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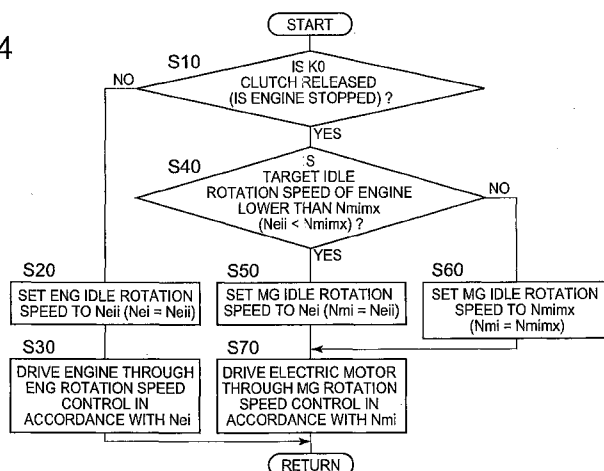
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FIG. 4



(57) Abstract: A control device for a vehicle includes: an engine (14) and an electric motor (M/G) as driving force sources. The electric motor is provided in a power transmission path between the engine and a drive wheel and is coupled to the engine via a clutch. The control device carries out creep running with the use of the electric motor in a state where the clutch is released, and keeps a rotation speed of the electric motor at a predetermined rotation speed during creep running with the use of the electric motor. The control device sets the rotation speed (Nmi) of the electric motor (M/G) to a rotation speed lower than a target idle rotation speed (Nmimx) of the engine during creep running with the use of the electric motor.



CONTROL DEVICE FOR VEHICLE

BACKGROUND OF THE INVENTION

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1. Field of the Invention

[0001] The invention relates to a control device for a vehicle including an engine and an electric motor as driving force sources and, more particularly, to a technique for creep running with the use of the electric motor.

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2. Description of Related Art

[0002] Japanese Patent Application Publication No. 2001-163071 (JP 2001-163071 A) and Japanese Patent Application Publication No. 2010-111194 (JP 2010-111194 A) describe a vehicle including an engine and an electric motor as driving force sources. JP 2001-163071 A describes a technique for stopping both the engine and the electric motor during the stop of the vehicle, causing the vehicle to run by using only the power (which is synonymous with torque and force unless otherwise distinguished) of the electric motor at the start of the vehicle, and shifting into running by using at least the power of the engine by igniting the engine in a relatively low vehicle speed state immediately after the start of the vehicle.

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SUMMARY OF THE INVENTION

[0003] Incidentally, there is also described that, if brake off operation is carried out while an accelerator off state is kept in a vehicle stop state where the engine is stopped, the vehicle is caused to carry out creep running with the use of the electric motor by operating the electric motor at a predetermined rotation speed (for example, a rotation speed corresponding to an engine idle rotation speed). On the other hand, there is also described that, for example, while the engine is cold, the engine idle rotation speed is set to be higher than that in a steady state after completion of engine warm-up. Thus, when an

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electric motor rotation speed during creep running with the use of the electric motor is set to the rotation speed corresponding to the engine idle rotation speed, if the engine idle rotation speed higher than that in a steady state is set, the corresponding electric motor rotation speed is also increased to a value higher than that in a steady state, so electric power consumed by the electric motor is increased. Therefore, electric power that may be utilized for running with the use of the electric motor reduces with an increase in electric power consumed, a travel distance is reduced, and it may be disadvantageous in terms of fuel economy. The above-described challenge is not publicly known, and there has not been suggested yet that creep running with the use of the electric motor is appropriately carried out on the assumption of a situation that the engine idle rotation speed in an engine cold state, or the like, is set to be high.

[0004] The invention provides a control device for a vehicle, which is able to improve fuel economy during creep running with the use of an electric motor.

[0005] An aspect of the invention provides a control device for a vehicle including: an engine and an electric motor as driving force sources, the electric motor being provided in a power transmission path between the engine and a drive wheel and coupled to the engine via a clutch, the vehicle being configured to carry out creep running with the use of the electric motor in a state where the clutch is released and to keep a rotation speed of the electric motor at a predetermined rotation speed during creep running with the use of the electric motor. The control device sets the rotation speed of the electric motor to a rotation speed lower than a target idle rotation speed of the engine during creep running with the use of the electric motor.

[0006] With this configuration, it is possible to decrease the rotation speed of the electric motor during creep running as compared to the case where the electric motor rotation speed during creep running with the use of the electric motor is set to the target idle rotation speed of the engine, so the amount of electric power consumed by the electric motor reduces (that is, the amount of electric power taken out reduces). Thus, it is possible to improve fuel economy during creep running with the use of the electric motor.

[0007] In the above aspect, the control device may set the rotation speed of the

electric motor during creep running to a rotation speed lower than a target idle rotation speed of the engine by setting the rotation speed of the electric motor during creep running to a predetermined upper limit rotation speed of the electric motor during creep running when the target idle rotation speed of the engine is higher than or equal to the upper limit rotation speed. With this configuration, when the target idle rotation speed of the engine is set to a rotation speed higher than or equal to the upper limit rotation speed of the electric motor during creep running with the use of the electric motor, it is possible to suppress an increase in electric power consumed by the electric motor during creep running with the use of the electric motor. That is, the advantageous effect of the aspect is appropriately obtained.

[0008] In the above aspect, the control device may be able to carry out creep running with the use of the engine in a state where the clutch is engaged, and, when the engine is started during creep running with the use of the electric motor, the control device may set a rotation speed of the engine to a rotation speed of the electric motor during creep running at timing at which engagement of the clutch completes and, after that, may shift into creep running with the use of the engine by gradually increasing the rotation speed of the engine to the target idle rotation speed of the engine. With this configuration, at the time of shifting from creep running with the use of the electric motor to creep running with the use of the engine, for the possibility of occurrence of a step in driving force with an increase in the engine rotation speed to the target idle rotation speed, driving force is smoothly varied by gradually increasing the engine rotation speed, it is possible to improve drivability by suppressing a shock (in other words, by reducing a feeling of strangeness experienced by a driver).

[0009] In the above configuration, the control device may carry out regeneration of the electric motor from power of the engine when the rotation speed of the engine is lower than a predetermined lower limit rotation speed at or above which the engine is autonomously operable. With this configuration, for the fact that it is difficult to bring the engine rotation speed into coincidence with a rotation speed lower than the lower limit rotation speed when the engine is controlled so as to generate power of the engine for

keeping the engine rotation speed in autonomous operation (that is, the fact that the engine rotation speed attempts to be higher than a rotation speed lower than the lower limit rotation speed), it is possible to suppress an increase in the engine rotation speed by adding a load to the engine through regenerative control of the electric motor (that is, by converting the redundant amount of the power of the engine for increasing the engine rotation speed to electric energy through power generation of the electric motor). Thus, even when the engine rotation speed becomes lower than the lower limit rotation speed at or above which the engine is autonomously operable, the advantageous effect of the configuration is appropriately obtained.

[0010] In the above configuration, at the time of shifting into creep running with the use of the electric motor by stopping the engine, the control device may set the rotation speed of the electric motor during creep running to the target idle rotation speed of the engine until the clutch is released, and may gradually decrease the rotation speed of the engine toward an upper limit rotation speed of the electric motor during creep running when the rotation speed of the engine has decreased to a rotation speed lower than the rotation speed of the electric motor during creep running. With this configuration, at the time of shifting from creep running with the use of the engine to creep running with the use of the electric motor, for the possibility of occurrence of a step in driving force with a decrease in the rotation speed of the electric motor during creep running from the target idle rotation speed of the engine to the upper limit rotation speed of the electric motor during creep running, driving force is smoothly varied by gradually decreasing the rotation speed of the electric motor during creep running. Thus, it is possible to improve drivability by suppressing a shock.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Features, 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 that illustrates the schematic configuration of a drive line provided in

a vehicle to which the invention is applied and is a view that illustrates a relevant portion of a control system in the vehicle;

FIG. 2 is a functional block diagram that illustrates a relevant portion of control functions of an electronic control unit;

5 FIG. 3 is a view that shows an example of the correlation between a target idle rotation speed of an engine and an MG idle rotation speed during EV creep running;

FIG. 4 is a flowchart that illustrates a relevant portion of control operations of the electronic control unit, that is, control operations for improving fuel economy during EV creep running;

10 FIG. 5 is a flowchart that illustrates a relevant portion of control operations of the electronic control unit, that is, control operations for improving fuel economy during EV creep running, and is another embodiment corresponding to FIG. 4;

FIG. 6 is an example of a time chart in the case where the control operations shown in the flowchart of FIG. 5 are executed;

15 FIG. 7 is a flowchart that illustrates a relevant portion of control operations of the electronic control unit, that is, control operations for improving fuel economy during EV creep running, and is another embodiment corresponding to FIG. 5;

FIG. 8 is an example of a time chart in the case where the control operations shown in the flowchart of FIG. 7 are executed;

20 FIG. 9 is a flowchart that illustrates a relevant portion of control operations of the electronic control unit, that is control operations for improving fuel economy during EV creep running, and is another embodiment corresponding to FIG. 4; and

FIG. 10 is an example of a time chart in the case where the control operations shown in the flowchart of FIG. 9 are executed.

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DETAILED DESCRIPTION OF EMBODIMENTS

[0012] In the invention, suitably, the vehicle includes a transmission in a power transmission path between the engine (or the electric motor) and the drive wheel. The transmission is a manual transmission, such as a known synchromesh parallel-two-shaft

transmission including a plurality of pairs of constant-mesh transmission gears between the two shafts, various automatic transmissions (a planetary gear automatic transmission, a synchromesh parallel-two-shaft automatic transmission, a DCT, a CVT, and the like), or the like. Each of the automatic transmissions is formed of an automatic transmission
5 alone, an automatic transmission including a fluid transmission device, an automatic transmission including an auxiliary transmission, or the like. During a stop of the vehicle, when the engine is operated at an idle, a configuration including the fluid transmission device is desirable. When the fluid transmission device includes a lockup clutch, the lockup clutch is desirably released or slipped during the idle operation.

10 [0013] Suitably, the engine is, for example, an internal combustion engine, such as a gasoline engine and a diesel engine, that generates power through combustion of fuel. The clutch provided in a power transmission path between the engine and the electric motor is a wet-type or dry-type engagement device.

[0014] Hereinafter, an embodiment of the invention will be described in detail
15 with reference to the accompanying drawings.

[0015] FIG. 1 is a view that illustrates the schematic configuration of a drive line
12 provided in a vehicle 10 to which the invention is applied and is a view that illustrates a relevant portion of a control system for various controls in the vehicle 10. In FIG. 1, the vehicle 10 is a hybrid vehicle that includes an engine 14 and an electric motor MG as
20 driving force sources. The drive line 12 includes an engine separating clutch K0 (hereinafter, referred to as separating clutch K0), a torque converter 16, an automatic transmission 18, and the like, in order from the engine 14 side inside a transmission case 20. The torque converter 16 serves as a fluid transmission device. The transmission case 20 serves as a non-rotating member. The drive line 12 includes a propeller shaft 26,
25 a differential gear 28, a pair of axles 30, and the like. The propeller shaft 26 is coupled to a transmission output shaft 24 that is an output rotating member of the automatic transmission 18. The differential gear 28 is coupled to the propeller shaft 26. The pair of axles 30 are coupled to the differential gear 28. A pump impeller 16a of the torque converter 16 is coupled to an engine coupling shaft 32 via the separating clutch K0, and is

directly coupled to the electric motor MG. A turbine impeller 16b of the torque converter 16 is directly coupled to a transmission input shaft 34 that is an input rotating member of the automatic transmission 18. A mechanical oil pump 22 is coupled to the pump impeller 16a. The mechanical oil pump 22 generates operating hydraulic pressure for
5 carrying out shift control over the automatic transmission 18, engagement/release control over the separating clutch K0, and the like, by being rotationally driven by the engine 14 (and/or the electric motor MG). The thus configured drive line 12 is, for example, suitably used in the FR vehicle 10. In the drive line 12, the power (which is synonymous with torque and force unless otherwise distinguished) of the engine 14 is transmitted from
10 the engine coupling shaft 32 to a pair of drive wheels 36 sequentially via the separating clutch K0, the torque converter 16, the automatic transmission 18, the propeller shaft 26, the differential gear 28, the pair of axles 30, and the like, when the separating clutch K0 is engaged. The engine coupling shaft 32 couples the engine 14 to the separating clutch K0. In this way, the drive line 12 constitutes a power transmission path from the engine 14 to
15 the drive wheels 36.

[0016] The automatic transmission 18 is a transmission that constitutes part of the power transmission path between both the engine 14 and the electric motor MG and the drive wheels 36 and that transmits power from the driving force sources (the engine 14 and the electric motor MG) to the drive wheels 36 side. The automatic transmission 18 is, for
20 example, a known planetary gear-type multi-speed transmission in which a plurality of speed positions having different speed ratios γ ($=$ Transmission input rotation speed N_{in} /Transmission output rotation speed N_{out}) are selectively established, a known continuously variable transmission in which the speed ratio γ is continuously variable in a stepless manner, or the like. In the automatic transmission 18, for example, a
25 predetermined speed position (speed ratio) is established on the basis of driver's accelerator operation, a vehicle speed V , and the like, by controlling a hydraulic actuator with the use of a hydraulic control circuit 50.

[0017] The electric motor MG is a so-called motor generator having the function of a motor that generates mechanical power from electric energy and the function of a

generator that generates electric energy from mechanical energy. The electric motor MG functions as the driving force source that generates running power instead of the engine 14 that is a power source or in addition to the engine 14. The electric motor MG is provided in the power transmission path between the engine 14 and the drive wheels 36, and carries out the following operations. That is, the electric motor MG, for example, generates electric energy through regeneration from power generated by the engine 14 or driven force that is input from the drive wheels 36 side, and stores the electric energy in an electrical storage device 54 via an inverter 52. The electric motor MG is coupled to the power transmission path between the separating clutch K0 and the torque converter 16. Power is transmitted to each other between the electric motor MG and the pump impeller 16a. Thus, the electric motor MG is coupled to the engine 14 via the separating clutch K0, and is coupled to the transmission input shaft 34 of the automatic transmission 18 such that power is transmittable without passing through the separating clutch K0.

[0018] The separating clutch K0 is, for example, a wet-type multi-disc friction engagement device in which a plurality of mutually stacked friction plates are pressed by the hydraulic actuator. The separating clutch K0 undergoes engagement/release control from the hydraulic control circuit 50 by using hydraulic pressure that is generated by the oil pump 22 as a source pressure. In the engagement/release control, a torque capacity (hereinafter, referred to as K0 torque) of the separating clutch K0 is changed by regulating a linear solenoid valve, or the like, in the hydraulic control circuit 50. In the engaged state of the separating clutch K0, the pump impeller 16a and the engine 14 are integrally rotated via the engine coupling shaft 32. On the other hand, in a released state of the separating clutch K0, transmission of power between the engine 14 and the pump impeller 16a is interrupted. That is, the engine 14 and the drive wheels 36 are disconnected from each other by releasing the separating clutch K0. Because the electric motor MG is coupled to the pump impeller 16a, the separating clutch K0 also functions as a clutch that is provided in the power transmission path between the engine 14 and the electric motor MG and that connects or interrupts the power transmission path.

[0019] The vehicle 10, for example, includes an electronic control unit 80 that

includes a control device for the vehicle 10, which is associated with creep running with the use of the electric motor MG, or the like. The electronic control unit 80 is, for example, configured to include a so-called microcomputer including a CPU, a RAM, a ROM, an input/output interface, and the like. The CPU executes various controls over the vehicle 10 by carrying out signal processing in accordance with a program prestored in the ROM while utilizing the temporary storage function of the RAM. For example, the electronic control unit 80 is configured to execute output control over the engine 14, drive control over the electric motor MG, including regenerative control over the electric motor MG, shift control over the automatic transmission 18, torque capacity control over the separating clutch K0, and the like. The electronic control unit 80 is formed separately in a unit for engine control, a unit for electric motor control, a unit for hydraulic pressure control, and the like, as needed. Various signals based on detected values of various sensors are supplied to the electronic control unit 80. The various sensors, for example, include an engine rotation speed sensor 56, a turbine rotation speed sensor 58, an output shaft rotation speed sensor 60, an electric motor rotation speed sensor 62, an accelerator operation amount sensor 64, a coolant temperature sensor 66, a battery sensor 68, and the like. The various signals, for example, include an engine rotation speed N_e that is the rotation speed of the engine 14, a crank angle A_{cr} , a turbine rotation speed N_t , that is, a transmission input rotation speed N_{in} that is the rotation speed of the transmission input shaft 34, a transmission output rotation speed N_{out} that is the rotation speed of the transmission output shaft 24 and corresponds to a vehicle speed V , an electric motor rotation speed (motor rotation speed, MG rotation speed) N_m that is the rotation speed of the electric motor MG, an accelerator operation amount θ_{acc} corresponding to a driver's drive request amount to the vehicle 10, a coolant temperature TH_{eng} that is the temperature of coolant of the engine 14 and corresponds to the temperature of the engine 14, a temperature TH_b , charging/discharging current I_b and voltage V_b of the electrical storage device 54, and the like. For example, an engine output control command signal Se for output control over the engine 14, an electric motor control command signal Sm for controlling the operation of the electric motor MG, hydraulic pressure command signals Sp

for operating electromagnetic valves (solenoid valves), and the like, included in the hydraulic control circuit 50 for controlling the hydraulic actuators of the separating clutch K0 and automatic transmission 18, and the like, are respectively output from the electronic control unit 80 to an engine control device, such as a throttle actuator and a fuel injection device, the inverter 52, the hydraulic control circuit 50, and the like. A charged amount (state of charge) SOC, chargeable power W_{in} and dischargeable power W_{out} of the electrical storage device 54 are calculated by the electronic control unit 80 on the basis of, for example, the temperature TH_b , charging/discharging current I_b and voltage V_b of the electrical storage device 54, and each of those calculated values is used in various controls as one of the above-described various signals.

[0020] FIG. 2 is a functional block diagram that illustrates a relevant portion of control functions of the electronic control unit 80. In FIG. 2, shift control means, that is, a shift control unit 82, determines whether to shift the automatic transmission 18 on the basis of, for example, a vehicle state (for example, an actual vehicle speed V , an actual accelerator operation amount θ_{acc} , and the like) by consulting a known correlation (shift line map, shift map (not shown)) obtained through an experiment or design and stored in advance (that is, predetermined) by using a vehicle speed V and a drive request amount (for example, accelerator operation amount θ_{acc} , or the like) as variables, outputs a shift command value for obtaining the determined speed position (speed ratio) to the hydraulic control circuit 50, and executes automatic shift control over the automatic transmission 18. The shift command value is one of the hydraulic pressure command signals Sp .

[0021] Hybrid control means, that is, a hybrid control unit 84, has the function of an engine drive control unit that executes drive control over the engine 14 and the function of an electric motor operation control unit that controls the operation of the electric motor MG as a driving force source or a generator via the inverter 52, and executes hybrid drive control, or the like, with the use of the engine 14 and the electric motor MG through those control functions. For example, the hybrid control unit 84 calculates a required driving torque T_{dtgt} as the drive request amount that is required for the vehicle 10 by a driver on the basis of the accelerator operation amount θ_{acc} and the vehicle speed V . In

consideration of a transmission loss, an auxiliary load, the speed ratio γ of the automatic transmission 18, the chargeable and dischargeable powers W_{in} , W_{out} of the electrical storage device 54, the command signals (the engine output control command signal S_e and the electric motor control command signal S_m) are output for controlling the driving force sources so as to obtain the output torques of the driving force sources (the engine 14 and the electric motor MG), which achieve the required driving torque T_{dtgt} . Other than the required driving torque T_{dtgt} [Nm] of the drive wheels 36, the drive request amount may be a required driving force [N] of the drive wheels 36, a required driving power [W] of the drive wheels 36, a required transmission output torque T_{outtgt} of the transmission output shaft 24, a required transmission input torque T_{inttgt} of the transmission input shaft 34, or the like. The drive request amount may also be merely the accelerator operation amount θ_{acc} [%], a throttle valve opening degree [%], an intake air amount [g/sec], or the like.

[0022] For example, when the required driving torque T_{dtgt} falls within the range in which the required driving torque T_{dtgt} can be provided by only the output torque T_m of the electric motor MG, the hybrid control unit 84 sets a traveling mode to a motor running mode (hereinafter, EV mode), and carries out motor running (EV traveling) in which the vehicle travels while transmitting running torque to the drive wheels 36 with the use of only the electric motor MG in a state where the separating clutch K0 is released. On one hand, for example, when the required driving torque T_{dtgt} falls within the range in which the required driving torque T_{dtgt} cannot be provided unless at least the output torque T_e of the engine 14 is used, the hybrid control unit 84 sets the traveling mode to an engine running mode, that is, a hybrid traveling mode (hereinafter, EHV mode), and carries out engine running, that is, hybrid traveling (EHV traveling) in which the vehicle travels with the use of at least the engine 14 as the driving force source in a state where the separating clutch K0 is engaged. On the other hand, for example, even when the required driving torque T_{dtgt} falls within the range in which the required driving torque T_{dtgt} can be provided by only the MG torque T_m , but when charging of the electrical storage device 54 is required or warm-up of the engine 14 or device associated with the engine 14 is required, the hybrid control unit 84 carries out EHV traveling. In the case of EHV traveling (EHV

mode) at the time of issuance of a warm-up request, or the like, the engine torque T_e is not required as the running torque, so the separating clutch K0 does not always need to be engaged.

[0023] The hybrid control unit 84 starts the engine 14 when the hybrid control unit 84 changes the traveling mode from the EV mode to the EHV mode. In a method of starting the engine 14 by the hybrid control unit 84, for example, the engine rotation speed N_e is increased by setting the released separating clutch K0 in the slipped or engaged state (in other words, by rotationally driving the engine 14 with the use of the electric motor MG), and the engine 14 is started by starting engine ignition, fuel supply, and the like. On the other hand, the hybrid control unit 84 stops the engine 14 when the hybrid control unit 84 changes the traveling mode from the EHV mode to the EV mode. In a method of stopping the engine 14 by the hybrid control unit 84, for example, the engine 14 is stopped by stopping supply of fuel to the engine 14, and the like, and the separating clutch K0 is released when the separating clutch K0 is engaged. Thus, the engine 14 is caused to stop its rotation in the result, and the engine rotation speed N_e is decreased.

[0024] Here, the vehicle 10 is able to carry out known creep running with the use of the engine 14 (engine creep running) and is also able to carry out creep running with the use of the electric motor MG (motor creep running, EV creep running). For example, in the EV mode, the hybrid control unit 84 carries out EV creep running in a state where the separating clutch K0 is released, and keeps the MG rotation speed N_m at a predetermined rotation speed during the EV creep running. On the other hand, for example, in the EHV mode, the hybrid control unit 84 carries out engine creep running in a state where the separating clutch K0 is engaged, and keeps the engine rotation speed N_e at a predetermined rotation speed during the engine creep running. In the present embodiment, for the sake of convenience, the predetermined rotation speed that is the MG rotation speed N_m during EV creep running is termed an idle rotation speed N_{mi} of the electric motor MG, and the predetermined rotation speed that is the engine rotation speed N_e during engine creep running is termed an idle rotation speed N_{ei} of the engine 14.

[0025] Incidentally, during engine creep running, the engine idle rotation speed

Nei is, for example, controlled to the set target value of the engine idle rotation speed Nei (a target idle rotation speed Neii of the engine 14). The target idle rotation speed Neii is, for example, set on the basis of the coolant temperature THeng of the engine 14, the magnitude of an auxiliary load, and the like. For example, during a cold state where
5 warm-up of the engine 14 is not completed, during air-conditioner operation, or the like, the target idle rotation speed Neii is increased as compared to that during steady operation, such as after completion of warm-up, during a stop of the air-conditioner, or the like. On the other hand, during EV creep running, it is conceivable that the MG idle rotation speed Nmi is adjusted to the target idle rotation speed Neii. Thus, when the target idle rotation
10 speed Neii is increased, the MG idle rotation speed Nmi is also increased, so the amount of electric power consumed by the electric motor MG is relatively large.

[0026] During EV creep running, the hybrid control unit 84 sets the MG idle rotation speed Nmi to a rotation speed lower than the target idle rotation speed Neii of the engine 14. However, when a change between the EV mode and the EHV mode in creep
15 running is considered, it is desirable that a step in driving force between EV creep running and engine creep running does not become large (in other words, a difference between the MG idle rotation speed Nmi and the target idle rotation speed Neii does not become large). That is, it is desired to set the MG idle rotation speed Nmi in consideration of suppressing the amount of electric power consumed and generation of a step in driving force as a result
20 of decreasing the MG idle rotation speed Nmi.

[0027] As shown in FIG. 3, when the target idle rotation speed Neii of the engine 14 is higher than or equal to a predetermined value Nmimx, the hybrid control unit 84 sets the MG idle rotation speed Nmi during EV creep running to the predetermined value Nmimx, thus setting the MG idle rotation speed Nmi to a rotation speed lower than the
25 target idle rotation speed Neii. On the other hand, as shown in FIG. 3, the hybrid control unit 84 sets the MG idle rotation speed Nmi during EV creep running to the target idle rotation speed Neii when the target idle rotation speed Neii of the engine 14 is lower than the predetermined value Nmimx. The predetermined value Nmimx is a predetermined upper limit rotation speed of the MG idle rotation speed Nmi during EV creep running

(MG idle upper limit rotation speed N_{mimx}) in consideration of, for example, a balance between the amount of electric power consumed by the electric motor MG during EV creep running and a step in driving force at the time of shifting from EV creep running to engine creep running (that is, on the basis of the amount of electric power consumed by the electric motor MG and a step in driving force).

[0028] Specifically, referring back to FIG. 2, the hybrid control unit 84 determines the target idle rotation speed Ne_{ii} on the basis of the coolant temperature TH_{eng} of the engine 14 and the magnitude of the auxiliary load by consulting a predetermined correlation (target idle rotation speed map (not shown)) for determining the target idle rotation speed Ne_{ii} . The target idle rotation speed map is, for example, set such that the target idle rotation speed Ne_{ii} increases as the coolant temperature TH_{eng} decreases or as the magnitude of the auxiliary load increases.

[0029] Traveling state determination means, that is, a traveling state determination unit 86, determines whether the target idle rotation speed Ne_{ii} of the engine 14 is lower than the MG idle upper limit rotation speed N_{mimx} when the separating clutch $K0$ is released at the time when creep running is carried out by the hybrid control unit 84.

[0030] FIG. 4 is a flowchart that illustrates a relevant portion of control operations of the electronic control unit 80, that is, control operations for improving fuel economy during EV creep running, and is, for example, repeatedly executed at an extremely short cycle time of about several milliseconds to several tens of milliseconds. The flowchart of FIG. 4 is, for example, predicated on a vehicle state where creep running is carried out.

[0031] In FIG. 4, initially, in step (hereinafter, step is omitted) S10 corresponding to the traveling state determination unit 86, for example, it is determined whether the separating clutch $K0$ is released. When negative determination is made in S10 (that is, when the separating clutch $K0$ is completely engaged, that is, when the engine 14 is operating), for example, the engine idle rotation speed Ne_i is set to the target idle rotation speed Ne_{ii} in S20 corresponding to the hybrid control unit 84. Subsequently, in S30 corresponding to the hybrid control unit 84, for example, in accordance with the engine idle rotation speed Ne_i set in S20, the engine 14 is driven through idle rotation speed

control (that is, during engine creep running). When affirmative determination is made in S10 (that is, when the separating clutch K0 is released, that is, when the engine 14 is stopped), for example, it is determined in S40 corresponding to the traveling state determination unit 86 whether the target idle rotation speed N_{eii} of the engine 14 is lower than the MG idle upper limit rotation speed N_{mimx} . When affirmative determination is made in S40, for example, the MG idle rotation speed N_{mi} is set to the target idle rotation speed N_{eii} in S50 corresponding to the hybrid control unit 84. On the other hand, when negative determination is made in S40, for example, the MG idle rotation speed N_{mi} is set to the MG idle upper limit rotation speed N_{mimx} in S60 corresponding to the hybrid control unit 84. Subsequent to S50 or S60, in S70 corresponding to the hybrid control unit 84, for example, in accordance with the MG idle rotation speed N_{mi} set in S50 or S60, the electric motor MG is driven through rotation speed control (that is, during EV creep running).

[0032] As described above, according to the present embodiment, it is possible to decrease the MG idle rotation speed N_{mi} during EV creep running as compared to the case where the MG idle rotation speed N_{mi} is set to the target idle rotation speed N_{eii} of the engine 14, so the amount of electric power consumed by the electric motor MG reduces (that is, the amount of electric power taken out from the electrical storage device 54 reduces). Thus, it is possible to improve fuel economy during EV creep running.

[0033] According to the present embodiment, when the target idle rotation speed N_{eii} of the engine 14 is higher than or equal to the MG idle upper limit rotation speed N_{mimx} , the MG idle rotation speed N_{mi} during EV creep running is set to the MG idle upper limit rotation speed N_{mimx} , so, when the target idle rotation speed N_{eii} is set to a value higher than or equal to the MG idle upper limit rotation speed N_{mimx} , it is possible to suppress an increase in the amount of electric power consumed by the electric motor MG during EV creep running. When the target idle rotation speed N_{eii} of the engine 14 is lower than the MG idle upper limit rotation speed N_{mimx} , the MG idle rotation speed N_{mi} during EV creep running is set to the target idle rotation speed N_{eii} , so a step in driving force between during EV creep running and during engine creep running is

suppressed as much as possible.

[0034] Next, another embodiment of the invention will be described. In the following description, like reference numerals denote portions common to the mutual embodiments, and the description is omitted.

5 **[0035]** In the above-described first embodiment, when the target idle rotation speed N_{eii} of the engine 14 is higher than or equal to the MG idle upper limit rotation speed N_{mimx} , the MG idle rotation speed N_{mi} during EV creep running is set to the MG idle upper limit rotation speed N_{mimx} . Therefore, when the engine 14 is started during EV creep running (that is, when the traveling mode shifts from EV creep running to engine
10 creep running), there is a possibility of occurrence of a step in driving force as the engine idle rotation speed N_{ei} is increased to the target idle rotation speed N_{eii} . The MG idle upper limit rotation speed N_{mimx} is a value that takes a step in driving force into consideration. In this embodiment, a method of further reducing a feeling of strangeness due to the step in driving force is suggested at the time of starting the engine 14.

15 **[0036]** Specifically, when the engine 14 is started during EV creep running, the hybrid control unit 84 gradually increases the MG idle rotation speed N_{mi} toward the target idle rotation speed N_{eii} at a predetermined slope in a period from initiation of the start of the engine 14 to completion of the start of the engine 14 (that is, until engagement of the separating clutch K0 completes). The gradual increase in the MG idle rotation
20 speed N_{mi} may be, for example, carried out immediately after the initiation of the start of the engine 14 or may be carried out when a gradual increase start condition is satisfied after a lapse of a predetermined period of time. Alternatively, when the MG idle rotation speed N_{mi} has reached the target idle rotation speed N_{eii} before engagement of the separating clutch K0 completes, the gradual increase is ended at that timing.

25 **[0037]** The hybrid control unit 84 sets the engine idle rotation speed N_{ei} after completion of the start of the engine 14 (after completion of engagement of the separating clutch K0) to the MG idle rotation speed N_{mi} at the engine start completion timing, and, after that, sets the engine idle rotation speed N_{ei} to a value that gradually increases at a predetermined slope from the MG idle rotation speed N_{mi} at the engine start completion

timing toward the target idle rotation speed N_{eii} . The gradual increase in the engine idle rotation speed N_{ei} is carried out until the engine idle rotation speed N_{ei} reaches the target idle rotation speed N_{eii} , and, after that, engine creep running is carried out at the target idle rotation speed N_{eii} .

5 **[0038]** FIG. 5 is a flowchart that illustrates a relevant portion of control operations of the electronic control unit 80, that is, control operations for improving fuel economy during EV creep running, and is, for example, repeatedly executed at an extremely short cycle time of about several milliseconds to several tens of milliseconds. FIG. 6 is a time chart in the case where the control operations shown in the flowchart of FIG. 5 are
10 executed, and is an example at the time of shifting from EV creep running to engine creep running. FIG. 5 shows another embodiment corresponding to FIG. 4 in the above-described first embodiment. In FIG. 5, S10 in FIG. 4 is changed to S10', S60 in FIG. 4 is changed to S60', and S20 in FIG. 4 is changed to S20'. The difference from FIG. 4 will be specifically described below.

15 **[0039]** In FIG. 5, in S10' corresponding to the traveling state determination unit 86, for example, it is determined whether the separating clutch K0 is being engaged (that is, start control over the engine 14 is being executed) or the separating clutch K0 is released. When affirmative determination is made in S10' (for example, when start control over the engine 14 is being executed), the process proceeds to S40. When negative determination
20 is made in S40, the MG idle rotation speed N_{mi} is set in S60' corresponding to the hybrid control unit 84. In S60', for example, it is determined in S601 whether the gradual increase start condition is satisfied (for example, whether a predetermined period of time has elapsed from the initiation of the start of the engine). When negative determination is made in S601, the MG idle rotation speed N_{mi} is, for example, set to MG idle upper limit
25 rotation speed N_{mimx} in S602 (t1 timing to t2 timing in FIG. 6) until affirmative determination is made in S601. When affirmative determination is made in S601, the MG idle rotation speed N_{mi} is, for example, set to a value that gradually increases toward the target idle rotation speed N_{eii} of the engine 14 in S603 (t2 timing to t3 timing in FIG. 6). Subsequently, in S604, for example, it is determined whether engagement of the separating

clutch K0 (start of the engine 14) has completed or whether the MG idle rotation speed N_{mi} is higher than or equal to the target idle rotation speed N_{ei} . Until affirmative determination is made in S604, S603 is repeatedly executed. On the other hand, when negative determination is made in S10' (that is, when the start of the engine 14 has
5 completed and the engine is operating), the engine idle rotation speed N_{ei} is set in S20' corresponding to the hybrid control unit 84. In S20', for example, the engine idle rotation speed N_{ei} is set to the MG idle rotation speed N_{mi} in S201 (t_3 timing in FIG. 6). Subsequently, for example, the engine idle rotation speed N_{ei} is set to a value that gradually increases toward the target idle rotation speed N_{ei} in S202 (t_3 timing to t_4
10 timing in FIG. 6). Subsequently, in S203, it is determined whether the engine idle rotation speed N_{ei} is higher than or equal to the target idle rotation speed N_{ei} . Until affirmative determination is made in S203, S202 is repeatedly executed. Through the control shown in FIG. 5, as shown in FIG. 6, the idle rotation speed is continuously controlled at the time of shifting from EV creep running to engine creep running, so the continuity of driving
15 force is maintained.

[0040] As described above, according to the present embodiment, in addition to the advantageous effect of the above-described first embodiment, when the engine 14 is started during EV creep running, the engine idle rotation speed N_{ei} after completion of the start of the engine is set to the MG idle rotation speed N_{mi} at the timing of completion of
20 engagement of the separating clutch K0, and, after that, is gradually increased to the target idle rotation speed N_{ei} , thus shifting into engine creep running, so driving force is smoothly varied. Thus, it is possible to improve drivability by suppressing a shock (in other words, by reducing a feeling of strangeness experienced by the driver).

[0041] In the above-described second embodiment, the engine idle rotation speed
25 N_{ei} is not immediately increased to the target idle rotation speed N_{ei} after the start of the engine, and is increased such that the engine idle rotation speed N_{ei} is gradually increased from the MG idle rotation speed N_{mi} . On the other hand, the engine 14, for example, has a predetermined lower limit rotation speed (engine lower limit rotation speed N_{emn}) at or above which the engine 14 is autonomously operable to keep the engine idle rotation speed

Nei in autonomous operation. In this case, when the engine idle rotation speed Nei that is set after completion of the start of the engine is lower than the engine lower limit rotation speed Nemn, if the engine 14 is controlled so as to generate the power of the engine 14 for keeping the engine idle rotation speed Nei in autonomous operation, it may be difficult to
5 bring the engine idle rotation speed Nei into coincidence with a rotation speed lower than the engine lower limit rotation speed Nemn (that is, the engine idle rotation speed Nei may attempt to become higher than a rotation speed lower than the engine lower limit rotation speed Nemn).

[0042] The hybrid control unit 84 carries out regeneration of the electric motor
10 MG from the power of the engine 14 when the engine idle rotation speed Nei that is set after completion of the start of the engine is lower than the engine lower limit rotation speed Nemn. That is, the hybrid control unit 84 controls the throttle valve opening degree, and the like, so as to keep the engine lower limit rotation speed Nemn, and, in addition to that, carries out regeneration of the electric motor MG (the amount of electric power
15 (negative torque) generated by the electric motor MG is generated) such that the set engine idle rotation speed Nei is attained.

[0043] FIG. 7 is a flowchart that illustrates a relevant portion of control operations of the electronic control unit 80, that is, control operations for improving fuel economy during EV creep running, and is, for example, repeatedly executed at an extremely short
20 cycle time of about several milliseconds to several tens of milliseconds. FIG. 8 is a time chart in the case where the control operations shown in the flowchart of FIG. 7 are executed, and is an example at the time of shifting from EV creep running to engine creep running. FIG. 7 shows another embodiment corresponding to FIG. 5 in the above-described second embodiment, and FIG. 7 mainly differs from FIG. 5 in the steps of
25 S25 and S28 are further added. The difference from FIG. 5 will be specifically described below.

[0044] In FIG. 7, subsequent to S20', in S25 corresponding to the traveling state determination unit 86, for example, it is determined whether the engine idle rotation speed Nei set in S20' is lower than the engine lower limit rotation speed Nemn. When

affirmative determination is made in S25, in S28 corresponding to the hybrid control unit 84, for example, engine rotation speed decreasing control is executed such that the engine rotation speed N_e becomes the engine idle rotation speed N_{ei} through regeneration of the electric motor MG while the throttle valve opening degree, and the like, are controlled so as to keep the engine lower limit rotation speed N_{emn} (t3 timing to t4 timing in FIG. 8). On the other hand, when negative determination is made in S25, S30 is executed (shifting to t4 timing in FIG. 8). Through the control shown in FIG. 7, while the combustion stability and engine stalling prevention performance of the engine 14 are ensured, as shown in FIG. 8, the engine rotation speed N_e after the start of the engine is decreased and the idle rotation speed is continuously controlled, so the continuity of driving force before and after the start of the engine is maintained.

[0045] As described above, according to the present embodiment, when the engine idle rotation speed N_{ei} after completion of the start of the engine is lower than the engine lower limit rotation speed N_{emn} , regeneration of the electric motor MG from the power of the engine 14 is carried out, so it is possible to suppress an increase in the engine idle rotation speed N_{ei} by adding a load to the engine 14 through regeneration control over the electric motor MG (that is, by converting the redundant amount of the power of the engine 14 for increasing the engine idle rotation speed N_{ei} to electric energy through power generation of the electric motor MG). Thus, even when the engine idle rotation speed N_{ei} that is set after completion of the start of the engine is lower than the engine lower limit rotation speed N_{emn} , the advantageous effect of the above-described third embodiment is appropriately obtained.

[0046] In the above-described first embodiment, when the target idle rotation speed N_{eii} of the engine 14 is higher than or equal to the MG idle upper limit rotation speed N_{mimx} , the MG idle rotation speed N_{mi} during EV creep running is set to the MG idle upper limit rotation speed N_{mimx} . Therefore, when the traveling mode shifts from engine creep running to EV creep running, there is a possibility of occurrence of a step in driving force with a decrease in the MG idle rotation speed N_{mi} from the target idle rotation speed N_{eii} of the engine 14 to the MG idle upper limit rotation speed N_{mimx} .

The MG idle upper limit rotation speed N_{mimx} is a value that takes a step in driving force into consideration; however, in this embodiment, a method of further reducing a feeling of strangeness due to the step in driving force at the time of stopping the engine 14 is suggested.

- 5 [0047] Specifically, at the time of shifting into EV creep running by stopping the engine 14, the hybrid control unit 84 sets the MG idle rotation speed N_{mi} to the target idle rotation speed N_{eii} in a period from initiation of the stop of the engine 14 to at least when the separating clutch K0 is released. The hybrid control unit 84 gradually decreases the MG idle rotation speed N_{mi} from the target idle rotation speed N_{eii} toward the MG idle upper limit rotation speed N_{mimx} at a predetermined slope. The gradual decrease in the MG idle rotation speed N_{mi} may be, for example, carried out immediately after the separating clutch K0 is released and may be carried out after a gradual decrease start condition is satisfied. The gradual decrease start condition is, for example, the fact that a predetermined period of time has elapsed after the separating clutch K0 is released.
- 10 Alternatively, the gradual decrease start condition is, for example, the fact that the engine rotation speed N_e has decreased by a value ($= N_m - \text{Predetermined margin}$) obtained by subtracting a predetermined margin from the MG rotation speed N_m . In short, the gradual decrease start condition just needs to be a condition by which it is possible to confirm that the separating clutch K0 is completely released and the engine rotation speed
- 15 N_e has reliably decreased to a value below the MG idle rotation speed N_{mi} .
- 20

- [0048] FIG. 9 is a flowchart that illustrates a relevant portion of control operations of the electronic control unit 80, that is, control operations for improving fuel economy during EV creep running, and is, for example, repeatedly executed at an extremely short cycle time of about several milliseconds to several tens of milliseconds. FIG. 10 is a time chart in the case where the control operations shown in the flowchart of FIG. 9 are
- 25 executed, and is an example at the time of shifting from engine creep running to EV creep running. FIG. 9 shows another embodiment corresponding to FIG. 4 in the above-described first embodiment. In FIG. 9, S10 in FIG. 4 is changed to S10" and S60 in FIG. 4 is changed to S60". The difference from FIG. 4 will be specifically described

below.

[0049] In FIG. 9, in S10" corresponding to the traveling state determination unit 86, for example, it is determined whether the separating clutch K0 is being released (that is, stop control over the engine 14 is being executed) or the separating clutch K0 is released.

5 When affirmative determination is made in S10" (for example, when stop control over the engine 14 is being executed), the process proceeds to S40. When negative determination is made in S40, the MG idle rotation speed Nmi is set in S60" corresponding to the hybrid control unit 84. In S60", for example, the MG idle rotation speed Nmi is set to the engine idle rotation speed Nei (or the target idle rotation speed Neii) in S605 (t1 timing to t3

10 timing in FIG. 10). Subsequently, in S606, for example, it is determined whether the gradual decrease start condition is satisfied. When negative determination is made in S606, the process is returned to S605; whereas, when affirmative determination is made in S606, for example, the MG idle rotation speed Nmi is set to a value that gradually decreases toward the MG idle upper limit rotation speed Nmimx in S607 (t3 timing to t4

15 timing in FIG. 10). Subsequently, in S608, for example, it is determined whether the MG idle rotation speed Nmi is lower than or equal to the MG idle upper limit rotation speed Nmimx. Until affirmative determination is made in S608, S607 is repeatedly executed. Through the control shown in FIG. 9, as shown in FIG. 10, the idle rotation speed is continuously controlled at the time of shifting from engine creep running to EV creep

20 running, so the continuity of driving force is maintained.

[0050] As described above, according to the present embodiment, in addition to the advantageous effect of the above-described first embodiment, when the engine 14 is stopped and the traveling mode shifts into EV creep running, the MG idle rotation speed Nmi is set to the target idle rotation speed Neii until the separating clutch K0 is released,

25 and, when the engine rotation speed Ne has decreased to a value lower than the MG idle rotation speed Nmi, gradually decreases toward the MG idle upper limit rotation speed Nmimx, so driving force is smoothly varied. Thus, it is possible to improve drivability by suppressing a shock.

[0051] The embodiment of the invention is described in detail with reference to

the drawings; however, the invention may be implemented by a combination of the embodiments with each other and may also be implemented in other embodiments.

[0052] For example, the above-described fourth embodiment may be implemented in combination with not only the above-described first embodiment but also
5 any one of the above-described second and third embodiments.

[0053] In the above-described second embodiment (particularly, S601 in the flowchart of FIG. 5), after the initiation of the start of the engine, the MG idle rotation speed N_{mi} is gradually increased after the gradual increase start condition is satisfied; however, the invention is not limited to this embodiment. For example, the MG idle
10 rotation speed N_{mi} may be gradually increased immediately after the initiation of the start of the engine 14. Thus, for example, S601 and S602 in the flowchart of FIG. 5 in the above-described embodiment may be omitted, the steps, the execution order, and the like, in each of the flowcharts shown in FIG. 4, FIG. 5, FIG. 7, and FIG. 9 may be changed as needed within the range of no difficulty.

[0054] In each of the above-described embodiments, when the separating clutch K0 is engaged, the electric motor MG and the engine 14 are substantially directly coupled to each other. Therefore, a comparison between the MG idle rotation speed N_{mi} and the target idle rotation speed N_{eii} of the engine 14 directly uses those numeric values; however, the invention is not limited to this embodiment. For example, when the electric motor
20 MG is coupled to the engine coupling shaft 32 via a reduction gear, a transmission, or the like, an electric motor rotation speed converted value, obtained by converting the MG idle rotation speed N_{mi} to a rotation speed on the engine shaft (for example, the crankshaft, the engine coupling shaft 32) on the basis of its speed ratio, or the like, is compared with the target idle rotation speed N_{eii} . Alternatively, an engine rotation speed converted value,
25 obtained by converting the engine rotation speed N_e to a rotation speed on the electric motor shaft, may be compared with the MG rotation speed N_m . In short, in the invention, in an embodiment in which the rotation speeds are compared with each other, such as the MG idle rotation speed N_{mi} is compared with the target idle rotation speed N_{eii} , the word of each rotation speed not only includes each rotation speed itself but also includes each

rotation speed converted value.

[0055] In each of the above-described embodiments, the vehicle 10 in which the engine 14 and the electric motor MG are indirectly coupled to each other via the separating clutch K0 is illustrated as the vehicle to which the invention is applied. However, the invention is not limited to this embodiment. For example, the invention may also be applied to a vehicle in which no separating clutch K0 is provided and the engine 14 and the electric motor MG are directly coupled to each other. For example, in the case where no separating clutch K0 is provided, the time when the separating clutch K0 is released in each of the above-described embodiments is read as the time when the engine 14 is stopped, and the time when the separating clutch K0 is engaged in each of the above-described embodiments is read as the time when the engine 14 is operated.

[0056] In each of the above-described embodiments, the torque converter 16 is used as the fluid transmission device; instead, another fluid transmission device, such as a fluid coupling having no torque amplification function, may be used.

[0057] In each of the above-described embodiments, the vehicle 10 includes the automatic transmission 18; however, the automatic transmission 18 does not always need to be provided.

[0058] The above-described embodiments are only illustrative, and the invention may be implemented in modes including various modifications and improvements on the basis of the knowledge of persons skilled in the art.

CLAIMS:

1. A control device for a vehicle including: an engine and an electric motor as driving force sources, the electric motor being provided in a power transmission path between the engine and a drive wheel and coupled to the engine via a clutch, the vehicle being configured to carry out creep running with the use of the electric motor in a state where the clutch is released and to keep a rotation speed of the electric motor at a predetermined rotation speed during creep running with the use of the electric motor, the control device characterized in that

the control device sets the rotation speed of the electric motor to a rotation speed lower than a target idle rotation speed of the engine during creep running with the use of the electric motor.

2. The control device according to claim 1, wherein

the control device sets the rotation speed of the electric motor during creep running to a rotation speed lower than a target idle rotation speed of the engine by setting the rotation speed of the electric motor during creep running to a predetermined upper limit rotation speed of the electric motor during creep running when the target idle rotation speed of the engine is higher than or equal to the upper limit rotation speed.

3. The control device according to claim 1 or 2, wherein

the control device is able to carry out creep running with the use of the engine in a state where the clutch is engaged, and

when the engine is started during creep running with the use of the electric motor, the control device sets a rotation speed of the engine to a rotation speed of the electric motor during creep running at timing at which engagement of the clutch completes and, after that, shifts into creep running with the use of the engine by gradually increasing the rotation speed of the engine to the target idle rotation speed of the engine.

4. The control device according to claim 3, wherein
the control device carries out regeneration of the electric motor from power of the engine when the rotation speed of the engine is lower than a predetermined lower limit rotation speed at or above which the engine is autonomously operable.

5. The control device according to any one of claims 2 to 4, wherein
at the time of shifting into creep running with the use of the electric motor by stopping the engine, the control device sets the rotation speed of the electric motor during creep running to the target idle rotation speed of the engine until the clutch is released, and gradually decreases the rotation speed of the electric motor toward an upper limit rotation speed of the electric motor during creep running when the rotation speed of the engine has decreased to a rotation speed lower than the rotation speed of the electric motor during creep running.

FIG. 1

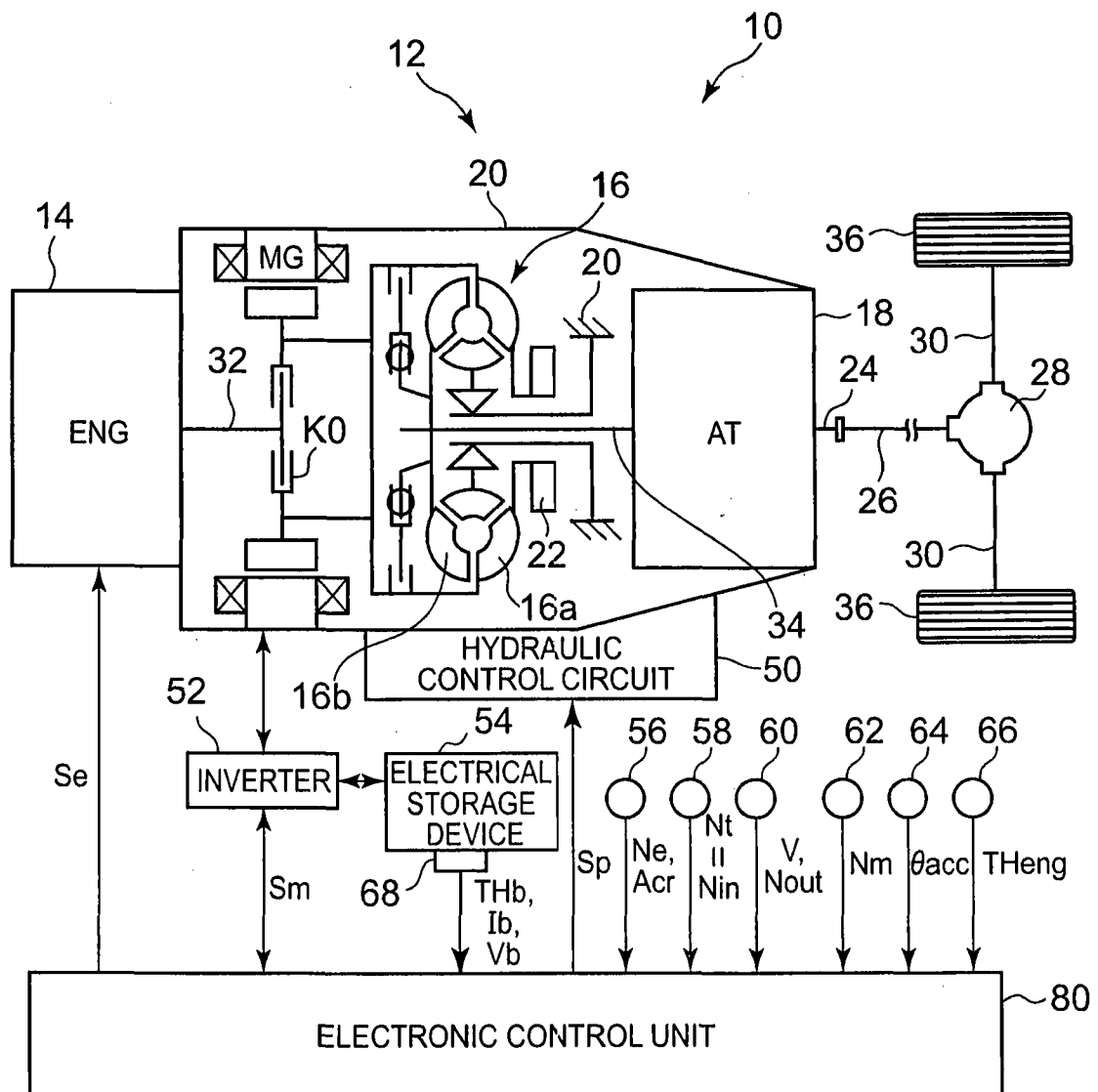


FIG. 2

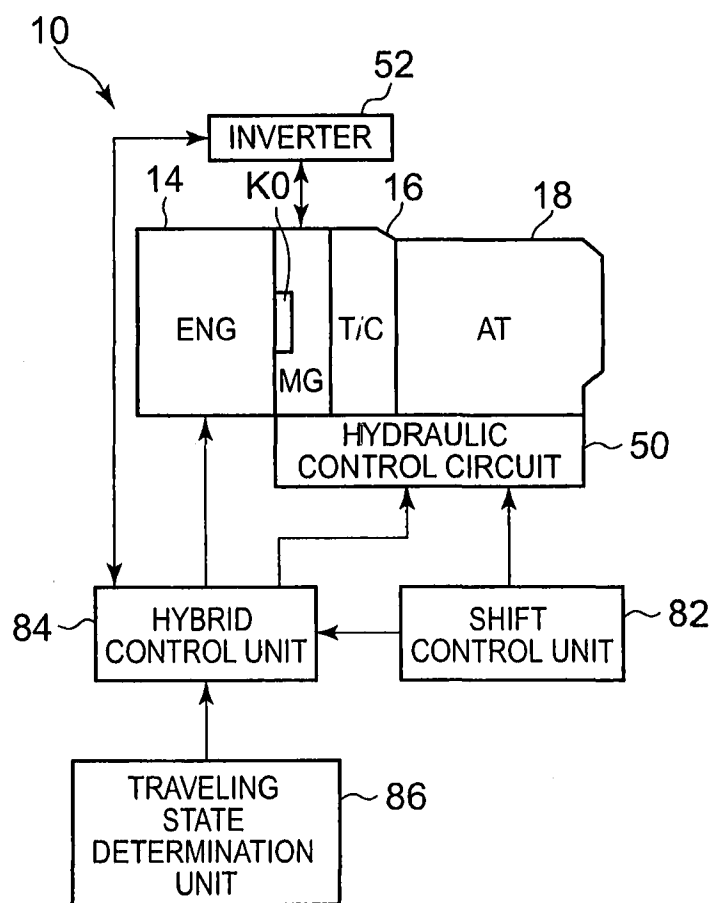


FIG. 3

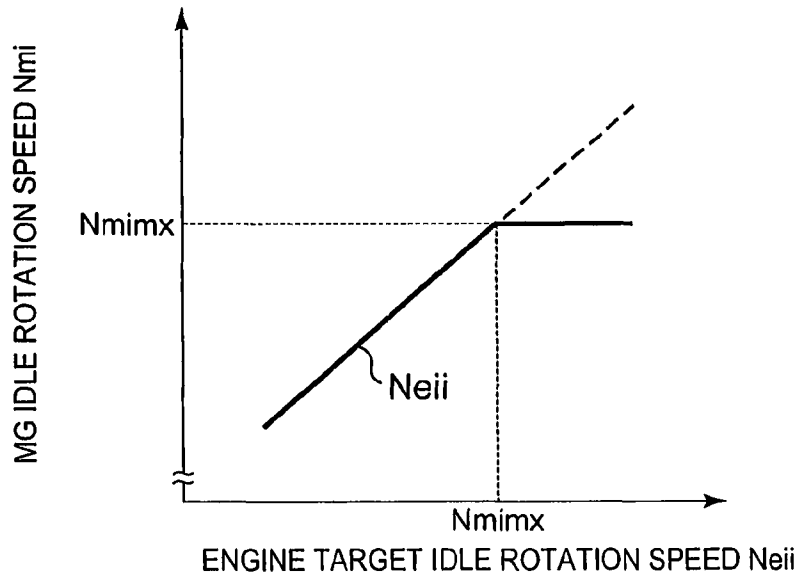


FIG. 4

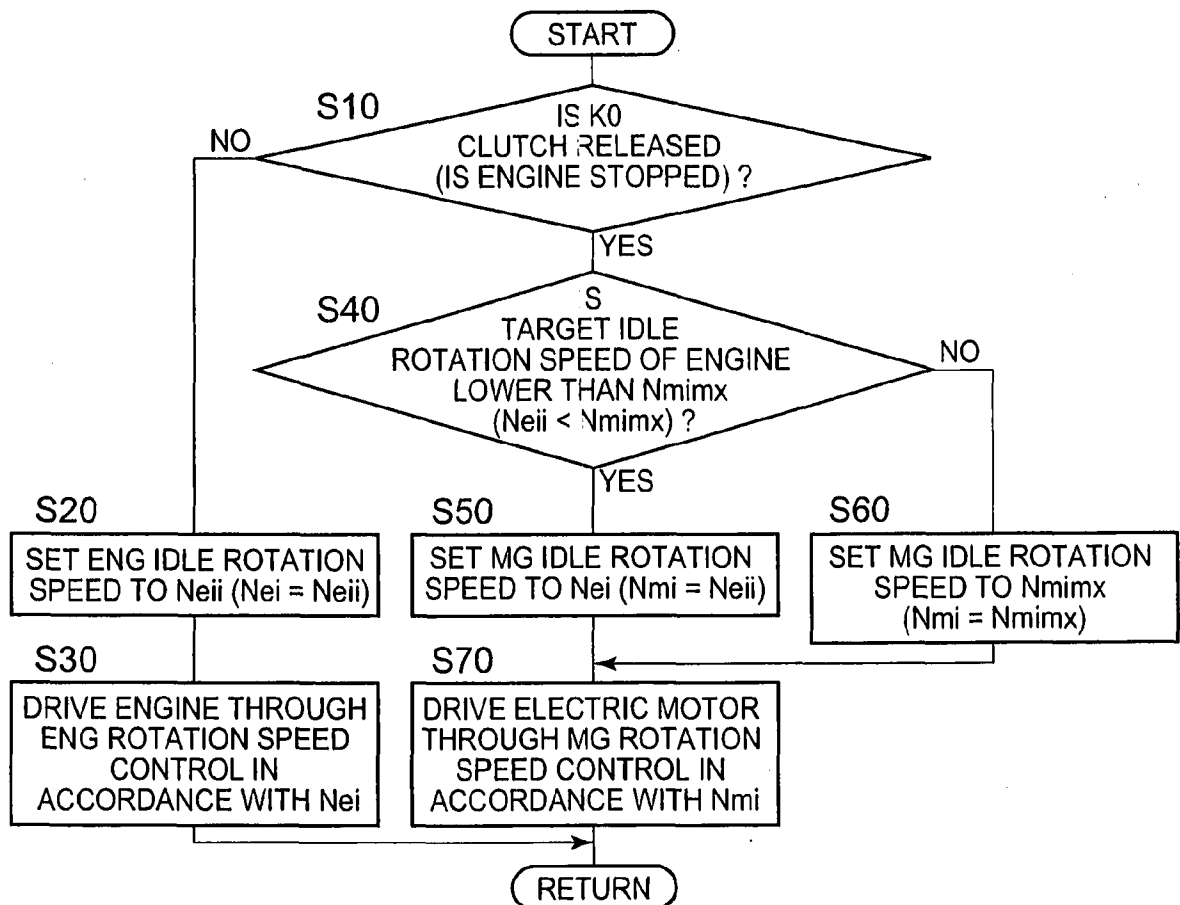


FIG. 5

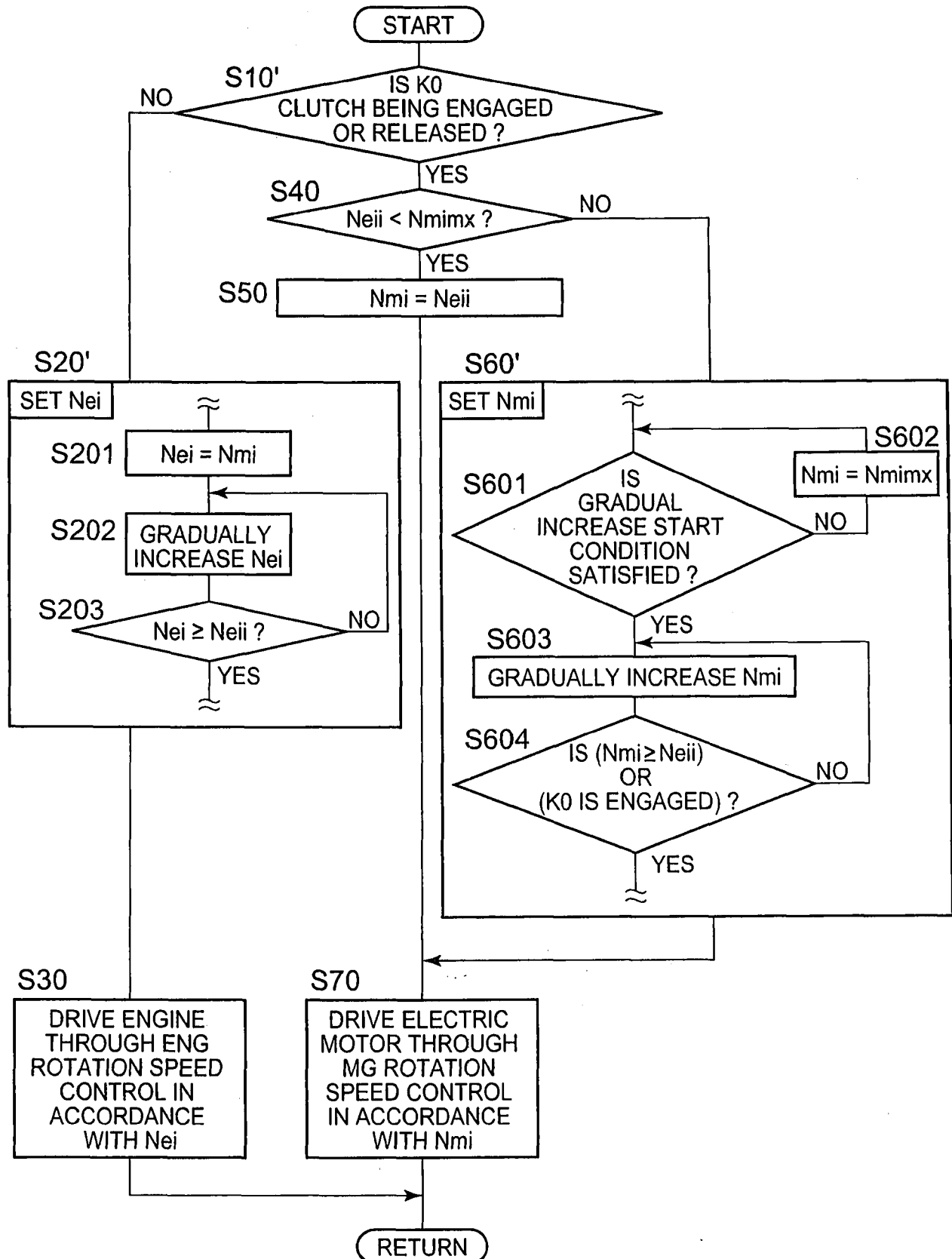


FIG. 6

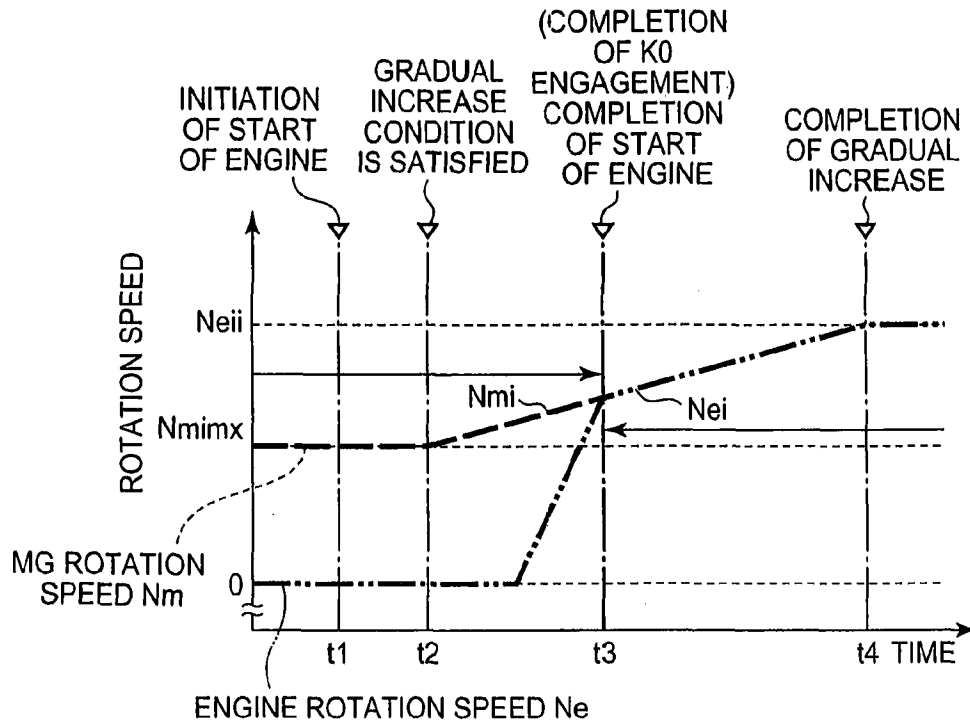


FIG. 7

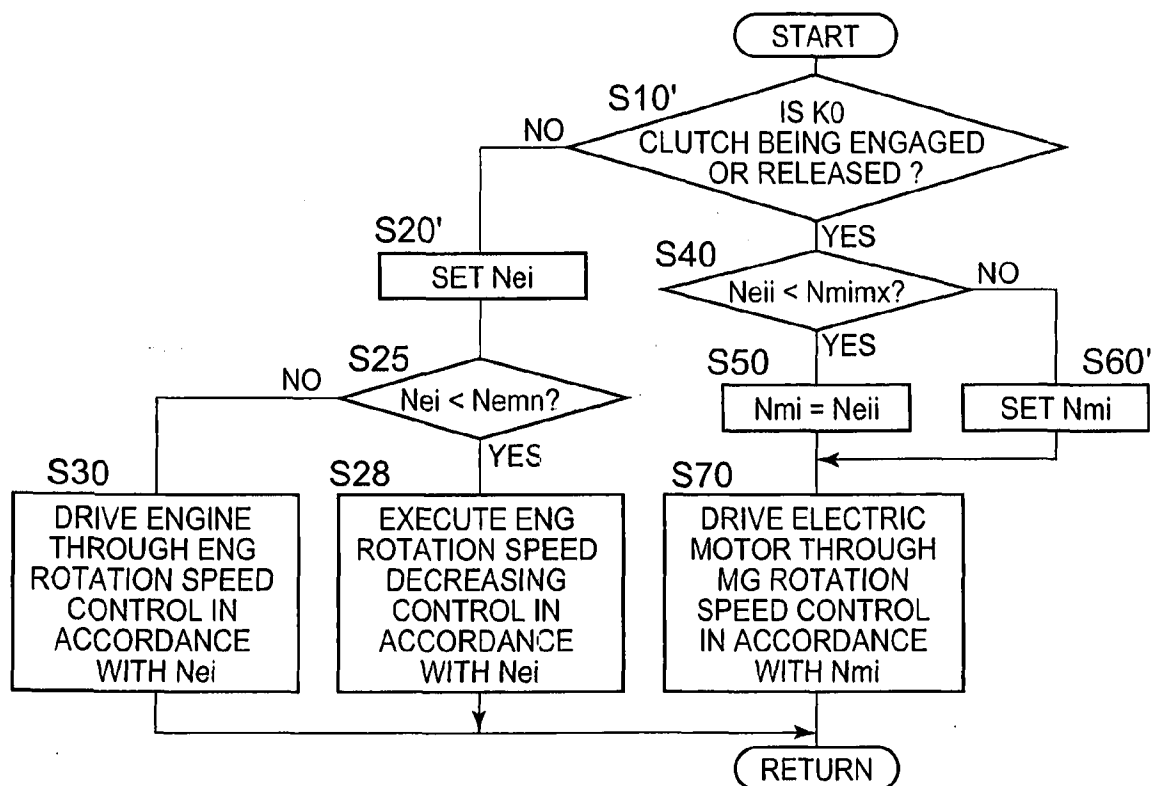


FIG. 8

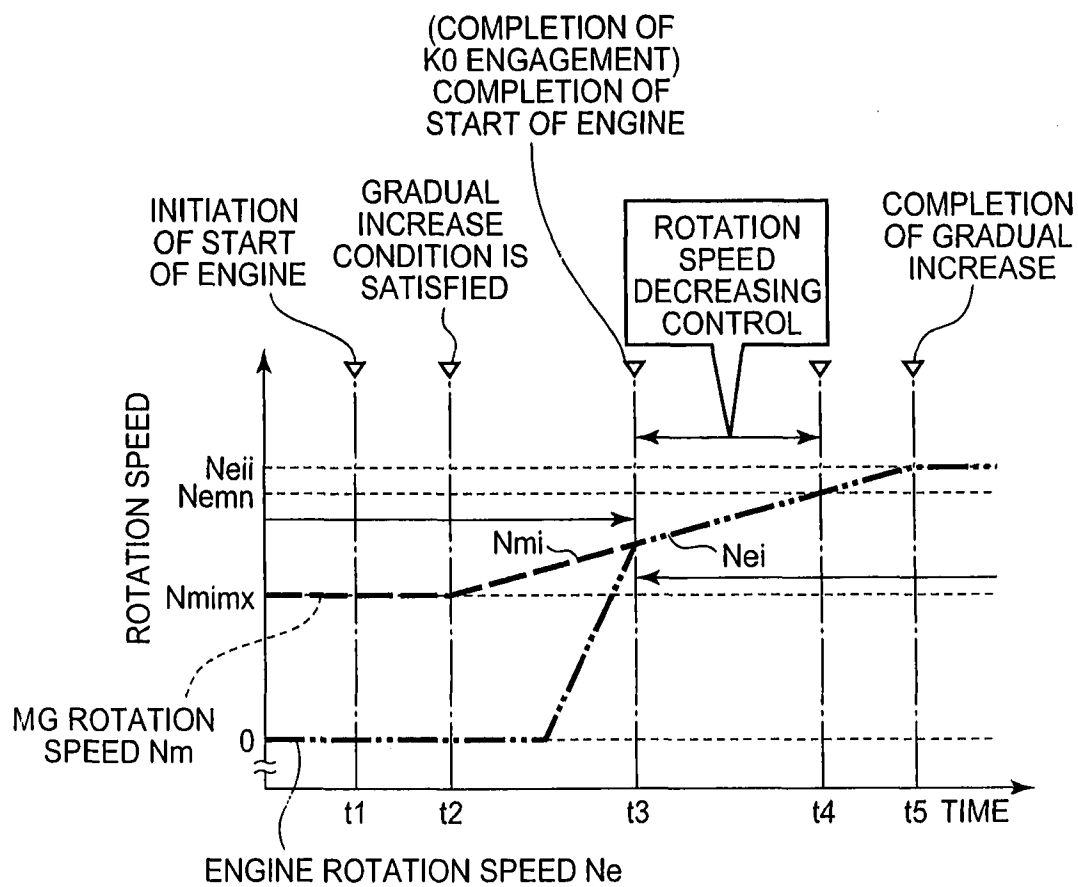


FIG. 9

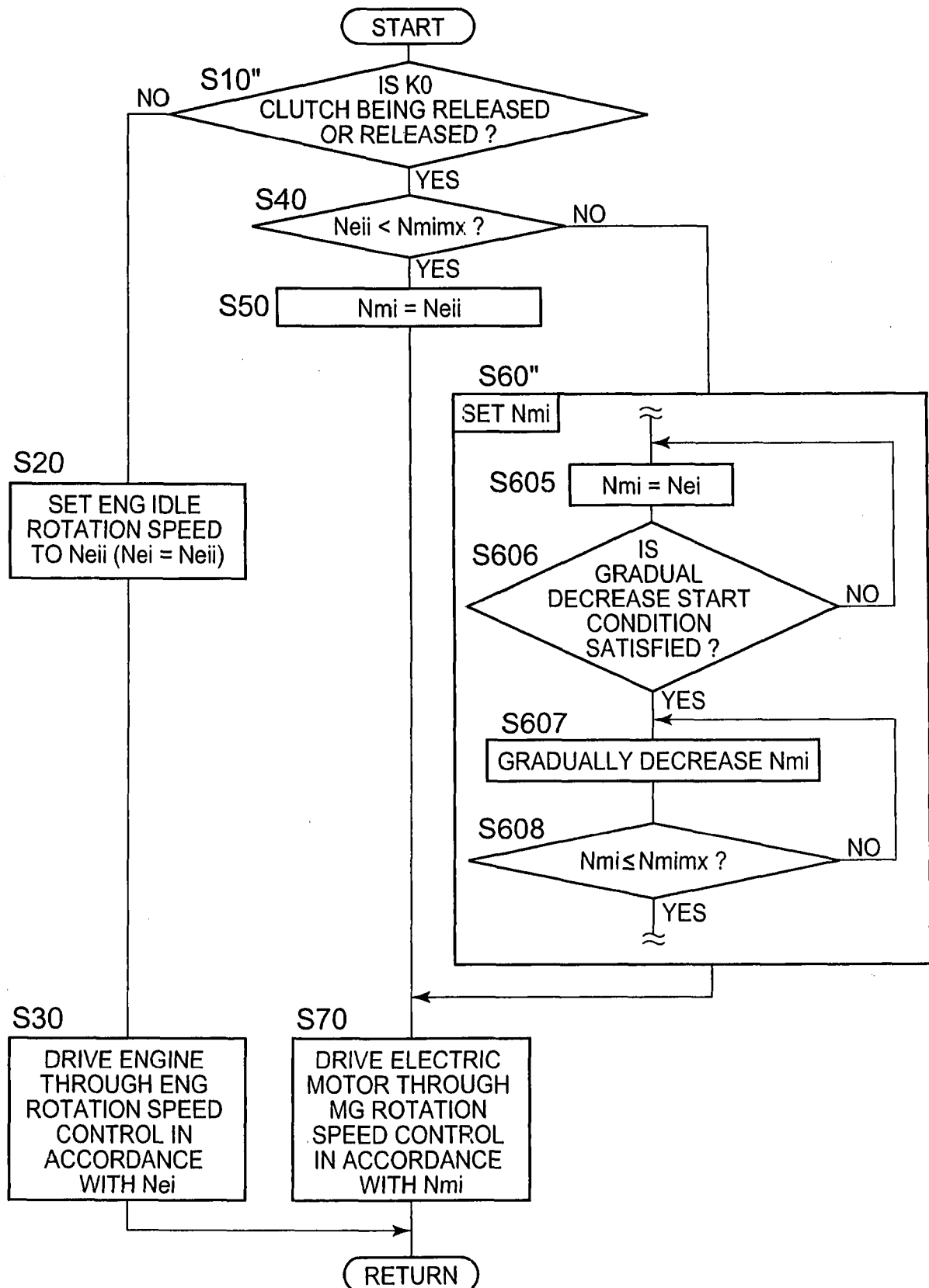
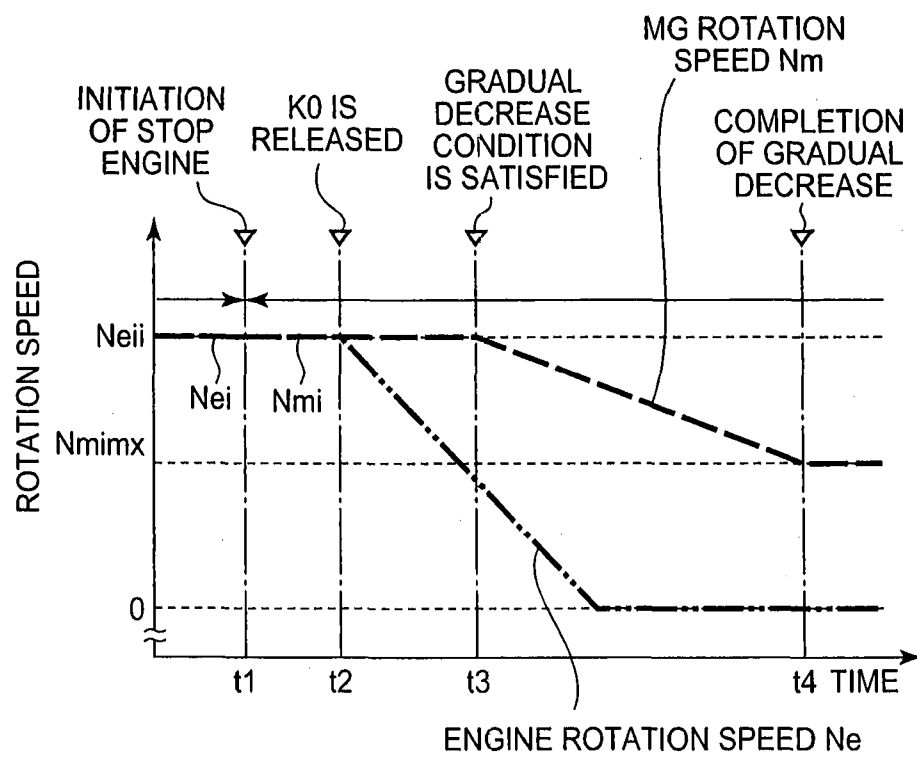


FIG. 10



INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2014/000639

A. CLASSIFICATION OF SUBJECT MATTER INV. B60K6/48 B60W30/18 B60W20/00 B60W10/02 B60W10/06 ADD. B60W30/09 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) B60K 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) EP0-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.
X	DE 10 2007 047712 A1 (BOSCH GMBH ROBERT [DE]) 9 April 2009 (2009-04-09)	1
Y	paragraph [0005] the whole document	3,5
Y	----- DE 10 2007 050117 A1 (BOSCH GMBH ROBERT [DE]) 23 April 2009 (2009-04-23) paragraphs [0003], [0005], [0008], [0009], [0014]	3,5
A	----- DE 10 2007 055787 A1 (ZAHNRADFABRIK FRIEDRICHSHAFEN [DE]) 18 June 2009 (2009-06-18) paragraphs [0015], [0043] - [0045] the whole document	1
A	----- US 6 376 927 B1 (TAMAI GORO [US] ET AL) 23 April 2002 (2002-04-23) column 5, lines 48-67 -----	1
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
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Date of the actual completion of the international search 16 June 2014		Date of mailing of the international search report 03/07/2014
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 Plenk, Rupert

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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