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(54) **NOTIFICATION METHOD AND NOTIFICATION SYSTEM**

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(57) **ABSTRACT**

A notification method of issuing a notification of arrival of maintenance of a vehicle includes: a step of acquiring, by a portable device, driving information from the vehicle through communication, the driving information indicating a driving state of the vehicle; and a step of outputting notification information regarding the maintenance of the vehicle to a notification device included in the portable device in case that the driving information satisfies a predefined notification condition.

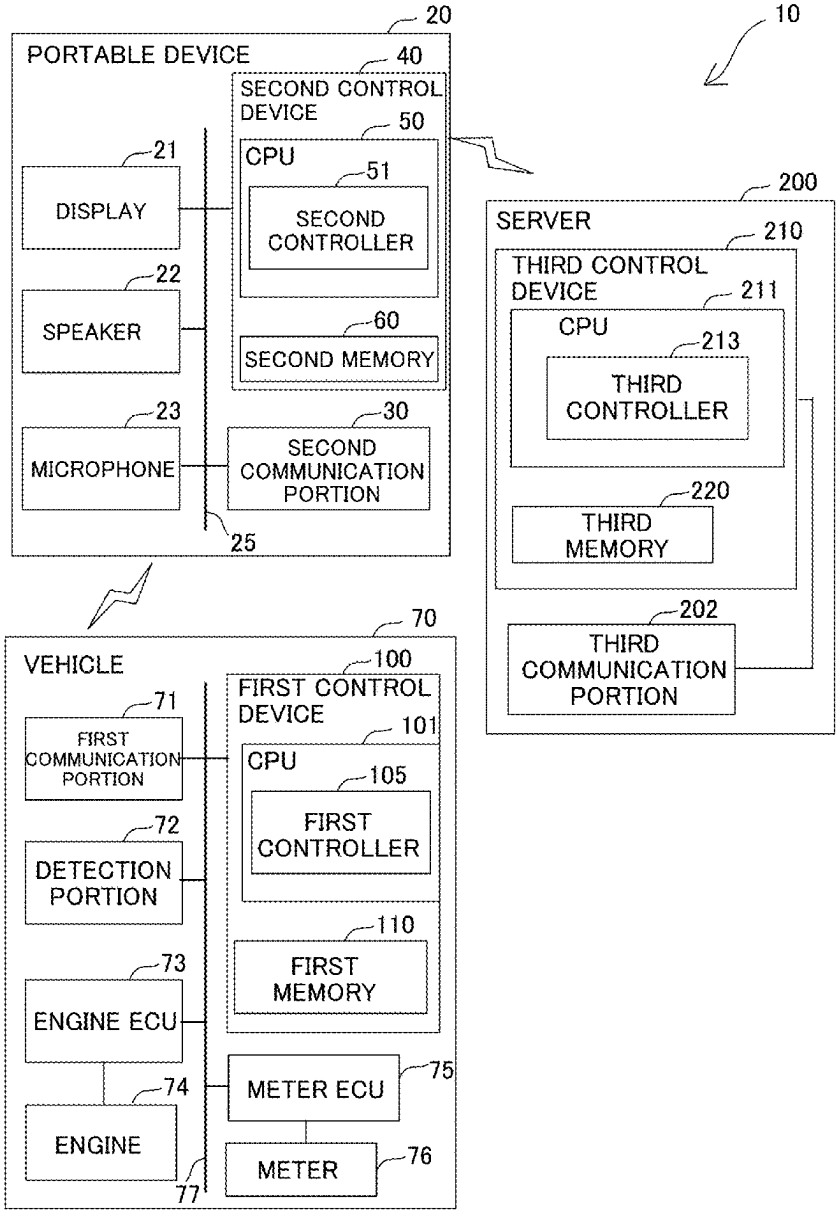


FIG.1

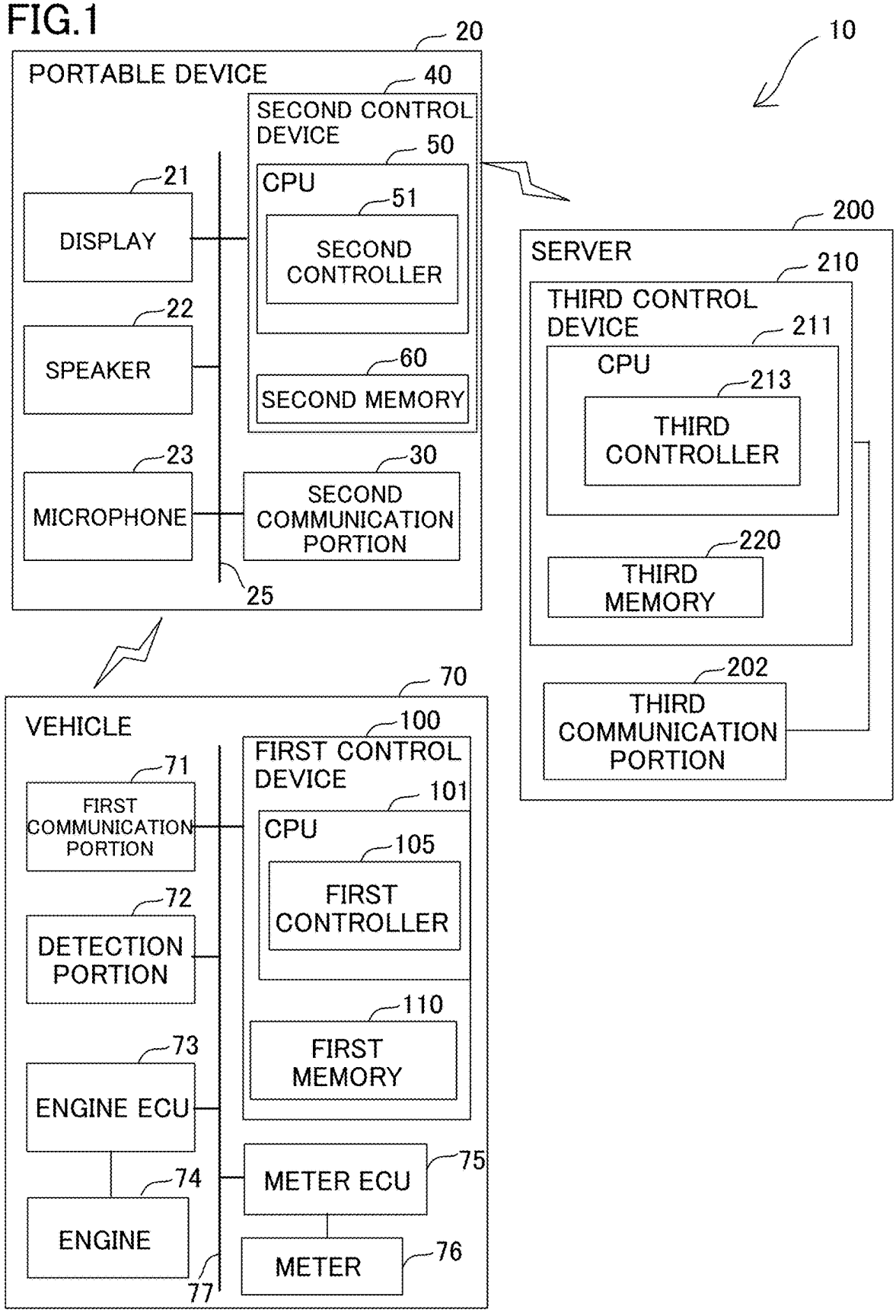

10
20
PORTABLE DEVICE
40
SECOND CONTROL DEVICE
50
CPU
51
SECOND CONTROLLER
21
DISPLAY
22
SPEAKER
60
SECOND MEMORY
23
MICROPHONE
30
SECOND COMMUNICATION PORTION
25
200
SERVER
210
THIRD CONTROL DEVICE
211
CPU
213
THIRD CONTROLLER
220
THIRD MEMORY
202
THIRD COMMUNICATION PORTION
70
VEHICLE
100
FIRST CONTROL DEVICE
101
CPU
105
FIRST CONTROLLER
71
FIRST COMMUNICATION PORTION
72
DETECTION PORTION
110
FIRST MEMORY
73
ENGINE ECU
74
ENGINE
75
METER ECU
76
METER
77

FIG.2

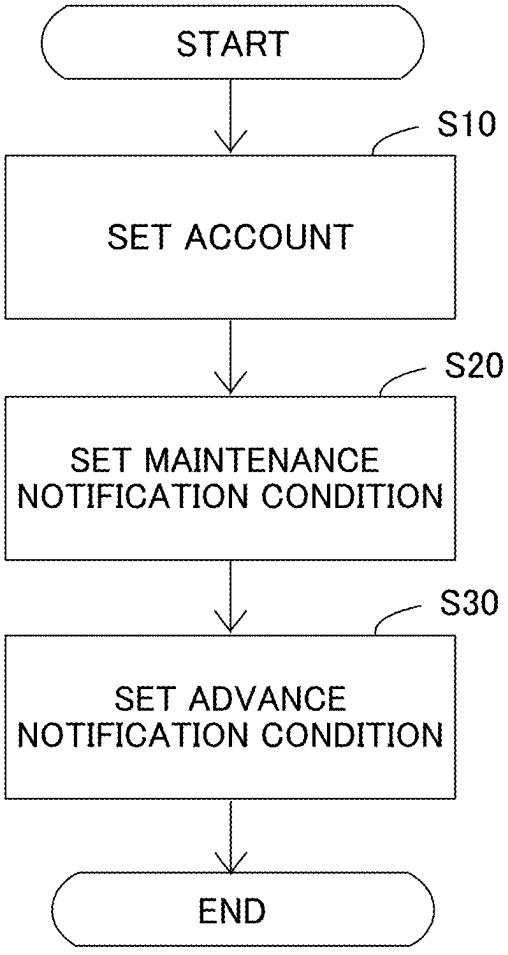

START
S10
SET ACCOUNT
S20
SET MAINTENANCE NOTIFICATION CONDITION
S30
SET ADVANCE NOTIFICATION CONDITION
END

FIG.3

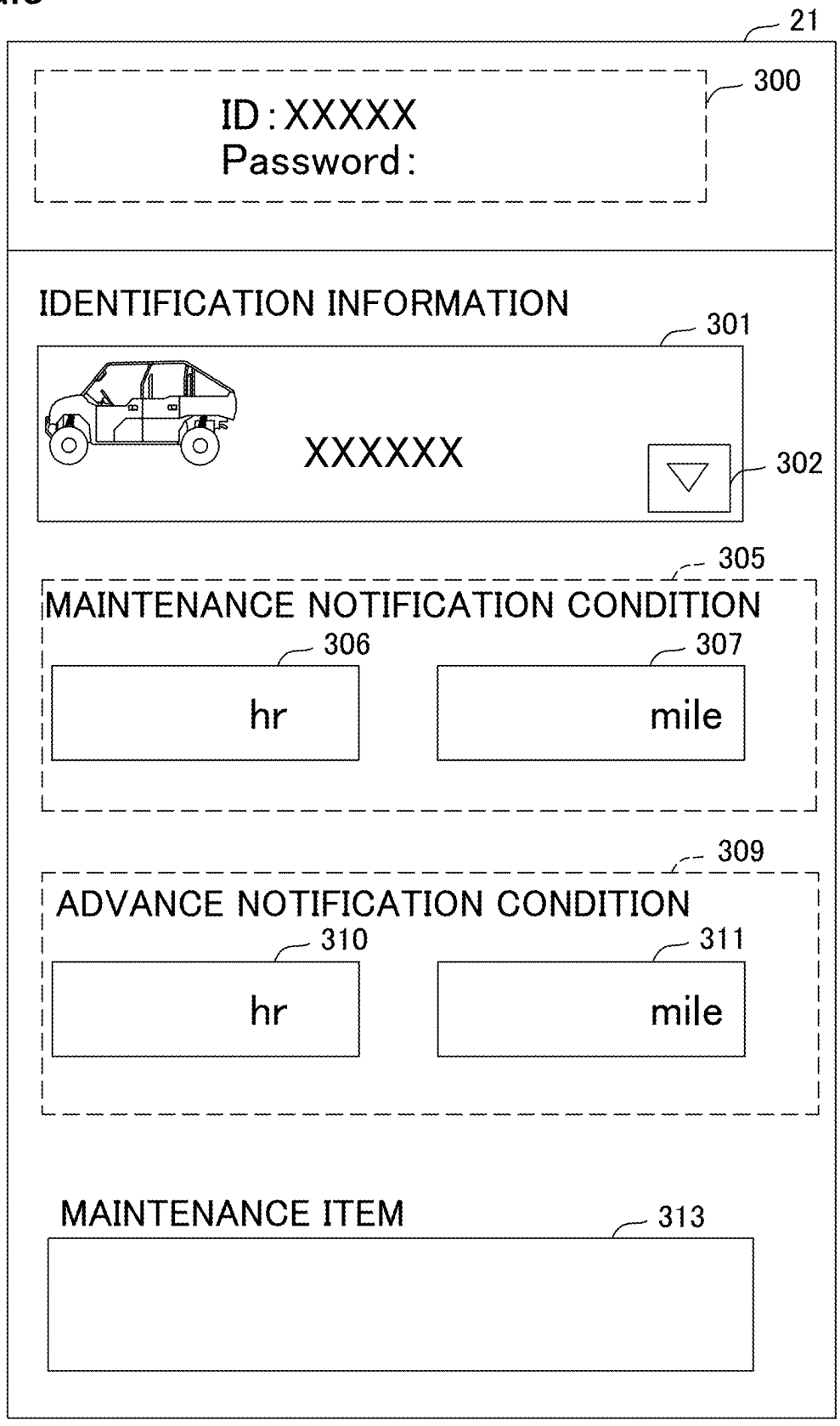

21
300
ID : XXXXX
Password :
IDENTIFICATION INFORMATION
301
XXXXXX
302
305
MAINTENANCE NOTIFICATION CONDITION
306
hr
307
mile
309
ADVANCE NOTIFICATION CONDITION
310
hr
311
mile
MAINTENANCE ITEM
313

FIG.4

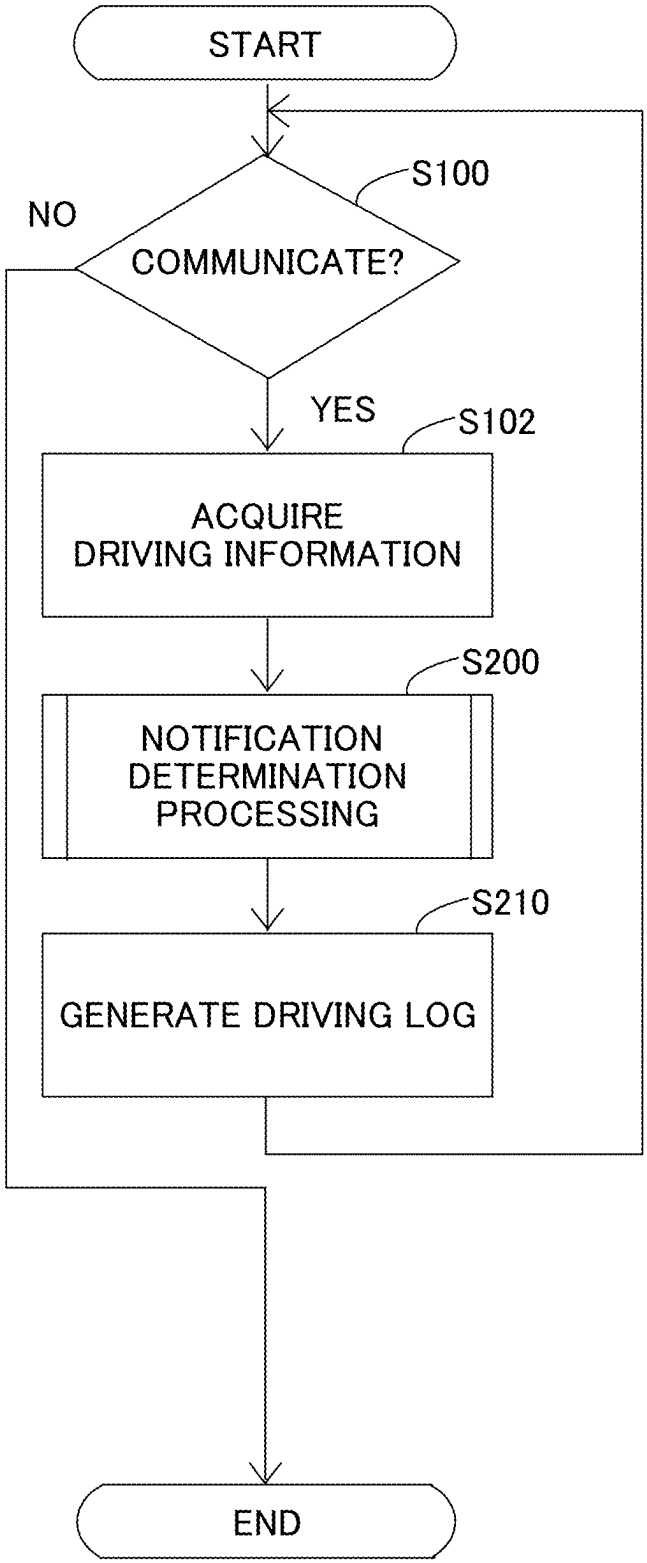

START
S100
NO
COMMUNICATE?
YES
S102
ACQUIRE DRIVING INFORMATION
S200
NOTIFICATION DETERMINATION PROCESSING
S210
GENERATE DRIVING LOG
END

FIG.5

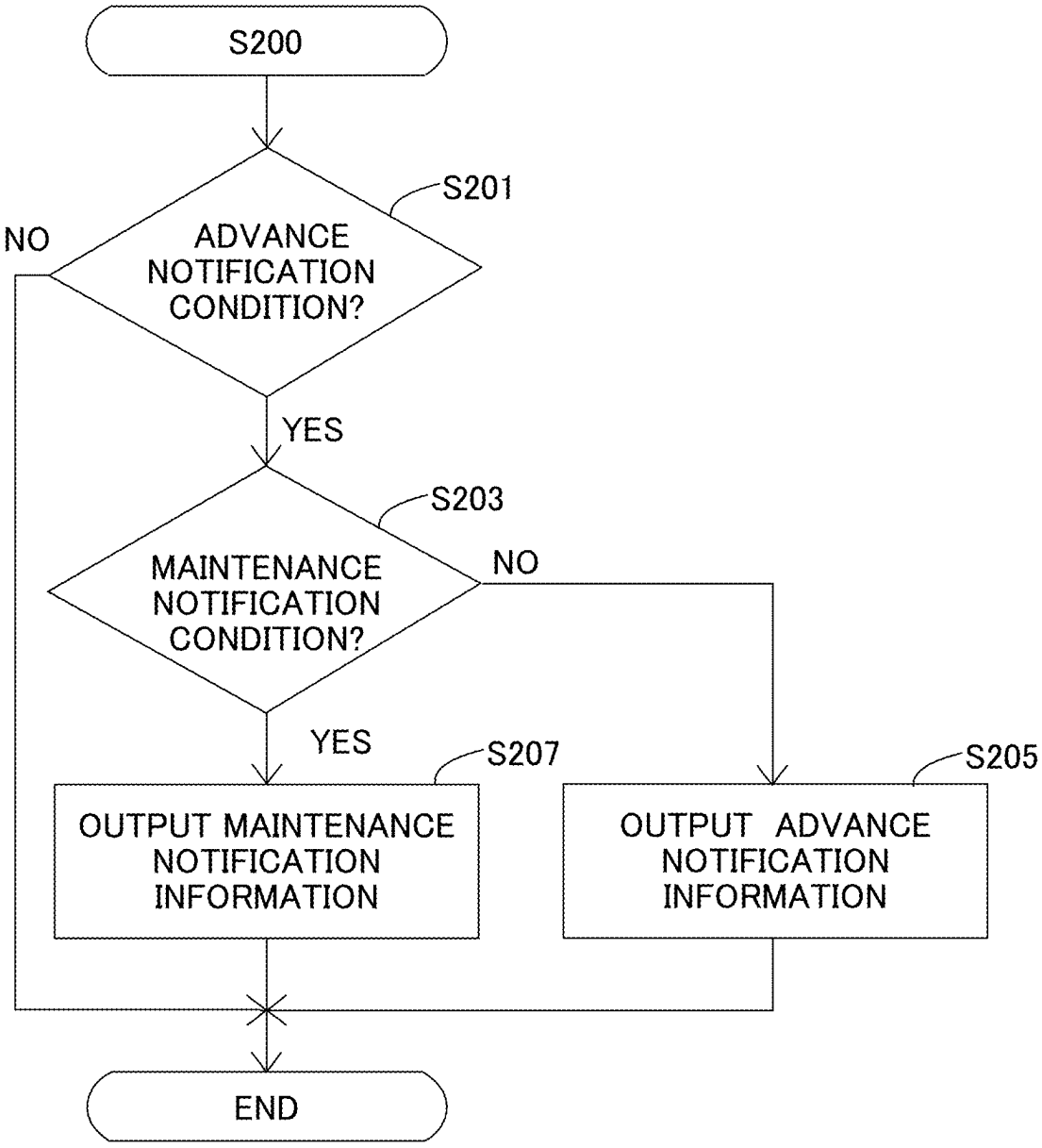

S200
S201
NO
ADVANCE NOTIFICATION CONDITION?
YES
S203
MAINTENANCE NOTIFICATION CONDITION?
NO
YES
S207
S205
OUTPUT MAINTENANCE NOTIFICATION INFORMATION
OUTPUT ADVANCE NOTIFICATION INFORMATION
END

FIG.6

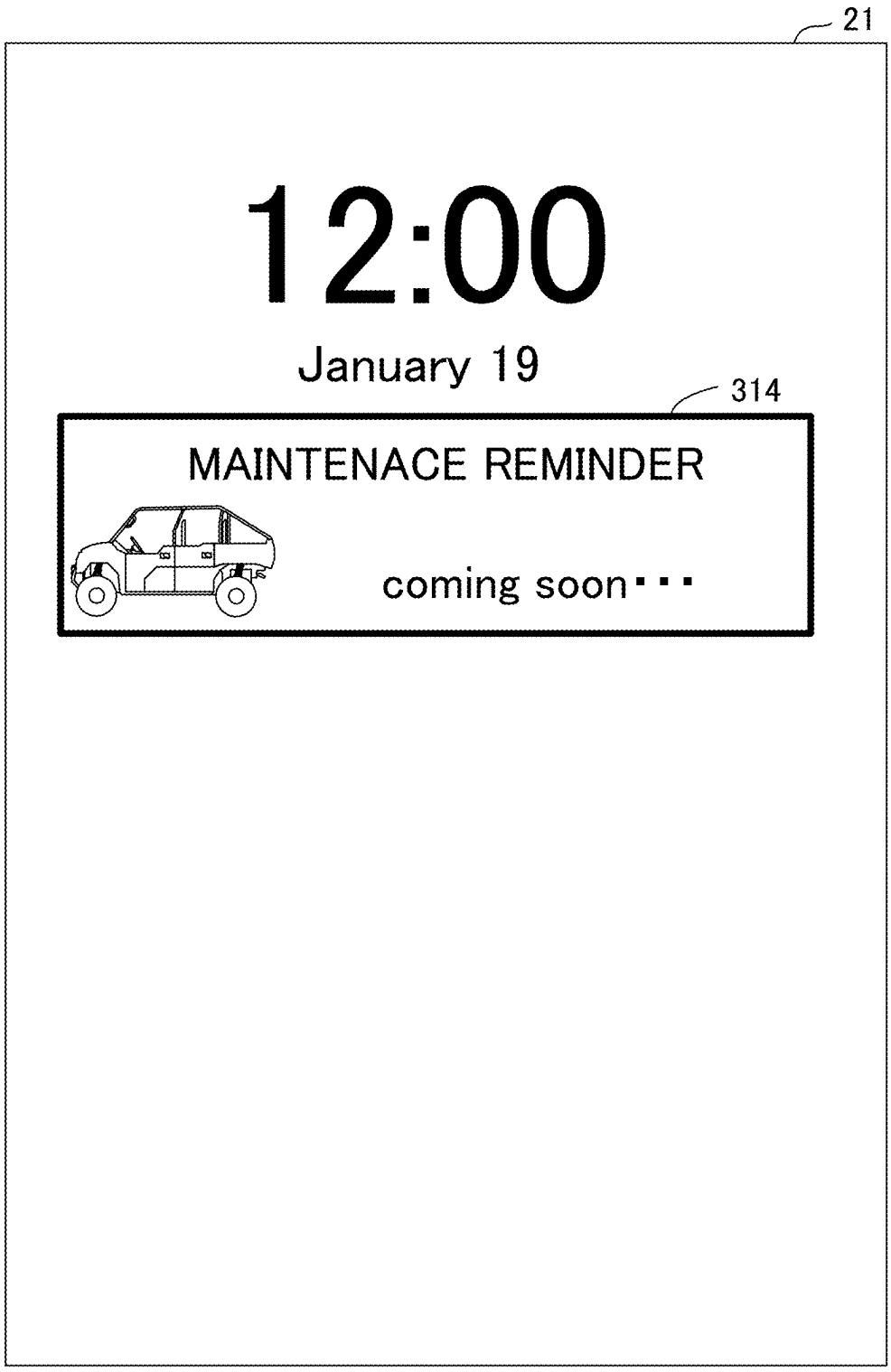


FIG.7

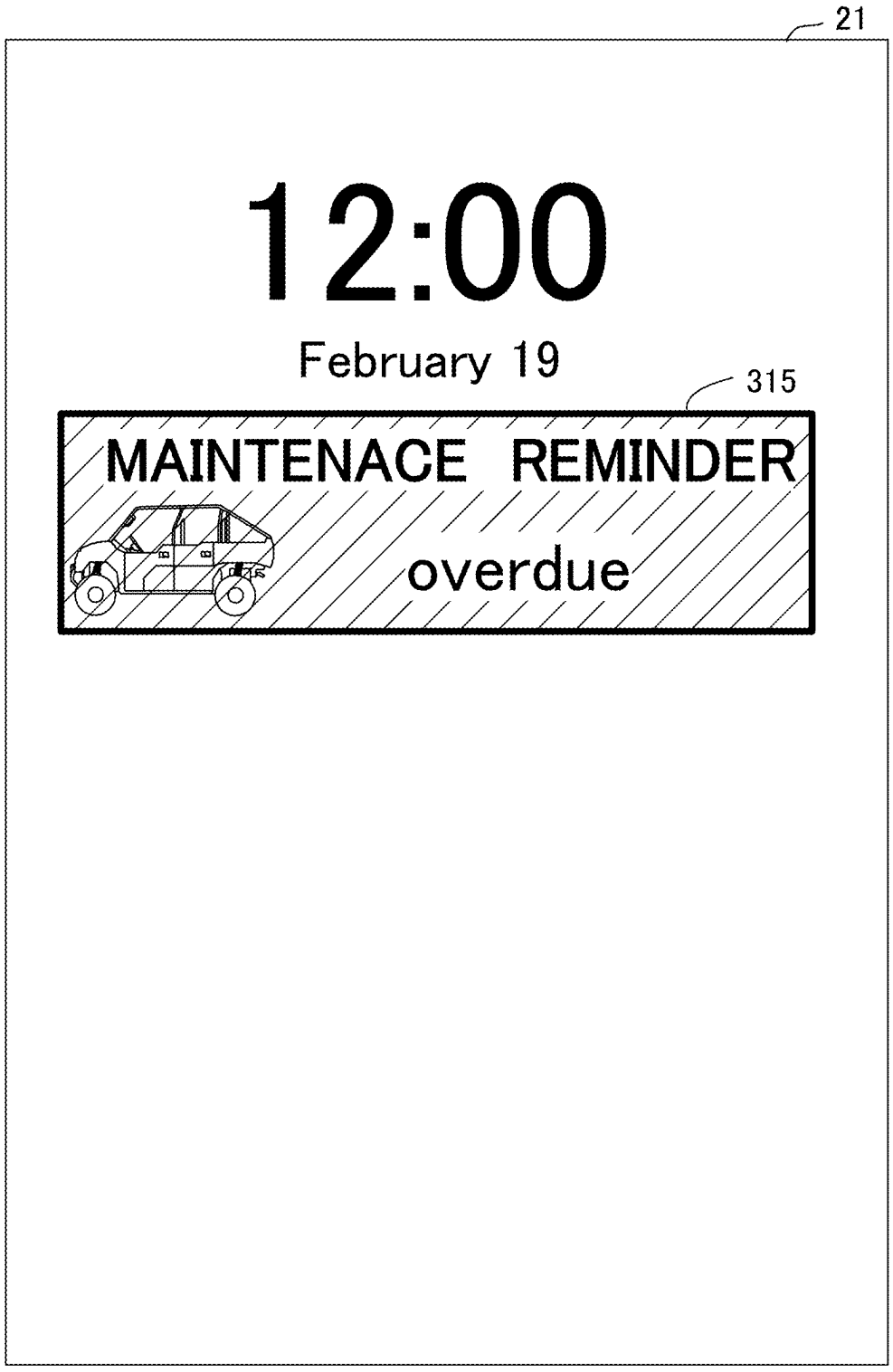


FIG.8

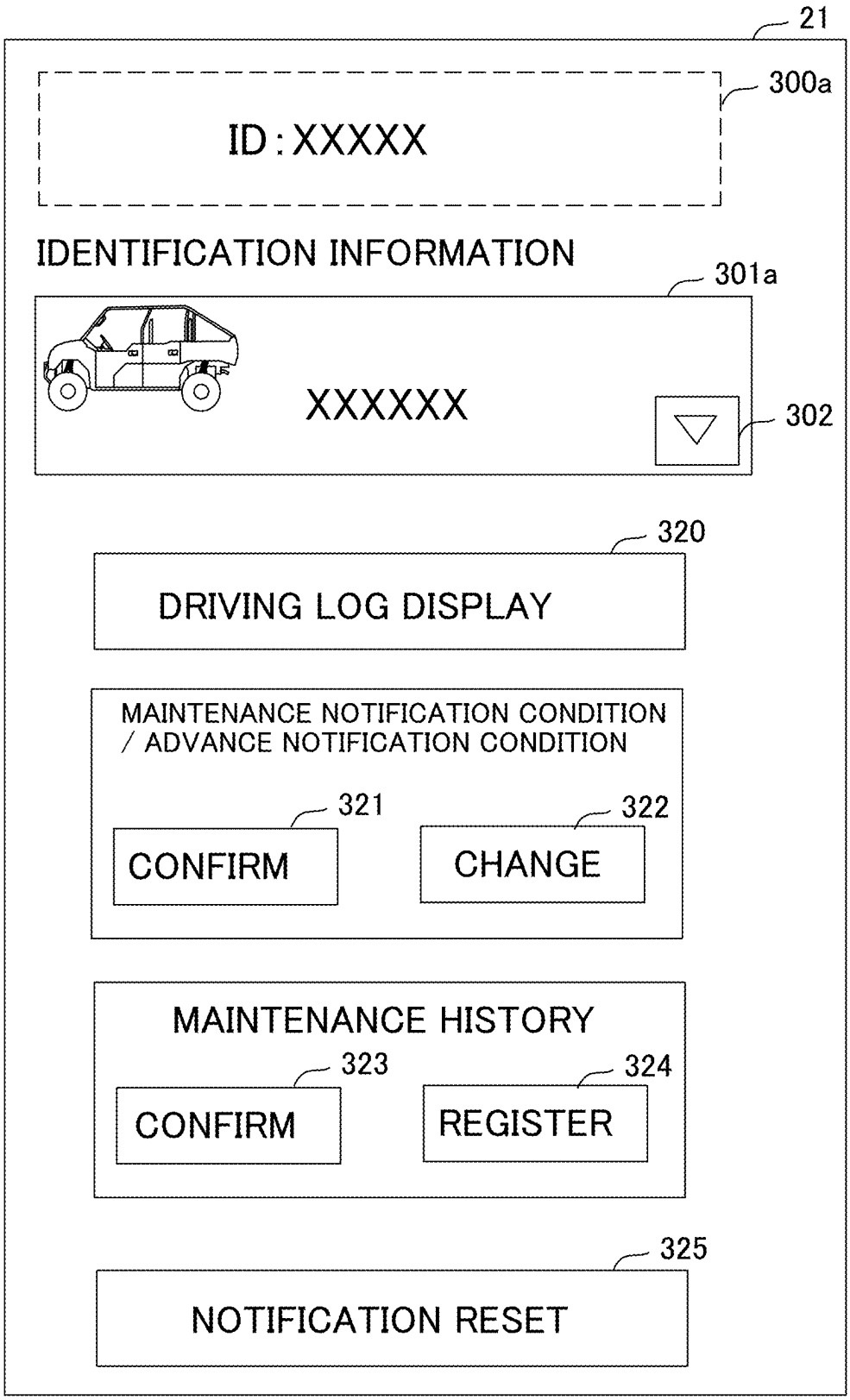

21
300a
ID : XXXXX
IDENTIFICATION INFORMATION
301a
XXXXXX
302
320
DRIVING LOG DISPLAY
MAINTENANCE NOTIFICATION CONDITION / ADVANCE NOTIFICATION CONDITION
321
CONFIRM
322
CHANGE
MAINTENANCE HISTORY
323
CONFIRM
324
REGISTER
325
NOTIFICATION RESET

FIG.9

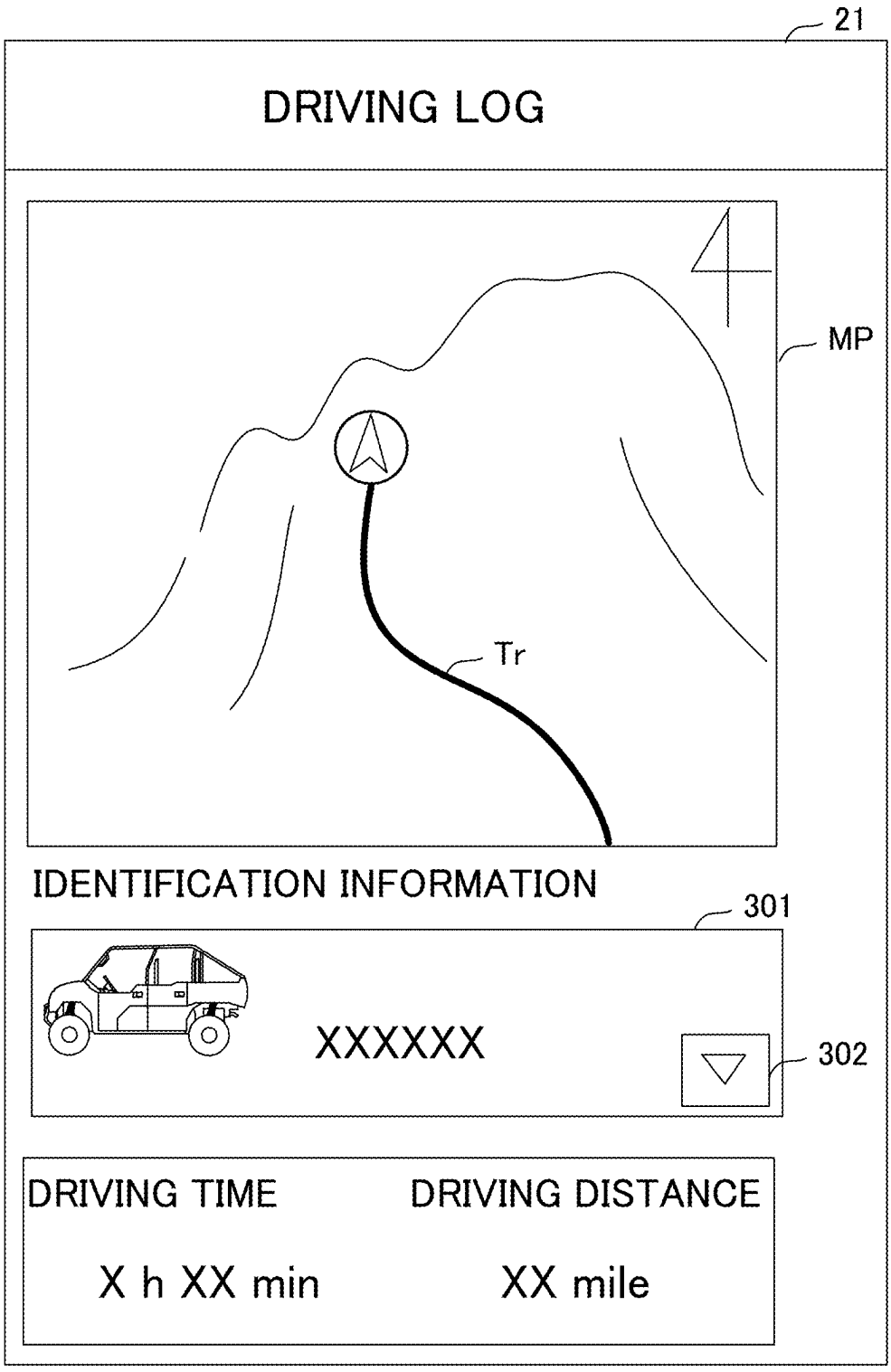

21
DRIVING LOG
MP
Tr
IDENTIFICATION INFORMATION
301
XXXXXX
302
DRIVING TIME
X h XX min
DRIVING DISTANCE
XX mile

FIG.10

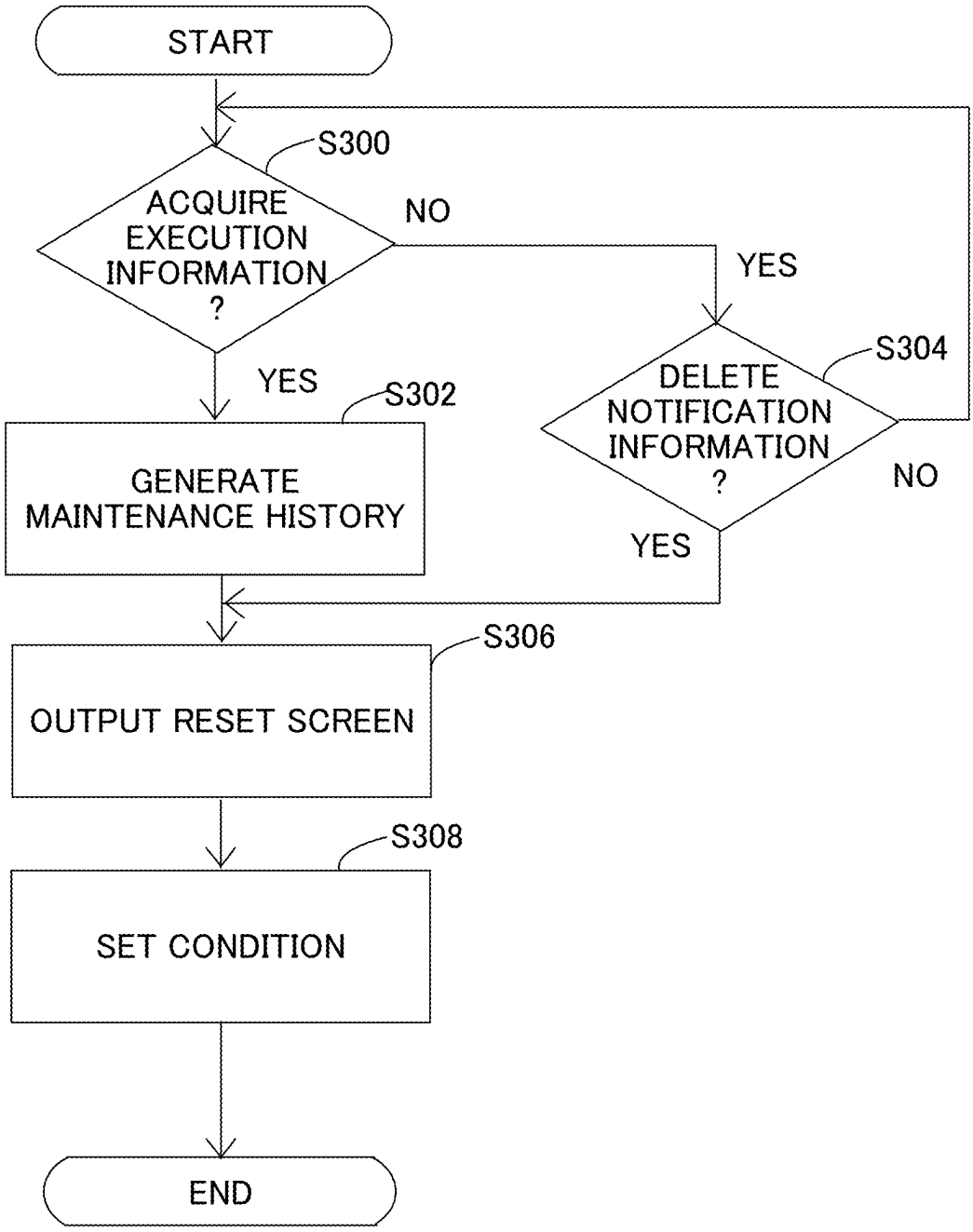

START
S300
ACQUIRE EXECUTION INFORMATION ?
NO
YES
YES
S302
GENERATE MAINTENANCE HISTORY
S304
DELETE NOTIFICATION INFORMATION ?
NO
YES
S306
OUTPUT RESET SCREEN
S308
SET CONDITION
END

FIG.11

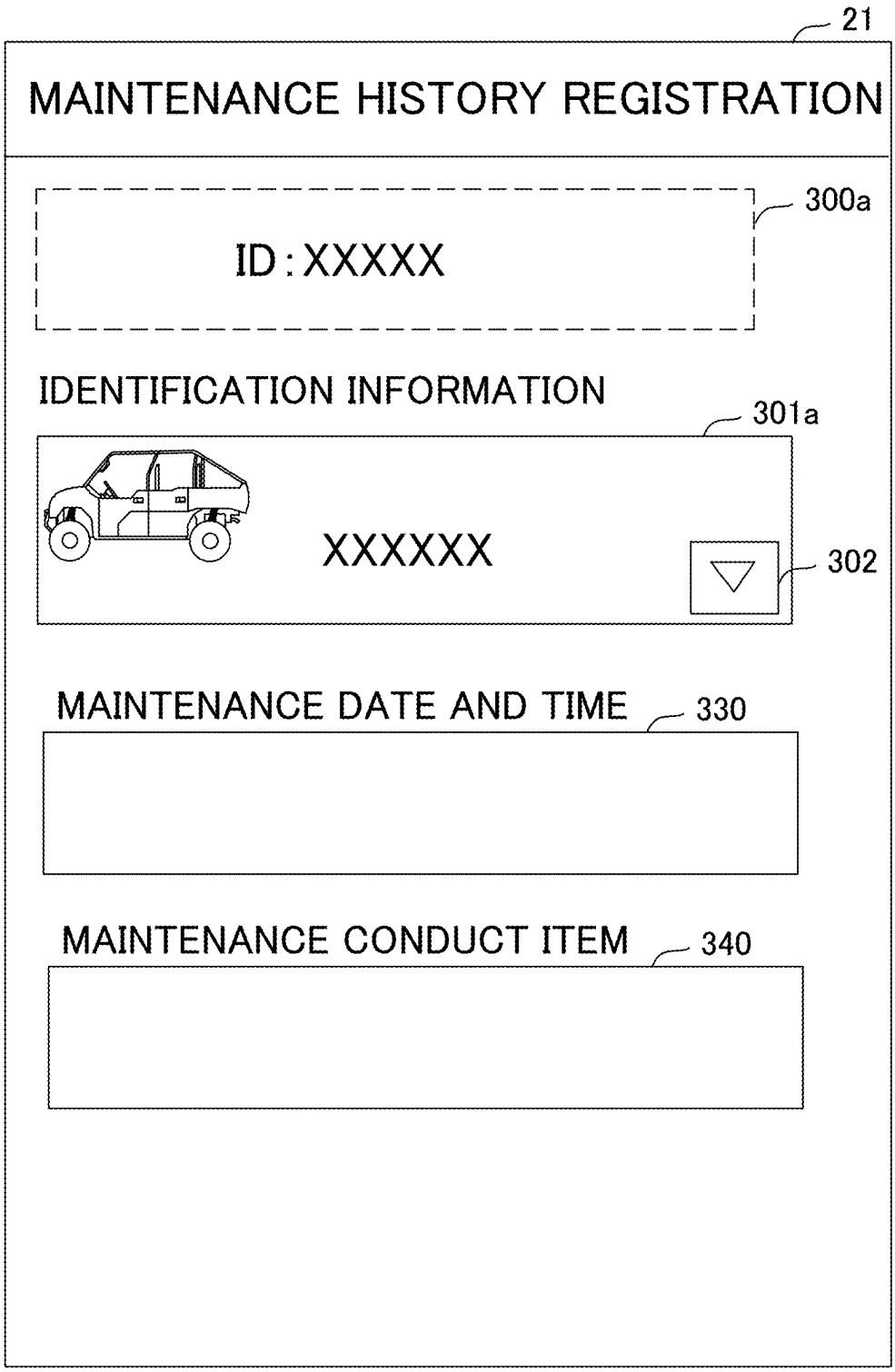
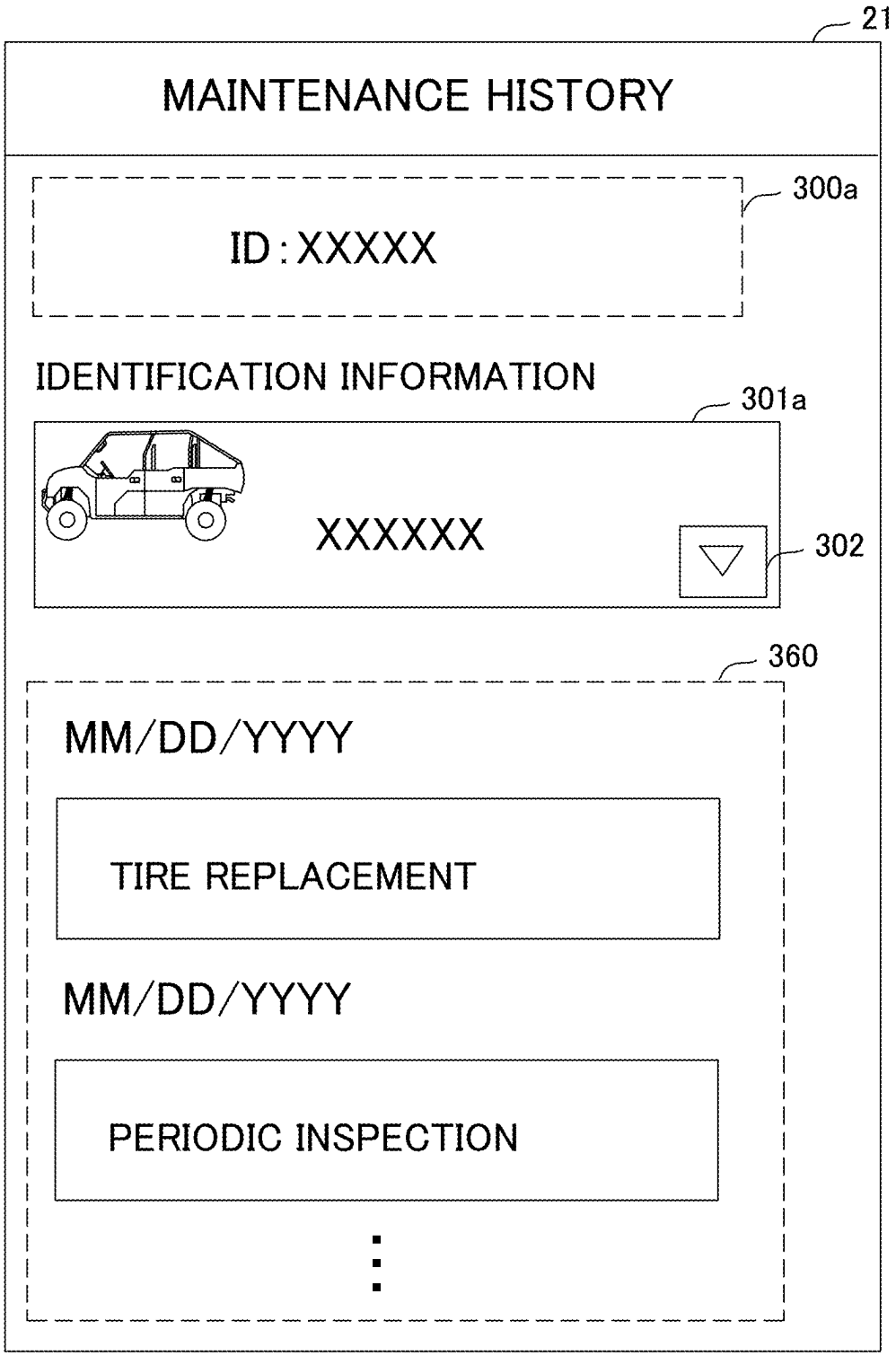

21
MAINTENANCE HISTORY REGISTRATION
300a
ID : XXXXX
IDENTIFICATION INFORMATION
301a
XXXXXX
302
MAINTENANCE DATE AND TIME
330
MAINTENANCE CONDUCT ITEM
340

FIG.12


21
MAINTENANCE HISTORY
300a
ID : XXXXX
IDENTIFICATION INFORMATION
301a
XXXXXX
302
360
MM/DD/YYYY
TIRE REPLACEMENT
MM/DD/YYYY
PERIODIC INSPECTION

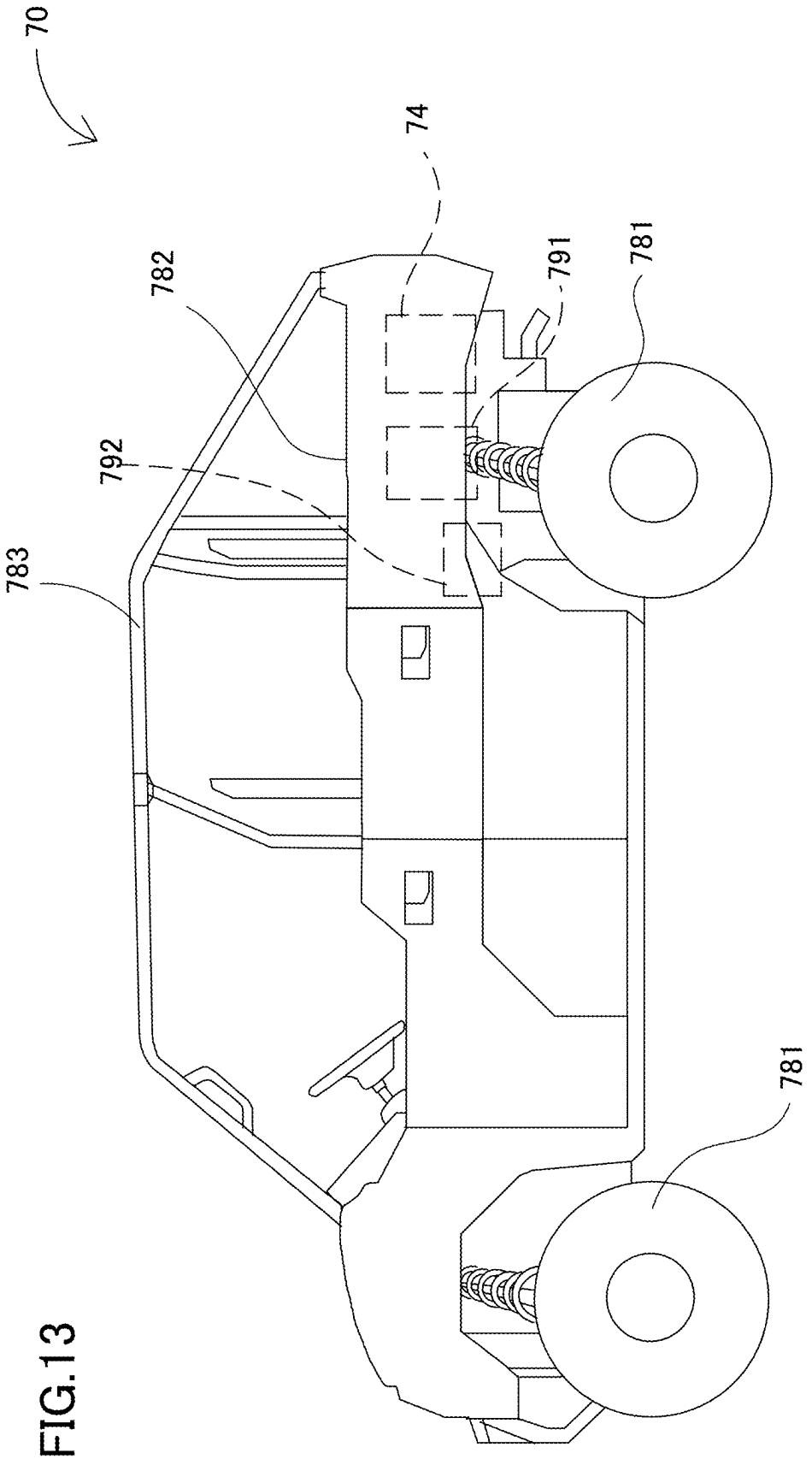


FIG.13

NOTIFICATION METHOD AND NOTIFICATION SYSTEM

TECHNICAL FIELD

[0001] The present disclosure relates to a notification method and a notification system that each issue a notification of the arrival of the maintenance of a vehicle.

BACKGROUND

[0002] As technology related to the maintenance of a wheeled vehicle, JP 2002-12132A describes a method in which a processing unit sets the next inspection time on the basis of data inputted to an input terminal of a management company of the wheeled vehicle.

SUMMARY

[0003] It is desired to notify a user of the maintenance of a vehicle at an appropriate timing.

[0004] An object of the present disclosure is to notify a user of the maintenance of a vehicle at an appropriate timing.

[0005] According to a first aspect of the present disclosure, there is provided a notification method of issuing a notification of arrival of maintenance of a vehicle. The notification method includes: acquiring, by a portable device, driving information from the vehicle through communication, the driving information indicating a driving state of the vehicle; and outputting notification information regarding the maintenance of the vehicle to a notification device included in the portable device in case that the driving information satisfies a predefined notification condition.

[0006] It is to be noted that the vehicle is a mobile object that includes a propulsion source such as an engine which is an internal combustion engine or an electric motor, and is movable with a user therein in this aspect.

[0007] According to a second aspect of the present disclosure, there is provided a notification system that issues a notification of arrival of maintenance of a vehicle. The notification system includes: a portable device including a notification device; and a vehicle that is communicable with the portable device. The portable device acquires driving i from the vehicle through communication, the driving information indicating a driving state of the vehicle, and outputs notification information regarding maintenance of the vehicle to the notification device in case that the driving information satisfies a predefined notification condition.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. **1** is a schematic configuration diagram of a notification system in an embodiment;

[0009] FIG. **2** is a diagram illustrating a flow of initial setting processing that is executed by a second controller;

[0010] FIG. **3** is a diagram illustrating an example of an initial setting screen that is outputted to a display of a portable device;

[0011] FIG. **4** is a diagram illustrating a flow of notification processing;

[0012] FIG. **5** is a diagram illustrating a flow of notification determination processing;

[0013] FIG. **6** is a diagram illustrating an example of advance notification information outputted to the display of the portable device;

[0014] FIG. **7** is a diagram illustrating an example of maintenance notification information outputted to the display of the portable device;

[0015] FIG. **8** is a diagram illustrating an example of an operation screen of a maintenance application;

[0016] FIG. **9** is a diagram illustrating an example of a driving log that is outputted to the portable device;

[0017] FIG. **10** is a diagram illustrating a flow of post-notification processing that is executed after notification information is outputted;

[0018] FIG. **11** is a diagram illustrating an example of an operation screen in which contents of maintenance are registered;

[0019] FIG. **12** is a diagram illustrating an example of a maintenance history that is outputted to the portable device; and

[0020] FIG. **13** is a diagram illustrating a utility vehicle serving as an example of a vehicle.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Embodiment

[0021] A notification system **10** serving as an embodiment of the present disclosure illustrated in FIG. **1** chiefly includes a vehicle **70** and a portable device **20** that wirelessly communicates with the vehicle **70**. The notification system **10** notifies a user of the portable device **20** of the arrival of the maintenance of the vehicle **70**. Specifically, the notification system **10** outputs notification information regarding maintenance to a notification device of the portable device **20**. The portable device **20** in the present embodiment is a communication terminal that is carriable with a user. In the present embodiment, the portable device **20** is implemented as a mobile phone (Cell Phone) capable of making a call through a public line.

[0022] The vehicle **70** includes a mobile object that includes a propulsion source which drives a driving wheel and allows an occupant to move. In the present embodiment, the vehicle **70** is a utility vehicle (UV). The utility vehicle is an off-roading wheeled vehicle that chiefly travels in unpaved mountain roads or forest roads, muddy areas or rocky areas, or the like in addition to grassland, gravel roads, farm land, and sandy areas. A utility vehicle exemplified in FIG. **13** includes low pressure tires **781**, in other words, balloon tires. This makes it easier to suppress, even in case that the utility vehicle travels on an uneven road surface, a shake that is given to an occupant and increase the ground contact area between each tire and the road surface. The utility vehicle includes a cargo bed **782** that is loaded with luggage to carry out luggage transportation work. This makes it possible to carry out various kinds of work such as luggage transportation, hunting, agriculture, livestock, security, and snow removal in addition to means of transporting an occupant outdoors. In the present embodiment, the vehicle **70** includes an engine **74** as a propulsion source. The engine **74** is an internal combustion engine.

[0023] The vehicle **70** included in the notification system chiefly includes a first control device **100**, a first communication portion **71**, a detection portion **72**, an engine ECU **73** and the engine **74**, and a meter ECU **75** and a meter **76**. The first control device **100** is mutually connected to the first communication portion **71**, the detection portion **72**, the

engine ECU **73** and the engine **74**, and the meter ECU **75** and the meter **76** through a CAN (Controller Area Network) bus **77**.

[0024] The first communication portion **71** transmits and receives wireless signals to and from a second communication portion **30** included in the portable device **20** under the control of the first control device **100**. For example, the first communication portion **71** includes an antenna that transmits and receives wireless radio waves and a communication circuit that transmits and receives wireless radio waves including predefined information. For example, the communication circuit may be implemented as an RF circuit that modulates predetermined information to radio signals to transmit the predetermined information and demodulates radio signals to extract predetermined information. The first communication portion **71** is configured to be capable of communicating with the portable device **20** carried by a user positioned in the riding space of the vehicle **70**. In the present embodiment, the first communication portion **71** includes a BLE communication device. The BLE communication device transmits and receives wireless signals through a BLE communication antenna provided to the vehicle **70** by using the BLE (Bluetooth Low Energy (R)) standard. As another embodiment, the first communication portion **71** may include a communication device that transmits and receives wireless signals by using not only the BLE standard, but also another wireless communication standard such as a Wi-Fi (Wireless Fidelity (R)) standard, an infrared communication standard, an RFID (Radio Frequency Identification) standard, or an NFC (Near Field Communication) standard.

[0025] The detection portion **72** is implemented as a sensor that detects information related to the driving of the vehicle **70**. The information related to the driving of the vehicle **70** may include information indicating at least one of the traveling state of the vehicle **70**, the state of the propulsion source, or the operation state of a driver. Examples of a sensor that detects the traveling state of the vehicle **70** include a vehicle speed sensor, a wheel speed sensor of a front or rear wheel, a longitudinal acceleration sensor, an inertial sensor that detects a vehicle attitude or angular velocity, a sensor that detects a vertical vibration of the vehicle body, a sensor that detects the vertical acceleration of a wheel, and a vehicle position/attitude sensor including a GPS or a GNSS. Examples of a sensor that detects the state of the propulsion source include an engine speed sensor, a gear position sensor, a throttle angle sensor, an intake air temperature sensor, an oil temperature sensor, and an intake pressure sensor. Examples of a sensor that detects the operation state of a driver include an accelerator operation amount sensor, a brake operation amount sensor, and a gear shift operation sensor. The detection portion **72** outputs a result of detection to the first control device **100** while supplied with power from a battery mounted on the vehicle **70**.

[0026] The first control device **100** is configured as an ECU (Electronic Control Unit) including a CPU **101**, a first memory **110**, and an unillustrated interface. The CPU **101** is implemented as a processing circuit that functions as a first controller **105** by loading and executing a program stored in the first memory **110**. The first **110** memory stores, for example, identification information with which the vehicle **70** is identified. It is to be noted that the first memory **110** and various memories described below each include a volatile memory and a nonvolatile memory. The volatile memory may be a RAM (Random Access Memory). The nonvolatile memory may include at least one of an EEPROM (Electrically Erasable Programmable Read-Only Memory) or an HDD (Hard Disk Drive).

[0027] The first controller **105** executes notification control regarding at least the maintenance of the vehicle **70**. The notification control includes updating and saving a driving integrated value of the vehicle **70** and transmitting the driving integrated value through the first communication portion **71**.

[0028] Control that is executed by the first controller **105** to update and save a driving integrated value will be described. In the present embodiment, the first controller **105** includes a timer and detects elapsed time. In addition, the first controller **105** calculates the traveling speed of the vehicle **70** on the basis of the detected wheel rotation speed or positional information about the wheeled vehicle. In the present embodiment, the first controller **105** receives a result of the detection by the detection portion **72** and calculates a driving integrated value that increases along with the driving of the vehicle **70**. The first controller **105** stores the calculated driving integrated value in the nonvolatile memory of the first memory **110**.

[0029] The control to update and save a driving integrated value will be described more specifically. The first controller **105** reads out, from the first memory **110**, driving integrated values stored in the past. The first controller **105** adds values to be newly integrated to the read driving integrated values on the basis of results of detection by the detection portion **72** and updates the driving integrated values. The first controller **105** replaces the driving integrated values in the first memory **110** with the updated driving integrated values and stores the updated driving integrated values. In the present embodiment, the driving integrated values are total driving distance and total driving time. The total driving distance corresponds to accumulated movement distance indicating the movement made with the propulsion source from manufacturing the vehicle **70** to detecting the newest value by the detection portion **72**. The total driving time corresponds to accumulated movement time for which the propulsion source is driven from manufacturing the vehicle **70** to detecting the newest value by the detection portion **72**. The total driving distance and the total driving time described above each correspond to "driving information" according to the present disclosure.

[0030] Next, control that is executed by the first controller **105** through the first communication portion **71** to transmit a driving integrated value will be described. The first controller **105** determines whether or not an output request condition of the driving information is satisfied. Each time the first controller **105** determines that the output requirement is satisfied, the first controller **105** transmits the driving information about the vehicle **70** to the portable device **20** through the first communication portion **71**. The output request condition of the driving information may be, for example, that the portable device **20** is positioned within the communication range of the first communication portion **71** or that the first communication portion **71** receives a predetermined signal from the portable device **20**.

[0031] It is to be noted that it is sufficient if the first controller **105** includes the above-described functions of updating and saving a driving integrated value and transmitting the driving integrated value through the first com-

munication portion **71**. The first controller **105** may be provided to an entity different from an existing control device in the vehicle **70** or may be integrally provided to the existing control device. For example, the first controller **105** may be implemented as one of the functions of the engine ECU **73**, the meter ECU **75**, the first communication portion **71**, or the like.

[0032] Next, the portable device **20** will be specifically described. Application software that issues a notification of the arrival of the maintenance of the vehicle **70** is installed in the portable device **20**. The following also refers to this application as a maintenance application. It is possible for a user to receive a notification of the arrival of maintenance from the portable device **20** by starting the maintenance application. In addition, even in case that the maintenance application is not started, it is possible for the user to receive a notification of the arrival of maintenance from the portable device **20** by setting the permission of a push function in the portable device **20** in advance.

[0033] In the present embodiment, the portable device **20** includes a display **21**, a speaker **22**, a microphone **23**, a second control device **40**, and the second communication portion **30** as hardware components. The respective portions **21**, **22**, **23**, **40**, and **30** are connected to each other by a bus **25**.

[0034] The second communication portion **30** is configured to be capable of communicating with the first communication portion **71**. As with the first communication portion **71**, the second communication portion **30** includes an antenna that transmits and receives wireless radio waves and a communication circuit that transmits and receives wireless radio waves including predefined information. In the present embodiment, the second communication portion **30** includes a BLE communication circuit. It is preferable that the second communication portion **30** further include a wireless communication circuit which wirelessly communicates with a server **200** connected to the Internet.

[0035] The second control device **40** is configured as a computer including a CPU **50**, a second memory **60**, and an unillustrated interface. The CPU **50** functions as a second controller **51** by loading and executing a program stored in the second memory **60**. The second controller **51** executes maintenance-related notification processing of issuing a notification of the arrival of maintenance. In addition, the second controller **51** controls the display **21** or the speaker **22** to cause the display **21** or the speaker **22** to output various kinds of information. The display **21** and the speaker **22** each correspond to a "notification device" that notifies a user of maintenance information. In addition, in the present embodiment, the display **21** functions as a touch screen. The following chiefly uses the display **21** as the notification device. It is to be noted that the second controller **51** causing the notification device to output information specifically corresponds to the second controller **51** transmitting, to the notification device, a command to cause information to be outputted and the notification device issuing a notification of the information in accordance with the command. In addition, the second controller **51** receives an input operation (input command) by a user through the touch screen function of the display **21** or an input operation such as a voice instruction through the microphone **23**. In this case, the display **21** and the microphone **23** each correspond to an "input device" that receives an operation by a user.

[0036] As illustrated in FIG. **1**, the notification system **10** according to the present embodiment further includes the server **200**. The server **200** is installed at a facility apart from the vehicle **70**. The server **200** includes a third communication portion **202** and a third control device **210**. The third communication portion **202** includes a communication circuit that communicates with the portable device **20** through a base station. The portable device **20** is connected to the Internet. The third control device **210** is configured as a computer including a CPU **211**, a third memory **220**, and an unillustrated interface. The CPU **211** functions as a third controller **213** by loading and executing a program stored in the third memory **220**.

[0037] It is possible for the server **200** to acquire pieces of information from the plurality of respective portable devices **20** in each of which application software that issues a notification of the arrival of maintenance is installed. It is preferable that the server **200** tally up and classify the pieces of information acquired from the respective portable devices and store the pieces of information in a database. In addition, the server **200** may be configured to be capable of transmitting information in the database to another server different from the server **200** in response to a request. The other server may be provided, for example, in at least one of a management group that manages the vehicle **70**, a sales company, a maintenance company, or a vehicle manufacturing company.

[0038] The third memory **220** stores a driving log or a maintenance history transmitted from the portable device **20**. The driving log and the maintenance history will be described below. It is to be noted that the server **200** is not an essential component in the notification system **10**. In another embodiment, the server **200** may be omitted.

[0039] The following describes the maintenance-related notification processing (that will also be referred to as "notification processing" below) that is executed by the second controller **51** of the portable device **20**. The second controller **51** executes initial setting processing before the notification processing when the application is started for the first time.

[0040] FIG. **2** illustrates a flow of the initial setting processing. In the initial setting processing, the second controller **51** of the portable device **20** sets an account including a user ID (step S**10**), sets a maintenance notification condition (step S**20**), and sets an advance notification condition (step S**30**). The maintenance notification condition and the advance notification condition each correspond to a "notification condition".

[0041] In the present embodiment, the second controller **51** outputs an initial setting screen as exemplified in FIG. **3** to the display **21**. In step S**10** (FIG. **2**), the second controller **51** prompts a user to register an account and input identification information about the vehicle **70**, for example, by displaying, for example, a cursor in an input region **300** of an account and an input region **301** of identification information (FIG. **3**). The identification information is a number unique to the vehicle **70**. In case that the vehicle **70** is a wheeled vehicle, the identification information is, for example, a vehicle identification number (VIN) that is individually set for each of wheeled vehicles. The second controller **51** (or the server **200** described below) generates link information in advance that associates the identification information transmitted from the wheeled vehicle and the user account information and stores the link information.

Upon acquiring the identification information from the wheeled vehicle, the second controller **51** refers to the link information and issues a maintenance notification in case that the acquired identification information is identification information associated with the user account. Executing various kinds of processing on the basis of the link information in this way offers an advantage that a maintenance notification is issued for a wheeled vehicle identified in advance even in case that the user uses a plurality of wheeled vehicles. In addition, it is advantageous that a maintenance notification is issued for a user identified in advance even in case that one wheeled vehicle is used by a plurality of users.

[0042] It is possible for the user to input the identification information about the vehicle **70** to the input region **301** of identification information by making an operation with the touch screen function of the display **21**. It is to be noted that the second controller **51** may acquire the identification information from the vehicle **70** by communicating with the vehicle **70** through the second communication portion **30**. The identification information does not have to be a vehicle identification number (VIN). For example, the identification information may be identification information that is set uniquely to the second communication portion **30**.

[0043] As illustrated in FIG. **3**, the input region **301** of identification information is provided with a pull-down tab **302**. It is possible for a user to associate a plurality of vehicles including different pieces of identification information with his or her own account (user ID) by operating the pull-down tab **302**. For example, it is possible to associate, in case that the user owns a plurality of vehicles, the respective vehicles with one account. In addition, in case that a plurality of vehicles is registered in an account, the user operates the tab **302** to select a vehicle. This allows the user to execute various operations regarding the maintenance of the selected vehicle **70** and obtain various kinds of information.

[0044] FIG. **2** will be referred to again. Once an account is set, the second controller **51** prompts a user to input a maintenance notification condition in step S**20**, for example, by displaying a cursor in an input region **305** of a maintenance notification condition (FIG. **3**). In the present embodiment, the maintenance notification condition may include at least one of (i) preset maintenance notification time being reached by count time that is the time obtained by counting the driving time of the vehicle **70** from a predetermined time (referred to as a starting time below) or (ii) preset maintenance notification distance being reached by count distance that is the distance obtained by counting the driving distance of the vehicle **70** from the starting time. In addition, the maintenance notification condition may include a preset maintenance date and time being reached by the detected current date and time. For example, the plurality of maintenance notification conditions may be set. In this case, in case that the plurality of conditions includes a condition that is achieved the earliest (that is, any one of the plurality of conditions is achieved), the second controller **51** may determine that the maintenance notification conditions are satisfied. In addition, a default value may be set for a maintenance condition such as maintenance distance or maintenance time. Alternatively, a user may optionally select a maintenance condition. In addition, a maintenance notification condition is not only selected by a user, but may also be individually set for each wheeled vehicle in accordance with the use frequency of the vehicle, the traveling operation tendency of a driver, or the tendency of a load on the wheeled vehicle.

[0045] When the maintenance application is set for the first time, the starting time in (i) and (ii) above may be the date and time of the first setting. The count time and the count distance are the time and the distance obtained by counting again the total driving time and the total driving distance on the basis of the starting time. As illustrated in FIG. **3**, an input region **306** of maintenance notification time and an input region **307** of maintenance notification distance are indicated in the input region **305** of a maintenance notification condition. The maintenance notification condition is set by inputting time or distance desired by a user to at least one of the input region **306** or the input region **307**. It is to be noted that default distance and time may be displayed in the input regions **306** and **307** in another embodiment. In this case, it is possible for the user to set the maintenance notification time and the maintenance notification distance by selecting or changing the default distance and time. It is to be noted that the count time and the count distance each correspond to a "count amount". In addition, the maintenance notification time and the maintenance notification distance each correspond to a "first setting value".

[0046] Once a maintenance notification condition is set, the second controller **51** prompts a user to input an advance notification condition in step S**30**, for example, by displaying a cursor in an input region **309** of an advance notification condition. In the present embodiment, the advance notification condition may include at least one of (iii) the count time reaching advance notification time shorter than the maintenance notification time or (iv) the count distance reaching advance notification distance shorter than the maintenance notification distance. A plurality of conditions may be set as such advance notification conditions. In this case, in case that the plurality of conditions includes a condition that is achieved the earliest (that is, any one of the plurality of conditions is achieved), the second controller **51** may determine that the advance notification conditions are satisfied. It is to be noted that the advance notification time and the advance notification distance each correspond to a "second setting value". As illustrated in FIG. **3**, an input region **310** of notification time and an input region **311** of notification distance are indicated in the input region **309** of an advance notification condition. The advance notification condition is set by inputting desired time or distance to at least one of the items of the input regions **310** and **311** corresponding to the maintenance notification conditions. In another embodiment, the advance notification distance and the advance notification distance may be predefined in relation to the maintenance notification time and the maintenance notification distance. For example, the advance notification time may be time that is ten hours shorter than the maintenance notification time. For example, the advance notification distance may be the distance that is 100 miles (miles) shorter than the maintenance notification distance. For example, the advance notification date and time may be one week earlier than the maintenance date and time. The values of such advance notification time and advance notification distance are examples and other values may be adopted. In addition, a default value may be set for an advance notification condition such as advance notification distance or advance notification time. Alternatively, a user may selectively select an advance notification condition. In addition, an advance

notification condition is not only selected by a user, but may also be individually set for each wheeled vehicle in accordance with the use frequency of the vehicle, the traveling operation tendency of a driver, or the tendency of a load on the wheeled vehicle.

[0047] In the present embodiment, the second controller **51** further prompts a user to input a maintenance item in step S**20** or step S**30**, for example, by displaying a cursor in an input region **313** of a maintenance item. It is possible for the user to input a desired maintenance item, a memorandum related to the maintenance, and the like to the input region **313**. Examples of maintenance items include engine oil, an oil filter, gear case oil, a brake pad, a brake fluid, a coolant, tire replacement, tire inflation pressure, an air cleaner, a wheel part, a CVT belt, and the like as a periodic inspection example in case that the vehicle **70** is a utility vehicle or a motorcycle. It is to be noted that the third memory **220** of the server **200** may store the relationship between the identification information, and the type of vehicle and a maintenance item (e. g., each part) corresponding to the identification information in another embodiment. In addition, the third memory **220** may store the default values of a maintenance notification condition and an advance notification condition for each piece of identification information. The second controller **51** may assist a user in performing an operation (setting operation) of inputting a maintenance item by transmitting the identification information about the vehicle **70** to the server **200** and acquiring the maintenance item and the default values of the vehicle **70** corresponding to the identification information to make an output to the input region **313**.

[0048] Once a maintenance notification condition (step S**20**) and an advance notification condition (step S**30**) are set as described above, the portable device **20** stores the maintenance notification condition and the advance notification condition in the second memory **60** in association with the account and the identification information set in step S**10** and ends the initial setting processing.

[0049] After the initial setting processing ends, the second controller **51** executes the notification processing illustrated in FIG. **4** in case that the maintenance application is on. The second controller **51** of the portable device **20** first determines in step S**100** whether or not communication with the vehicle **70** is established. For example, the second controller **51** transmits a request signal including the identification information stored in the second memory **60** to the vehicle **70** through the second communication portion **30**. If the first controller **105** of the vehicle **70** is supplied with power from a battery, the first controller **105** receives the request signal through the first communication portion **71**. In case that the identification information included in the received request signal matches the identification information about the vehicle **70** stored in the first memory **110**, the first controller **105** transmits a response signal. In case that the second controller **51** receives the response signal, the second controller **51** advances the processing to step S**102**.

[0050] In step S**102**, the second controller **51** acquires driving information from the vehicle **70**. In the present embodiment, the second controller **51** transmits a request signal to the **70** through the second communication portion **30**. The request signal requests the transmission of the driving information. The first controller **105** of the vehicle **70** transmits the total driving time and the total driving distance to the portable device **20** in response to the request signal acquired through the first communication portion **71**. The total driving time and the total driving distance are pieces of driving information stored in the first memory **110**.

[0051] In step S**200**, the second controller **51** executes notification determination processing. The notification determination processing is processing of determining with the pieces of driving information acquired from the vehicle **70**, and the set maintenance notification condition and advance notification condition whether or not to output the information regarding the maintenance to the notification device of the portable device **20** and outputting the information regarding the maintenance in accordance with a result of the determination.

[0052] FIG. **5** is a flowchart of the notification determination processing. In step S**201**, the second controller **51** determines whether or not an advance notification condition is satisfied. In the present embodiment, as described above, the advance notification condition may be at least one of (iii) the count time reaching the advance notification time or (iv) the count distance reaching the advance notification distance. The second controller **51** calculates the count time and the count distance based on the starting time stored in the second memory **60** by using the pieces of driving information acquired from the vehicle **70**. The second controller **51** determines (iii) and (iv) above by using the calculated count time and count distance. In case that at least one of (iii) or (iv) above is satisfied, the second controller **51** makes an affirmative determination for step S**201** and advances the processing to step S**203**. Meanwhile, in case that none of the advance notification conditions are not satisfied (NO in step S**201**), the second controller **51** ends the notification determination processing in step S**200**.

[0053] In case that the advance notification condition is satisfied (YES in step S**201**), the second controller **51** further determines in step S**203** whether or not the maintenance notification condition is satisfied. As described above, the maintenance notification condition in the present embodiment is at least one of (i) the count time reaching the maintenance notification time or (ii) the count distance reaching the maintenance notification distance. As in step S**201**, the second controller **51** determines (i) and (ii) above by using the calculated count time and count distance. In case that none of (i) or (ii) above are satisfied, the second controller **51** makes a negative determination for step S**203** and advances the processing to step S**205**.

[0054] In step S**205**, the second controller **51** outputs advance notification information to the display **21**. The advance notification information is information that is outputted to the notification device of the portable device **20** in case that the advance notification condition is satisfied (YES in step S**201**) and in case that the maintenance notification condition is not satisfied (NO in step S**203**). The advance notification information is information that notifies a user that a maintenance time of the vehicle **70** registered in the maintenance application is coming closer. FIG. **6** illustrates a first push notification **314** that is outputted to the display **21** as an example of the advance notification information. It is to be noted that a push notification including the first push notification **314** is displayed on the display **21** of the portable device **20** by a user setting the permission of the push function in the portable device **20** in advance as described above even in case that the maintenance application is not on.

[0055] In contrast, in case that at least one of (i) or (ii) above is satisfied, the second controller **51** makes an affirmative determination for step S**203** and advances the processing to step S**207**. In step S**207**, the second controller **51** outputs maintenance notification information to the display **21**. The maintenance notification information is information that is outputted to the notification device of the portable device **20** in case that the maintenance notification condition is satisfied (YES in step S**203**). The output aspect of the maintenance notification information is different from that of the advance notification information. The maintenance notification information is information that notifies a user that a maintenance time of the vehicle **70** registered in the maintenance application has already arrived. The maintenance notification information is configured in an emphasized display aspect as compared with that of the advance notification information. Specifically, FIG. **7** illustrates a second push notification **315** that is outputted to the display **21** as an example of the maintenance notification information. As illustrated in FIGS. **6** and **7**, the character size, the color, or the like of the second push notification **315** is emphasized more than that of the first push notification **314**. In another embodiment, the second controller **51** may output sound related to the advance notification information or the maintenance notification information with sound by the speaker **22** or vibration by a vibrator instead of or in addition to outputting the first push notification **314** or the second push notification **315** to the display **21**. In addition, the second controller **51** may issue a notification of each piece of notification information at a timing when the second controller **51** determines that the portable device **20** is operated after driving of the vehicle **70** (drive state) is terminated. This causes a notification of each piece of notification information to be issued at a timing at which a driver does not have to pay attention to driving the vehicle **70**. It is thus possible to make the user more conscious of the notification information.

[0056] Upon executing the notification determination processing illustrated in FIG. **5**, the second controller **51** advances the notification processing in FIG. **4** to step S**210** and generates a driving log by using the acquired driving information. The driving log is a history regarding the driving state of the vehicle **70** from turning on the engine **74** of the vehicle **70** to turning off the engine **74** of the vehicle **70**. In the present embodiment, the portable device **20** includes a sensor such as a GPS that measures a self-position. In addition, the second memory **60** of the portable device **20** stores map information. The second controller **51** uses the self-position, the map information stored in the second memory **60**, and the driving information acquired from the vehicle **70** to generate, as a driving log, a movement trajectory of the vehicle **70**, and the driving time and the driving distance from starting to acquire the driving information about the vehicle **70**. In addition, the second controller **51** serially stores the generated driving log in the second memory **60**. It is to be noted that the self-position with which a movement trajectory is generated does not have to be the self-position of the portable device **20**. The second controller **51** may acquire the self-position of the vehicle **70** from the vehicle **70** along with the driving information and generate a driving log by using the self-position of the vehicle **70**.

[0057] FIG. **8** is a diagram illustrating an example of an operation screen of the maintenance application that is displayed on the display **21**. In FIG. **8**, a user ID **300***a*, identification information **301***a* of the vehicle **70**, and various operation buttons including a driving log display button **320** are outputted. The second controller **51** outputs the operation screen exemplified in FIG. **8** to the display **21** in case that the maintenance application is started after the initial setting processing ends. The second controller **51** outputs a driving log to the display **21** in case that the driving log display button **320** receives an on operation. FIG. **9** is a diagram illustrating an example of a driving log that is outputted to the display **21**. In FIG. **9**, a map MP obtained by superimposing a movement trajectory Tr of the vehicle **70** on map information, and the driving time and the driving distance from turning on the engine **74** of the vehicle **70** are outputted as a driving log.

[0058] FIG. **8** further illustrates a confirm button **321** of a maintenance notification condition and an advance notification condition, a change button **322** of these conditions, a confirm button **323** of a maintenance history, a register button **324** of the maintenance history, and a notification reset button **325**. In case that the confirm button **321** of a maintenance notification condition and an advance notification condition receives an on operation, the second controller **51** outputs the current maintenance notification condition and advance notification condition to the display **21**. In addition, in case that the change button **322** of the conditions receives an on operation, the second controller **51** outputs, to the display **21**, an operation screen that receives a change from the current maintenance notification condition and advance notification condition. In case that at least one of the maintenance notification condition or the advance notification condition is changed, the second controller **51** executes again the notification determination processing in step S**200** by using the changed condition. The confirm button **323** and the register button **324** of a maintenance history and the notification reset button **325** will be described below.

[0059] FIG. **4** will be referred to again. Once a driving log is generated in step S**210**, the second controller **51** returns the notification processing to step S**100**. In case that communication with the vehicle **70** is established (YES in step S**100**), that is, while the supply of power to the first controller **105** is retained, the second controller **51** repeats the acquirement of driving information (step S**102**), the execution of the notification determination processing (step S**200**), and the generation of a driving log (step S**210**) at predetermined intervals. In case that communication with the vehicle **70** is interrupted (NO in step S**100**), that is, in case that the supply of power to the first controller **105** is interrupted, the second controller **51** ends the notification processing. It is to be noted that the second controller **51** may transmit the account and the identification information set in the initial setting processing, the maintenance notification condition, the advance notification condition, the driving information acquired in the notification processing, the driving log generated in the notification processing, and the like to the server **200** in case that communication with the server **200** is established.

[0060] The following describes post-notification processing that is executed subsequently to the notification processing after the second controller **51** outputs the advance notification information or the maintenance notification information in the notification processing.

[0061] FIG. **10** illustrates a flow of the post-notification processing. The second controller **51** determines in step

S300 whether or not execution information is acquired. The execution information is information regarding the execution of maintenance. In the present embodiment, the second controller **51** makes an affirmative determination for step S300 in case that the information regarding the execution of maintenance is inputted through the display **21** of the portable device **20**.

[0062] FIG. **11** is a diagram illustrating an operation screen that is an example of an operation screen of the maintenance application displayed on the display **21**. In the operation screen, the contents of maintenance are registered. The second controller **51** outputs the operation screen illustrated in FIG. **11** in case that the register button **324** of a maintenance history illustrated in FIG. **8** is turned on. The operation screen illustrated in FIG. **11** indicates the user ID **300***a*, the identification information **301***a* about the vehicle **70**, an input region **330** of a maintenance date and time, and an input region **340** of a maintenance conduct item. The second controller **51** prompts a maintenance date and time or a maintenance conduct item to be inputted, for example, by displaying a cursor in the input region **330** or **340**. In case that at least one of the maintenance date and time or the maintenance conduct item is inputted, the second controller **51** makes an affirmative determination for step S300 and resets the count time and the count distance.

[0063] The second controller **51** generates a maintenance history in step S302 by using the information acquired in step S300. The maintenance history is a history regarding a maintenance conduct date and time and a maintenance conduct item of the vehicle **70** up to now. The second controller **51** adds the information acquired in step S300 to maintenance history data generated in the past and generates the newest maintenance history. It is to be noted that the second controller **51** may transmit the generated maintenance history to the server **200** in case that communication with the server **200** is established.

[0064] FIG. **12** is an example of a maintenance history that is outputted to the display **21**. For example, in case that the confirm button **323** (FIG. **8**) of a maintenance history is turned on, the second controller **51** outputs the maintenance history generated in step S302 to the display **21**. FIG. **12** illustrates the user ID **300***a*, the identification information **301***a* about the vehicle **70**, and a correspondence relationship **360** between a maintenance conduct date and time and a maintenance conduct item. It is possible for a user to grasp a maintenance date and time and a maintenance item up to now by swiping, for example, on the region in which the correspondence relationship **360** is indicated.

[0065] FIG. **10** will be referred to again. In case that the second controller **51** does not acquire the execution information (NO in step S300), the second controller **51** determines in step S304 whether or not an operation of deleting the advance notification information or the maintenance notification information is performed. For example, in case that an operation of deleting the first push notification **314** or the second push notification **315** illustrated in FIG. **6** or **7** is performed or in case that the notification reset button **325** receives an on operation on the operation screen illustrated in FIG. **8**, the second controller **51** makes an affirmative determination for step S304 and resets the count time and the count distance. In case that the deleting operation is not executed (NO in step S304), the second controller **51** returns the post-notification processing to step S300. In this case, the second controller **51** continues outputting the advance notification information or the maintenance notification information until an affirmative determination is made for step S300 or step S304.

[0066] In step S306, the second controller **51** outputs a reset screen of a maintenance notification condition and an advance notification condition. The reset screen is a screen including the input region **305** of a maintenance notification condition and the input region **306** of an advance notification condition outputted to the display **21** by the second controller **51** in the initial setting processing. The second controller **51** outputs the reset screen to prompt a user to input a maintenance notification condition and an advance notification condition regarding the next maintenance. It is to be noted that the second controller **51** may output by default the maintenance notification condition and the advance notification condition set the last time.

[0067] Once the maintenance notification condition and the advance notification condition are reset, the second controller **51** stores the reset maintenance notification condition and advance notification condition in the second memory **60** and executes again the notification processing described in FIGS. **4** and **5** in step S308.

[0068] According to the embodiment described above, in case that the driving information acquired by the portable device **20** from the vehicle **70** satisfies a notification condition, the notification device of the portable device **20** outputs notification information regarding maintenance. There are many opportunities for the portable device **20** to approach the vehicle **70** along with a user who gets in the vehicle **70**. Thus, there are more opportunities for the portable device **20** to acquire the driving information from the vehicle **70** than a fixed device that is installed at a position apart from the vehicle **70**. This makes it possible to increase the update frequency of the driving information and issue a notification of maintenance at an appropriate timing.

[0069] Further, the portable device **20** is carried by a user in many cases even when apart from the vehicle **70**. This allows the user to quickly grasp the information regarding maintenance after driving the vehicle **70** in case that the portable device **20** issues a notification of the information regarding maintenance. This also makes it possible to issue a notification of maintenance at an appropriate timing. For example, in case that a driver is carrying the portable device **20**, the driver confirms the notification with the portable device **20** after driving. The driver does not have to pay attention to a driving operation after the driving. This allows the driver to grasp the contents of the notification more than confirming the contents of the notification while driving.

[0070] In addition, the driving information acquired from the vehicle **70** by the portable device **20** communicating with the vehicle **70** includes driving integrated values that increase along with the driving of the vehicle **70**. Specifically, the driving information includes driving time and driving distance. It is highly related to the condition of the vehicle **70** whether the driving integrated values are large or small. Specifically, as the driving integrated values increase, the vehicle needs maintenance more. In the present embodiment, a maintenance notification condition and an advance notification condition are determined on the basis of the driving time and the driving distance. It is thus possible for a user to acquire notification information at a timing appropriate for the maintenance of the vehicle **70**.

[0071] In addition, in the present embodiment, a notification condition is set on the basis of the driving information

about the vehicle **70**. A notification of notification information such as advance notification information or maintenance notification information is thus issued in accordance with the use frequency of the vehicle **70**. This makes it possible to issue a notification of the information regarding maintenance at a more appropriate timing than a timing in case that a notification condition is set on the basis of a date and time.

[0072] In addition, it is possible for a user to input a maintenance notification condition and an advance notification condition through the input device of the portable device **20**. This allows the user to set a desired maintenance notification condition and advance notification condition. According to the present embodiment, it is thus possible to output notification information that is very convenient for the user. For example, a maintenance notification condition and an advance notification condition desired by a user are set. This makes it easier to set the frequency of maintenance in accordance with a preference and a request of the user. It is possible to notify each user of the information regarding maintenance.

[0073] In addition, the second controller **51** outputs notification information on the basis of an advance notification condition before a maintenance notification condition is satisfied. This allows a user to grasp the arrival of the maintenance notification in advance and execute maintenance with margin time.

[0074] In addition, the second controller **51** outputs advance notification information through the notification device of the portable device **20** in the period from the satisfaction of an advance notification condition satisfaction to the of a maintenance notification condition. After the maintenance notification condition is satisfied, the second controller **51** outputs maintenance notification information through the notification device of the portable device **20**. The aspects of the advance notification information and the maintenance notification information are different. This allows a user to recognize a difference between the pieces of notification information and allows the user to grasp the emergency degree of maintenance more easily.

[0075] In addition, the second controller **51** stops outputting notification information in response to an input (output stop operation) to the input device by a user. This makes it possible to suppress a notification continuing even after a user confirms that the maintenance of the vehicle **70** is completed or that the maintenance of the vehicle **70** is unnecessary. It is to be noted the second controller **51** may execute the notification processing to periodically repeat a notification in case that the notification is not stopped, that is, no output stop operation is performed. This makes it possible to prevent outputting the notification information from being stopped with a stop of a notification not confirmed. It is thus possible to increase an effect of reminding a user.

[0076] Further, in case that the second controller **51** stops outputting the notification information by a user making an input to the input device, the second controller **51** outputs information that prompts the notification condition to be reset. This offers an advantage that a notification regarding maintenance is easily achieved at a timing of maintenance which newly arrives after the user performs an output stop operation.

[0077] In addition, the second controller **51** changes the notification condition by a user making an input to the input device even after the initial setting processing. This allows the user to reset the notification timing in response to a change in a situation including the usage situation of the vehicle **70**. In this way, according to the present embodiment, there is provided an opportunity to reset the notification condition. This makes it possible to achieve a notification regarding maintenance at a timing desired by a user.

[0078] In addition, according to the present embodiment, each time communication between the first communication portion **71** and the second communication portion **30** is enabled, the driving information is outputted to the portable device **20**. It is thus possible to transmit the driving information to the portable device **20** more frequently. In addition, outputting the driving information to the portable device **20** at least once in one round (one trip) of the vehicle **70** from a traveling start to a traveling end makes it possible to transmit the driving information more frequently. It is to be noted that the driving information may be outputted to the portable device **20** a plurality of times while the vehicle **70** is traveling.

[0079] According to the present embodiment, a push notification causes a notification to be displayed. Even when a user does not display a screen regarding the maintenance application on the display **21**, it is possible for the user to grasp information (advance notification information or maintenance notification information) regarding a maintenance time. In addition, it is possible to grasp the information regarding maintenance after the vehicle **70** is driven. Missing the maintenance time is thus suppressed.

[0080] In addition, in the present embodiment, the first communication portion **71** is configured to be capable of performing contactless wireless communication with the portable device **20** carried by a user positioned in the riding space of the vehicle **70**. For example, the first communication portion **71** is configured to be capable of wirelessly communicating with the portable device **20** carried by a driver sitting on a seat in the vehicle **70**. This allows the portable device **20** to achieve the transmission and reception of signals to and from the vehicle **70** whenever the driver drives. This makes it possible to transmit and receive signals more frequently. In addition, a person who carries the portable device **20** does not have to perform a special operation to transmit and receive signals. It is thus possible to increase the operability regarding a notification. It is to be noted that, for example, the communicable range of the second communication portion **30** and the first communication portion **71** is desirably set to distance which enables communication with the first communication portion **71** when a user puts the portable device **20** in a pocket, a bag, or the like. For example, it is desirable that the communicable distance be distance which enables communication even one m or more apart from the position of the first communication portion **71**. This allows a user to achieve communication without having to take out the portable device **20** and it is possible to increase convenience. It is to be noted that the portable device **20** may be communicable by a user taking out the found portable device **20** and moving the portable device **20** to a predetermined position set in the vehicle **70**. Additionally, the portable device **20** may communicate with the first communication portion **71** through wired communication.

[0081] In addition, in the present embodiment, the driving information is stored in a nonvolatile memory. Specifically, a driving integrated value is stored in the nonvolatile

memory. Information about the driving integrated value is not thus deleted even in case that the supply of power to the first control device **100** is interrupted. In addition, the driving information keeps stored in the first memory **110** of the vehicle **70** as an integrated value. Even when the vehicle **70** is driven with no driving information exchanged, it is thus possible to acquire driving information without fail and issue a notification of a maintenance time with high precision by a user getting in the vehicle with the portable device **20** at the next opportunity.

[0082] It is to be noted that a utility vehicle is exemplified in the present embodiment as a vehicle included in the notification system **10**, but it is preferable that the vehicle included in the notification system **10** be an off-roading wheeled vehicle. The off-roading frequency, the condition of a rough road to be traveled, and the driving state of the off-road wheeled vehicle vary with the off-roading wheeled vehicle in accordance with the usage of each user. This considerably varies a maintenance notification time in accordance with whether the driving integrated value is large or small. The application of the notification system described above to such an off-roading wheeled vehicle makes it easier to make a notification timing appropriate for each user. The off-roading wheeled vehicle includes a riding lawn mower, an agricultural wheeled vehicle or a constructional wheeled vehicle, or the like in addition to the utility vehicle. For example, an off-road driving wheeled vehicle included in the notification system **10** includes ROPS (Roll-Over Protective Structures) **783** (see FIG. **13**). The ROPS are structures that secure an occupant space even in case that the vehicle travels in an uneven area and rolls over. For example, pipe members are disposed outside the occupant space in the width direction and above the occupant space.

[0083] In case that the vehicle included in the notification system **10** is an off-road driving wheeled vehicle, the wheeled vehicle is preferably configured to be capable of traveling with four-wheel drive. In addition, the wheeled vehicle is preferably configured to be capable of switching traveling modes between four-wheel drive and two-wheel drive. Four-wheel drive makes it possible to impart, even when any of the front and rear wheels slips, driving forces to the wheels that are not slipping. This makes it possible to increase the roadability with respect to rough roads. In addition, the off-road driving wheeled vehicle includes a differential gear. The differential gear has a differential function, that is, applies driving forces to left and right wheels or front and rear wheels in accordance with the loads on the wheels with the driving forces different therebetween. In addition, it is preferable that the off-road driving wheeled vehicle include a differential lock function of stopping the differential function described above. This makes it possible to impart, even when any of left and right wheels or front and rear wheels slips due to the irregularities of the surface of a traveled road, driving forces to the wheels that are not slipping. This makes it possible to increase the roadability with respect to rough roads. The differential lock function may be provided to the front left and right wheels, the rear left and right wheels, and any of the front and rear wheels. FIG. **13** exemplifies a four-wheel drive mechanism **791** that allows for traveling with four-wheel drive and a differential/differential lock switching mechanism (first mechanism) **792** serving as a switching mechanism that performs a differential function and stops the differential function. FIG. **13** is a diagram describing that the vehicle **70** may include the four-wheel drive mechanism **791** and the differential/differential lock switching mechanism **792**. The disposition of the respective mechanisms **791** and **792** is not limited to FIG. **13**.

[0084] It is to be noted that the notification system **10** according to the present disclosure and the notification method including the initial setting processing, the notification processing, the determination processing, and the post-notification processing are not limited to the embodiment. For example, at least one of other non-limiting embodiments described below may be adopted in combination with the notification system **10** exemplified in the embodiment, the notification method including the initial setting processing, the notification processing, the determination processing, and the post-notification processing, and at least one of the features described in the respective claims.

Another Embodiment 1

[0085] In case that the first push notification **314** or the second push notification **315** (FIG. **6** or **7**) is held down, the second controller **51** may output the operation screen of the maintenance application illustrated in FIG. **8** to the display **21**. The information related to maintenance may be further displayed on the operation screen. For example, a URL link serving as information that helps order a maintenance item (part) of the vehicle **70**, information about a maintenance company or a maintenance plant that executes the maintenance of the vehicle **70**, or a link to a reservation form serving as information that helps make a reservation for maintenance in the maintenance company or the maintenance plant may be displayed. In addition, the advance notification information and the maintenance notification information are not limited to the push notifications **314** and **315** described above. The portable device **20** may be notified of the advance notification information and the maintenance notification information by e-mail. Alternatively, the advance notification information and the maintenance notification information may be displayed on an operation screen of the maintenance application.

[0086] In this form, it is preferable that the portable device **20** transmit not only the driving information, but also other information to the server **200**. For example, the portable device **20** may transmit at least any of the identification information about a vehicle for which the driving information is acquired, a user ID, information indicating an attribute of a user, information indicating an attribute of the vehicle, or a driving log along with the driving information. The information indicating an attribute of a user may include the sex of the user, the age, the residential area, the sales company of the vehicle, a repair shop of the vehicle, and the like. The information indicating an attribute of the vehicle may include the type of the vehicle, the maintenance history, and the like. This makes it possible to gather and classify driving information for each attribute of a user or each attribute of a vehicle. This may cause the server **200** to transmit a result of the estimation of a maintenance time to the portable device **20** by extracting pieces of information including similar attributes from a database.

[0087] In addition, in case that a user gives permission, the portable device **20** or the server **200** may transmit the notification information regarding maintenance to a person who is relevant to the maintenance on the basis of user information. For example, the notification information regarding maintenance may be transmitted to a server in a

management company of the vehicle, a maintenance company of the vehicle, a company that supplies a part necessary for maintenance, the sales company of the vehicle, or the manufacturing company of the vehicle. In addition, advance registration by a user may cause a notification of notification information to be issued for a portable device of another user to whom it is desirable to transmit a notification of maintenance. This allows the maintenance information to be shared. This makes it possible to reduce pieces of information that are provided by the user to a person who is relevant when maintenance is started.

Another Embodiment 2

[0088] The second controller **51** may estimate the driving time and the driving distance of the vehicle **70** in one trip that are associated with an account (user ID) by using a driving log stored in the second memory **60**. In case that it is possible to estimate that the driving time or the driving distance is to satisfy an advance notification condition or a maintenance notification condition in the next trip by using the estimated driving time and the estimated driving distance, the second controller **51** may issue a notification indicating that a maintenance time can possibly come closer in the next trip or that a maintenance time can possibly arrive in the next trip after the notification processing (FIGS. **4** and **5**) ends. According to this form, the convenience for a user further increases.

Another Embodiment 3

[0089] The notification conditions are not limited to the conditions described in the embodiment. For example, a maintenance notification condition may include the arrival of a date and time (timing) set by a user. In this case, an advance notification condition may be a date and time closer to the starting time than the set date and time.

[0090] In addition, the second controller **51** may be configured to correct a notification condition in relation to a default value or a value inputted by a user in accordance with the driving information acquired from the vehicle **70**. The corrected value may be a value that makes a notification arrive earlier in accordance with the time elapsed from manufacturing the vehicle **70**. In addition, the second controller **51** may correct the notification condition to delay the arrival of the notification if the information acquired from the vehicle **70** is information indicating a driving operation or a traveling state that suppresses the arrival of maintenance. In this way, the second controller **51** may correct the maintenance notification time on the basis of the cause-effect relationship with maintenance in accordance with the traveling state of the vehicle **70**, the state of the engine that is a propulsion source, and the operation state of a driver.

Another Embodiment 4

[0091] The execution information acquired by the second controller **51** in step S**300** (FIG. **10**) of the post-notification processing is not limited to the date and time of the execution of maintenance and a maintenance conduct item and may be other information regarding the execution of maintenance. For example, the second controller **51** may output an input region of a maintenance place, an image of a maintained part, or the like to the display **21**. In case that the maintenance place or the image is inputted, the second controller **51** may determine that the execution information is acquired. In addition, the maintenance history may include at least one of the maintenance place, the image of the part, or the count time and the count distance from the starting time to the conduct of maintenance in addition to the execution date and time of maintenance and the maintenance conduct item.

[0092] In addition, in case that a part for which maintenance is to be prompted is clear from a result of the detection of a sensor value, the second controller **51** may determine that the notification condition is satisfied regardless of the driving integrated value. For example, in case that engine intake pressure deviates from a predetermined range, the portable device **20** may issue a notification of a request to replace an air cleaner element. Alternatively, in case that the pressure of engine oil deviates from a predetermined range, the portable device **20** may issue a notification of a request to replace an oil filter.

Another Embodiment 5

[0093] It is sufficient if the driving integrated value is a value that increases along with the driving of the vehicle. The driving integrated value does not have to be total driving distance and total driving time. For example, the driving integrated value may be the total traveling time for which the vehicle is traveling instead of the total driving time for which the propulsion source is driven. In this case, the total traveling time does not include the time for which the engine is in an idling state and the vehicle stops traveling. Alternatively, the driving integrated value may be the total number of rotations of an output shaft of the propulsion source or the total number of revolutions of a rotor that revolves along with the rotations of the output shaft, the total output of the propulsion source, the total amount of consumed fuel or the total amount of consumed power, the total number of times the brake is stepped on, the total number of skids, the total number of times the engine stalls, or the like from manufacturing the vehicle to detecting the newest value by the detection portion **72**. In addition, the driving integrated value may be the integrated value of impact forces or loads applied to the vehicle body due to jumps, collisions with obstacles, or the like, the integrated value of the total amount of stroke movements of the suspension or the number of vibrations. The traveling speed, the engine speed, or the like may be divided into a plurality of ranges and the driving integrated value may be obtained for each of the ranges. For example, a threshold that satisfies a notification condition may be set lower for an integrated value obtained for the high speed range than that of an integrated value obtained for the low speed range.

[0094] It is to be noted that the engine ECU **73** of the vehicle **70** sometimes acquires a result of detection by the detection portion **72** and outputs warning information indicating an abnormality regarding the vehicle **70** including the engine **74** or a wiring line or an electronic part such as a sensor or an actuator. In this case, the first controller **105** may transmit an error code that is a type of warning to the portable device **20** as the driving information. The second controller **51** of the portable device **20** may notify a user of an abnormal condition by using the notification device. Further, information that describes the details of the abnormal condition which means warning may be displayed along with the notification in accordance with the type of warning. This allows the user to grasp the specific contents of the warning and the emergency degree of repair or maintenance.

It is to be noted that, in case that the second controller **51** receives an error code, the second controller **51** may transmit a request signal including the identification information about the vehicle **70** and the error code to the server **200**. The third controller **213** of the server **200** may transmit, to the portable device **20**, information about the cause of the error occurring in the vehicle **70** or a part for which maintenance is recommended with reference to the correspondence relationship between an error code stored in the third memory **220** in advance and the cause of the generation of the error. In case that the second controller **51** of the portable device **20** receives information corresponding to the error code from the server **200**, the second controller **51** may output, to the display **21**, the information regarding the cause of the abnormality regarding the vehicle **70** or the part for which maintenance is recommended regardless of whether or not a maintenance notification condition or an advance notification condition is satisfied. It is possible to prevent the portable device **20** from running out of memory capacity by acquiring the information from the server **200**.

Another Embodiment 6

[0095] It is sufficient if the driving information that is transmitted by the first communication portion **71** is driving information related to a notification of the vehicle **70**. The driving information that is transmitted by the first communication portion **71** may be information other than the information with which a notification of maintenance is issued described above. For example, the driving information may be information regarding the driving of the propulsion source or information regarding the driving of the vehicle **70** other than the propulsion source. For example, it is possible for the portable device **20** to allow a user to grasp the driving state of the vehicle **70** by displaying the total traveling time or the total traveled distance transmitted from the second communication portion **30** separately from a notification of maintenance. For example, it is easier for the user to manage the vehicle **70** by quickly grasping notification information such as the total traveled distance or the total traveling time. In this way, information regarding maintenance is preferable as the notification information, but the notification information may be used to issue a notification other than a notification of maintenance.

Another Embodiment 7

[0096] In the other embodiment 5, the second controller **51** may acquire, from the vehicle **70**, the driving information including driving time, driving distance, results of detection by various sensors included in the detection portion **72**, and the like in a predetermined period of time before an error code is outputted. Further, the second controller **51** may transmit the driving information to the server **200**. The third controller **213** of the server **200** may acquire error codes and pieces of driving information in a predetermined time for learning from the plurality of portable devices **20** connected to the server **200** through the Internet and estimate time in which error codes are outputted in response to the inputted pieces of driving information by using a result of learning. In this case, the third controller **213** may communicate with the portable device **20** in the notification processing and estimate time in which an abnormality can possibly occur in the vehicle **70** by using the pieces of driving information. The third controller **213** may transmit information about the estimated time and a part in which an abnormality can possibly occur to the portable device **20**. The second controller **51** of the portable device **20** may output the acquired information about the estimated time and the part to the display **21**. According to this form, it is possible for a user to obtain information about a part or the like to be maintained before an abnormality occurs. This further increases the convenience for the user.

Another Embodiment 8

[0097] In the embodiment, the driving information that is acquired by the portable device **20** from the vehicle **70** through communication may be one of driving time or driving distance. In addition, the driving information may be other information that allows the driving state of the vehicle **70** to be grasped. For example, the driving information may be a result of detection by an accelerator position sensor, a brake position sensor, an acceleration sensor, or a speed sensor. The first controller **105** or the second controller **51** may estimate that short distance is repeatedly traveled, a slope is traveled, or a rough road is traveled by using the result of detection by each of the sensors. In this case, a maintenance notification condition or an advance notification condition may be, for example, that short distance is repeatedly traveled, a slope is traveled, or a rough road is traveled a predetermined number of times. According to this form, it is possible to set a maintenance notification condition or an advance notification condition corresponding to the characteristics of the vehicle **70**.

Another Embodiment 9

[0098] In case that a maintenance notification condition or an advance notification condition is fixed at a default value in advance, a selection operation by a user may be omitted. In addition, the difference or the proportion between the current integrated value, and a notification or a threshold of the notification may be expressed as a character or a diagram. This offers an advantage that it is possible for a user to easily grasp the period of a notification of maintenance notification information or advance notification information. In addition, any one of time or distance in a notification condition does not have to be described (inputted) and may be blank.

Another Embodiment 10

[0099] In the embodiment, in case that (iii) the count time reaching the advance notification time and (iv) the count distance reaching the advance notification distance are both satisfied in the determination about the advance notification condition described in step S**201** in FIG. **5**, the second controller **51** may make an affirmative determination for step S**201**. Similarly, in case that (i) the count time reaching the maintenance notification time and (ii) the count distance reaching the maintenance notification distance are both satisfied in step S**203** in FIG. **5**, the second controller **51** may make an affirmative determination for step S**203**. According to this form, it is possible to satisfy the needs of a user who wishes to execute maintenance by taking into consideration both the driving time and the driving distance. It is to be noted that the second controller **51** may be configured to cause a user to select, for example, the satisfaction of at least one of (i) or (ii) above or the satisfaction of both (i) and (ii) as an output condition of notification information.

Another Embodiment 11

[0100] In the embodiment, the second controller **51** acquires an advance notification condition and a maintenance notification condition through the input device. In case that the advance notification condition is satisfied or in case that the maintenance notification condition is satisfied, the second controller **51** outputs notification information. In contrast, the second controller **51** may be configured to output the notification information (maintenance notification information) by using only the maintenance notification condition. Even in this form, in case that the maintenance notification condition is satisfied, the maintenance notification information is outputted to the portable device **20**. It is thus possible for a user to grasp the arrival of a maintenance time. Alternatively, the second controller **51** may be configured to output the notification information (advance notification information) by using only the advance notification condition. Even in this form, in case that the advance notification condition is satisfied, the advance notification information is outputted to the portable device **20**. It is thus possible for a user to quickly grasp that a maintenance time is coming closer.

Another Embodiment 12

[0101] In the embodiment, at least part of the processing executed by the second controller **51** of the portable device **20** may be executed by the third controller **213** of the server **200**. At least part of the processing executed by the third controller **213** may be executed by the second controller **51**.

Another Embodiment 13

[0102] In the initial setting processing (FIG. **2**), the notification processing (FIG. **4**), the notification determination processing (FIG. **5**), and the post-notification processing (FIG. **10**) in the embodiment, the order of the respective steps may be changed as appropriate or any of the respective steps may be executed at the same time.

Another Embodiment 14

[0103] The vehicle **70** included in the notification system **10** is not limited to a wheeled vehicle that travels in an uneven area. A wheeled vehicle that travels in a public road or an even area may be used. Specifically, a four-wheeled automobile, a motorbike, a golf cart, or a PTV may be used.

[0104] In addition, the vehicle **70** included in the notification system **10** is not limited to a utility vehicle (UV) and may be a craft such as a personal watercraft (PWC) or a motorcycle (MC). In case that the vehicle **70** is a PWC, examples of maintenance items include engine oil, an oil filter, handle bar pivot lubrication, joint lubrication, a spark plug, and a periodic inspection.

[0105] In addition, it is possible to exemplify an internal combustion engine or an electric motor as the propulsion source. The propulsion source may be a hybrid structure including both an internal combustion engine and an electric motor or a structure including any one of an internal combustion engine and an electric motor. In case that the propulsion source is an internal combustion engine, biomass-derived fuel such as ethanol or fuel gas including hydrocarbon, hydrogen, and the like may be used as the fuel in addition to gasoline and diesel fuel.

[0106] It is to be noted that the vehicle included the vehicle in the notification system **10** may be a sports-driving vehicle. The sports-driving vehicle is mainly for hobbies and the frequency of sports driving or the degree of sports driving varies with each user. A maintenance notification time thus varies much in accordance with the magnitude of the driving state. The use of the notification system described above facilitates an appropriate notification timing to be offered to each of such sports-driving vehicles in accordance with a complaint situation. A preferred sports-driving vehicle is sometimes referred to as a recreational vehicle (RV) and includes a buggy, a snowmobile, a boat, an all-terrain vehicle (ATV), a side-by-side vehicle, a motorcycle, and the like.

[0107] In addition, the vehicle included in the notification system **10** may be not only a vehicle owned by an individual, but a wheeled vehicle managed/used by a group such as a corporation or the administration. In particular, in case that a plurality of vehicles is managed, the use frequency and the driving state vary. The use of the notification system **10** thus makes it possible to offer different maintenance notification timings to the respective wheeled vehicles. It is thus possible to suppress unnecessary maintenance and execute efficient maintenance. In case that a plurality of vehicles is managed, farm work, construction work, renting business, and the like are conceivable in which a plurality of vehicles is supposed to be used at the same time.

Another Embodiment 15

[0108] The portable device **20** may be configured as a wearable terminal such as a watch wearable on a user or may be a function accompanying a key that starts the vehicle **70**. In other words, it is sufficient if the portable device **20** is capable of acquiring the driving information from the vehicle **70** and includes a notification function. The portable device **20** does not have to include a calling (telephone) function.

[0109] It is also possible to implement the present disclosure in various forms other than those described above. For example, it is possible to implement the present disclosure in the form of a computer program that implements a function of at least one of the portable device **20**, the first controller **105**, the second controller **51**, or the third controller **213**, a non-transitory recording medium (non-transitory storage medium) in which the computer program is recorded, or the like. For example, the computer program may be a program that causes a computer to execute: acquiring, by a portable device, driving information from the vehicle through communication, the driving information indicating a driving state of the vehicle; and outputting notification information regarding the maintenance of the vehicle to a notification device included in the portable device in case that the driving information satisfies a predefined advance notification condition.

[0110] It is possible to execute a function of an element disclosed herein by using a circuit or a processing circuit including a general-purpose processor, a dedicated processor, an integrated circuit, ASIC (Application Specific Integrated Circuits), a conventional circuit, and/or a combination thereof configured or programed to execute the disclosed function. A processor includes a transistor and another circuit and is thus considered a processing circuit or a circuit. In the present disclosure, a circuit, a unit, or means is hardware that executes the listed functions or hardware

programed to execute the listed functions. The hardware may be the hardware disclosed herein or other known hardware programed or configured to execute the listed functions. In case that the hardware is a processor that is considered a type of circuit, a circuit, means, or a unit is a combination of hardware and software and the software is used to configure the hardware and/or the processor.

1. A notification method of issuing a notification of arrival of maintenance time of a vehicle, the notification method comprising:

acquiring, by a portable device, driving information from the vehicle through communication, the driving information indicating a driving state of the vehicle; and

outputting notification information regarding the maintenance of the vehicle to a notification device included in the portable device in case that the driving information satisfies a predefined notification condition.

2. The notification method according to claim **1**, wherein the driving information includes a driving integrated value that increases along with driving of the vehicle.

3. The notification method according to claim **1**, wherein the notification condition is defined on a basis of a condition inputted to an input device provided to the portable device.

4. The notification method according to claim **2**, wherein the notification condition includes

a count amount reaching a preset maintenance setting value, the count amount being obtained by counting the driving integrated value from a predetermined time, and

the count amount reaching a preset advance setting value smaller than the maintenance setting value.

5. The notification method according to claim **1**, wherein, in case that an input device provided to the portable device receives an instruction to stop outputting the notification information, the notification condition is reset.

6. The notification method according to claim **1**, wherein, in case that an input device provided to the portable device receives an instruction to change the notification condition, the notification condition is changed in accordance with the instruction.

7. The notification method according to claim **1**, wherein, in case that an input device provided to the portable device receives an instruction to stop outputting the notification information, information that prompts the notification condition to be reset is outputted to the notification device.

8. The notification method according to claim **4**, wherein

the notification condition includes an advance notification condition and a maintenance notification condition, the advance notification condition including the count amount reaching the advance setting value, the maintenance notification condition including the count amount reaching the maintenance setting value, and

the notification information includes advance notification information and maintenance notification information different from the advance notification information, the advance notification information being outputted to the notification device in a period of time from satisfaction of the advance notification condition to satisfaction of the maintenance notification condition, the maintenance notification information being outputted to the notification device in a period of time after the satisfaction of the maintenance notification condition.

9. The notification method according to claim **2**, wherein

the notification condition includes a count amount reaching a maintenance setting value, the count amount being obtained by counting the driving integrated value from a predetermined time, and

the maintenance setting value is defined on a basis of a condition inputted to an input device provided to the portable device.

10. The notification method according to claim **1**, wherein a driving log including the driving information about the vehicle for each predetermined time is generated and the generated driving log is outputted to the notification device.

11. The notification method according to claim **1**, wherein, in case that an input device provided to the portable device receives execution information regarding execution of the maintenance of the vehicle, a maintenance history of the vehicle is generated by using the execution information.

12. The notification method according to claim **1**, wherein the portable device

determines whether or not the driving information satisfies the notification condition, and

outputs the notification information to the notification device.

13. A notification system comprising:

a portable device including a notification device; and

a vehicle that is capable for communicating with the portable device, wherein

the portable device

acquires driving information from the vehicle through communication, the driving information indicating a driving state of the vehicle, and

outputs notification information regarding maintenance of the vehicle to the notification device in case that the driving information satisfies a predefined notification condition.

14. The notification system according to claim **13**, wherein the vehicle is an off-roading wheeled vehicle.

15. The notification system according to claim **13**, wherein the vehicle includes low pressure tires and a ROPS (rollover protective structure).

16. The notification system according to claim **13**, wherein the vehicle includes at least one of a switching mechanism or a four-wheel drive mechanism, the switching mechanism switching a start of a differential function and a stop of the differential function.

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