



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
22.11.2017 Bulletin 2017/47

(51) Int Cl.:
B61L 25/04 ^(2006.01)

(21) Application number: **16737159.0**

(86) International application number:
PCT/IB2016/051433

(22) Date of filing: **14.03.2016**

(87) International publication number:
WO 2016/113724 (21.07.2016 Gazette 2016/29)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

• **WATANABE, Takao**
Tokyo 100-8280 (JP)
• **IWASAKI, Katsuyuki**
Tokyo 100-8280 (JP)

(74) Representative: **Gill, Stephen Charles et al**
Mewburn Ellis LLP
City Tower
40 Basinghall Street
London EC2V 5DE (GB)

(30) Priority: **15.01.2015 JP 2015005482**

(71) Applicant: **Hitachi, Ltd.**
Tokyo 100-8280 (JP)

(72) Inventors:
• **FURUTANI, Ryo**
Tokyo 100-8280 (JP)

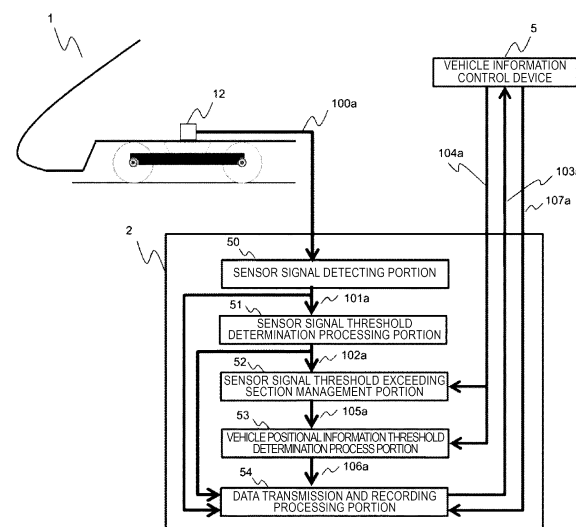
Remarks:

The filing date of the international application is within two months from the date of expiration of the priority period (R. 26bis.3 PCT).

(54) **STATE MONITORING DEVICE, STATE MONITORING SYSTEM, AND TRAIN**

(57) In the related art, a system is not disclosed in which a predetermined location or position is automatically recorded regardless of any sensor information for preventive maintenance from characteristic sensor information that is generated at the predetermined location or section. There is provided a state-monitoring device that performs state monitoring of a vehicle based on a sensor signal and positional information of the vehicle, the state-monitoring device is configured to have a sensor signal detecting portion, a sensor signal threshold determination processing portion, a sensor signal threshold exceeding section management portion that inputs positional information of the vehicle and a determination result by the sensor signal threshold determination processing portion and measures the number of times that the threshold is exceeded within a predetermined section, and an automatic recording section management portion that determines whether or not the number of times that the threshold is exceeded within the predetermined section exceeds the predetermined number of times and sets the predetermined section as an automatic recording section in a case where the number of times that the threshold is exceeded exceeds the predetermined number of times.

[Fig. 3]



Description

Technical Field

[0001] The present invention relates to a state-monitoring device, a state-monitoring system, and an organization train.

Background Art

[0002] JP-A-2013-164869 (PTL 1) is an example of the background art of the present technical field. The public information discloses a problem of "providing a drive recorder that is able to detect an accident with good precision without determination mistakes due to noise and disturbance and able to make a determination appropriate to specifications of the vehicle, running habits, road conditions, and road surface conditions" (refer to PTL 1 (paragraph [0007])), as means for solving the problem, "the drive recorder is provided with a camera installed in a vehicle, an acceleration sensor that is able to detect acceleration of at least two axes of the front/rear and left/right of the vehicle, and storage means for storing an image captured by the camera and acceleration that is detected by the acceleration sensor, in which a condition is set in which the acceleration that is detected by the acceleration sensor exceeds a predetermined threshold in a fixed time, when the condition is fulfilled, an image is captured in a predetermined time, a file that includes the time at which the condition is fulfilled and image information which is captured within the predetermined time is generated and stored in the storage means, and the fixed time is modifiable by a user designating a number of times the acceleration that is detected by a predetermined sampling cycle continuously exceeds the threshold" (refer to PTL 1 (paragraph [0008])), and the like.

Citation List

Patent Literature

[0003] PTL 1: JP-A-2013-164869

Summary of Invention

Technical Problem

[0004] However, a technique in which a predetermined location or position is automatically recorded regardless of any sensor signal for preventive maintenance based on the characteristic sensor signal that is generated at the predetermined location or section is not disclosed in PTL 1, and there is room for improvement of efficiency of work such as an operation or maintenance.

Solution to Problem

[0005] In order to solve the problem described above, according to an aspect of the present invention, there is provided a state-monitoring device that performs state monitoring of a vehicle based on, for example, a sensor signal acquired from a sensor that is mounted in the vehicle and positional information of the vehicle that is acquired from a vehicle information control device, the state-monitoring device is configured to have a sensor signal detecting portion that detects the sensor signal, a sensor signal threshold determination processing portion that determines whether or not the sensor signal exceeds a predetermined threshold, a sensor signal threshold exceeding section management portion that inputs positional information of the vehicle and a determination result by the sensor signal threshold determination processing portion and measures the number of times that the threshold is exceeded within a predetermined section, and an automatic recording section management portion that determines whether or not the number of times that the threshold is exceeded within the predetermined section exceeds the predetermined number of times and sets the predetermined section as an automatic recording section in which data recording is automatically performed in a case where the number of times that the threshold is exceeded exceeds the predetermined number of times.

Advantageous Effects of Invention

[0006] According to the present invention, it is possible to provide a state-monitoring system that is able to make work such as an operation or maintenance efficient.

Brief Description of Drawings

[0007]

[Fig. 1] Fig. 1 is a configuration example of the entirety of a state-monitoring system of a railway vehicle of Embodiment 1.

[Fig. 2] Fig. 2 is a configuration example of a hardware system of a state-monitoring device illustrated in Fig. 1.

[Fig. 3] Fig. 3 is an example of a system configuration that detects the sensor signal in a predetermined section in the entirety of the configuration diagram illustrated in Fig. 1.

[Fig. 4] Fig. 4 is an example of the flow of the state-monitoring system illustrated in Fig. 1.

[Fig. 5] Fig. 5 is an example of a sensor signal threshold determination process illustrated in Fig. 3.

[Fig. 6] Fig. 6 is an example of a process of a sensor signal threshold exceeding section management portion and a vehicle positional information threshold determination process portion illustrated in Fig. 3.

[Fig. 7] Fig. 7 is an example of a state display result

of the state-monitoring system illustrated in Fig. 1.
 [Fig. 8] Fig. 8 is an example of a trend display result of the state display result illustrated in Fig. 7.
 [Fig. 9] Fig. 9 is a configuration example of the entirety of a state-monitoring system of the railway vehicle of Embodiment 2.
 [Fig. 10] Fig. 10 is a configuration diagram of a system that detects the sensor signal in a predetermined section in the entirety of the configuration diagram illustrated in Fig. 9.
 [Fig. 11] Fig. 11 is a configuration example of the entirety of a state-monitoring system of the railway vehicle of Embodiment 3.

Description of Embodiments

[0008] In a mobile system (elevator, motor vehicle, and the like) including a railway vehicle or a plant system (wind power generation, nuclear power generation, and the like) including a thermal power plant, there is demand to promote improvement of work and increasing efficiency of work such as an operation or maintenance in each system by communicating, accumulating, and analyzing a large amount of data from various sensor signals and the like that are equipped in each system.

[0009] In the present embodiment, it is possible to provide a state-monitoring system of a railway vehicle that it is possible to construct using a simple system configuration, and it is possible to provide a system in which a predetermined location or position is automatically recorded regardless of any sensor signal for preventive maintenance based on the characteristic sensor signal that is generated at the predetermined location or section.

[0010] An embodiment is described below with reference to the drawings. Note that, in each diagram, the same numbers are given to constituent elements that have common functions, and overlapping explanation is omitted.

Embodiment 1

[0011] First, the configuration of the entirety of the system in the present embodiment is described using Fig. 1. In Fig. 1, information transmitted to a vehicle information control device 5 from various devices (door 3, underfloor device 4, and the like) including a state-monitoring device 2 that is attached to a railway vehicle 1 is accumulated in a database 8 of a ground-side monitoring system 6 via the railway vehicle 1 and a wireless transmission device 7 that is installed at the ground side. The ground-side monitoring system 6 is constituted by a personal computer 9, an analysis device 10, and the database 8 via a network 11. In addition, the ground-side monitoring system 6 acquires information from a plurality of vehicles.

[0012] An example in which the personal computer 9, the analysis device 10, and the database 8 are separate

bodies is indicated, but the entirety or a part may be constituted by one device. For example, the function that is realized by the personal computer 9 and the analysis device 10 may be realized by one device.

[0013] The state-monitoring device 2 is able to input various sensor signals with respect to state-monitoring items that are required by the respective railway vehicles 1, in Fig. 1, a vibration acceleration sensor 12 that is installed in the floor of a vehicle body 13 for the purpose of ride comfort monitoring of the railway vehicle 1 as a wired connection example, but the vibration acceleration sensor 12 may be installed in a carriage 14 of the railway vehicle 1 for the purpose of monitoring abnormalities of track infrastructure or carriage parts. Furthermore, a microphone for noise measurement may be installed in the vehicle body 13 or the carriage 14 of the railway vehicle 1 for the purpose of monitoring abnormalities of interior and exterior noise of the railway vehicle 1. Furthermore, a strain sensor may be installed in the vehicle body 13 or the carriage 14 of the railway vehicle 1 for the purpose of monitoring deterioration of the railway vehicle 1. In addition, various sensors and the state-monitoring device 2 may use wireless transmission.

[0014] Note that, an example in which information is acquired from the railway vehicle is indicated in Fig. 1, but for example, a mobile system other than the railway vehicle (motor vehicle, elevator, and the like) or a plant system (thermal power generation, wind power generation, nuclear power generation, and the like), may be constituted so as to acquire information from other than the railway vehicle.

[0015] Next, a configuration example of a hardware system of the state-monitoring device 2 of Fig. 1 will be described using Fig. 2.

[0016] The state-monitoring device 2 is constituted by a processor 30, a switch 31, a display portion 32, and a setting portion 40, and the processor 30 is constituted by a central processing unit (CPU) 33, an interface 34, a random access memory (RAM) 35, a read only memory (ROM) 36, and a card connector 37. The CPU 33 of the processor 30 is connected to the interface 34, the RAM 35, the ROM 36, and the card connector 37 via a bus 38, and the card connector 37 is connected to a memory card 39. The interface 34 is connected to the switch 31, the display portion 32, the setting portion 40, various sensors including the vibration acceleration sensor 12, and the vehicle information control device 5. Note that, various sensors including the vibration acceleration sensor 12 may be installed inside the state-monitoring device 2. Furthermore, the state-monitoring device 2 may be configured as a part of the vehicle information control device 5. In addition, the switch 31, the display portion 32, and the setting portion 40 may be installed on the front surface of the state-monitoring device 2. In addition, the memory card 39 that is connected to the card connector 37 may be directly taken out from the front surface of the state-monitoring device 2.

[0017] Next, a configuration diagram of the state-mon-

itoring system of a railway vehicle that is realized by the state-monitoring device of Fig. 2 will be described using Fig. 3. Here, a sensor that is connected to the state-monitoring device 2 is set as the vibration acceleration sensor 12. In Fig. 3, a vibration acceleration sensor signal 100a that is detected by the vibration acceleration sensor 12 is output to a sensor signal detecting portion 50 of the state-monitoring device 2.

[0018] The sensor signal detecting portion 50 converts the vibration acceleration sensor signal 100a to a digital sensor signal 101a and outputs the signal to a sensor signal threshold determination processing portion 51 and a data transmission and recording processing portion 54.

[0019] The sensor signal threshold determination processing portion 51 determines whether or not the sensor signal threshold that is set in advance is exceeded with respect to the digital sensor signal 101a, then a sensor signal threshold determination process result 102a is output to a sensor signal threshold exceeding section management portion 52 and the data transmission and recording processing portion 54.

[0020] The sensor signal threshold exceeding section management portion 52 inputs the sensor signal threshold determination process result 102a and a vehicle positioning signal 104a of the vehicle information control device 5, counts the number of times the sensor signal threshold is exceeded at a predetermined section, location, or position based on the vehicle positioning signal 104a, and outputs a number of times the sensor signal threshold is exceeded 105a to a vehicle positional information threshold determination process portion 53. Note that, preferably the vehicle information control device 5 acquires detection information according to a track circuit or positional information of the vehicle using wireless communication and the like with a ground device.

[0021] The vehicle positional information threshold determination process portion 53 inputs the number of times the sensor signal threshold is exceeded 105a and the vehicle positioning signal 104a, and determines whether or not the number of times the sensor signal threshold is exceeded 105a exceeds the threshold number of times of exceeding that is set in advance, then a determination process result 106a is output to the data transmission and recording processing portion 54.

[0022] The data transmission and recording processing portion 54 inputs the determination process results 102a and 106a and the digital sensor signal 101a and outputs the digital sensor signal 101a to the vehicle information control device 5 based on the sensor signal threshold determination process result 102a and the determination process result 106a. Furthermore, the data transmission and recording processing portion 54 inputs a vehicle information signal 107a of the vehicle information control device 5 and records the digital sensor signal 101a and the vehicle information signal 107a based on the determination process results 102a and 106a in the memory card 39 of the state-monitoring device 2. In addition, the data transmission and recording processing

portion 54 is installed on the ground side, and may be provided with means for transmitting the determination process result 106a or the digital sensor signal 101a and the vehicle information signal 107a to the ground-side device by wireless communication. In that case, it is possible to reduce cost or a space in which the data transmission and recording processing portion 54 or the memory card 39 is installed on the pick-up side. In addition, it is possible to reduce the processing costs while running by performing the data transmission and recording while the vehicle is stopped and is particularly favorable to perform while the vehicle stopped in a station or a vehicle maintenance base for the railway operation.

[0023] In this manner, it may be possible to set and manage an automatic recording section in which data is automatically recorded as described later by the vehicle positional information threshold determination process portion 53 and the data transmission and recording processing portion 54, and two portions may be combined and called an automatic recording section management portion.

[0024] Note that, the vehicle positioning signal 104a preferably applies station information (for example, a unique station code assigned to each station), kilometer information that indicates a running distance, a global positioning system (GPS) signal, or the like. In addition, preferably the vehicle information signal 107a selects items such as vehicle running velocity information, GPS information, or the like that is necessary in a detailed analysis of the digital sensor signal 101a. Note that, the sensor signal threshold determination processing portion 51 may be configured as a system that outputs an alarm signal to the vehicle information control device 5 and outputs the alarm signal to the personal computer 9 of the ground-side monitoring system 6 in a case where it is determined that the sensor signal threshold that is set in advance is exceeded with respect to the digital sensor signal 101a. Furthermore, the vehicle positional information threshold determination process portion 53 may be configured as a system that outputs an automatic recording start signal to the vehicle information control device 5 and outputs the signal to the personal computer 9 of the ground-side monitoring system 6 in a case where it is determined that the number of times the threshold is exceeded that is set in advance is exceeded with respect to the number of times the sensor signal threshold is exceeded 105a.

[0025] Next, a state-monitoring flow of a railway vehicle will be described using a flow diagram in Fig. 4. First, a state-monitoring system power on process 200 is executed, and device error confirmation of each device including the state-monitoring device 2 (vehicle information control device 5 and the like) or initial setting 201 of a threshold parameter reading process, or the like is executed. After the initial setting 201 ends, a detection process 202 of the sensor signal and the vehicle positional information is executed, a threshold determination process 203 is executed with respect to the sensor signal,

and it is determined whether the threshold is exceeded (204). In a case where the threshold is exceeded, a recording and transmission process 205 of the sensor signal that exceeds the threshold is executed. Furthermore, a status start-up process exceeding the threshold 206 is executed, and a status of threshold exceeded is set to ON.

[0026] Next, an ON/OFF determination process 207 of status of threshold exceeded is executed. In a case where the status of threshold exceeded is set to ON, a status stand-down process exceeding the threshold 208 is executed, and furthermore, a determination process 209 is executed of whether or not current vehicle positional information that is acquired from the vehicle information control device 5 is already present in the sensor signal threshold exceeding section. Here, a counter update process exceeding the sensor signal threshold 210 is executed in a case where the current vehicle positional information that is acquired from the vehicle information control device 5 is already present in the sensor signal threshold exceeding section. A section generation process exceeding the sensor signal threshold 211 is newly executed in a case where the current vehicle positional information that is acquired from the vehicle information control device 5 is not present in the sensor signal threshold exceeding section. Next, a determination process 212 is executed of whether the number of times the threshold is exceeded that is set in advance by the counter exceeding the sensor signal threshold, and the current vehicle positional information is set to an automatic recording section as an automatic recording section setting process 213 in a case where the threshold is exceeded.

[0027] Next, a determination process 214 is executed of whether or not the current vehicle positional information that is acquired from the vehicle information control device 5 is present in the automatic recording section. Here, a recording transmission process 215 of the sensor signal for automatic recording is executed in a case where the current vehicle positional information that is acquired from the vehicle information control device 5 is present in the automatic recording section. For example, it is preferable to compare automatic recording section information that is set by the vehicle positional information threshold determination process portion 53 and positional information that is acquired from the vehicle information control device 5, and permit data transmission to the data transmission and recording processing portion 54 in a case where the sets of information match. Next, a series of subsequent processes of the process 202 are repeatedly executed until a state-monitoring system power source disconnection process 217 is executed. Note that, an update process such as a current parameter is executed and the system is disconnected in a case where the state-monitoring system power source disconnection process 217 is executed.

[0028] Next, the sensor signal threshold determination process will be described using an example of a vibration acceleration sensor signal waveform in Fig. 5. A vibration

acceleration waveform 60 is represented by a position in the horizontal axis and acceleration in the vertical axis, and includes an exceptionally large vibration generation section 63. Here, in the sensor signal threshold determination process, a vibration acceleration threshold 61 and a vibration acceleration threshold exceeding time 62 are set in advance. First, the sensor signal threshold determination process detects an exceeding point at which the vibration acceleration waveform 60 initially exceeded the vibration acceleration threshold 61. Next, the sensor signal threshold determination process determines whether the vibration acceleration waveform 60 exceeds the vibration acceleration threshold exceeding time 62 with reference to the exceeding point of the vibration acceleration threshold 61 and outputs a threshold exceeding determination process result 102a in a case where the time is exceeded.

[0029] Next, each management and processing method of the sensor signal threshold exceeding section management portion 52, the vehicle positional information threshold determination process portion 53, and the data transmission and recording processing portion 54 using a vibration acceleration sensor signal waveform example, an example of the number of times the sensor signal threshold is exceeded, a vehicle positional information example, and a data recording transmission propriety signal example of Fig. 6 will be described. Fig. 6 indicates a vibration acceleration sensor signal waveform 71, a number of times the threshold of the sensor signal is exceeded 72 between stations A-B, a number of times the threshold of the sensor signal is exceeded 73 between stations C-D, a station code 76 that is vehicle positional information, and a data recording transmission propriety signal 74 as positions on the horizontal axis when the railway vehicle 1 repeatedly passes through station A, station B, station C, and station D as station 70 three times. Here, the vibration acceleration sensor signal waveform includes exceptional vibration acceleration 75 that is detected as exceeding the threshold using the sensor signal threshold determination processing portion 51 between the stations A-B and between the stations C-D of the first time, between the stations A-B and between the stations C-D of the second time, and between the stations C-D of the third time. First, the sensor signal threshold exceeding section management portion 52 counts the number of times the threshold of the sensor signal is exceeded 72 between the stations A-B on the basis of the station code 76 that is vehicle positional information by the exceptional vibration acceleration 75 that is generated between the stations A-B. Furthermore, the exceptional vibration acceleration 75 is recorded on the memory card 39 and is transmitted to the vehicle information control device 5 by the data transmission and recording processing portion 54 switching the data recording transmission propriety signal 74 from OFF to ON. Next, the sensor signal threshold exceeding section management portion 52 counts the number of times the threshold of the sensor signal is exceeded 73 between

the stations C-D on the basis of the station code 76 by the exceptional vibration acceleration 75 that is generated between the stations C-D. The data recording and transmission process by the data transmission and recording processing portion 54 at this time is described above.

[0030] Next, the sensor signal threshold exceeding section management portion 52 counts each of the number of times the threshold of the sensor signal is exceeded 72 between the stations A-B and the number of times the threshold of the sensor signal is exceeded 73 between the stations C-D on the basis of the station code 76 by the exceptional vibration acceleration 75 that is generated between the stations A-B and between the stations C-D when running inter-section in the second time. Here, in a case where the number of times the threshold of the sensor signal is exceeded is set in advance to 2, the number of times the threshold of the sensor signal is exceeded 72 between the stations A-B and the number of times the threshold of the sensor signal is exceeded 73 between the stations C-D are determined to exceed the threshold, and the station code 76 between the stations A-B and the station code 76 between the stations C-D are automatically set as automatic recording section targets.

[0031] Next, since the threshold exceeding vibration acceleration 75 between the stations A-B is not confirmed when running inter-section in the third time, but is already set as the automatic recording section target, the vibration acceleration sensor signal waveform 71 is recorded on the memory card 39 and is transmitted to the vehicle information control device 5 by the data transmission and recording processing portion 54 switching the data recording transmission propriety signal 74 from OFF to ON regardless of whether a threshold exceeding vibration acceleration 75 is generated. In addition, the threshold exceeding vibration acceleration 75 between the stations C-D is confirmed, but the vibration acceleration sensor signal waveform 71 is recorded on the memory card 39 and is transmitted to the vehicle information control device 5 by the data transmission and recording processing portion 54 switching the data recording transmission propriety signal 74 from OFF to ON in the same manner as the automatic recording of the vibration acceleration between the stations A-B described above. By doing so, the recording section is automatically generated on the basis of the number of times the threshold is exceeded 72 between the stations A-B, the number of times the threshold is exceeded 73 between the stations C-D and the station code 76. Note that, preferably the maximum number of the number of times that the threshold is exceeded is selected according to the memory of the state-monitoring device 2.

[0032] In addition, other than the station code 76, kilometer information that indicates a running distance, a GPS signal, and the like may be applied. Furthermore, it is possible to carry out threshold determination process of a vehicle running velocity with respect to the station

code 76 in a case where only the vibration acceleration sensor during running is set as the target.

[0033] In addition, a method of manually releasing from a setting portion 40 of the state-monitoring device 2 or the ground-side monitoring system 6 may be set as the release method of the automatic recording section. Furthermore, a method may be set for automatically releasing from the automatic recording section in a case where the threshold exceeding vibration acceleration 75 is not detected in the time or running distance set in advance.

[0034] Next, a display method of recording data will be described using a display screen in Fig. 7. Fig. 7 is a diagram that indicates the position on the horizontal axis and time on the vertical axis, and visualizes a vibration generation state between position A and position B.

[0035] Here, as an example of vibration acceleration, a gray value of a vibration acceleration distribution 80 is expressed in Fig. 7 as a size of the vibration acceleration level. As illustrated in Fig. 7, when the vibration acceleration level increases, the gray value of the vibration acceleration distribution 80 becomes higher step by step so as to indicate vibration acceleration distributions 81, 82, and 83, and it is possible to visually ascertain whether some vibration acceleration level is changed in some section. In addition, in the manner of vibration acceleration 84, the vibration acceleration level may be expressed as a size of an illustration of a circle or the like. In addition, it is possible to ascertain a trend of the time indicated on the horizontal axis and the acceleration indicated on the vertical axis as shown in Fig. 8 by carrying out a trend analysis range specification 85 when ascertaining a tendency of a specific vibration acceleration level 90. Note that, the displays are not only position or time, and may apply a restriction using vehicle velocity and the like.

[0036] A case of applying to the railway vehicle is described in the present embodiment, but it is possible to apply to a general moving body such that a monorail, an automobile, or the like runs at a specific position or location.

[0037] As above, according to the present embodiment, it is possible to provide a system in which a predetermined location or position is automatically recorded regardless of any sensor signal for preventive maintenance based on the characteristic sensor signal that is generated at the predetermined location or section without always recording and transmitting a large sensor signal of data capacity, improve vehicle operation reliability, and improve efficiency of vehicle maintenance work.

Embodiment 2

[0038] Fig. 9 illustrates an example of a state-monitoring system of a railway vehicle of Embodiment 2. In the system configuration diagram in Fig. 9, an additional point with respect to the system configuration diagram in Fig. 1 will be described. First, in Fig. 9, a railway vehicle 20 is added as well as the railway vehicle 1, and a gangway 21 is installed in the railway vehicle 1 and the railway

vehicle 20. A state-monitoring device 2' and a vibration acceleration sensor 12' are installed in the railway vehicle 20, and the sensor signal of the vibration acceleration sensor 12' is input to the state-monitoring device 2'.

[0039] Next, a configuration diagram of the state-monitoring system of a railway vehicle that is realized by the state-monitoring device of Fig. 9 will be described using Fig. 10. In the system configuration diagram in Fig. 10, an additional point with respect to the system configuration diagram in Fig. 3 will be described. First, here a sensor that is connected to the state-monitoring device 2' which is set in the railway vehicle 20 is set as the vibration acceleration sensor 12'. A sensor signal threshold exceeding section management portion 52' inputs the vehicle positioning signal 104a of the vehicle information control device 5 via the state-monitoring device 2, counts the number of times the sensor signal threshold is exceeded at a predetermined section, location, or position based on the vehicle positioning signal 104a, and outputs a number of times the sensor signal threshold is exceeded 105a' to a vehicle positional information threshold determination process portion 53'. The vehicle positional information threshold determination process portion 53' inputs the vehicle positioning signal 104a of the vehicle information control device 5 via the state-monitoring device 2, and determines whether or not the number of times the sensor signal threshold is exceeded 105a' exceeds the threshold number of times of exceeding that is set in advance, then a determination process result 106a' is output to a data transmission and recording processing portion 54'. Furthermore, the vehicle positional information threshold determination process portions 53 and 53' respectively communicate an automatic recording section signal 110a that indicates the automatic recording locations, shares the automatic recording section that is set by each railway vehicle 1 and 20 and automatically executes data recording and transmission. Note that, the state-monitoring device 2' may have a system configuration that connects to the state-monitoring device 2 via the vehicle information control device 5. In addition, preferably the same system configuration is set even if the number of the railway vehicles 20 is raised.

[0040] Furthermore, the number of times that the threshold is exceeded may be shared between the sensor signal threshold exceeding section management portions 52 and 52' and the automatic recording location may be determined.

[0041] As above, according to the present embodiment, it is possible to provide an automatic recording system that captures a characteristic sensor signal that is generated by each vehicle and a change over time thereof by sharing the predetermined data recording location and section that are respectively detected and set between a plurality of vehicles with different vehicle characteristics between vehicles in an organization train, improve vehicle operation reliability, and improve efficiency of vehicle maintenance work.

Embodiment 3

[0042] Fig. 11 illustrates an example of a state-monitoring system of a railway vehicle of Embodiment 3. In the system configuration diagram in Fig. 11, an additional point with respect to the system configuration diagram in Fig. 1 will be described. First, in Fig. 11, railway vehicles 1' and 1" are added as well as the railway vehicle 1, and transmission information of each railway vehicle is accumulated in the database 8 of the ground-side monitoring system 6 via wireless transmission devices 7, 7', and 7" and the wireless transmission device 7 on the ground side. Next, the ground-side monitoring system 6 is connected to a threshold management update device 150 via the network 11. The threshold management update device 150 centrally manages the number of times the sensor signal threshold is exceeded and the automatic recording section of each railway vehicle 1, 1', and 1", and for example, sets and updates the transmission information which relates to the shared number of times the sensor signal threshold is exceeded and the automatic recording section of each railway vehicle 1, 1', and 1" to state-monitoring devices 2, 2', and 2". Note that, there may be a system configuration in which threshold management updating is carried out between the wireless transmission device 7, the wireless transmission device 7', and the wireless transmission device 7" not through the ground-side monitoring system 6. In addition, preferably the same system configuration is set even if the number of railway vehicles 1 is raised.

[0043] As above, according to the present embodiment, it is possible to provide an automatic recording system that captures a characteristic sensor signal between each of a plurality of compositions and a change over time thereof by sharing the predetermined data recording location and section that are respectively detected and set between the plurality of compositions with different vehicle operation states or vehicle maintenance states, improve vehicle operation reliability, and improve efficiency of vehicle maintenance work.

Reference Signs List

[0044]

- 1 RAILWAY VEHICLE
- 2 STATE-MONITORING DEVICE
- 3 DOOR
- 4 UNDERFLOOR DEVICE
- 5 VEHICLE INFORMATION CONTROL DEVICE
- 6 GROUND-SIDE MONITORING SYSTEM
- 7 WIRELESS TRANSMISSION DEVICE
- 8 DATABASE
- 9 PERSONAL COMPUTER
- 10 ANALYSIS DEVICE
- 11 NETWORK
- 12 VIBRATION ACCELERATION SENSOR
- 13 VEHICLE BODY

14 CARRIAGE
 20 RAILWAY VEHICLE
 21 GANGWAY
 30 PROCESSOR
 31 SWITCH 5
 32 DISPLAY PORTION
 33 CPU
 34 INTERFACE
 35 RAM
 36 ROM 10
 37 CARD CONNECTOR
 38 BUS
 39 MEMORY CARD
 40 SETTING PORTION
 50 SENSOR SIGNAL DETECTING PORTION 15
 51 SENSOR SIGNAL THRESHOLD DETERMINATION PROCESSING PORTION
 52 SENSOR SIGNAL THRESHOLD EXCEEDING SECTION MANAGEMENT PORTION
 53 VEHICLE POSITIONAL INFORMATION THRESHOLD DETERMINATION PROCESS PORTION 20
 54 DATA TRANSMISSION AND RECORDING PROCESSING PORTION
 60 VIBRATION ACCELERATION WAVEFORM 25
 61 VIBRATION ACCELERATION THRESHOLD
 62 VIBRATION ACCELERATION THRESHOLD EXCEEDING TIME
 63 EXCEPTIONALLY LARGE VIBRATION GENERATION SECTION 30
 70 STATION
 71 VIBRATION ACCELERATION SENSOR SIGNAL WAVEFORM
 72 NUMBER OF TIMES THRESHOLD IS EXCEEDED BETWEEN STATIONS A-B 35
 73 NUMBER OF TIMES THRESHOLD IS EXCEEDED BETWEEN STATIONS C-D
 74 DATA RECORDING TRANSMISSION PROPRIETY SIGNAL
 75 THRESHOLD EXCEEDING VIBRATION ACCELERATION 40
 76 STATION CODE
 80 VIBRATION ACCELERATION DISTRIBUTION
 81 VIBRATION ACCELERATION DISTRIBUTION
 82 VIBRATION ACCELERATION DISTRIBUTION 45
 83 VIBRATION ACCELERATION DISTRIBUTION
 84 VIBRATION ACCELERATION
 85 TREND ANALYSIS RANGE SPECIFICATION
 90 VIBRATION ACCELERATION LEVEL
 100a VIBRATION ACCELERATION SENSOR SIGNAL 50
 101a DIGITAL SENSOR SIGNAL
 102a SENSOR SIGNAL THRESHOLD DETERMINATION PROCESS RESULT
 104a VEHICLE POSITIONING SIGNAL 55
 105a NUMBER OF TIMES SENSOR SIGNAL THRESHOLD IS EXCEEDED
 106a DETERMINATION PROCESS RESULT

107a VEHICLE INFORMATION SIGNAL
 110a AUTOMATIC RECORDING SECTION SIGNAL
 150 THRESHOLD MANAGEMENT UPDATE DEVICE
 200 POWER ON PROCESS
 201 INITIAL SETTING
 202 DETECTION PROCESS OF SENSOR SIGNAL AND VEHICLE POSITIONAL INFORMATION
 203 SENSOR SIGNAL THRESHOLD DETERMINATION PROCESS
 205 RECORDING AND TRANSMISSION PROCESS OF SENSOR SIGNAL EXCEEDING SENSOR SIGNAL THRESHOLD
 206 STATUS START-UP PROCESS EXCEEDING SENSOR SIGNAL THRESHOLD
 207 STATUS DETERMINATION PROCESS
 208 STATUS STAND-DOWN PROCESS EXCEEDING SENSOR SIGNAL THRESHOLD
 210 COUNTER UPDATE PROCESS EXCEEDING SENSOR SIGNAL THRESHOLD
 211 SECTION GENERATION PROCESS EXCEEDING SENSOR SIGNAL THRESHOLD
 213 SECTION SETTING PROCESS
 215 RECORDING AND TRANSMISSION PROCESS OF SENSOR SIGNAL
 217 STATE-MONITORING SYSTEM DISCONNECTION PROCESS

Claims

1. A state-monitoring device that performs state monitoring of a vehicle based on a sensor signal acquired from a sensor that is mounted in the vehicle and positional information of the vehicle that is acquired from a vehicle information control device, the state-monitoring device comprising:
 - a sensor signal detecting portion that detects the sensor signal;
 - a sensor signal threshold determination processing portion that determines whether or not the sensor signal exceeds a predetermined threshold;
 - a sensor signal threshold exceeding section management portion that inputs positional information of the vehicle and a determination result by the sensor signal threshold determination processing portion and measures the number of times that the threshold is exceeded within a predetermined section; and
 - an automatic recording section management portion that determines whether or not the number of times that the threshold is exceeded within the predetermined section exceeds the predetermined number of times and sets the predetermined section as an automatic record-

ing section in which data recording is automatically performed in a case where the number of times that the threshold is exceeded exceeds the predetermined number of times.

2. The state-monitoring device according to Claim 1, wherein it is detected whether or not the vehicle is on a rail in the automatic recording section, and a signal that enables data recording is output when the sensor signal exceeds the predetermined threshold or while the vehicle is running in the automatic recording section.
3. The state-monitoring device according to Claim 1, wherein the sensor is at least any one of a vibration acceleration sensor, a sound level meter, and a strain sensor that are installed in a vehicle body or on the periphery of a carriage of the vehicle, and the positional information of the vehicle is at least any one of a station code, kilometers, and GPS that are set in each specific station.
4. The state-monitoring device according to Claim 2, wherein the sensor is at least any one of a vibration acceleration sensor, a sound level meter, and a strain sensor that are installed in a vehicle body or on the periphery of a carriage of the vehicle, and the positional information of the vehicle is at least any one of a station code, kilometers, and GPS that are set in each specific station.
5. The state-monitoring device of a railway vehicle according to Claim 4, wherein the station code that is set by the automatic recording section management portion and the station code that is transmitted from the vehicle information control device are compared, and when the station codes match, the data recording is permitted.
6. The state-monitoring device according to Claim 3, further comprising either:

based on a determination result by the sensor signal threshold determination processing portion and a determination result by the automatic recording section management portion, a recording portion that records the sensor signal and vehicle running velocity information that is acquired from the vehicle information control device; or
 based on a determination result by the sensor signal threshold determination processing portion and a determination result by the automatic recording section management portion, a transmission portion that transmits the sensor signal and the vehicle running velocity information to the outside by wireless communication.

7. The state-monitoring device according to Claim 5, further comprising either:

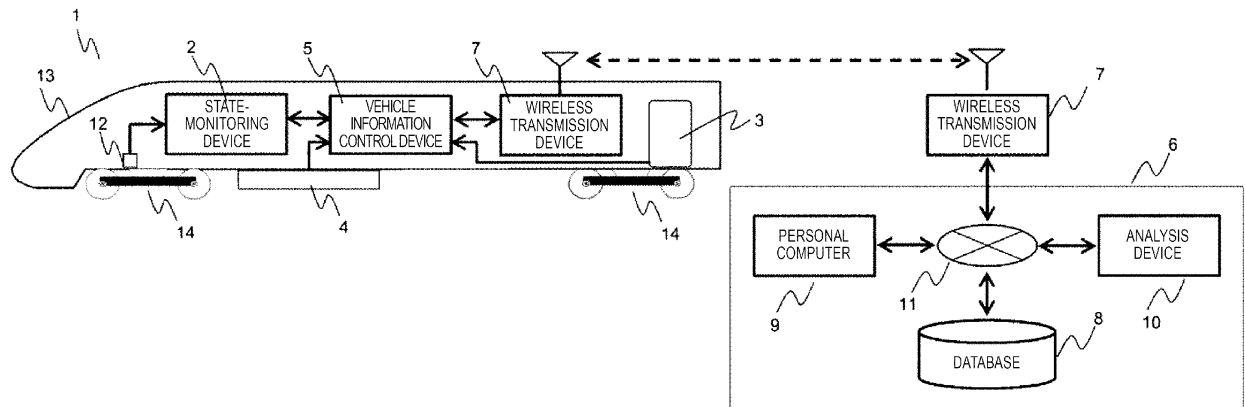
based on a determination result by the sensor signal threshold determination processing portion and a determination result by the automatic recording section management portion, a recording portion that records the sensor signal and vehicle running velocity information that is acquired from the vehicle information control device; or
 based on a determination result by the sensor signal threshold determination processing portion and a determination result by the automatic recording section management portion, a transmission portion that transmits the sensor signal and the vehicle running velocity information to the outside by wireless communication.

8. The state-monitoring device according to Claim 6, wherein either the recording portion or the transmission portion is executed by the vehicle while stopped in a station or a vehicle maintenance base.
9. A state-monitoring system that has a plurality of the vehicles which are provided with the state-monitoring device and the vehicle information control device according to Claim 1, wherein each of the plurality of the vehicles is provided with a wireless communication portion that is able to transmit and receive data to and from the outside, and the predetermined threshold or the predetermined number of times are updated based on a determination result by the sensor signal threshold determination processing portion or a determination result by the automatic recording section management portion of the plurality of vehicles.
10. The state-monitoring system according to Claim 9, further comprising:

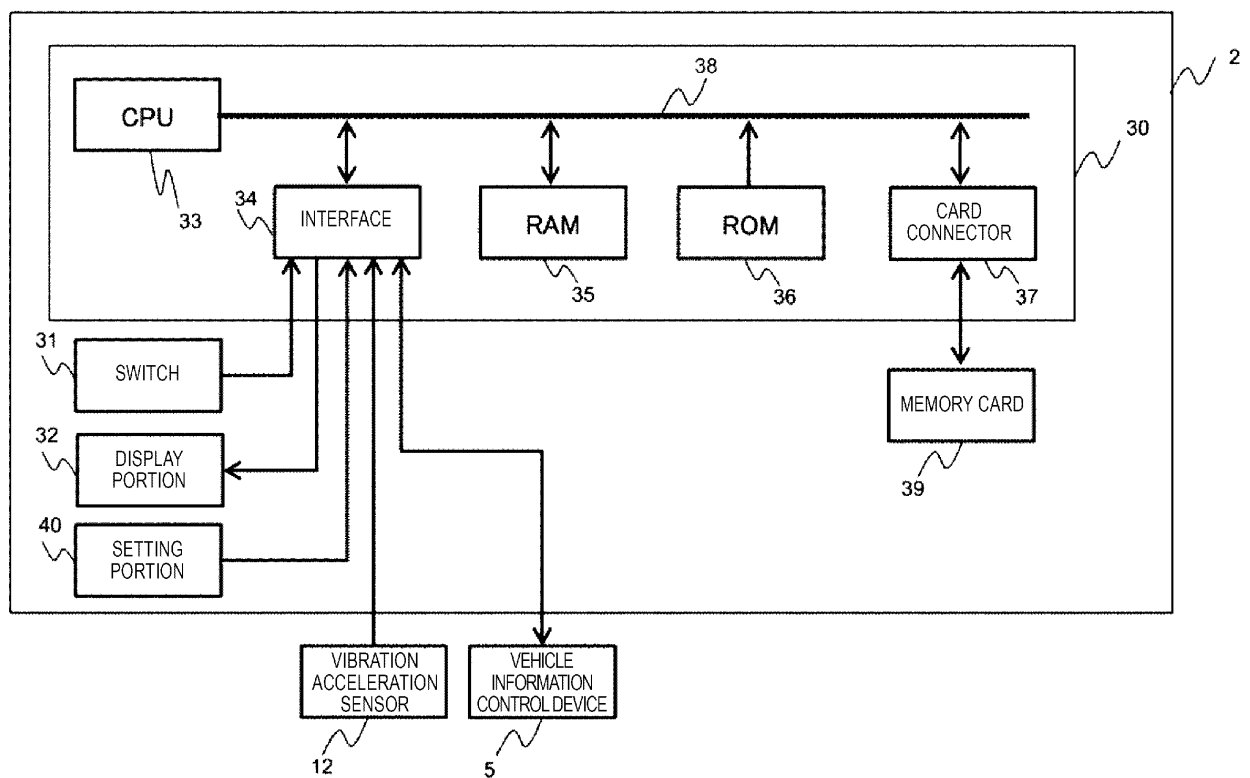
a ground device that is able to receive the plurality of determination results via wireless communication.

11. An organization train that has a plurality of the vehicles which are provided with the state-monitoring device and the vehicle information control device according to Claim 1, wherein a determination result by the sensor signal threshold determination processing portion or a determination result by the automatic recording section management portion of the plurality of vehicles is shared between each of the vehicles.

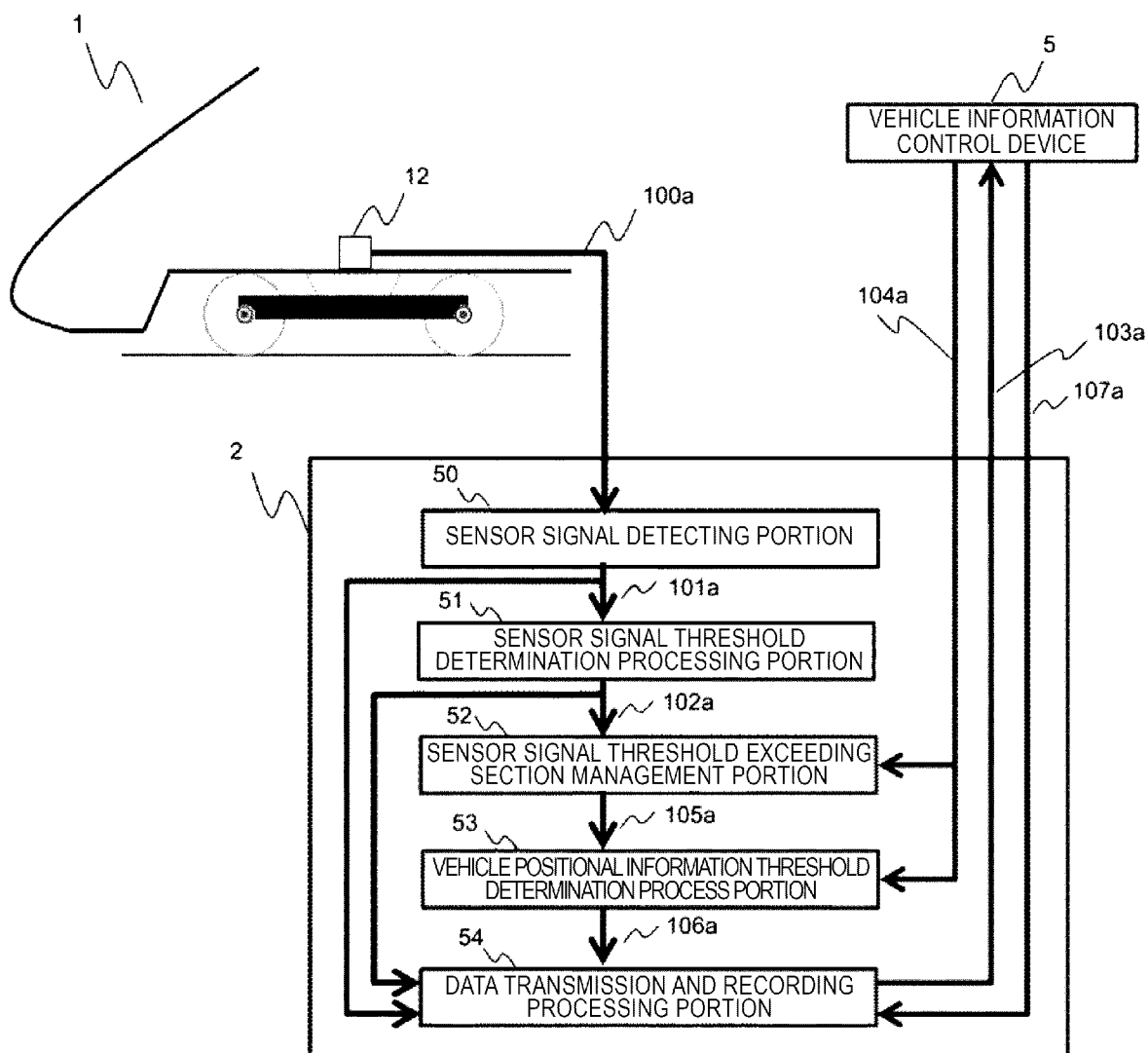
[Fig. 1]



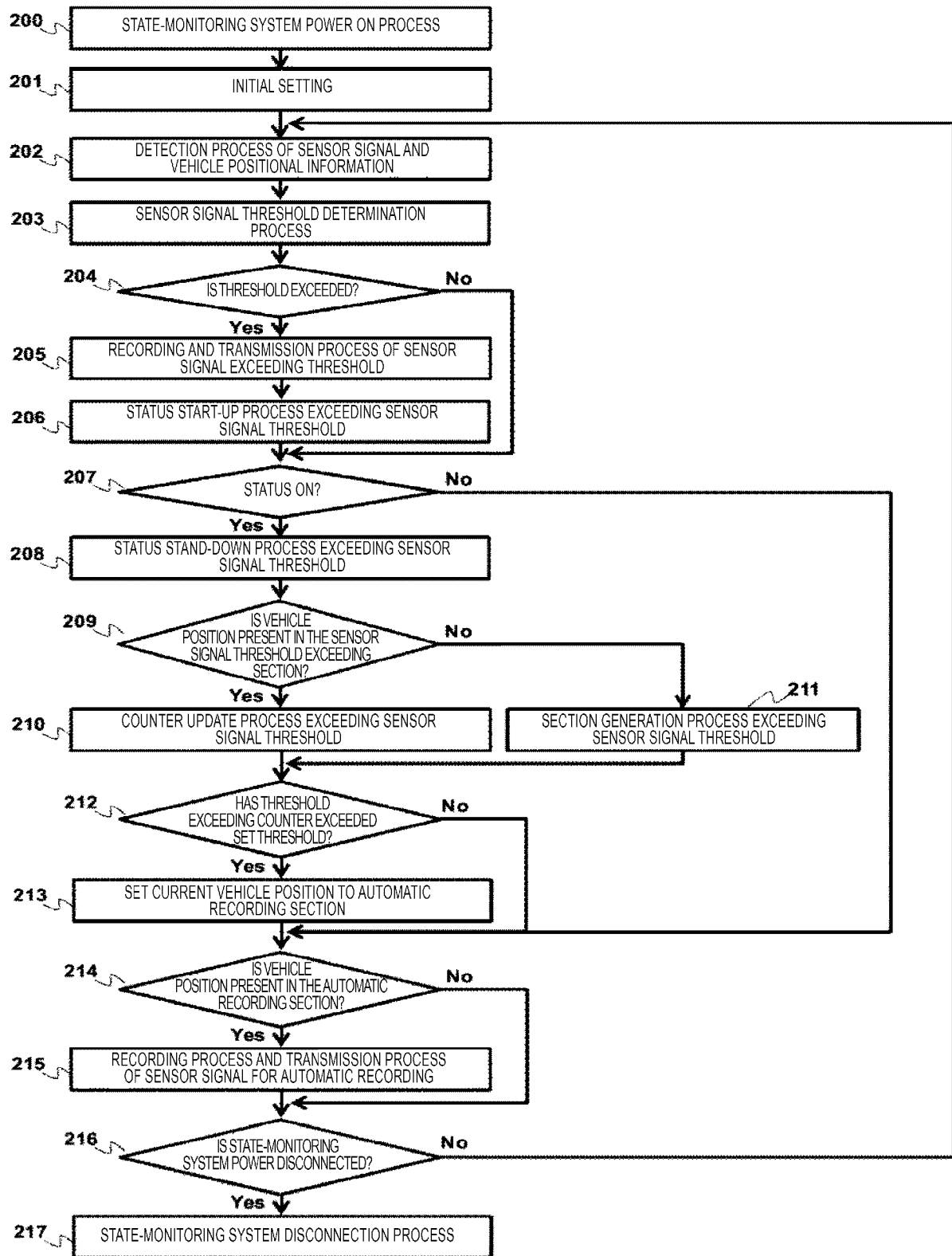
[Fig. 2]



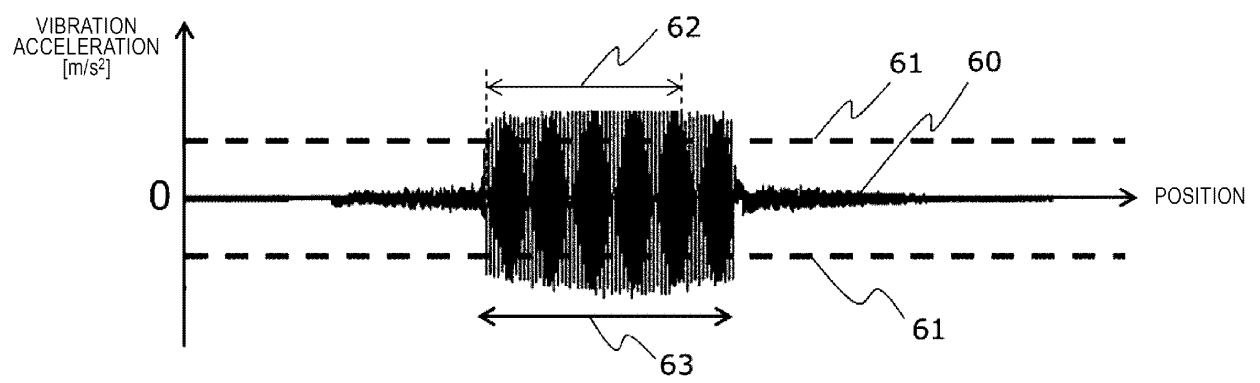
[Fig. 3]



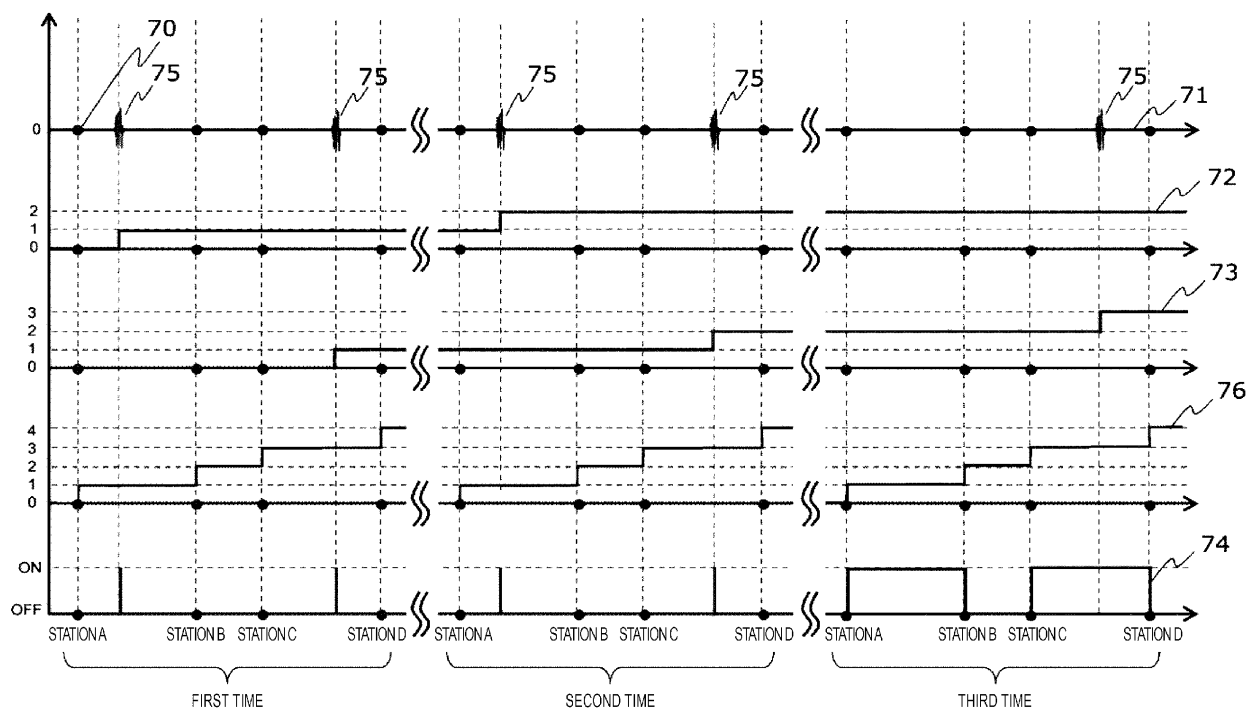
[Fig. 4]



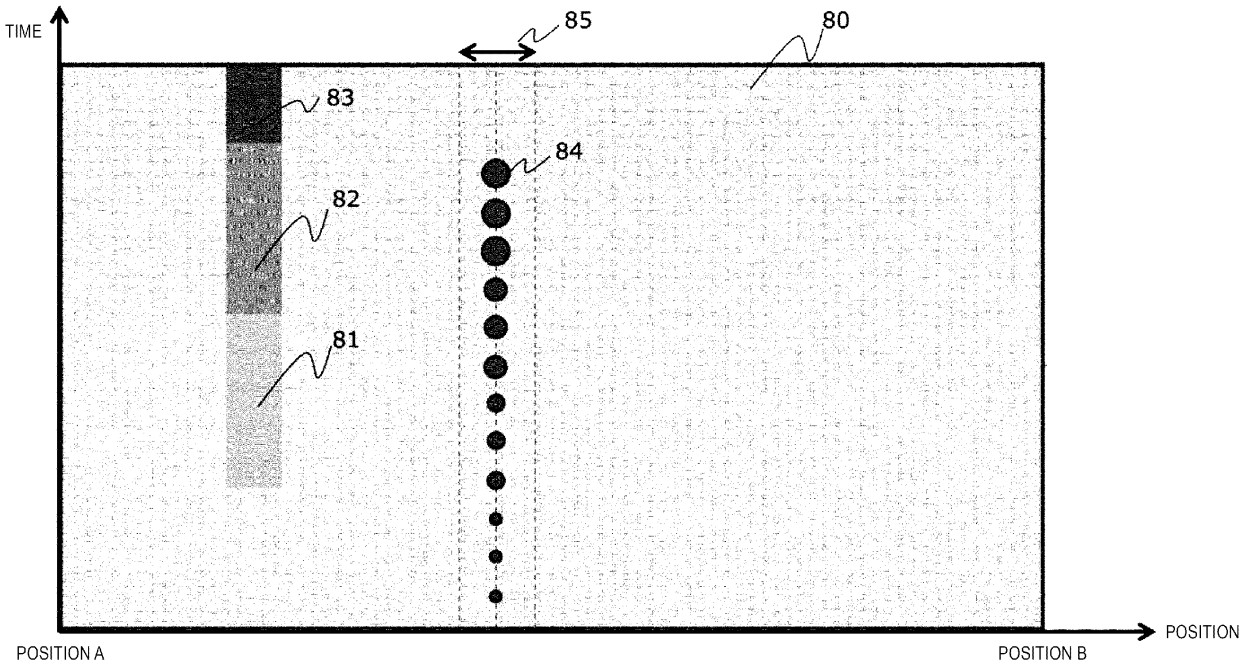
[Fig. 5]



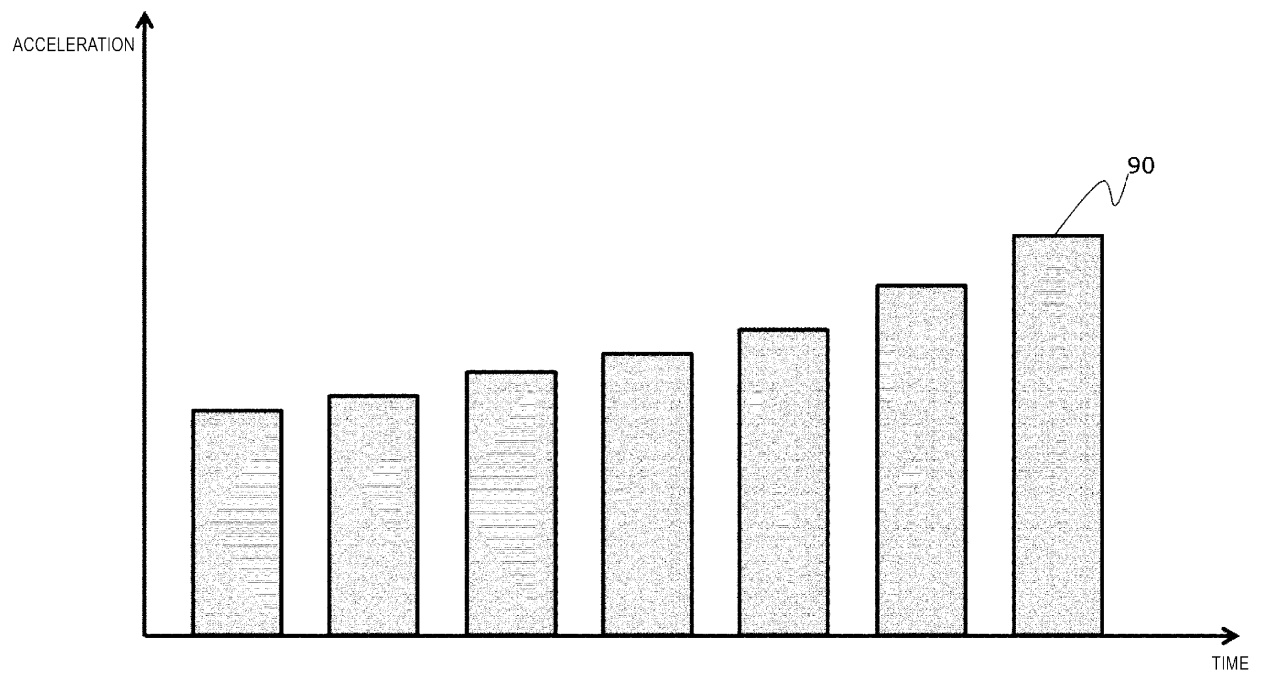
[Fig. 6]



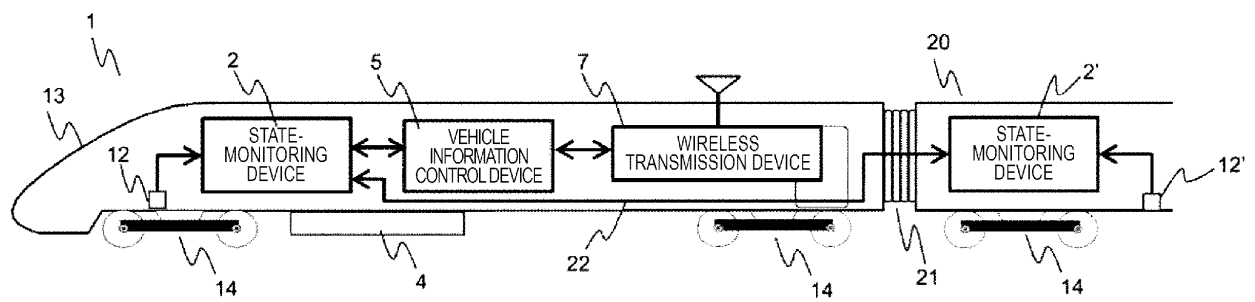
[Fig. 7]



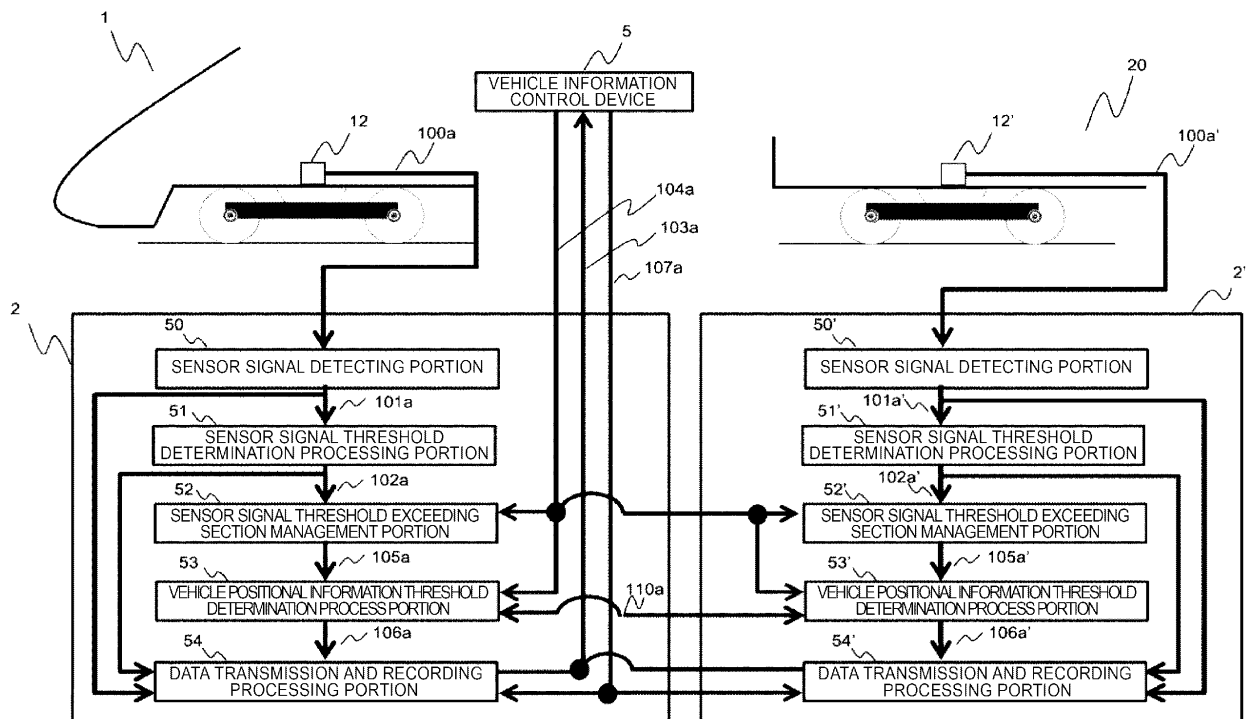
[Fig. 8]



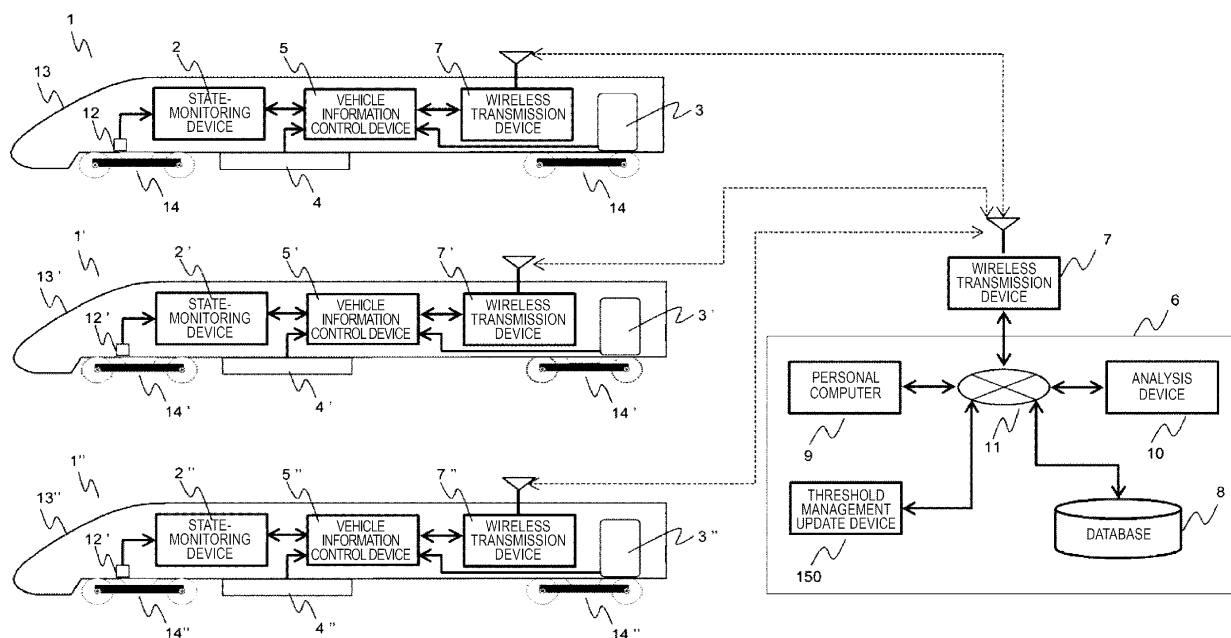
[Fig. 9]



[Fig. 10]



[Fig. 11]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB2016/051433

A. CLASSIFICATION OF SUBJECT MATTER

B61L25/04(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B61L25/04, G08G1/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2016

Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2011-245917 A (Hitachi, Ltd.), 08 December 2011 (08.12.2011), entire text; all drawings (Family: none)	1-11
A	JP 2012-100434 A (Akebono Brake Industry Co., Ltd.), 24 May 2012 (24.05.2012), entire text; all drawings (Family: none)	1-11
A	JP 2013-139671 A (Fujitsu Ltd.), 18 July 2013 (18.07.2013), entire text; all drawings & US 2013/0170701 A1 & CN 103184719 A	1-11

☒ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
02 June 2016 (02.06.16)Date of mailing of the international search report
14 June 2016 (14.06.16)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB2016/051433

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2006-112127 A (Hitachi, Ltd.), 27 April 2006 (27.04.2006), entire text; all drawings (Family: none)	1-11

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2013164869 A [0002] [0003]