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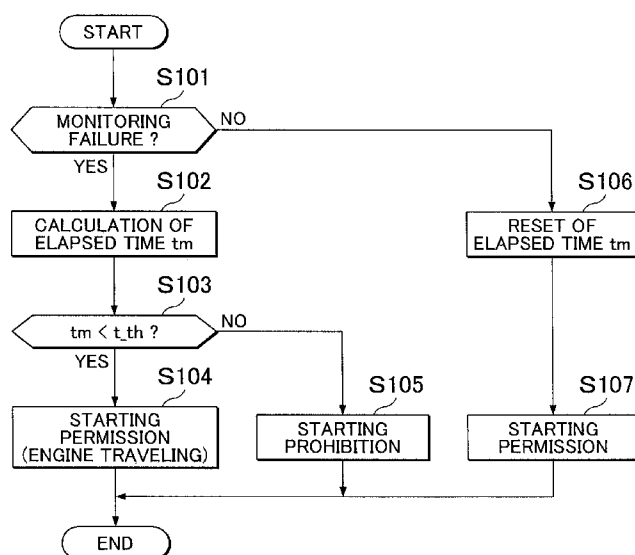
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(54) Title: CONTROLLER FOR HYBRID VEHICLE

FIG. 2



(57) Abstract: A vehicle includes an engine, a battery, a first control unit and a second control unit. The first control unit is configured to control the traveling of the vehicle. The first control unit is configured to calculate elapsed time during which a state of the battery is unable to be monitored on a condition that an ignition switch of the vehicle is turned on and the state of the battery is unable to be monitored. The first control unit is configured to start the engine to permit traveling using only an output of the engine on a condition that the elapsed time is less than a predetermined time. The first control unit is configured to prohibit the traveling of the vehicle on a condition that the elapsed time is equal to or more than the predetermined time.

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VEHICLE

BACKGROUND OF THE INVENTION

5 1. Field of the Invention

[0001] The present invention relates to a vehicle that can travel using the output of a battery and an engine.

2. Description of Related Art

10 [0002] In a hybrid vehicle described in Japanese Patent Application Publication No. 2008-239079 (JP 2008-239079 A), a battery electric control unit (ECU) acquires the state of a battery (battery for traveling). As the state of the battery, there are a current value, a voltage value, temperature, and the like. HV_ECU receives information acquired by the battery ECU to control the entire hybrid system, through
15 communication with the battery ECU.

[0003] In 2008-239079 A, if the battery ECU fails or the HV_ECU cannot receive the information acquired by the battery ECU, the HV_ECU cannot grasp the state of the battery. Meanwhile, the battery may be brought into the overdischarged state due to short circuiting or the like inside the battery, and if the battery in the
20 overdischarged state is charged or discharged, there is a concern that the battery may generate heat excessively.

[0004] If it is assumed that the battery is brought into the overdischarged state while the state of the battery cannot be grasped, in JP 2008-239079 A, it is possible to prohibit the starting of the hybrid system when the state of the battery cannot be grasped.
25 However, in this case, if the traveling of the hybrid vehicle is stopped and the hybrid system is temporarily stopped, the hybrid system cannot be started again. Accordingly, the hybrid vehicle cannot be made to travel, and the traveling distance required for moving the hybrid vehicle to a safe place is not easily secured.

30 SUMMARY OF THE INVENTION

[0005] A vehicle related to the first aspect of the invention includes an engine, a battery, a first control unit and a second control unit. The battery is configured to perform charge or discharge and configured to output energy for traveling of the vehicle and starting of the engine. The first control unit is configured to control the traveling
35 of the vehicle. The second control unit is configured to acquire the state of the battery

and transmit acquired information to the first control unit.

[0006] The first control unit is configured to calculate elapsed time during which a state of the battery is unable to be monitored on a condition that an ignition switch of the vehicle is turned on and the state of the battery is unable to be monitored.

5 The first control unit is configured to start the engine to permit traveling using only an output of the engine on a condition that the elapsed time is less than a predetermined time. The first control unit is configured to prohibit the traveling of the vehicle on a condition that the elapsed time is equal to or more than the predetermined time.

[0007] According to the first aspect of the invention, if the elapsed time is
10 shorter than the predetermined time even if the first control unit cannot monitor the state of the battery, the first control unit starts the engine to permit the traveling using only the output of the engine. Even if the battery is brought into the overdischarged state while the state of the battery cannot be monitored, the charge or the discharge of the battery can be permitted if the elapsed time is shorter than the predetermined time. For
15 this reason, the engine can be started using the battery, and the vehicle can be made to travel using only the output of the engine. Accordingly, the traveling distance of the vehicle can be extended, and the vehicle can be moved to a safe place.

[0008] The first control unit may be configured to count the number of times of permission of the traveling using only the output of the engine is permitted. The
20 first control unit may be configured to permit the traveling using only the output of the engine on a condition that the elapsed time is less than the predetermined time and the number of times of the permission is less than a predetermined number of times. The first control unit may be configured to prohibit the traveling of the vehicle on a condition that the number of times of the permission is equal to or more than the
25 predetermined number of times.

[0009] If the battery in the overdischarged state is charged or discharged, the temperature of the battery rises easily. Here, if the number of times (that is, the number of times of permission) by which the engine is started using the battery in order to permit the traveling using only the output of the engine increases excessively, the
30 temperature of the battery rises easily. For this reason, when the elapsed time is shorter than the predetermined time and the number of times of permission is less than the predetermined number of times, the traveling using only the output of the engine is permitted. As a result, the temperature rise of the battery can be suppressed.

[0010] Each of the predetermined time and the predetermined number of times
35 can also be made into a fixed value, and can also be changed. The first control unit

may be configured to set the predetermined time such that the predetermined time become shorter as the number of times of the permission is increased. The temperature rise of the battery can be suppressed by this configuration.

[0011] The first control unit may be configured to set the predetermined number of times such that the predetermined number of times is reduced as the elapsed time becomes longer. When the battery is brought into the overdischarged state, the battery continues to be kept in the overdischarged state as the elapsed time becomes longer. In this case, the degradation of the battery proceeds, and becomes hard to start the engine with the progress of this degradation. However, by this configuration, the predetermined number of times can be set in consideration of the degradation of the battery.

[0012] The first control unit may be configured to calculate the elapsed time by setting the time when the ignition switch is previously turned off. When the ignition switch is turned on and when the state of the battery cannot be monitored, it is considered that the state of the battery cannot be monitored before the ignition switch is turned on. It is also considered that the battery is brought into the overdischarged state before the ignition switch is turned on. Thus, when the time from when the ignition switch is previously turned off to when the ignition switch is turned on is calculated as the elapsed time, underestimating the time during which the state of the battery cannot be monitored can be prevented.

[0013] A vehicle of the second aspect of the invention includes an engine, a battery, a first control unit and a second control unit. The battery is configured to perform charge or discharge and configured to output energy for traveling of the vehicle and starting of the engine. The first control unit is configured to control the traveling of the vehicle, the first control unit being configured to start the engine to permit traveling using only an output of the engine on a condition that an ignition switch of the vehicle is turned on and a state of the battery is unable to be monitored. The first control unit is configured to count the number of times of permission of the traveling using only the output of the engine is permitted. The first control unit is configured to permit the traveling using only the output of the engine on a condition that the number of times of the permission is less than a predetermined number of times. The first control unit is configured to prohibit the traveling of the vehicle on a condition that the number of times of the permission is equal to or more than the predetermined number of times. The second control unit is configured to acquire the state of the battery and transmit acquired information to the first control unit.

[0014] Even in the second aspect of the invention, the traveling distance of the vehicle can be extended by making the vehicle travel using only the output of the engine, similar to the first invention of the present application. As a result, the vehicle can be easily moved to a safe place.

5 [0015] Here, if the battery in the overdischarged state is charged or discharged, the temperature of the battery rises easily. If the number of times (that is, the number of times of permission) by which the engine is started using the battery in order to permit the traveling using only the output of the engine increases excessively, the temperature of the battery rises easily. For this reason, when the number of times of
10 permission is less than the predetermined number of times, the temperature rise of the battery can be suppressed by permitting the traveling using only the output of the engine.

BRIEF DESCRIPTION OF THE DRAWINGS

15 [0016] Features and advantages, and technical and industrial significance of exemplary embodiments of the invention will be described below with reference to the accompanying drawings, in which like numerals denote like elements, and wherein:

FIG. 1 is a view illustrating the configuration of a hybrid system;

20 FIG. 2 is a flowchart illustrating the processing when an ignition switch is turned on, in Embodiment 1;

FIG. 3 is a view illustrating a starting point when elapsed time is calculated;

FIG. 4 is a view illustrating the starting point when the elapsed time is calculated;

FIG. 5 is a flowchart illustrating the processing when the hybrid system is in a starting state;

25 FIG. 6 is a flowchart illustrating the processing when the ignition switch is turned on, in Embodiment 2;

FIG. 7 is a flowchart illustrating the processing when the ignition switch is turned on, in Embodiment 3;

30 FIG. 8 is a view illustrating the correspondence relationship between predetermined time and the number of times of starting permission; and

FIG. 9 is a view illustrating the correspondence relationship between a predetermined number of times and elapsed time.

DETAILED DESCRIPTION OF EMBODIMENTS

35 [0017] Embodiments of the invention will be described below.

[0018] FIG. 1 illustrates the configuration of a hybrid system in the present embodiment. The hybrid system illustrated in FIG. 1 is mounted on a vehicle (a so-called hybrid vehicle). The vehicle, as will be described below, is equipped with a main battery and an engine as power sources that make the vehicle travels. In addition, the invention is not limited to the hybrid system illustrated in FIG. 1, and can also be applied to other hybrid systems (for example, so-called series-type or so-called parallel type hybrid systems).

[0019] A main battery (equivalent to the battery of the invention) 10 has a plurality of single batteries 11 that are connected in series. Secondary batteries, such as nickel hydride batteries or and lithium ion batteries, can be used as the single batteries 11. In addition, a plurality of single batteries 11 that are connected in parallel may be included in the main battery 10.

[0020] A voltage sensor 20 detects a voltage value V_b of the main battery 10, and outputs the detection result to a battery electric control unit (ECU) 40. In addition, the voltage values of the respective single batteries 11 can also be detected using the voltage sensor 20. A temperature sensor 21 detects the temperature (referred to as battery temperature) T_b of the main battery 10, and outputs the detection result to the battery ECU 40. The current sensor 22 detects a current value I_b of the main battery 10, and outputs the detection result to the battery ECU 40.

[0021] The battery ECU 40 has a central processing unit (CPU) 41. The voltage value V_b , the battery temperature T_b , and the current value I_b are information (hereinafter referred to as battery information) showing the state of the main battery 10. The battery ECU 40 acquires battery information and transmits the battery information to a hybrid vehicle electric control unit (HV_ECU) 50. The battery ECU is an example of a second control unit of the invention.

[0022] The HV_ECU 50 controls the entire hybrid system illustrated in FIG. 1. Specifically, the HV_ECU 50 controls the main battery 10, an inverter 31, and motor generators MG1 and MG2, and an engine 34, thereby controls the traveling of the vehicle. Here, an ECU that controls the inverter 31 and the motor generators MG1 and MG2, and an ECU that controls the engine 34 can be provided.

[0023] The HV_ECU 50 can control the inverter 31 and the motor generators MG1 and MG2, and the engine 34 by communicating with these ECUs. The battery information transmitted from the battery ECU 40 to the HV_ECU 50 is used when the HV_ECU 50 controls the entire hybrid system. The HV_ECU 50 has a central processing unit (CPU) 51, a timer 52, and a memory 53. The timer 52 and the memory

53 may be provided outside the HV_ECU 50.

[0024] A positive electrode line PL is connected to a positive electrode terminal of the main battery 10, and a negative electrode line NL is connected to a negative electrode terminal of the main battery 10. The main battery 10 is connected to the inverter 31 via the positive electrode line PL and the negative electrode line NL. The positive electrode line PL is provided with a system main relay SMR-B, and the negative electrode line NL is provided with a system main relay SMR-G.

[0025] The system main relays SMR-B, SMR-G receive driving signals from the HV_ECU 50, and are switched between ON and OFF. When the ignition switch of the vehicle is switched from OFF to ON, the HV_ECU 50 switches the system main relays SMR-B, SMR-G from OFF to ON. Accordingly, the main battery 10 and the inverter 31 are connected together, and the hybrid system illustrated in FIG. 1 is brought into a starting state (Ready-On). Bringing the hybrid system into the starting state brings the vehicle into a state where traveling is possible.

[0026] On the other hand, when the ignition switch is switched from ON to OFF, the HV_ECU 50 switches the system main relays SMR-B, SMR-G from ON to OFF. Accordingly, the main battery 10 and the inverter 31 are disconnected from each other, and the hybrid system illustrated in FIG. 1 is brought into a stopped state (Ready-Off). When the hybrid system is in the stopped state, the traveling of the vehicle is prohibited, and the vehicle cannot be made to travel.

[0027] The inverter 31 converts DC power output from the main battery 10 into AC power, and outputs the AC power to the motor generator MG2. The motor generator MG2 receives AC power output from the inverter 31 to generate power (kinetic energy). The vehicle can be made to travel by transmitting the power generated by the motor generator MG2 to a driving wheel 32.

[0028] The motor generator MG2 converts kinetic energy, which is generated when the vehicle is braked, into AC power, and outputs the AC power to the inverter 31. The inverter 31 converts the AC power from the motor generator MG2 into DC power, and outputs the DC power to the main battery 10. Accordingly, the main battery 10 can store regenerative electric power.

[0029] A power division mechanism 33 transmits the power of the engine 34 to the driving wheel 32 or transmits the power to the motor generator MG1. The motor generator MG1 receives the power of the engine 34 to perform electric power generation. The AC power generated by the motor generator MG1 is supplied to the motor generator MG2 or is supplied to the main battery 10 via the inverter 31.

[0030] If the electric power generated by the motor generator MG1 is supplied to the motor generator MG2, the driving wheel 32 can be driven with the power generated by the motor generator MG2. If the electric power generated by the motor generator MG1 is supplied to the main battery 10, the main battery 10 can be charged.
5 On the other hand, cranking of the engine 34 can be performed by supplying the electric power of the main battery 10 to the motor generator MG1 to use the power generated by the motor generator MG1.

[0031] A booster circuit (not illustrated) can be provided in a current path between the main battery 10 and the inverter 31. The booster circuit can boost the
10 output voltage of the main battery 10, and can output electric power after the boosting to the inverter 31. The booster circuit can step down the output voltage of the inverter 31, and can output the electric power after the step-down to the main battery 10.

[0032] A DC/DC converter 35 is connected to the positive electrode line PL between the system main relay SMR-B and the inverter 31 and to the negative electrode
15 line NL between the system main relay SMR-G and the inverter 31. The DC/DC converter 35 steps down the output voltage of the main battery 10, and outputs electric power after the step-down to an auxiliary machine battery 36. Accordingly, the auxiliary machine battery 36 can be charged. The auxiliary machine battery 36 supplies electric power to an auxiliary machine mounted on the vehicle. For example,
20 the auxiliary machine battery 36 becomes a power source for actuating the battery ECU 40, the HV_ECU 50, and the engine 34.

[0033] The HV_ECU 50 acquires the battery information to monitor the state of the main battery 10, through the communication between the HV_ECU 50 and the battery ECU 40. However, there is a concern that the state of the main battery 10
25 becomes unable to be monitored. For example, a case where the HV_ECU 50 cannot receive the battery information and a case where the battery information received by the HV_ECU 50 is different from true battery information, are included in cases where the state of the main battery 10 is unable to be monitored. The case that the state of the main battery 10 is unable to be monitored means that the case where the HV_ECU 50
30 cannot monitor the state of the main battery 10. The case where the HV_ECU 50 cannot monitor the state of the main battery 10 is referred to as a monitoring failure.

[0034] As one of the causes in which the monitoring failure occurs, there is a case where the HV_ECU 50 cannot receive the battery information. For example, unless electric power is supplied from the auxiliary machine battery 36 to the battery
35 ECU 40, no battery information is transmitted from the battery ECU 40 to the HV_ECU

50, and the HV_ECU 50 cannot receive any battery information. If abnormality occurs in the communication between the battery ECU 40 and the HV_ECU 50, the HV_ECU 50 cannot receive the battery information from the battery ECU 40. Whether or not a failure in which the HV_ECU 50 cannot receive the battery information occurs, that is, whether or not the monitoring failure occurs can be determined using a well-known cyclic redundancy check (CRC).

[0035] As one of the causes in which the monitoring failure occurs, there is a case where the battery information that the HV_ECU 50 has received from the battery ECU 40 is different from the true battery information. For example, there is a case where, as the CPU 41 of the battery ECU 40 fails, battery information different from the true battery information may be transmitted from the battery ECU 40 to the HV_ECU 50. Whether or not the failure of the CPU 41 occurs, that is, whether or not the monitoring failure occurs can be determined by comparing calculation results of the CPUs 41 and 51 as being widely known.

[0036] If the CPUs 41 and 51 perform calculation processing on the basis of the same input and the calculation results of the CPUs 41 and 51 coincide with each other, it can be determined that the CPUs 41 and 51 do not fail. On the other hand, if the calculation results of the CPUs 41 and 51 do not coincide with each other, it can be determined that one of the CPUs 41 and 51 fails. Here, if it is determined in advance that the CPU 51 does not fail, it can be determined that the CPU 41 fails.

[0037] When the voltage sensor 20, the temperature sensor 21, and the current sensor 22 fail, the battery information that the HV_ECU 50 has received from the battery ECU 40 may differ from the true battery information. Here, well-known methods can be appropriately adopted as methods of determining whether or not the voltage sensor 20, the temperature sensor 21, and the current sensor 22 fail. By determining whether or not the voltage sensor 20, the temperature sensor 21, and the current sensor 22 fail, whether or not the monitoring failure occurs can be determined.

[0038] Next, processing about the monitoring failure will be described using a flowchart illustrated in FIG. 2. The processing illustrated in FIG. 2 is executed by the HV_ECU 50 when the ignition switch is switched from OFF to ON.

[0039] In Step S101, the HV_ECU 50 determines whether or not the monitoring failure occurs on the basis of the above-described determination method. When the monitoring failure occurs, in Step S102, the HV_ECU 50 calculates elapsed time t_m using a timer 52. The elapsed time t_m is the time during which the HV_ECU 50 cannot monitor the state of the main battery 10. The elapsed time t_m is the time

until the ignition switch is turned on from OFF and it becomes clear that the state of the main battery 10 is unable to be monitored, from the starting point. That is, the elapsed time t_m is the time until it is determined that the monitoring failure occurs, from the starting point. In the present embodiment, as illustrated in FIGS. 3 and 4, the starting point is set when the elapsed time t_m is calculated.

[0040] As illustrated in FIG. 3, when the monitoring failure occurs for the first time immediately after the ignition switch is turned on (IG ON), the timing at which the ignition switch that has been previously turned off becomes the starting point of the elapsed time t_m . When the ignition switch is turned on and when the monitoring failure occurs, it is considered that the monitoring failure occurs before the ignition switch is turned on. Thus, in the present embodiment, the monitoring failure is regarded as occurring from the timing at which the ignition switch has been previously turned off. A period during which the ignition switch is turned off is included in the elapsed time t_m . If measurement of time is started using the timer 52 when the ignition switch is switched from ON to OFF, the elapsed time t_m illustrated in FIG. 3 can be calculated.

[0041] On the other hand, although no monitoring failure occurs immediately after the ignition switch is switched from OFF to ON, the monitoring failure may occur for the first time when the hybrid system is in the starting state. In this case, as illustrated in FIG. 4, the timing at which the monitoring failure occurs becomes the starting point of the elapsed time t_m . If measurement of time is started from the timing at which the monitoring failure occurs using the timer 52, the elapsed time t_m illustrated in FIG. 4 can be calculated. As illustrated in FIG. 4, a period during which the ignition switch is turned off is also included in the elapsed time t_m . As illustrated in FIGS. 3 or 4, if the starting point of the elapsed time t_m is set, the elapsed time t_m is updated while the monitoring failure continues occurring.

[0042] In addition, when the monitoring failure occurs for the first time immediately after the ignition switch is turned on, this timing can also be set to the starting point of the elapsed time t_m . That is, as illustrated in FIG. 3, it is not necessary to trace the starting point of the elapsed time t_m back to the timing at which the ignition switch has been previously turned off. However, if the elapsed time t_m is calculated as illustrated in FIG. 3, a situation in which the period during which the monitoring failure occurs is underestimated can be suppressed.

[0043] In Step S103 illustrated in FIG. 2, the HV_ECU 50 determines whether or not the elapsed time t_m calculated through the processing of Step S102 is shorter than

a predetermined time t_{th} . The predetermined time t_{th} can be set in advance, and information on the predetermined time t_{th} can be stored in the memory 53. In the present embodiment, the predetermined time t_{th} is set in consideration of points described below.

5 **[0044]** If the monitoring failure occurs, the HV_ECU 50 cannot grasp the state of the main battery 10. There is also a concern that the single batteries 11 included in the main battery 10 are brought into an overdischarged state after the monitoring failure occurs. Here, if the single batteries 11 in the overdischarged state continue being left, degradation of the single batteries 11 continues to proceed, and it is not possible to
10 perform the cranking of the engine 34 using the output power of the main battery 10. The degradation of the single batteries 11 include, for example, a material constituting negative electrodes of the single batteries 11 being eluted in an electrolytic solution. Thus, in the present embodiment, when the monitoring failure occurs, it is supposed that the single batteries 11 are brought into the overdischarged state, and the time when the
15 overdischarged state of the single batteries 11 can be allowed, in securing the cranking of an engine 34 is set as the predetermined time t_{th} .

[0045] In the processing of Step S103, when the elapsed time t_m is shorter than the predetermined time t_{th} , the HV_ECU 50 switches the system main relays SMR-B, SMR-G from OFF to ON, thereby bringing the hybrid system illustrated in FIG.
20 1 into the starting state, in Step S104. Here, the HV_ECU 50 brings the hybrid system into the starting state in order to perform the cranking of the engine 34.

[0046] If the hybrid system is brought into the starting state and the cranking of the engine 34 is performed, the traveling (engine traveling) of the vehicle can be performed using only the power of the engine 34. After the cranking of the engine 34
25 is ended, the engine 34 can continue being driven using the electric power of the auxiliary machine battery 36. Therefore, the HV_ECU 50 switches the system main relays SMR-B, SMR-G from ON to OFF after the cranking of the engine 34 is ended. Accordingly, the vehicle can be made to travel, and the main battery 10 can be prevented from being charged or discharged according to the traveling of the vehicle
30 while the monitoring failure occurs.

[0047] On the other hand, in the processing of Step S103, when the elapsed time t_m is equal to or more than the predetermined time t_{th} , the HV_ECU 50 prohibits the starting of the hybrid system illustrated in FIG. 1 in Step S105. That is, the HV_ECU 50 keeps the system main relays SMR-B, SMR-G off even if the ignition
35 switch is turned on. In this case, the traveling of the vehicle is prohibited, and the

vehicle cannot be made to travel.

[0048] Since the monitoring failure occurs when the HV_ECU 50 proceeds to the processing of Step S105, the main battery 10 cannot be charged or discharged. Since the elapsed time t_m is equal to or more than the predetermined time t_{th} , the engine 34 cannot be cranked using the output of the main battery 10 either. Thus, the starting of the hybrid system is prohibited in the processing of Step S105.

[0049] When the monitoring failure does not occur in the processing of Step S101, the HV_ECU 50 resets the elapsed time t_m in Step S106. Here, when the elapsed time t_m is not calculated, the elapsed time t_m is kept reset. Then, the HV_ECU 50 brings the hybrid system into the starting state in Step S107. In this case, traveling of the vehicle using the main battery 10 can be performed. Specifically, traveling (so-called HV traveling) in which the main battery 10 and the engine 34 are used together, or traveling (so-called EV traveling) using only the main battery 10 can be performed. In addition, traveling using only then engine 34 can also be performed.

[0050] Next, the processing after the hybrid system is brought into the starting state will be described using a flowchart illustrated in FIG. 5. The processing illustrated in FIG. 5 is executed by the HV_ECU 50, and is performed in a predetermined cycle after the hybrid system is brought into the starting state.

[0051] In Step S201, the HV_ECU 50 determines whether or not the monitoring failure occurs. The processing of Step S201 is the same as the processing of Step S101 illustrated in FIG. 2. When the monitoring failure does not occur, the HV_ECU 50 ends the processing illustrated in FIG. 5. On the other hand, when the monitoring failure occurs, the HV_ECU 50 determines whether or not the engine 34 is started in Step S202. In addition, when the elapsed time t_m illustrated in FIG. 4 is calculated, the timing at which it is determined that the monitoring failure occurs becomes the starting point of the elapsed time t_m .

[0052] When the engine 34 is started in the processing of Step S202, the HV_ECU 50 proceeds to the processing of Step S204. On the other hand, when the engine 34 is not started, the HV_ECU 50 performs the cranking of the engine 34 in Step S203. The HV_ECU 50 proceeds to the processing of Step S204 after the engine 34 is started. In Step S204, the HV_ECU 50 switches the system main relays SMR-B, SMR-G from ON to OFF. Accordingly, the charge or the discharge of the main battery 10 is no longer performed, and the vehicle can be made to travel using only the power of the engine 34.

[0053] In the present embodiment (the processing illustrated in FIG. 2), while

the elapsed time t_m is shorter than the predetermined time t_{th} , even if the monitoring failure occurs, the hybrid system illustrated in FIG. 1 is brought into the starting state according to ON of the ignition switch, and the vehicle can be made to travel using only the power of the engine 34. Accordingly, when the monitoring failure occurs, the window of opportunity in which the vehicle can travel can be increased so as to extend the traveling distance of the vehicle, and the vehicle is easily moved to a safe place.

[0054] Embodiment 2 of the invention will be described. In the present embodiment, the same constituent elements as the constituent elements described in Embodiment 1 will be designated by the same reference numerals, and the detailed description thereof will be omitted. Hereinafter, differences from Embodiment 1 will mainly be described.

[0055] In Embodiment 1 (the flowchart illustrated in FIG. 2), when the monitoring failure occurs, the hybrid system is started or the starting of the hybrid system is prohibited, on the basis of the elapsed time t_m . On the other hand, in the present embodiment, when the monitoring failure occurs, the hybrid system is started or the starting of the hybrid system is prohibited, on the basis of the number of times by which the starting of the hybrid system has been permitted (hereinafter referred to as the number of times of starting permission).

[0056] This processing will be described using a flowchart illustrated in FIG. 6. The flowchart illustrated in FIG. 6 corresponds to the flowchart illustrated in FIG. 2, and is started when the ignition switch is switched from OFF to ON.

[0057] In Step S301, the HV_ECU 50 determines whether or not the monitoring failure occurs. The processing of Step S301 is the same as the processing of Step S101 illustrated in FIG. 2. When the monitoring failure occurs, in Step S302, the HV_ECU 50 determines whether or not the number N_a of times of starting permission is less than a predetermined number N_{th} of times. The number N_a of times of starting permission is the number of times by which the starting of the hybrid system is permitted in the monitoring failure. In other words, the number N_a of times of starting permission is the number of times by which the traveling of the vehicle is permitted using only the power of the engine 34 as will be described below. When the monitoring failure occurs for the first time, the number N_a of times of starting permission is "0".

[0058] The predetermined number N_{th} of times is a larger value than "0", and can be set in advance. Information on the predetermined number N_{th} of times can be stored in the memory 53. In the present embodiment, the predetermined number N_{th}

of times is set in consideration of the points described below.

[0059] As described in Embodiment 1, there is a concern that the single batteries 11 included in the main battery 10 are brought into the overdischarged state while the monitoring failure occurs. When the hybrid system is started to perform the cranking of the engine 34, the main battery 10 is discharged or discharged. Here, if the single batteries 11 in the overdischarged state are charged or discharged for the cranking, the battery temperature T_b rises easily. If the cranking is frequently performed, the battery temperature T_b rises more easily.

[0060] If the battery temperature T_b does not reach an upper limit temperature T_{b_max} that is allowed in the main battery 10 (single batteries 11), the cranking of the engine 34 can be allowed. If the battery temperature T_b according to the number of times of cranking is measured in advance on the basis of experiments using the single batteries 11 in the overdischarged state, the number of times of cranking that can be allowed until the battery temperature T_b reaches the upper limit temperature T_{b_max} can be grasped. This number of times of cranking can be set as the predetermined number N_{th} of times.

[0061] In the processing of Step S302, when the number N_a of times of starting permission is less than the predetermined number N_{th} of times, the HV_ECU 50 starts the hybrid system in Step S303. The processing of Step S303 is the same as the processing of Step S104 illustrated in FIG. 2. In the processing of Step S303, the battery stem is brought into the starting state in order to perform the cranking of the engine 34. Then, the vehicle can be made to travel using only the power of the engine 34.

[0062] If the hybrid system is started through the processing of Step S303, the HV_ECU 50 counts up the number N_a of times of starting permission in Step S304. Whenever the traveling using only the power of the engine 34 is permitted through the processing of Step S303, the number N_a of times of starting permission is counted up. Information on the number N_a of times of starting permission is stored in the memory 53. When the processing illustrated in FIG. 6 is performed next time, in the processing of Step S302, it is determined whether or not the counted-up number N_a of times of starting permission is less than the predetermined number N_{th} of times.

[0063] In the processing of Step S302, when the number N_a of times of starting permission is equal to or more than the predetermined number N_{th} of times, the HV_ECU 50 prohibits the starting of the hybrid system in Step S305. That is, the HV_ECU 50 keeps the system main relays SMR-B, SMR-G off even if the ignition

switch is turned on. When the number N_a of times of starting permission is equal to or more than the predetermined number N_{th} of times, a situation in which the battery temperature T_b reaches the upper limit temperature T_{b_max} can be suppressed by prohibiting the starting of the hybrid system.

5 **[0064]** When the monitoring failure does not occur in the processing of Step S301, the HV_ECU 50 resets the number N_a of times of starting permission in Step S306. In addition, when the counting-up of the number N_a of times of starting permission is not performed, the number N_a of times of starting permission is kept reset. In Step S307, the HV_ECU 50 starts the hybrid system. The processing of Step S307
10 is the same as the processing of Step S107 illustrated in FIG. 2.

[0065] According to the present embodiment, while the number N_a of times of starting permission is less than the predetermined number N_{th} of times even if the monitoring failure occurs, the hybrid system illustrated in FIG. 1 can be brought into the starting state according to ON of the ignition switch, and the vehicle can be made to
15 travel using only the power of the engine 34. Accordingly, when the monitoring failure occurs, an opportunity in which the vehicle can travel can be increased so as to extend the traveling distance of the vehicle. As a result, the vehicle is easily moved to a safe place.

[0066] Embodiment 3 of the invention will be described. In the present
20 embodiment, the same constituent elements as the constituent elements described in Embodiment 1 will be designated by the same reference numerals, and the detailed description thereof will be omitted. Hereinafter, differences from Embodiments 1 and 2 will mainly be described.

[0067] In the present embodiment, when the monitoring failure occurs, the
25 hybrid system is started or the starting of the hybrid system is prohibited, on the basis of the elapsed time t_m and the number N_a of times of starting permission. This processing will be described using a flowchart illustrated in FIG. 7. The flowchart illustrated in FIG. 7 corresponds to the flowchart illustrated in FIG. 2 or 6, and is started when the ignition switch is switched from OFF to ON.

30 **[0068]** In Step S401, the HV_ECU 50 determines whether or not the monitoring failure occurs. The processing of Step S401 is the same as the processing of Step S101 illustrated in FIG. 2 or the processing of Step S301 illustrated in FIG. 6. When the monitoring failure occurs, the HV_ECU 50 calculates the elapsed time t_m in Step S402. The processing of Step S402 is the same as the processing of Step S102
35 illustrated in FIG. 2.

[0069] In Step S403, the HV_ECU 50 determines whether or not the elapsed time t_m calculated through the processing of Step S402 is shorter than the predetermined time t_{th} . The processing of Step S403 is the same as the processing of Step S103 illustrated in FIG. 2. When the elapsed time t_m is shorter than the predetermined time t_{th} , in Step S404, the HV_ECU 50 determines whether or not the number N_a of times of starting permission is less than the predetermined number N_{th} of times. The processing of Step S404 is the same as the processing of Step S302 illustrated in FIG. 6.

[0070] When the number N_a of times of starting permission is less than the predetermined number N_{th} of times, the HV_ECU 50 starts the hybrid system in Step S405. The processing of Step S405 is the same as the processing of Step S104 illustrated in FIG. 2 or the processing of Step S303 illustrated in FIG. 6. When the hybrid system is started through the processing of Step S405, in Step S406, the HV_ECU 50 counts up the number N_a of times of starting permission. The processing of Step S406 is the same as the processing of Step S304 illustrated in FIG. 6.

[0071] When the elapsed time t_m is equal to or more than the predetermined time t_{th} in the processing of Step S403, or when the number N_a of times of starting permission is equal to or more than the predetermined number of times in the processing of Step S404, in Step S407, the HV_ECU 50 prohibits the starting of the hybrid system. The processing of Step S407 is the same as the processing of Step S105 illustrated in FIG. 2 or the processing of Step S305 illustrated in FIG. 6.

[0072] When the monitoring failure does not occur in the processing of Step S401, in Step S408, the HV_ECU 50 resets the elapsed time t_m and number N_a of times of starting permission. In addition, when the elapsed time t_m is not calculated or when the counting-up of the number N_a of times of starting permission is not performed, the elapsed time t_m and the number N_a of times of starting permission are kept reset. In Step S409, the HV_ECU 50 starts the hybrid system. The processing of Step S409 is the same as the processing of Step S107 illustrated in FIG. 2 or the processing of Step S307 illustrated in FIG. 6.

[0073] According to the present embodiment, when the elapsed time t_m is shorter than the predetermined time t_{th} and the number N_a of times of starting permission is less than the predetermined number N_{th} of times even if the monitoring failure occurs, the hybrid system illustrated in FIG. 1 is brought into the starting state according to ON of the ignition switch. Then, the vehicle can be made to travel using only the power of the engine 34. Accordingly, when the monitoring failure occurs, an

opportunity in which the vehicle can travel can be increased so as to extend the traveling distance of the vehicle. As a result, the vehicle is easily moved to a safe place.

[0074] In the processing illustrated in FIG. 7, each of the predetermined time t_{th} and the predetermined number N_{th} of times can also be a fixed value and can also be changed. When the predetermined time t_{th} is changed, the number N_a of times of starting permission can be taken into consideration. As illustrated in FIG. 8, if the correspondence relationship (a map or an operational expression) between the predetermined time t_{th} and the number N_a of times of starting permission is determined in advance, the predetermined time t_{th} according to the number N_a of times of starting permission can be set.

[0075] As illustrated in FIG. 8, as the number N_a of times of starting permission is larger, the predetermined time t_{th} can be made shorter. In other words, as the number N_a of times of starting permission is smaller, the predetermined time t_{th} can be lengthened. As described in Embodiment 2, if the hybrid system is started and the cranking of the engine 34 is frequently performed, the battery temperature T_b rises easily. Therefore, in suppressing a rise in the battery temperature T_b , it is preferable that, as the number N_a of times of starting permission increases, the time (that is, the predetermined time t_{th}) capable of permitting the starting of the hybrid system can be shortened. In addition, in the correspondence relationship illustrated in FIG. 8, even if the number N_a of times of starting permission varies, a range where the predetermined time t_{th} does not change may be included.

[0076] When the predetermined number N_{th} of times is changed, the elapsed time t_m can be taken into consideration. As illustrated in FIG. 9, if the correspondence relationship (a map or an operational expression) between the predetermined number N_{th} of times and the elapsed time t_m is determined in advance, the predetermined number N_{th} of times according to the elapsed time t_m can be set. As illustrated in FIG. 9, as the elapsed time t_m is longer, the predetermined number N_{th} of times can be reduced. In other words, as the elapsed time t_m is shorter, the predetermined number N_{th} of times can be increased.

[0077] When the main battery 10 is in the overdischarged state, as described above, the degradation of the main battery 10 proceeds as the elapsed time t_m becomes longer. Also, as the degradation of the main battery 10 proceeds, the cranking of the engine 34 is not easily performed. In consideration of this point, as the elapsed time t_m is longer, the predetermined number N_{th} of times can be reduced. In addition, in

the correspondence relationship illustrated in FIG. 9, even if the elapsed time t_m varies, a range where the predetermined number N_{th} of times does not change may be included.

[0078] In Embodiments 1 to 3, when the monitoring failure occurs, warning
5 can be given to a user. Sound or display can be used for the warning to the user. Here, as the elapsed time t_m approaches the predetermined time t_{th} or as the number N_a of times of starting permission approaches the predetermined number N_{th} of times, the contents of the warning can be changed. For example, when the warning is performed using sound, the type of sound can be changed according to the elapsed time
10 t_m or the number N_a of times of starting permission. When the warning is performed by periodically generating sound, the intervals at which the sound is generated can be changed according to the elapsed time t_m or the number N_a of times of starting permission.

[0079] Meanwhile, a lamp can be used as the display for performing the
15 warning. Here, the color of the lamp can be changed according to the elapsed time t_m or the number N_a of times of starting permission. When the lamp is periodically blinked, the intervals (turn-on intervals or turn-off intervals of the lamp) at which the lamp is blinked can be changed according to the elapsed time t_m or the number N_a of times of starting permission.

[0080] Meanwhile, by lowering the traveling performance of the vehicle,
20 warning can also be given to a user who is driving the vehicle. By intentionally lowering the traveling performance of the vehicle, the user can be made to recognize that a certain abnormality occurs. For example, when the monitoring failure occurs, the required output of the vehicle accompanying the operation of an accelerator pedal
25 can be lowered compared to when the monitoring failure does not occur. Here, as the elapsed time t_m approaches the predetermined time t_{th} or as the number N_a of times of starting permission approaches the predetermined number N_{th} of times, the traveling performance of the vehicle can be lowered.

CLAIMS:

1. A vehicle comprising:

an engine;

5 a battery configured to perform charge or discharge and configured to output energy for traveling of the vehicle and starting of the engine;

a first control unit configured to control the traveling of the vehicle, the first control unit being configured to calculate elapsed time during which a state of the battery is unable to be monitored on a condition that an ignition switch of the vehicle is
10 turned on and the state of the battery is unable to be monitored, the first control unit being configured to start the engine to permit traveling using only an output of the engine on a condition that the elapsed time is less than a predetermined time, and the first control unit being configured to prohibit the traveling of the vehicle on a condition that the elapsed time is equal to or more than the predetermined time; and

15 a second control unit configured to acquire the state of the battery and transmit acquired information to the first control unit.

2. The vehicle according to claim 1,

wherein the first control unit is configured to count the number of times of
20 permission of the traveling using only the output of the engine is permitted,

wherein the first control unit is configured to permit the traveling using only the output of the engine on a condition that the elapsed time is less than the predetermined time and the number of times of the permission is less than a predetermined number of times, and

25 wherein the first control unit is configured to prohibit the traveling of the vehicle on a condition that the number of times of the permission is equal to or more than the predetermined number of times.

3. The vehicle according to claim 2,

30 wherein the first control unit is configured to set the predetermined time such that the predetermined time become shorter as the number of times of the permission is increased.

4. The vehicle according to claim 2 or 3,

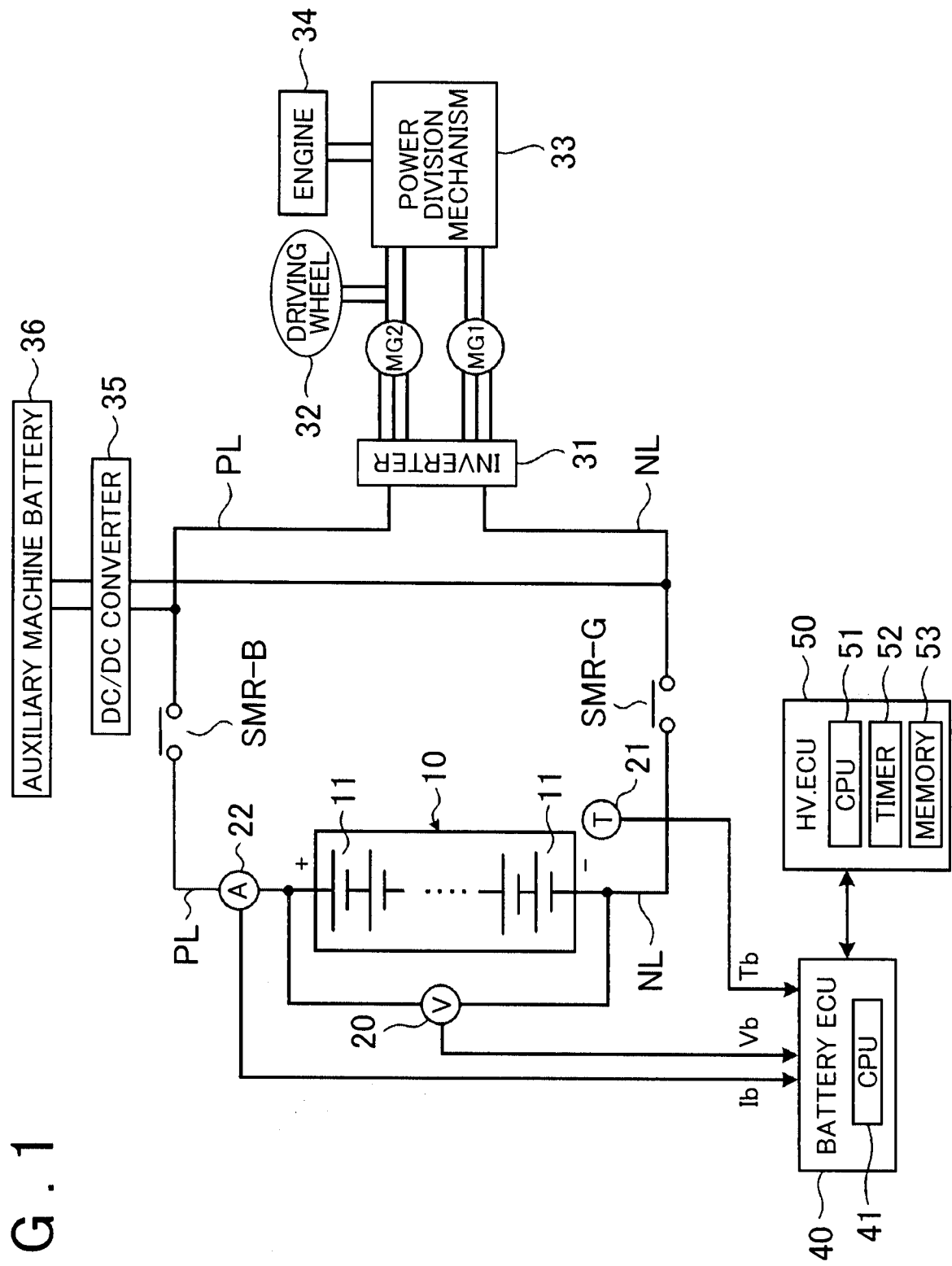
35 wherein the first control unit is configured to set the predetermined number of

times such that the predetermined number of times is reduced as the elapsed time becomes longer.

- 5 5. The vehicle according to any one of claims 1 to 4,
 wherein the first control unit is configured to calculate the elapsed time by setting
 the time when the ignition switch is previously turned off.

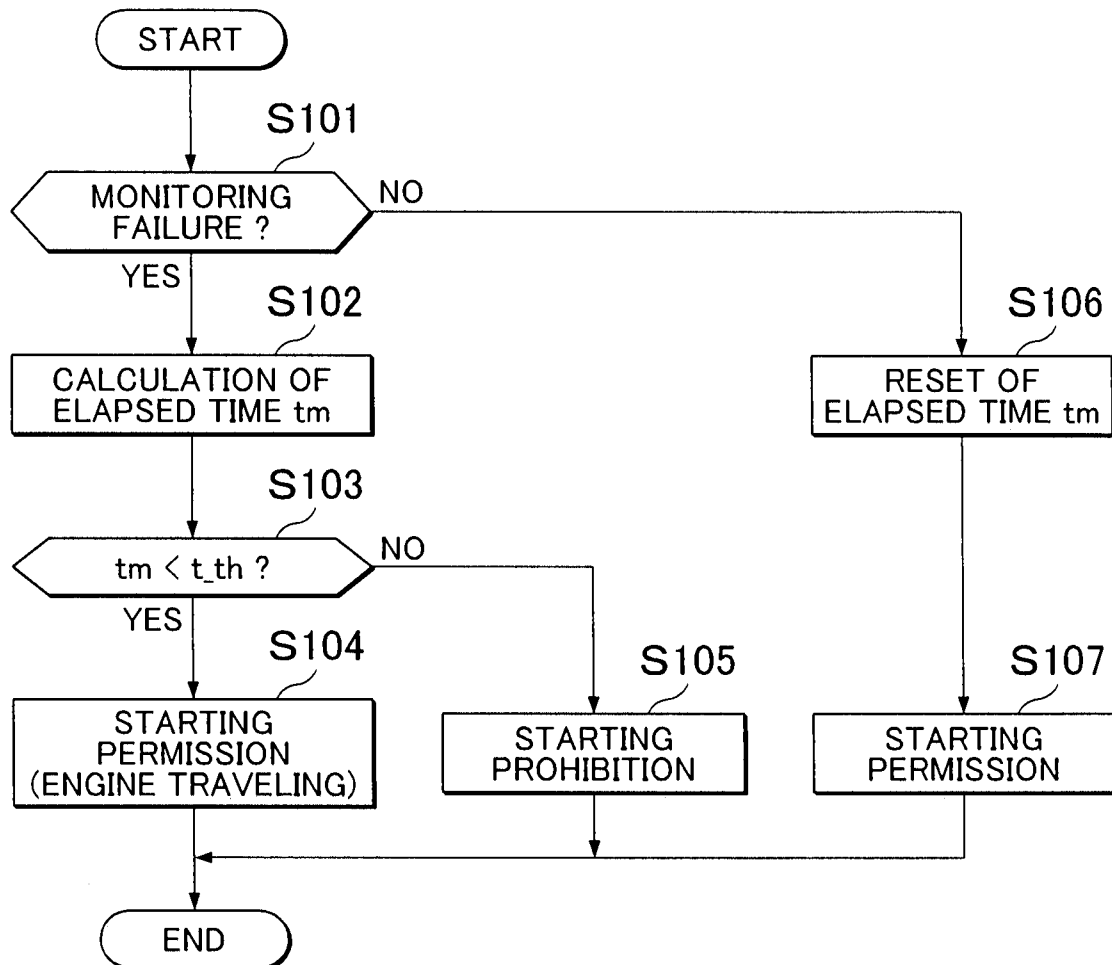
6. A vehicle comprising:
 an engine;
10 a battery configured to perform charge or discharge and configured to output
 energy for traveling of the vehicle and starting of the engine;
 a first control unit configured to control the traveling of the vehicle, the first
 control unit being configured to start the engine to permit traveling using only an output
 of the engine on a condition that an ignition switch of the vehicle is turned on and a
15 state of the battery is unable to be monitored, the first control unit being configured to
 count the number of times of permission of the traveling using only the output of the
 engine is permitted, the first control unit being configured to permit the traveling using
 only the output of the engine on a condition that the number of times of the permission
 is less than a predetermined number of times, and the first control unit being configured
20 to prohibit the traveling of the vehicle on a condition that the number of times of the
 permission is equal to or more than the predetermined number of times; and
 a second control unit configured to acquire the state of the battery and transmit
 acquired information to the first control unit.

FIG. 1



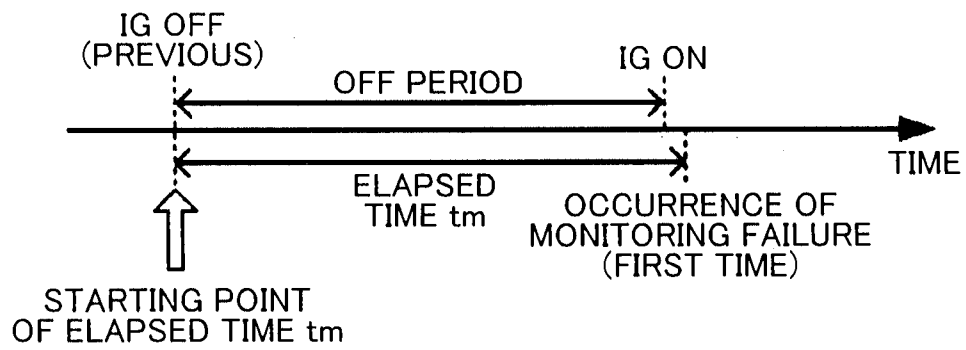
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FIG. 2



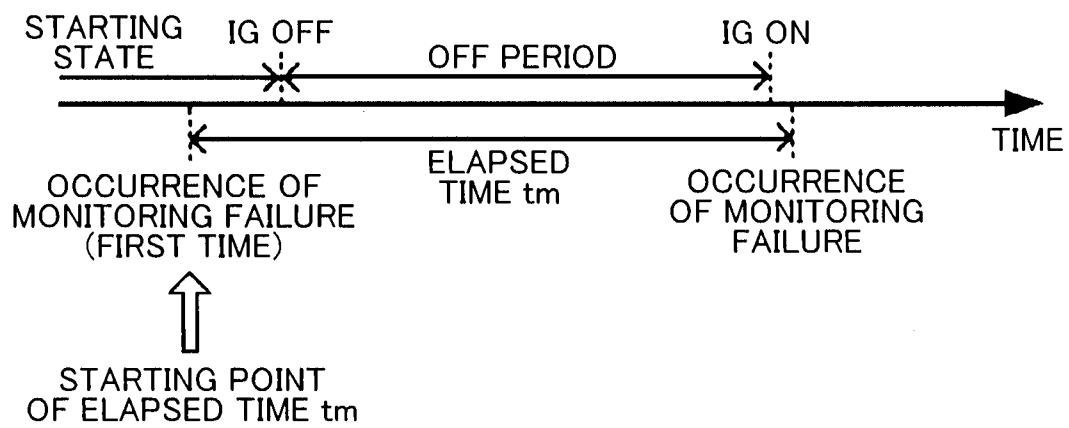
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FIG. 3



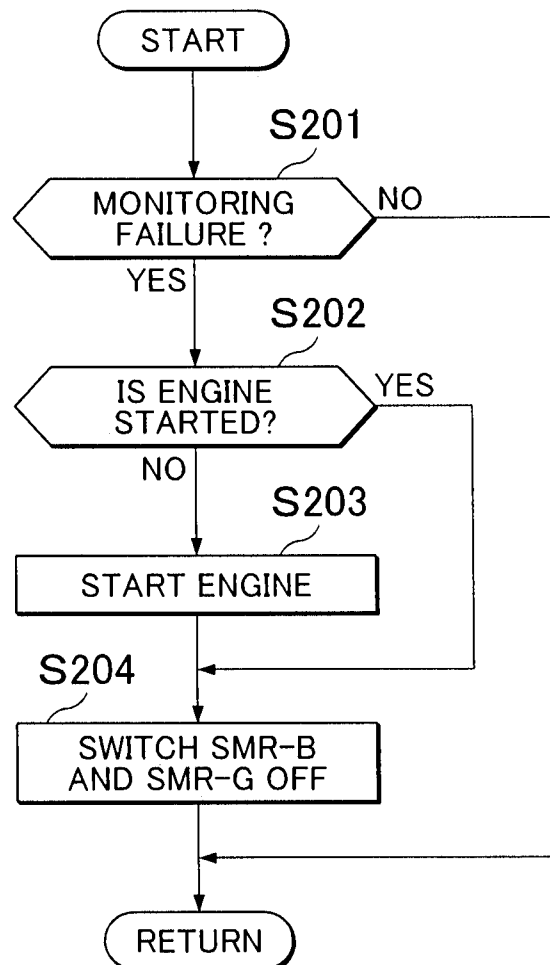
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FIG. 4



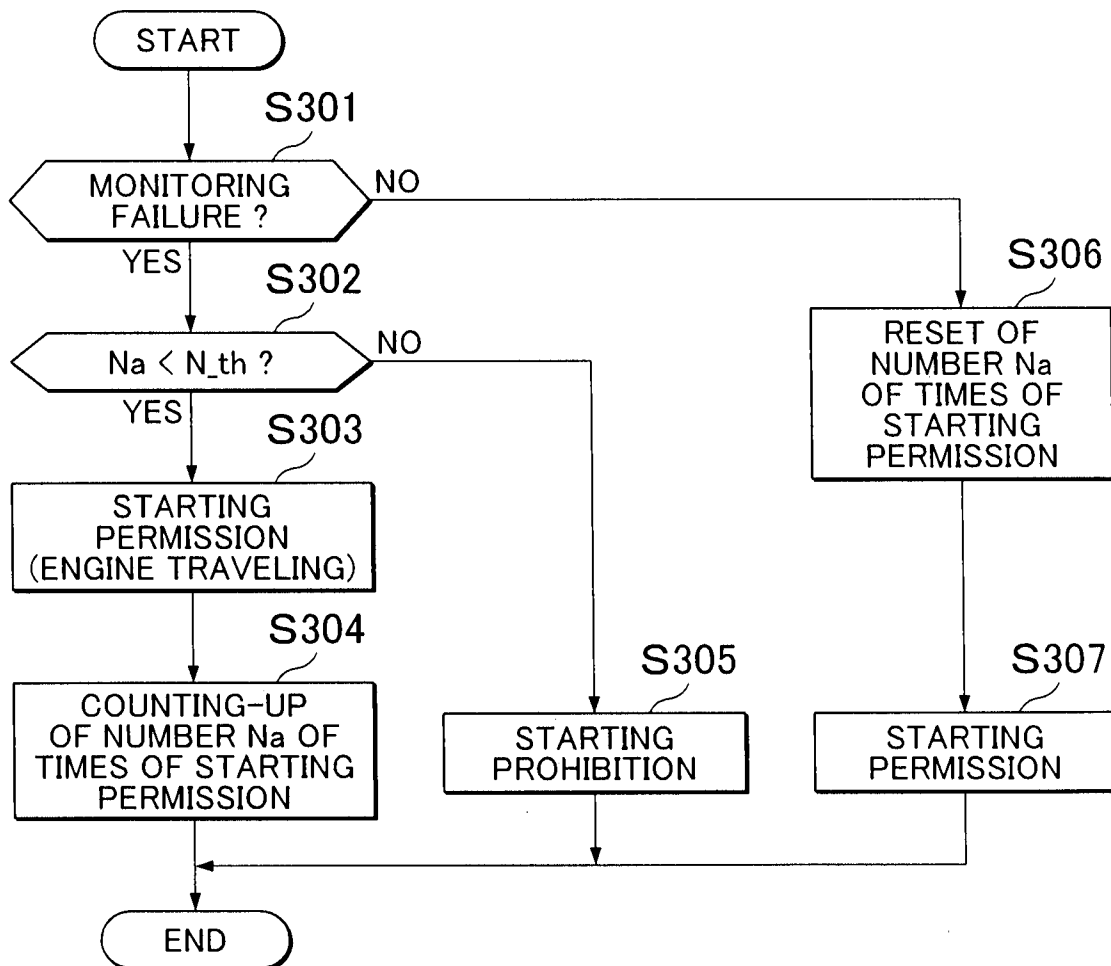
5 / 8

FIG. 5



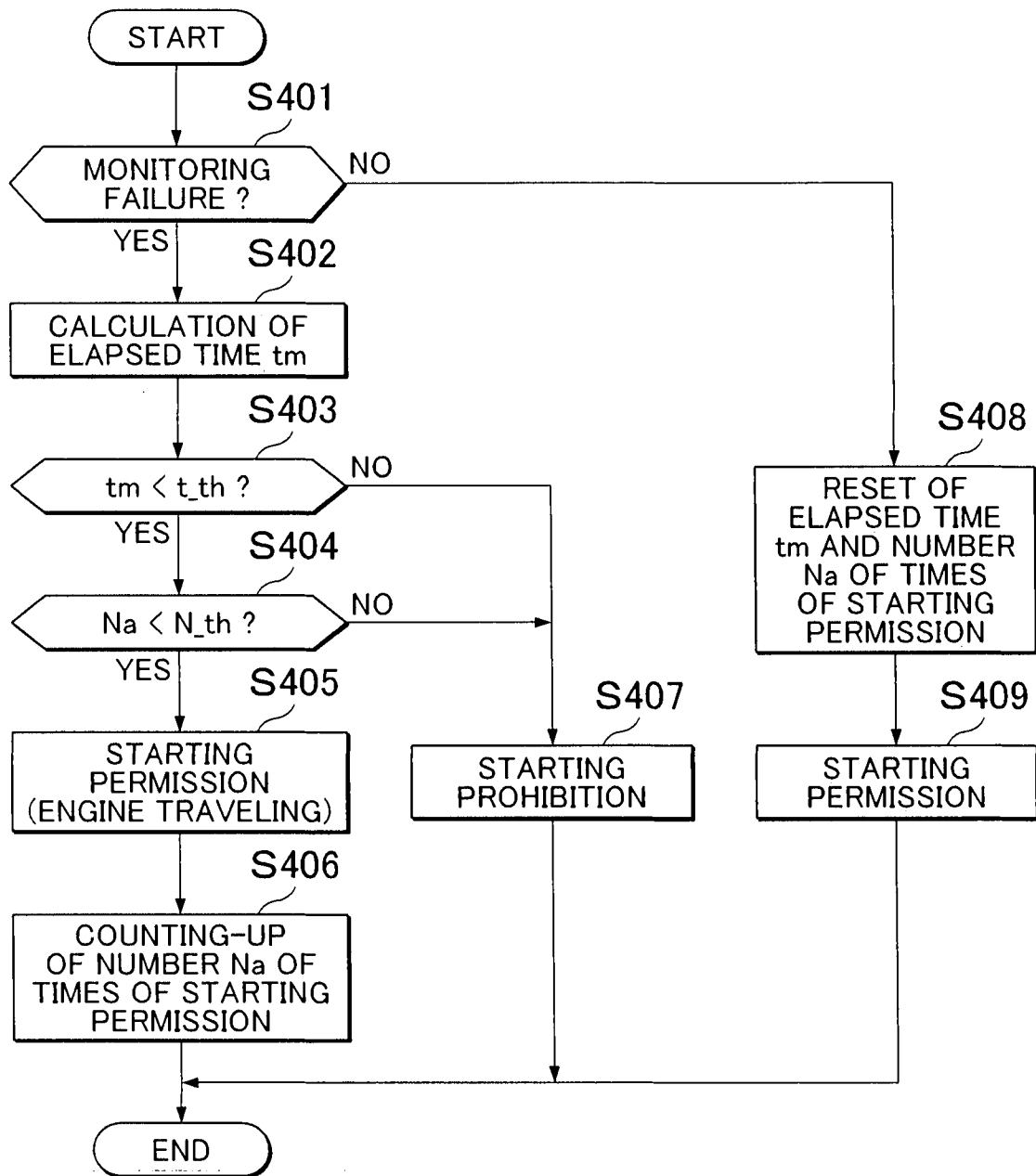
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FIG. 6



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FIG. 7



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FIG. 8

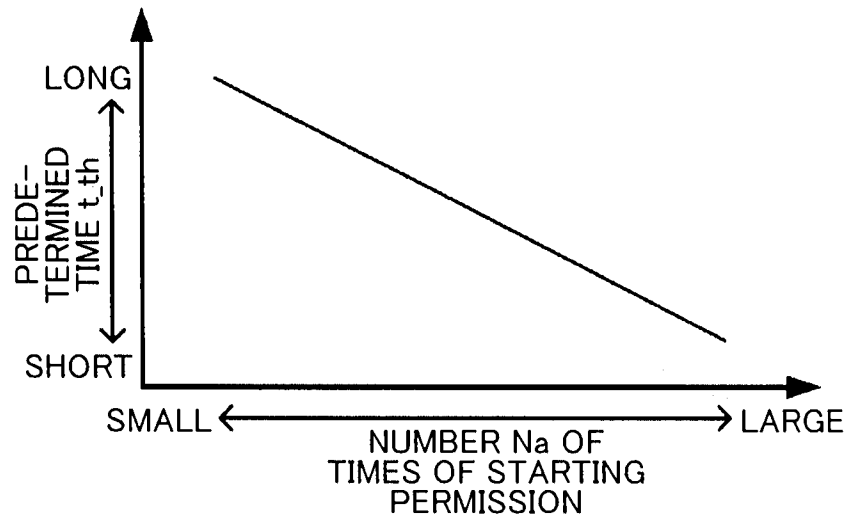
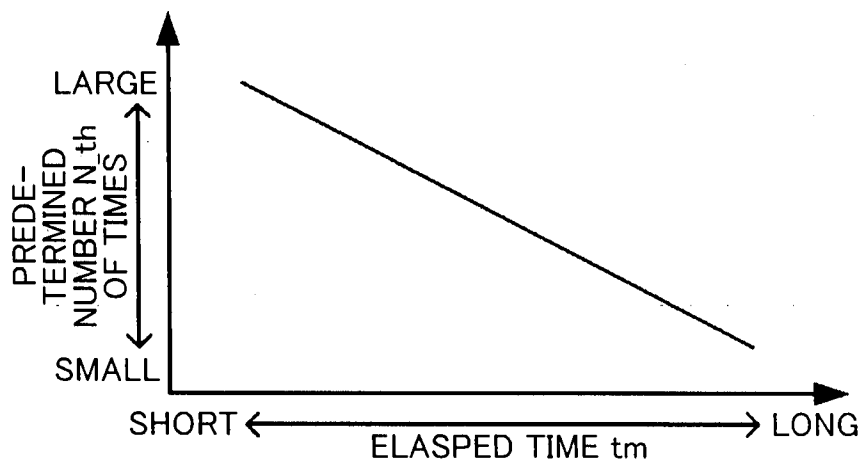


FIG. 9



INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2015/000925

A. CLASSIFICATION OF SUBJECT MATTER INV. B60L11/18 B60L11/02 B60W20/00 B60L3/04 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) B60L B60W		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 23 September 2015		Date of mailing of the international search report 01/10/2015
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Furlan, Stéphane

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