19 30 6476

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B61C
B61D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	15 May 2020	Awad, Philippe

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