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(54) Title: METHOD AND SYSTEM FOR SEPARATING MATERIALS FROM A SURFACE OF A VEHICLE

(57) Abstract: Disclosed herein is a system and method for separating materials from a surface of a vehicle. The method comprises monitoring, in real-time, temperature of at least one heating element detected by at least one thermocouple coupled with the at least one heating element, comparing the monitored temperature with a first predetermined temperature threshold to determine whether the monitored temperature is below the first predetermined threshold, activating the at least one heating element corresponding to the at least one thermocouple to heat the surface of the vehicle, in response to determining that the monitored temperature is below the first predetermined threshold, and triggering one or more vibration modules for a predetermined time duration, after the activation of the at least one heating element.

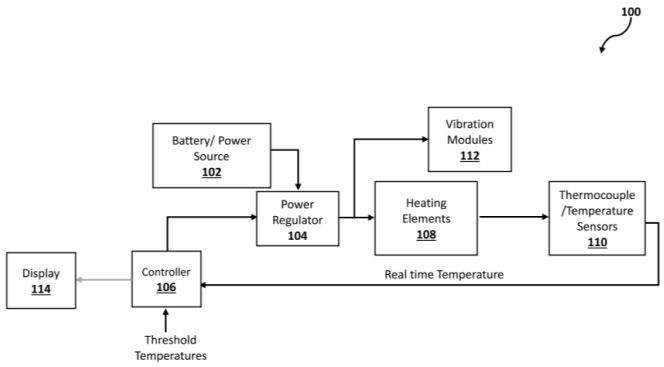

FIG. 1

FORM 2

THE PATENTS ACT 1970
(39 OF 1970)
&
The Patent Rules, 2003

Complete Specification

(See Section 10 and Rule 13)

1. TITLE OF THE INVENTION

METHOD AND SYSTEM FOR SEPARATING MATERIALS FROM A SURFACE OF A VEHICLE

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3. PREAMBLE TO THE DESCRIPTION

COMPLETE

The following specification describes the invention and the manner in which it is to be performed

TECHNICAL FIELD

[0001] This disclosure relates generally to removal of material which adheres to the surface, and more particularly to relates techniques for separating materials from a surface of a vehicle.

BACKGROUND OF THE INVENTION

[0002] The following description includes information that may be useful in understanding the present invention. It is not an admission that any of the information provided herein is prior art or relevant to the presently claimed invention, or that any publication specifically or implicitly referenced is prior art.

[0003] Mining vehicles, also referred to as dump trucks or mining trucks are all-terrain utility vehicles that are used by the mining agencies to transport oil sand from the mining sites. The adhesive force existing between the oil sand particles increases with decrease in temperature and results in solidification of oil sand into hard rock.

[0004] During cold weather conditions, the oil sand tends to adhere the contact surface dump truck's container thereby resisting ejection/discharge of the material from the dump truck due to high natural shear strength of oil sand. Even though the dump trucks have the tiltable dump body mounted on the frame of the dump truck, the oil sand still adheres to the contact surface and cannot be discharge easily.

[0005] For ejection of such cohesive material from the dump truck body nowadays exhaust gases from engine are used to heat body of dump truck to avoid solidification of oil sand into hard rock. However, the implementation of an exhaust-heated dump body is not an optimal solution as upcoming engine generations neither produce enough hot exhaust gas. Also, the world is moving towards electric vehicles (EV) which eliminates the engine. As a result, exhaust gases heating systems used in dump truck are unsuitable for future vehicle generations.

[0006] In view of the above, there exists a need to provide a system and a method which overcomes the above-mentioned problems and reduces material carry back and prevents the solidification/settling of materials being transported in extreme weather conditions.

SUMMARY OF THE INVENTION

[0007] The following presents a simplified summary to provide a basic understanding of some aspects of the disclosed technique for heating a surface of a vehicle. This summary is not an extensive overview and is intended to neither identify key or critical elements nor delineate the scope of such elements. Its purpose is to present some concepts of the described features in a simplified form as a prelude to the more detailed description that is presented later.

[0008] Various example aspects described herein relate to a system for separating materials from a surface of a vehicle. The system comprises a plurality of heating elements and a plurality of thermocouples placed in close proximity to the plurality of heating elements. Each thermocouple being coupled to a respective heating element. The system further comprises a plurality of vibration modules and at least one controller operatively coupled to the plurality of thermocouples and the plurality of vibration modules.

[0009] Various example aspects described herein relate to a system for separating materials from a surface of a vehicle. The at least one controller is configured to monitor, in real-time, temperature of at least one heating element detected by the at least one thermocouple coupled with the at least one heating element. The at least one controller is configured to compare the monitored temperature with a first predetermined temperature threshold to determine whether the monitored temperature is below the first predetermined temperature threshold and activate the at least one heating element corresponding to the at least one thermocouple to heat the surface of the vehicle, in response to determination that the monitored temperature is below the first predetermined temperature threshold. The at least one controller is configured to trigger one or more vibration modules for a predetermined time duration, after the activation of the at least one heating element.

[0010] Various example aspects described herein relate to a system for separating materials from a surface of a vehicle, wherein the plurality of heating elements are mounted uniformly on a surface of the vehicle in a predefined pattern.

[0011] Various example aspects described herein relate to a system for separating materials from a surface of a vehicle. The at least one controller is further configured to compare the monitored temperature with a second predetermined temperature threshold to determine whether the monitored temperature is above the second predetermined temperature threshold. The at least one controller is further configured to deactivate the at least one heating element corresponding to the at least one thermocouple and turn off the one or more vibration modules,

in response determining that the monitored temperature is above the second predetermined temperature threshold.

[0012] Various example aspects described herein relate to a system for separating materials from a surface of a vehicle. The at least one controller is configured to trigger the one or more vibration modules for the predetermined time duration, when the monitored temperature is greater than a third predetermined threshold. The third predetermined threshold is between the first predetermined temperature threshold and the second predetermined temperature threshold.

[0013] Various example aspects described herein relate to a system for separating materials from a surface of a vehicle, and wherein the at least one controller is configured to vibrate, the one or more vibration modules, at a predefined frequency to destabilize a material placed on the surface of the vehicle.

[0014] Various example aspects described herein relate to a method of separating materials from a surface of a vehicle. The method comprises monitoring, in real-time, temperature of at least one heating element detected by at least one thermocouple coupled with the at least one heating element, comparing the monitored temperature with a first predetermined temperature threshold to determine whether the monitored temperature is below the first predetermined temperature threshold, activating the at least one heating element corresponding to the at least one thermocouple to heat the surface of the vehicle, in response to determining that the monitored temperature is below the first predetermined temperature threshold, and triggering a vibration module mapped to the at least one activated heating element, for a predetermined time duration, after the activation of the at least one heating element.

[0015] Various example aspects described herein relate to a method of separating materials from a surface of a vehicle, wherein the method further comprises comparing the monitored temperature with a second predetermined temperature threshold to determine whether the monitored temperature is above the second predetermined temperature threshold. The method further comprises deactivating the at least one heating element corresponding to the at least one thermocouple and turning off the one or more vibration modules, in response determining that the monitored temperature is above the second predetermined temperature threshold.

[0016] Various example aspects described herein relate to a method of separating materials from a surface of a vehicle, wherein triggering the one or more vibration modules comprises triggering one or more vibration modules for the predetermined time duration, when the monitored temperature is greater than a third predetermined temperature threshold. The third

predetermined temperature threshold is between the first predetermined temperature threshold and the second predetermined temperature threshold.

[0017] Various example aspects described herein relate to a method of separating materials from a surface of a vehicle, wherein the method further comprises heating, by the at least one heating element, at least a portion of the surface of the vehicle.

[0018] Various example aspects described herein relate to a method of separating materials from a surface of a vehicle, wherein the method further comprises vibrating the one or more vibration modules at a predefined frequency to destabilize a material placed on the surface of the vehicle.

[0019] The above summary is provided merely for purposes of summarizing some example aspects to provide a basic understanding of some aspects of the disclosure. Accordingly, it will be appreciated that the above-described aspects are merely examples and should not be construed to narrow the scope or spirit of the disclosure in any way. It will be appreciated that the scope of the disclosure encompasses many potential aspects in addition to those here summarized, some of which will be further described below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The accompanying drawings, which are incorporated in and constitute a part of this disclosure, illustrate exemplary aspects and, together with the description, explain the disclosed principles.

[0021] **FIG. 1** illustrates an exemplary representation of an environment depicting monitoring and maintaining temperature of a surface, in accordance with some aspects of the present disclosure;

[0022] **FIG. 2a** illustrates an exemplary implementation of a system for preventing the solidification/settling of material on a surface of the vehicle, in accordance with some aspects of the present disclosure;

[0023] **FIG. 2b** illustrates an exemplary implementation of vehicle comprising a system for preventing the solidification/settling of material, in accordance with some aspects of the present disclosure;

[0024] **FIG. 2c** illustrates a heating element and a thermocouple, in accordance with some aspects of the present disclosure;

[0025] **FIG. 2d** illustrates a vibration module, in accordance with some aspects of the present disclosure;

[0026] **FIG. 3** shows a block diagram of a system for separating materials from a surface of a vehicle, in accordance with some aspects of the present disclosure; and

[0027] **FIG. 4** shows a flowchart illustrating a method of separating materials from a surface of a vehicle, in accordance with some aspects of the present disclosure.

[0028] It should be appreciated by those skilled in the art that any block diagrams herein represent conceptual views of illustrative systems embodying the principles of the present subject matter. Similarly, it will be appreciated that any flow charts, flow diagrams, state transition diagrams, pseudo code, and the like represent various processes which may be substantially represented in computer readable medium and executed by a computer or processor, whether such computer or processor is explicitly shown.

DETAILED DESCRIPTION

[0029] Exemplary aspects are described with reference to the accompanying drawings. Wherever convenient, the same reference numbers are used throughout the drawings to refer to the same or like parts. While examples and features of disclosed principles are described herein, modifications, adaptations, and other implementations are possible without departing from the spirit and scope of the disclosed aspects. It is intended that the following detailed description be considered as exemplary only, with the true scope and spirit being indicated by the following claims. Additional illustrative aspects are listed below.

[0030] Various aspects of the present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all aspects of the invention are shown. Indeed, the invention may be embodied in many different forms and should not be construed as limited to the aspects set forth herein. Rather, these aspects are provided so that this disclosure will satisfy applicable legal requirements. The term “or” is used herein in both the alternative and conjunctive sense, unless otherwise indicated. The terms “illustrative,” “example,” and “exemplary” are used to be examples with no indication of quality level. Like numbers refer to like elements throughout.

[0031] The phrases “in an aspect,” “in one aspect,” “according to one aspect,” and the like generally mean that the particular feature, structure, or characteristic following the phrase may be included in at least one aspect of the present disclosure and may be included in more than

one aspect of the present disclosure (importantly, such phrases do not necessarily refer to the same aspect).

[0032] The word "exemplary" is used herein to mean "serving as an example, instance, or illustration." Any implementation described herein as "exemplary" is not necessarily to be construed as preferred or advantageous over other implementations.

[0033] If the specification states a component or feature "can," "may," "could," "should," "would," "preferably," "possibly," "typically," "optionally," "for example," "often," or "might" (or other such language) be included or have a characteristic, that particular component or feature is not required to be included or to have the characteristic. Such component or feature may be optionally included in some aspects, or it may be excluded.

[0034] Throughout this specification, the term 'material' or 'cohesive material' may be used interchangeably, and these terms shall not be taken in a sense to limit the scope of the present disclosure. The term 'temperature sensor' or 'thermocouple' may be used interchangeably, and these terms shall not be taken in a sense to limit the scope of the present disclosure Further, the term 'controller' or 'at least one controller' or "processor" may be used interchangeably, and these terms shall not be taken in a sense to limit the scope of the present disclosure.

[0035] Throughout this specification, the system for separating materials from a surface of a vehicle that prevents the solidification/settling of material on the surface of the vehicle is illustrated in the context of dumping truck, dump trailer, dumper trailer, dump lorry or dumper lorry. However, such examples are used for explaining the one or more aspects for the purpose of understanding the present disclosure and not for purposes of limitation. A person skilled in the art will understand that the aspects described may be well suited for any other type of vehicles where it is required to maintain the temperature under extreme weather conditions. Therefore, the examples mentioned throughout the specification shall not be taken in a sense to limit the scope of the present disclosure.

[0036] Referring now to FIG. 1, an exemplary representation of an environment 100 depicting, monitoring and maintaining temperature of a surface of a vehicle (not shown) is illustrated in accordance with an aspect of the present disclosure is illustrated. The environment 100 may comprise a battery/power source 102, a power regulator 104, a controller 106, heating elements 108, temperature sensors 110, vibration modules 112, and a display 114 coupled to each other. The battery/power source 102 may be configured to power the heating elements 108, the temperature sensors 110, and the vibration modules 112 through the power regulator

104, which provides necessary supply voltage for operating the heating elements 108, the temperature sensors 110, and the vibration modules 112. In one non-limiting aspect, the controller 106 may also be powered through the battery/power source 102.

[0037] In an aspect of the present disclosure, each heating element 108 may be coupled to a respective temperature sensor 110. The heating elements 108, the temperature sensors 110, and the vibration modules 112 may be arranged or mounted on a surface of container of a vehicle in a predetermined pattern such that they occupy the entire surface of container of the vehicle. In one non-limiting aspect, the surface may be an inner surface of the vehicle that is used for carrying the material. The temperature sensor 110 may be configured to measure the temperature of the corresponding heating element 108 in real-time and transmit the real-time temperature of corresponding heating element 108 to controller 106. The controller 106 may be configured to monitor temperature of each heating element 108 and may maintain the temperature of each heating element 108 by turning ON and OFF the respective heating element 108. The heating element 108 may be turned off by cutting off the power supply from the battery/power source 102.

[0038] In one exemplary aspect of the present disclosure, the display 114 may be configured to display/indicate the temperature of the heating elements mounted on the surface of the vehicle. In one aspect, the display 114 may only indicate the temperature of the heating element whose temperature is below a predefined threshold value. However, the display of the temperature of the heating elements is completely optional and is only displayed to system administrator for testing and verification purpose.

[0039] In an aspect of the present disclosure, the controller 106 may be configured to generate vibrations through a vibration module of the plurality of vibration modules 112 for unsettling/destabilizing the material present on the surface of the container of the vehicle. Further, such arrangement is not limited to vehicles and may be installed on any other container for maintaining a temperature of a surface and for preventing solidification/settling of material on the surface of the container.

[0040] **FIG. 2a** illustrates an exemplary implementation 200a of a system to prevent the solidification/settling of material on a surface of the vehicle, in accordance with some aspects of the present disclosure.

[0041] In aspect of the present disclosure, a dump bed/box/container 202 may be mounted on a frame of a dump truck for carrying the material. The dump bed 202 may be tiltable for

ejection/discharge of the material from the dump truck. A plurality of heating elements 204 and a plurality of vibration modules 206 may be installed in a predefined pattern on the inner surface of the dump bed 202. The predefined pattern is not limited to the pattern as shown in fig. 2 and any other pattern used for uniformly heating the surface is well within the scope of present disclosure.

[0042] The plurality of heating elements 204 may have respective thermocouple/temperature sensor mounted along with corresponding heating element, which is used for monitoring temperature of the corresponding heating element 204. Also, the one or more vibration modules of the plurality of vibration modules 206 may be mapped with a heating element of the plurality of heating elements 204. However, the above arrangement is not limited to dump bed/box/container 202 of dump trucks and may be installed on any other container for maintaining a temperature of a surface of the container and for separating materials from the surface of the container to prevent solidification/settling of material on the surface of the container.

[0043] **FIG. 2b** illustrates an exemplary implementation of vehicle 210 comprising a system for preventing the solidification/settling of material, in accordance with some aspects of the present disclosure. The vehicle 210 may be dump truck, mining truck, or like. The vehicle 210 may comprise a dump bed/box/container 202 that is mounted on a frame of a dump truck for carrying the material. The dump bed 202 may be tiltable for ejection/discharge of the material from the vehicle 210. A plurality of heating elements 204 and a plurality of vibration modules 206 may be installed in a predefined pattern on the surface of the dump bed 202 as discussed in above aspects.

[0044] **FIG. 2c** illustrates a heating element 204 and a thermocouple 205, in accordance with some aspects of the present disclosure. The thermocouple 205 may be coupled to the heating element 204 for monitoring the temperature of the heating element 204.

[0045] **FIG. 2d** illustrates a vibration module 206, in accordance with some aspects of the present disclosure. In one non-limiting aspect of the present disclosure, the vibration module 206 may be of rotating type, oscillating type, or like to destabilize the material present on the surface. However, the type of vibration module 206 is not limited to above example and any other type of vibration module known to a person skilled in the art is well within the scope of present disclosure.

[0046] **FIG. 3** shows a block diagram of a system 300 for separating materials from a surface of a vehicle, in accordance with some aspects of the present disclosure.

[0047] In an aspect of the present disclosure, the system 300 may comprise a plurality of heating elements 302, a plurality of thermocouples 304, a plurality of vibration modules 306, at least one controller 308, a memory 310, a power source 312, and one or more image sensor 314. In another non-limiting aspect of the present disclosure, the one or more image sensor 314 may be optional.

[0048] In one non-limiting aspect of the present disclosure, the power source 312 used for powering the components of the system may comprise batteries such as lead-acid, NiMH, & Li-ion. However, the power source 312 is not limited to above example and any other type of power source 312 capable of powering the above mentioned components of the system 300 is well within the scope of the present disclosure.

[0049] Each heating element of the plurality of heating elements 302 is connected to one thermocouple of the plurality of thermocouples 304 such that each thermocouple is configured to monitor temperature of the respective heating element to which it is mapped to. In an exemplary aspect of the present disclosure, the heating elements 302 may be IR Diodes /pad/ plate/ rod/ coil and like, which will be powered from the batteries. The plurality of heating elements 302 along with plurality of thermocouples 304 may be mounted on an inner surface of a vehicle as shown in **FIG. 2**. Hence, each thermocouple may be configured to measure a temperature of a predefined portion of the surface of the vehicle and covers a predefined region within its vicinity. In one non-limiting aspect, each thermocouple may be integrated onto the surface of the corresponding heating element for measuring the temperature of the corresponding heating element.

[0050] Further, each heating element of the plurality of heating elements 302 may be configured to heat at least a predefined portion of the surface on which it is mounted. Thus, the heating element may be configured to heat the material present on the surface of the container or dump box of the vehicle.

[0051] In an aspect of the present disclosure, the plurality of vibration modules 306 may work in conjunction with the plurality of heating elements 302 and the plurality of vibration modules 306 may be configured to vibrate at a predefined frequency for a predetermined time period to destabilize the material present on the surface of the container of the vehicle. Each heating

element of the plurality of heating elements 302 may be mapped to one or more vibration module that vibrate once the respective heating element is activated.

[0052] In an aspect of the present disclosure, the at least one controller 308 may be configured to monitor a temperature of the surface of the container by monitoring the temperature of the plurality of heating elements 302 through the plurality of thermocouples 304 in real-time. The monitoring temperature of the plurality of heating elements 302 comprises receiving temperature of the plurality of heating elements 302 from their respective thermocouple. The at least one controller 308 may be configured to compare the monitored temperature of all the heating elements with a first predetermined temperature threshold to determine whether the monitored temperature falls below the first predetermined threshold. The first predetermined threshold may be the minimum temperature to be maintained at a heating element and below which the heating element is required to be activated.

[0053] If the temperature of at least one heating element of the plurality of heating elements 302 falls below the first predetermined temperature threshold, the at least one controller 308 may be configured to activate at least one corresponding heating element till a second predetermined temperature threshold is reached to increase the temperature of the corresponding region/portion of the surface it covers, thereby heating the material placed on the surface of the vehicle. The second threshold is the maximum temperature till which the heating element is heated to ensure that sufficient temperature for maintaining the material in its normal destabilized state. The first and second threshold is the maintenance temperature range for the material to avoid solidification and may vary based on the type of material present on the surface of the vehicle.

[0054] In an exemplary aspect of the present disclosure, solidification of material may start from a boundary of the surface of the container of the vehicle. The at least one heating element present at the boundary may detect the fall in temperature below the first predetermined temperature threshold through their respective thermocouples and the at least one controller 308 may be configured to activate the at least one heating element to provide heating at the boundary region where the solidification of material may have started. Thus, only the heating elements present at the boundary where the solidification of material started is activated instead of activating all the heating elements, thereby facilitating power saving.

[0055] The at least one controller 308 may be then configured to deactivate the at least one heating element if the corresponding at least one thermocouple of the at least one heating

element indicates that the monitored temperature is above the second predetermined temperature threshold.

[0056] In one exemplary aspect of the present disclosure, the system 300 may also comprise a display unit in communication with the at least one controller 308, which may be configured to display/indicate the temperature of the heating elements mounted on the surface of the vehicle. In one aspect, the display may only indicate the temperature of the heating element whose temperature is below the first predetermined temperature threshold value. However, the display of the temperature of the heating elements is completely optional and is only displayed to system administrator for testing and verification purpose.

[0057] In an exemplary aspect of the present disclosure, the material present on the dump body or container of the vehicle is oil sand which requires temperature of 32 °C – 35 °C to be maintained. In such a case, the at least one controller 308 may be required to maintain a temperature of 40 °C - 43 °C of each heating element to overcome/reduce the adhesive force of the oil sand.

[0058] In an aspect of the present disclosure, the at least one controller 308 may be configured to activate/trigger one or more vibration modules of the plurality vibration modules 306 to vibrate at a predefined frequency. The one or more vibration modules may be mapped to the respective heating element whose temperature has dropped below the first predetermined temperature threshold. The frequency of vibrations generated by the one or more vibration modules may be modulated based on the requirement. Further, the frequency of vibrations may be modulated based on the type of material present on the surface of the vehicle. The vibrations generated by the one or more vibration modules may be used to destabilize the material present over it, thereby preventing solidification and settling of the material being present on the surface of the vehicle.

[0059] In an exemplary aspect of the present disclosure, the one or more vibration modules may be activated by the at least one controller 308, after the at least one heating element mapped to the one or more vibration modules is activated. In one non-limiting aspect, the at least one controller 308 may be configured to activate the one or more vibration modules mapped to the at least one heating element if the temperature of the at least one heating element reaches a third temperature predetermined threshold. The third predetermined temperature threshold may be a value between the first predetermined temperature threshold and the second predetermined temperature threshold.

[0060] The activation of the one or more vibration modules after the temperature of the at least one heating element reaches the third temperature predetermined threshold may increase the effectiveness of the one or more vibration modules, thereby reducing the overall power consumption of the one or more vibration modules. In one non-limiting aspect, the one or more vibration modules may be triggered for a predetermined time period. In another non-limiting aspect, the one or more vibration modules may be turned off in response determining that the monitored temperature is above the second predetermined threshold.

[0061] In another exemplary aspect, the system 300 may comprise one or more sensor such as image sensor for capturing one or more images of the material being place on the surface of the vehicle. The at least one controller 308 may be configured to apply an image processing technique to identify solidification or settling of material in at least a portion of the vehicle. The at least one controller 308 may activate the one or more heating elements corresponding to the identified portion to increase the temperature of the identified portion, thereby reducing the solidification or settling of material in at least a portion of the vehicle. In one non-limiting aspect, the at least one controller 308 may also trigger one or more vibration module for quickly destabilizing the identified material. The at least one controller 308 may be configured to apply any image processing technique known to a person skilled in the art for identifying the solidification or settling of material in at least a portion of the vehicle.

[0062] In another exemplary aspect, the system 300 may comprise one or more sensor such as thermal scanners installed on the vehicle for determining temperature of the material being placed on the surface of the vehicle. Each thermal scanner may be mapped to the respective heating element that is placed in the portion covered by the thermal scanner. The at least one controller 308 may be configured to implement thermal scanning through the thermal scanners to identify solidification or settling of material in at least a portion of the vehicle. The at least one controller 308 may activate the one or more heating elements corresponding to the identified portion to increase the temperature of the identified portion, thereby reducing the solidification or settling of material in at least a portion of the vehicle. In one non-limiting aspect, the at least one controller 308 may also trigger one or more vibration module for quickly destabilizing the identified settled material.

[0063] Thus, the system 300 reduces material carry back and prevents the solidification/settling of materials being transported by the vehicle in extreme weather conditions.

[0064] In some examples, the at least one controller 308 may be an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A controller can be a microprocessor, but in the alternative, it can be a microcontroller, or the like. Although the embodiments described herein are primarily with respect to the controller 106 may also include primarily analog components. For example, any of the signal processing techniques described herein may be implemented in analog circuitry. The at least one controller 308 in communication with the at least one controller 308 may include capabilities to monitor the temperature of the surface and to control different essential components such as the heating elements 108 and vibration modules 112, to maintain temperature of the surface. In one non-limiting aspect of the present disclosure, the vibration modules 112 may be of rotating type, oscillating type, or like to destabilize the material present on the surface. However, the type of vibration modules 112 is not limited to above example and any other type of vibration module known to a person skilled in the art is well within the scope of present disclosure. In one non-limiting aspect, the at least one controller 308 may be electronic control unit (ECU) of the vehicle that may perform all the functionalities of the at least one controller 308 to maintain temperature of the surface and avoid solidification/settling of the material on the surface of the vehicle.

[0065] In one non-limiting example, the system may comprise a memory 310 coupled to the at least one controller 308. In some examples, the memory may represent any type of non-transitory computer readable medium such as random-access memory (RAM), read only memory (ROM), magnetic disk or tape, optical disk, flash memory, or holographic memory. In one aspect, the memory may comprise a combination of random-access memory and read only memory and may include data/instructions related to processing of one or more components of the system. In some aspects, the at least one controller 308 and memory may be combined in a single chip.

[0066] **FIG. 4** shows a flowchart illustrating a method of heating a surface of a vehicle, in accordance with some aspects of the present disclosure. The order in which the method 400 is described is not intended to be construed as a limitation, and any number of the described method blocks can be combined in any order to implement the method 400 or alternate methods. Additionally, individual blocks may be deleted from the method 400 without departing from the spirit and scope of the subject matter described herein. Furthermore, the

method can be implemented in any suitable hardware, software, firmware, or combination thereof. However, for ease of explanation, in the aspects described below, the method 300 may be considered to be implemented by the at least one controller 308 and/or one more component described with reference to FIG. 3.

[0067] At step 402, the method 400 may include monitoring, in real-time, temperature of at least one heating element detected by at least one thermocouple coupled with the at least one heating element. Each heating element is connected to a thermocouple such that each thermocouple is configured to monitor temperature of the respective heating element it is mapped to. In one non-limiting aspect, each thermocouple may be integrated onto the surface of the corresponding heating element for measuring the temperature of the corresponding heating element.

[0068] At step 404, the method 400 may include comparing the monitored temperature with a first predetermined temperature threshold to determine whether the monitored temperature is below the first predetermined temperature threshold. The first predetermined threshold may be the minimum temperature to be maintained at a heating element and below which the heating element is required to be activated.

[0069] At step 406, the method 400 may include activating the at least one heating element corresponding to the at least one thermocouple to heat the surface of the vehicle, in response to determining that the monitored temperature is below the first predetermined temperature threshold to increase the temperature of the corresponding region/portion of the surface it covers, thereby heating the material placed on the surface of the vehicle.

[0070] Further, the method 400 comprises comparing the monitored temperature with a second predetermined temperature threshold to determine whether the monitored temperature is above the second predetermined temperature threshold and deactivating the at least one heating element if the corresponding at least one thermocouple of the at least one heating element indicates that the monitored temperature is above the second predetermined temperature threshold. The method 400 may further comprise turning off the one or more vibration modules, in response determining that the monitored temperature is above the second predetermined threshold.

[0071] The second threshold is the maximum temperature till which the heating element is heated to ensure that sufficient temperature for maintaining the material in its normal destabilized state. The first and second threshold is the maintenance temperature range for the

material to avoid solidification and may vary based on the type of material present on the surface of the vehicle.

[0072] In an exemplary aspect of the present disclosure, the material present on the dump body or container of the vehicle is oil sand which requires temperature of 32 °C – 35 °C to be maintained. In such a case, the at least one controller 308 may be required to maintain a temperature of 40 °C - 43 °C of each heating element to overcome/reduce the adhesive force of the oil sand.

[0073] At step 408, the method 400 may include trigger one or more vibration modules mapped to the at least one activated heating element, for a predetermined time duration, after the activation of the at least one heating element to unsettle the material present on the surface of the container of the vehicle. Each heating element may be mapped to one or more vibration modules that vibrate once the respective heating element is activated. The one or more vibration modules may be mapped to the respective heating element whose temperature has dropped below the first predetermined temperature threshold. The frequency of vibrations generated by the one or more vibration modules may be modulated based on the requirement. The frequency of vibrations may be modulated based on the type of material present on the surface of the vehicle. The vibrations generated by the one or more vibration modules may be used to unsettle the material present over it, thereby preventing solidification and settling of the material being present on the inner surface of the vehicle.

[0074] In an exemplary aspect of the present disclosure, the one or more vibration modules may be activated, after the at least one heating element mapped to the one or more vibration modules is activated. In one non-limiting aspect, the vibration module mapped to the at least one heating element is activated if the temperature of the at least one heating element reaches a third temperature predetermined threshold. The third predetermined temperature threshold may be a value between the first predetermined temperature threshold and the second predetermined temperature threshold. The activation of the one or more vibration modules after the temperature of the at least one heating element reaches the third temperature predetermined threshold may increase the effectiveness of the one or more vibration modules, thereby reducing the overall power consumption of the one or more vibration modules. In one non-limiting aspect, the one or more vibration modules may be triggered for a predetermined time period. In another non-limiting aspect, the one or more vibration modules may be turned off in

response determining that the monitored temperature is above the second predetermined threshold.

[0075] Thus, the method 400 reduces material carry back and prevents the solidification/settling of materials being transported by the vehicle in extreme weather conditions.

[0076] The illustrated steps are set out to explain the exemplary aspects shown, and it should be anticipated that ongoing technological development will change the manner in which particular functions are performed. These examples are presented herein for purposes of illustration, and not limitation. Further, the boundaries of the functional building blocks have been arbitrarily defined herein for the convenience of the description. Alternative boundaries can be defined so long as the specified functions and relationships thereof are appropriately performed.

[0077] The foregoing method descriptions and the process flow diagrams are provided merely as illustrative examples and are not intended to require or imply that the steps of the various aspects must be performed in the order presented. As will be appreciated by one of skill in the art the order of steps in the foregoing aspects may be performed in any order. Words such as "thereafter," "then," "next," etc. are not intended to limit the order of the steps; these words are simply used to guide the reader through the description of the methods. Further, any reference to claim elements in the singular, for example, using the articles "a," "an" or "the" is not to be construed as limiting the element to the singular.

[0078] In some example aspects, certain ones of the operations herein may be modified or further amplified as described below. Moreover, in some aspects additional optional operations may also be included. It should be appreciated that each of the modifications, optional additions or amplifications described herein may be included with the operations herein either alone or in combination with any others among the features described herein.

[0079] The hardware used to implement the various illustrative logics, logical blocks, modules, and circuits described in connection with the aspects disclosed herein may include a general purpose processor, a digital signal processor (DSP), a special-purpose processor such as an application specific integrated circuit (ASIC) or a field programmable gate array (FPGA), a programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor may be a microprocessor, but, in the alternative, the processor may be any

conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration. Alternatively or additionally, some steps or methods may be performed by circuitry that is specific to a given function.

[0080] In one or more example aspects, the functions described herein may be implemented by special-purpose hardware or a combination of hardware programmed by firmware or other software. In implementations relying on firmware or other software, the functions may be performed as a result of execution of one or more instructions stored on one or more non-transitory computer-readable media and/or one or more non-transitory processor-readable media. These instructions may be embodied by one or more processor-executable software modules that reside on the one or more non-transitory computer-readable or processor-readable storage media. Non-transitory computer-readable or processor-readable storage media may in this regard comprise any storage media that may be accessed by a computer or a processor. By way of example but not limitation, such non-transitory computer-readable or processor-readable media may include random access memory (RAM), read-only memory (ROM), electrically erasable programmable read-only memory (EEPROM), FLASH memory, disk storage, magnetic storage devices, or the like. Disk storage, as used herein, includes compact disc (CD), laser disc, optical disc, digital versatile disc (DVD), floppy disk, and Blu-ray disc™, or other storage devices that store data magnetically or optically with lasers. Combinations of the above types of media are also included within the scope of the terms non-transitory computer-readable and processor-readable media. Additionally, any combination of instructions stored on the one or more non-transitory processor-readable or computer-readable media may be referred to herein as a computer program product.

[0081] Many modifications and other aspects of the inventions set forth herein will come to mind to one skilled in the art to which these inventions pertain having the benefit of teachings presented in the foregoing descriptions and the associated drawings. Although the figures only show certain components of the apparatus and systems described herein, it is understood that various other components may be used in conjunction with the supply management system. Therefore, it is to be understood that the inventions are not to be limited to the specific aspects disclosed and that modifications and other aspects are intended to be included within the scope of the appended claims. Moreover, the steps in the method described above may not necessarily occur in the order depicted in the accompanying diagrams, and in some cases one or more of

the steps depicted may occur substantially simultaneously, or additional steps may be involved. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

[0082] The various illustrative logical blocks, modules, circuits, and algorithm steps described in connection with the aspects disclosed herein may be implemented as electronic hardware, computer software, or combinations of both. To clearly illustrate this interchangeability of hardware and software, various illustrative components, blocks, modules, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the present invention.

WE CLAIM:

1. A system for separating materials from a surface of a vehicle, the system comprising:

a plurality of heating elements;

a plurality of thermocouples placed in close proximity to the plurality of heating elements, wherein each thermocouple is coupled to a respective heating element;

a plurality of vibration modules; and

at least one controller operatively coupled to the plurality of thermocouples and the plurality of vibration modules, wherein the at least one controller is configured to:

monitor, in real-time, temperature of at least one heating element detected by the at least one thermocouple coupled with the at least one heating element;

compare the monitored temperature with a first predetermined temperature threshold to determine whether the monitored temperature is below the first predetermined threshold;

activate the at least one heating element corresponding to the at least one thermocouple to heat the surface of the vehicle, in response to determination that the monitored temperature is below the first predetermined threshold; and

trigger one or more vibration modules for a predetermined time duration, after the activation of the at least one heating element.

2. The system as claimed in claim 1, wherein the plurality of heating elements are mounted uniformly on a surface of the vehicle in a predefined pattern.

3. The system as claimed in claim 1, wherein the at least one controller is further configured to:

compare the monitored temperature with a second predetermined temperature threshold to determine whether the monitored temperature is above the second predetermined threshold;

deactivate the at least one heating element corresponding to the at least one thermocouple, in response determining that the monitored temperature is above the second predetermined threshold; and

turn off the one or more vibration modules, in response determining that the monitored temperature is above the second predetermined threshold.

4. The system as claimed in claim 1, wherein the at least one controller is configured to:

trigger the one or more vibration modules for the predetermined time duration, when the monitored temperature is greater than a third predetermined threshold, and wherein the third predetermined threshold is between the first predetermined threshold and the second predetermined threshold.

5. The system as claimed in claim 1, wherein the at least one controller is configured to vibrate, the one or more vibration modules, at a predefined frequency to destabilize a material placed on the surface of the vehicle.

6. A method of separating materials from a surface of a vehicle, the method comprising:

monitoring, in real-time, temperature of at least one heating element detected by at least one thermocouple coupled with the at least one heating element;

comparing the monitored temperature with a first predetermined temperature threshold to determine whether the monitored temperature is below the first predetermined threshold;

activating the at least one heating element corresponding to the at least one thermocouple to heat the surface of the vehicle, in response to determining that the monitored temperature is below the first predetermined threshold; and

triggering one or more vibration modules for a predetermined time duration, after the activation of the at least one heating element.

7. The method as claimed in claim 6, further comprising:

comparing the monitored temperature with a second predetermined temperature threshold to determine whether the monitored temperature is above the second predetermined threshold;

deactivating the at least one heating element corresponding to the at least one thermocouple, in response determining that the monitored temperature is above the second predetermined threshold; and

turning off the one or more vibration modules, in response determining that the monitored temperature is above the second predetermined threshold.

8. The method as claimed in claim 6, wherein triggering the one or more vibration modules comprises:

triggering the one or more vibration modules for the predetermined time duration, when the monitored temperature is greater than a third predetermined threshold, and wherein the third predetermined threshold is between the first predetermined threshold and the second predetermined threshold.

9. The method as claimed in claim 6, further comprising:

heating, by the at least one heating element, at least a portion of the surface of the vehicle.

10. The method as claimed in claim 6, further comprising:

vibrating the one or more vibration modules at a predefined frequency to destabilize a material placed on the surface of the vehicle.

Dated this 12th day of June 2023

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ABSTRACT

“METHOD AND SYSTEM FOR SEPARATING MATERIALS FROM A SURFACE OF A VEHICLE”

Disclosed herein is a system and method for separating materials from a surface of a vehicle. The method comprises monitoring, in real-time, temperature of at least one heating element detected by at least one thermocouple coupled with the at least one heating element, comparing the monitored temperature with a first predetermined temperature threshold to determine whether the monitored temperature is below the first predetermined threshold, activating the at least one heating element corresponding to the at least one thermocouple to heat the surface of the vehicle, in response to determining that the monitored temperature is below the first predetermined threshold, and triggering one or more vibration modules for a predetermined time duration, after the activation of the at least one heating element.

[Fig. 1]

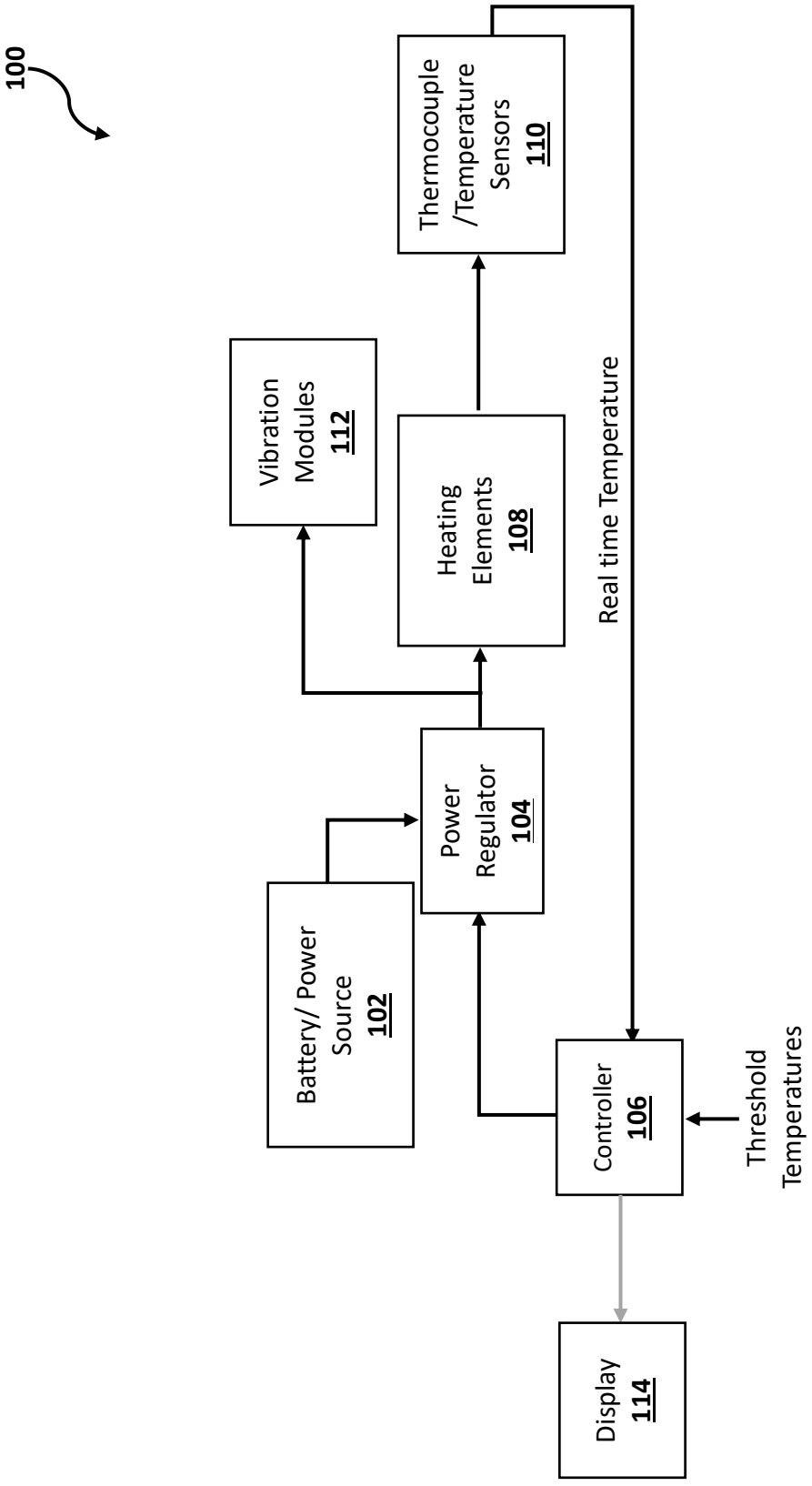

FIG. 1

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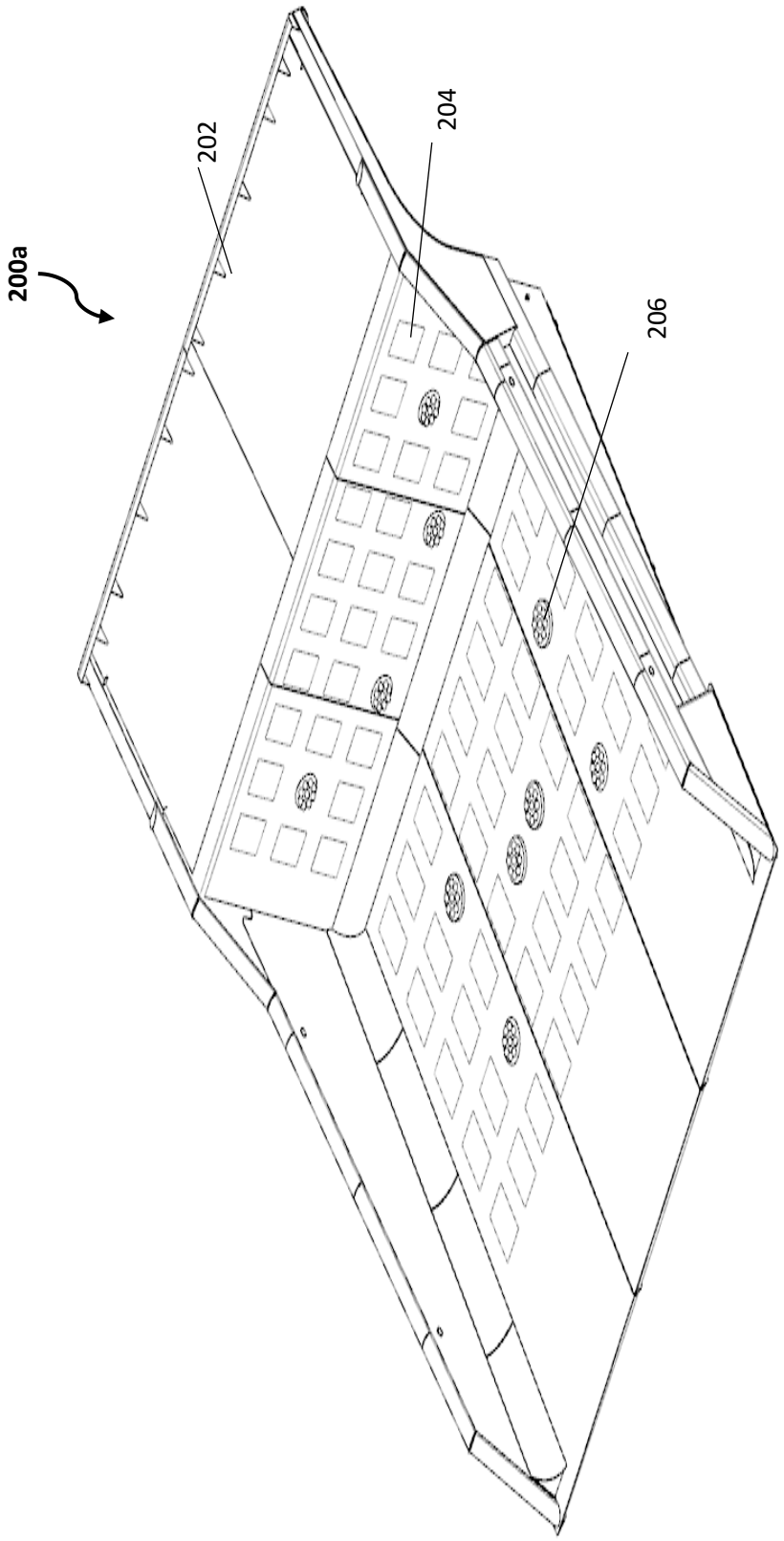

FIG. 2(a)

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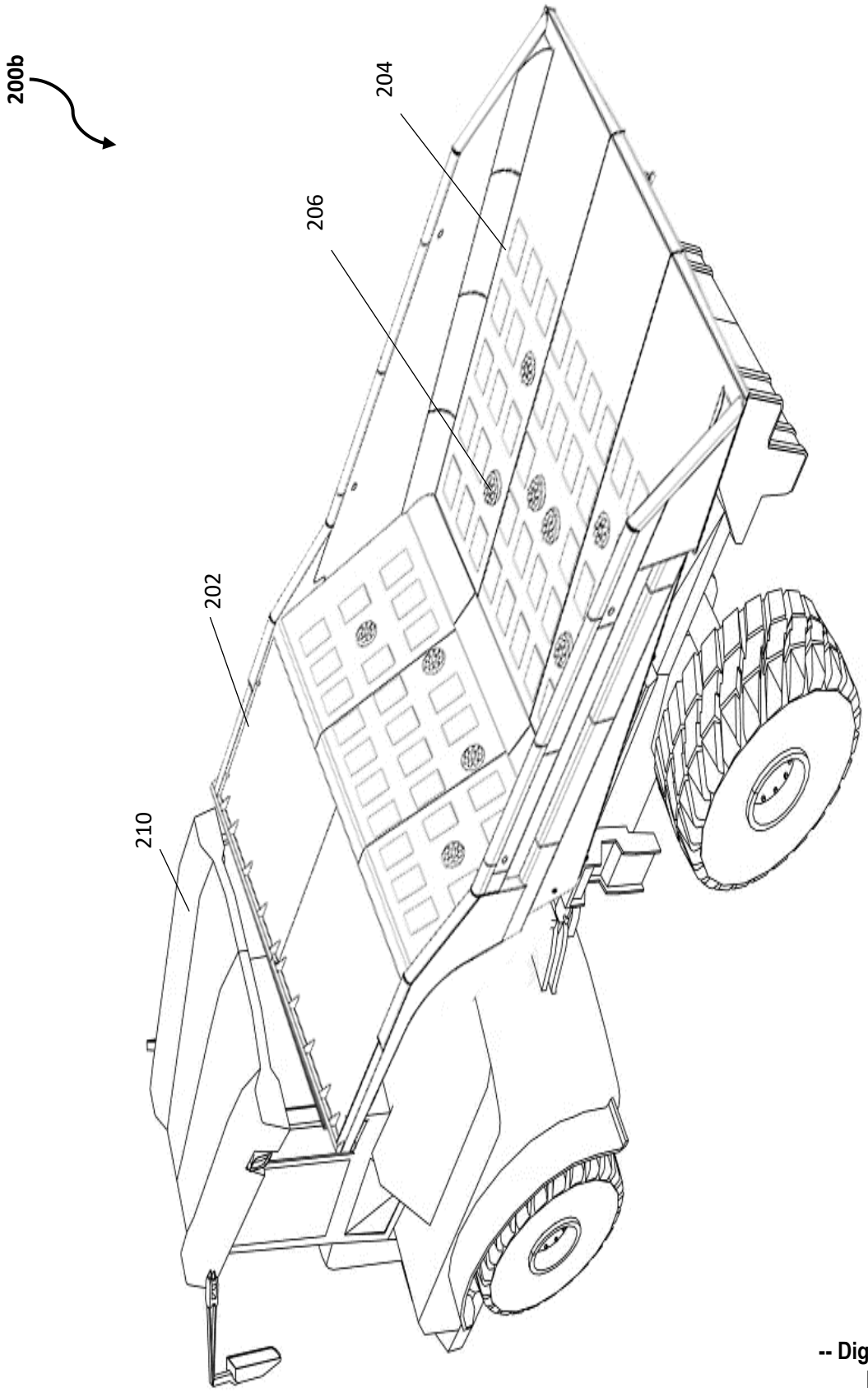

FIG. 2(b)

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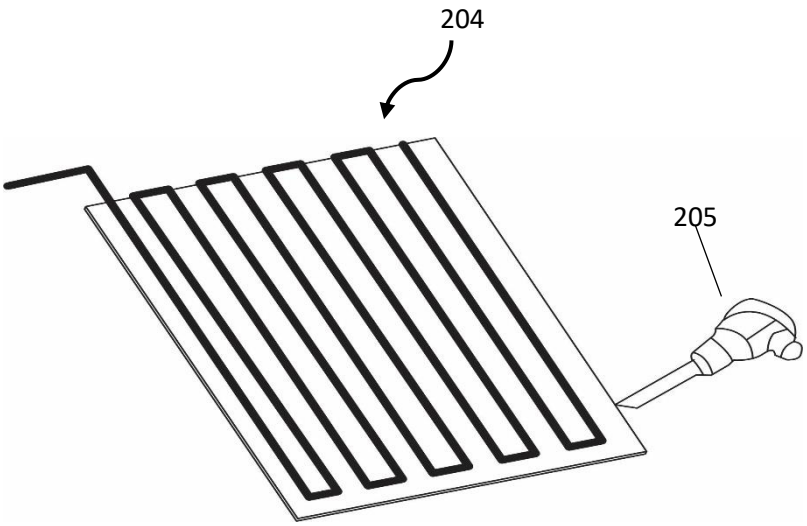

FIG. 2(c)

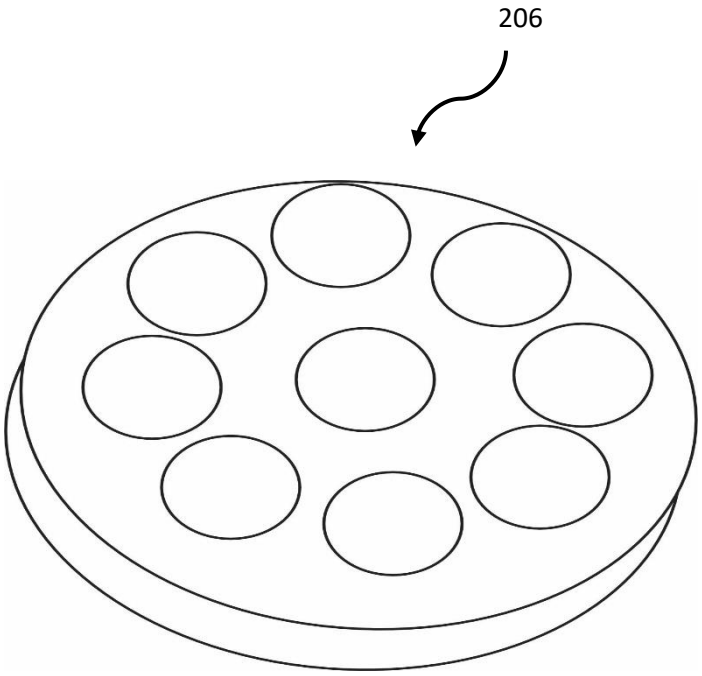

FIG. 2(d)

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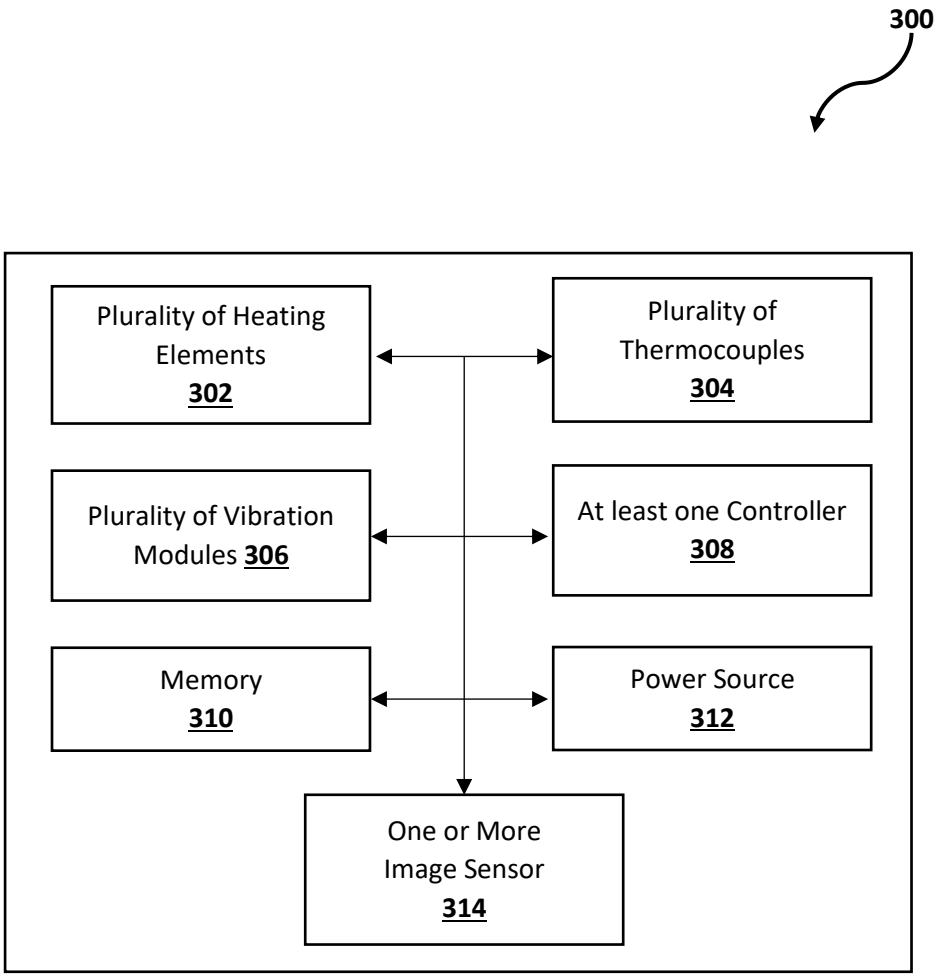

FIG. 3

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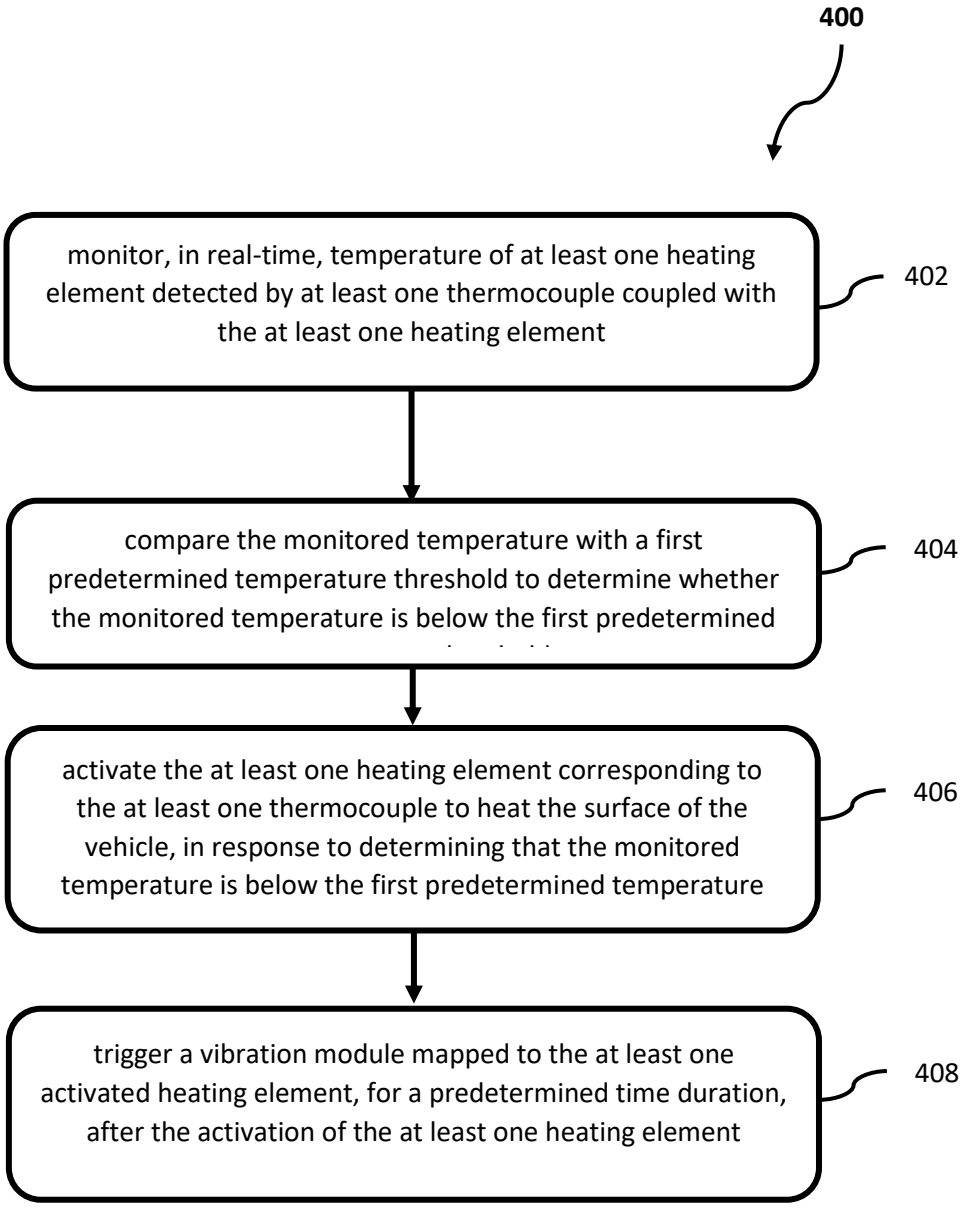

FIG. 4

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