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(71) Applicant: **Aisin Seiki Kabushiki Kaisha**
Kariya-shi, Aichi 448-8650 (JP)

(72) Inventor: **TAMARU, Daisuke**
Kariya-shi, Aichi 448-8650 (JP)

(74) Representative: **Kramer Barske Schmidtchen Patentanwälte PartG mbB**
European Patent Attorneys
Landsberger Strasse 300
80687 München (DE)

(54) ## DRIVE DEVICE FOR VEHICLE

(57) A drive device for a vehicle that can prevent excessive increases in an engine rotation speed at startup of a vehicle provided with a manual clutch is provided. The drive device includes a first obtaining portion obtaining a clutch torque (Tc) generated by a clutch (3), a second obtaining portion obtaining a temperature (Tmpc) of the clutch, a first calculation portion calculating a startup engine torque (Tes) on the basis of the clutch torque (Tc) and the temperature (Tmpc) of the clutch, and an engine control portion (10) controlling an engine (2) to achieve the startup engine torque (Tes) at the startup of a vehicle (100).

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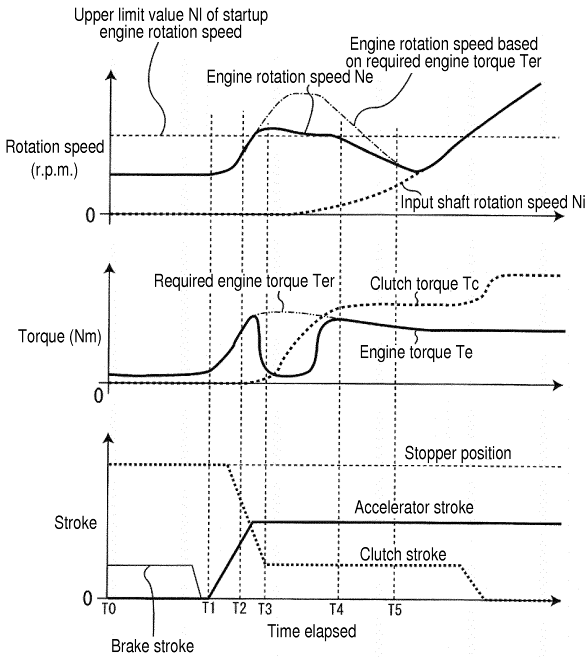

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Description

TECHNICAL FIELD

[0001] The present invention relates to a drive device for a vehicle, which controls startup of a vehicle provided with a manual-type clutch.

BACKGROUND ART

[0002] At a vehicle provided with a manual transmission and a manual clutch, at a time of startup, a driver presses down a clutch pedal to disengage a clutch and shifts the manual transmission to the first speed. Then, the driver gradually returns the clutch pedal to engage the clutch while pressing down an accelerator pedal to increase an engine rotation speed, and thus the driver makes engine torque to be transmitted to a wheel. As described above, the driver conducts a smooth startup by performing an operation which coordinates the pressing of the accelerator pedal, that is, an engine output (an engine rotation speed), and returning of the clutch pedal, that is, the engagement of the clutch (an engine load), with each other.

[0003] Patent document 1 discloses a technique of limiting the engine torque to prevent the clutch from being overheated on the vehicle provided with the manual transmission and the clutch in a case where a clutch temperature is equal to or more than a predetermined temperature and a clutch difference rotation speed exceeds a predetermined value.

DOCUMENT OF PRIOR ART

PATENT DOCUMENT

[0004] Patent document 1: Specification of US Patent No. 2008/0147288A1

OVERVIEW OF INVENTION

PROBLEM TO BE SOLVED BY INVENTION

[0005] In the technique disclosed in Patent document 1, the torque of the engine is limited in a case where the clutch temperature is equal to or more than the predetermined temperature and the clutch difference rotation speed exceeds a predetermined rotation speed. Thus, in a case where an amount of pressing down the clutch pedal decreases and the clutch torque increases in a state where the engine torque is being limited, the engine rotation speed decreases. Generally, a maximum engine torque that the engine can output depends on the engine rotation speed. Thus, there arises a problem that, once the engine rotation speed decreases, the maximum engine torque is limited even if the engine torque is aimed to be increased, and accordingly the startup/acceleration may not be conducted according to an intention of the driver.

[0006] The present invention is made in view of such circumstances and a purpose of the present invention is to provide a drive device for a vehicle, which can prevent an engine rotation speed from decreasing while preventing a clutch from being overheated at startup of a vehicle provided with a manual clutch.

MEANS FOR SOLVING PROBLEM

[0007] The invention of the drive device for the vehicle related to claim 1, which is made to solve the above-mentioned problem, includes a clutch provided between a drive shaft of an engine and an input shaft of a manual transmission and making a clutch torque between the drive shaft and the input shaft variable by an operation of a clutch operation member, a first obtaining portion obtaining the clutch torque generated by the clutch, a second obtaining portion obtaining a temperature of the clutch, a first calculation portion calculating a startup engine torque on the basis of the clutch torque obtained by the first obtaining portion and the temperature of the clutch obtained by the second obtaining portion, and an engine control portion controlling the engine at startup so that the startup engine torque calculated by the first calculation portion is achieved.

[0008] The invention related to claim 2 according to the invention described in claim 1, includes an upper limit calculation portion calculating an upper limit value of a startup engine rotation speed, wherein the upper limit value is set in such a manner that the upper limit value decreases as the clutch temperature becomes higher, and the first calculation portion calculates the startup engine torque on the basis of the clutch torque obtained by the first obtaining portion and a difference between a rotation speed of the engine and the upper limit value of the startup engine rotation speed.

[0009] The invention related to claim 3 according to the invention described in either claim 1 or 2, wherein in a case where the rotation speed of the engine is equal to or more than a predetermined value, the engine control portion controls the engine so that the startup engine torque is achieved.

[0010] The invention related to claim 4 according to the invention described in any one of claims 1 to 3, includes a second calculation portion calculating a required engine torque on the basis of an operation amount of an engine operation member operating engine torque outputted by the engine in such a manner that the engine torque is variable, wherein in a case where the required engine torque calculated by the second calculation portion is equal to or less than the startup engine torque, the engine control portion controls the engine so that the required engine torque is achieved.

[0011] The invention related to claim 5 according to the invention described in any one of claims 1 to 4, includes a third calculation portion calculating a maintaining torque corresponding to torque needed to maintain the rotation speed of the engine, the third calculation portion calculating the maintaining torque on the basis of a load acting on the engine, wherein the first calculation portion calculates the startup engine torque while adding the maintaining torque calculated by the third calculation portion.

[0012] The invention related to claim 6 according to the invention described in any one of claims 1 to 5, wherein the first obtaining portion detects an operation amount of the clutch operation member.

[0013] The invention related to claim 7 according to the invention described in any one of claims 1 to 6, wherein the engine control portion controls the engine so that the startup engine torque is achieved only in a case where a current vehicle speed is smaller than a predetermined speed.

[0014] The invention related to claim 8 according to the invention described in any one of claims 1 to 7, wherein the engine control portion controls the engine so that the startup engine torque is achieved only in a case where a braking force operation member is not being operated, the braking force operation member is for operating a braking force of a braking force generating portion in such a manner that the braking force is variable, the braking force generating portion generates the braking force.

EFFECTS OF THE INVENTION

[0015] According to the invention related to claim 1, at the startup of the vehicle, the engine is controlled so that the startup engine torque calculated on the basis of the clutch torque and the clutch temperature is achieved. Because the engine is controlled to achieve the startup engine torque calculated on the basis of the clutch temperature as described above, the clutch is prevented from being overheated. That is, as the clutch temperature increases, the startup engine torque is restrained from increasing, and consequently, an engine rotation speed is restrained from increasing. As a consequence, a clutch difference rotation speed is restrained from increasing, and the overheating of the clutch is prevented from occurring.

[0016] In addition, because the engine is controlled to achieve the startup engine torque calculated on the basis of the clutch torque, the engine rotation speed is prevented from decreasing. That is, in a case where a driver increases an amount of the operation of the clutch operation member in an engagement direction of the clutch operation member and thus the clutch torque increases, the startup engine torque increases in association with the increase of the clutch torque. Consequently, the engine rotation speed is prevented from decreasing and a drive power desired by the driver can be maintained, and as a result, the drive device for the vehicle which includes an excellent drivability may be provided.

[0017] On the other hand, in a case where the driver reduces the amount of the operation of the clutch operation member in the engagement direction and thus the clutch torque decreases, the startup engine torque is controlled to decrease in association with the decrease of the clutch torque. Consequently, the engine rotation speed is prevented from increasing unnecessarily, and occurrence of noises and/or unnecessary fuel consumption are prevented.

[0018] According to the invention related to claim 2, the upper limit calculation portion calculates the upper limit value of the startup engine rotation speed. As the clutch temperature becomes higher, the upper limit value of the startup engine rotation speed decreases more. Then, the first calculation portion calculates the startup engine torque on the basis of the clutch torque, and the difference rotation speed between the rotation speed of the engine and the upper limit value of the startup engine rotation speed. Because the upper limit value of the startup engine rotation speed, which decreases more as the clutch temperature becomes higher, is calculated as described above, the startup engine torque is restrained from increasing. Consequently, in a case where the clutch temperature is high, the clutch is prevented from further being overheated, and deterioration of the clutch is prevented.

[0019] According to the invention related to claim 3, the engine control portion controls the engine so that the startup engine torque is achieved in a case where the engine rotation speed is equal to or more than the predetermined rotation speed. Accordingly, in a case where the rotation speed of the engine is lower than the predetermined rotation speed, a normal engine control is executed, that is, the engine is controlled in accordance with an operation of an accelerator performed by the driver. Consequently, in a state where the rotation speed of the engine is lower than the predetermined rotation speed that does not cause the clutch to be overheated, the engine torque does not deviate from an intention of the driver, and thus the driver does not feel a sense of discomfort.

[0020] According to the invention related to claim 4, the engine control portion controls the engine so that the required engine torque is achieved in a case where the required engine torque is equal to or less than the startup engine torque. Accordingly, the engine is controlled to achieve the required engine torque that reflects the intension of the driver in a case where the required engine torque is equal to or less than the startup engine torque. Consequently, the engine torque does not deviate from the intention of the driver, and thus the engine rotation speed can be prevented from excessively increasing while the sense of discomfort of the driver is reduced.

[0021] According to the invention related to claim 5, the third calculation portion calculates the maintaining torque on the basis of the load acting on the engine. The first calculation portion calculates the startup engine torque while adding the maintaining torque. Accordingly, the startup engine torque to which increase and decrease of the load of the engine has been added is calculated. Consequently, the engine rotation speed can be prevented from increasing and/or decreasing in association with the increase and decrease of the load of the engine. The above-mentioned engine load includes operations of an air conditioner, a head light, and an alternator for electric power generation, for example.

[0022] According to the invention related to claim 6, the first obtaining portion is a clutch operation amount detection portion detecting an operation amount of the clutch operation member. Accordingly, the clutch torque can be obtained with a simple configuration and in a reliable manner.

[0023] According to the invention related to claim 7, the engine control portion controls the engine so that the startup engine torque is achieved only in a case where the vehicle speed is smaller than the predetermined speed. Accordingly, after the startup of the vehicle, in a case where the driver performs an operation to disengage the clutch for the purpose of conducting a speed change operation, the engine is not controlled in such a manner that the startup engine torque calculated on the basis of the clutch torque is achieved. Consequently, the vehicle does not decelerate and the driver does not feel the sense of discomfort.

[0024] According to the invention related to claim 8, the engine control portion controls the engine to achieve the startup engine torque only in a case where the braking force operation member is not being operated. Accordingly, in a case where the braking force operation member is being operated, the engine is not controlled in such a manner that the startup engine torque, which is calculated on the basis of the clutch torque, is achieved. Consequently, the vehicle can be decelerated and/or stopped safely.

BRIEF DESCRIPTION OF DRAWINGS

[0025]

[Fig. 1] is a structural view of a drive device for a vehicle of the present embodiment.

[Fig. 2] is an example of "Clutch torque mapping data" representing a relationship between a clutch stroke and a clutch torque.

[Fig. 3] is a graph representing an overview of the present embodiment, wherein a horizontal axis represents a time elapsed, and a vertical axis represents an engine rotation speed, an input shaft rotation speed, an engine torque, the clutch torque, an accelerator stroke, a clutch stroke and a brake stroke.

[Fig. 4] is a flowchart of "Clutch/engine cooperative control".

[Fig. 5] is a flowchart of "Torque down control" that is a subroutine of "Clutch/engine cooperative control".

[Fig. 6] is a diagram showing an example of "Engine rotation speed reduction torque calculation data" that is mapping data representing a relationship of a difference rotation speed between an upper limit value Nl of the startup engine rotation speed and a current engine rotation speed Ne, and an engine rotation speed reduction torque Ten with each other.

[Fig. 7] is a flowchart of "Maintaining torque calculation process" that is a subroutine of "Torque down control".

[Fig. 8] is a diagram showing "Compressor auxiliary machine torque calculation data" that is mapping data representing a relationship between the engine rotation speed Ne and a compressor auxiliary machine torque Tac.

[Fig. 9] is a diagram showing "Calculation data of the upper limit value of the startup engine rotation speed" that is mapping data representing a relationship between a clutch temperature Tmpc and the upper limit value Nl of the startup engine rotation speed.

MODE FOR CARRYING OUT THE INVENTION

[0026] (Explanation of vehicle) A drive device 1 for a vehicle according an embodiment of the present invention will be described with reference to Fig. 1. Fig. 1 is a view illustrating a configuration of the drive device 1 for the vehicle of a vehicle 100 provided with an engine 2. In Fig. 1, the bold lines indicate mechanical connection among the devices and the arrows by broken lines indicate signal lines for controlling.

[0027] As illustrated in Fig. 1, the engine 2, a clutch 3, a manual transmission 4 and a differential 17 are provided on the vehicle 100 in series with one another in the above-mentioned order of arrangement. Drive wheels 18R, 18L of the vehicle 100 are connected to the differential 17. The drive wheels 18R, 18L are either front, rear or front/rear wheels of the vehicle 100.

[0028] The vehicle includes an accelerator pedal 51 (an engine operation member), a clutch pedal 53 (a clutch operation member) and a brake pedal 56 (a braking force operation member). The accelerator pedal 51 operates an engine torque outputted by the engine 2 in such a manner that the engine torque is variable. The accelerator pedal 51 is provided with an acceleration sensor 52 detecting an accelerator stroke Ac which corresponds to an operation amount of the accelerator pedal 51.

[0029] The clutch pedal 53 is for causing the clutch 3 to be in a disconnected state or in a connected state, and for causing a clutch torque Tc which will be described below to be variable. The vehicle 100 includes a master cylinder 55 which generates a fluid pressure corresponding to an operation amount of the clutch pedal 53. The master cylinder 55 is provided with a clutch sensor 54 which detects a stroke (a clutch stroke Cl) of the master cylinder 55.

[0030] The brake pedal 56 is provided with a brake sensor 57 which detects an operation amount (a brake stroke) of the brake pedal 56. The vehicle 100 includes a brake master cylinder (not shown) which generates a fluid pressure corresponding to the operation amount of the brake pedal 56 and a brake device 19 (a braking force generating portion) which generates a braking force to the wheels in accordance with a master pressure generated by the brake master cylinder.

[0031] The engine 2 is, for example, a gasoline engine or a diesel engine which uses hydrocarbon based fuel including, for example, gasoline or light oil. The engine 2 includes a drive shaft 21, a throttle valve 22, an engine rotation speed sensor 23, an oil temperature sensor 25 and a fuel injection apparatus 28. The drive shaft 21 rotates unitary with a crankshaft which is rotatably driven by a piston. Thus, the engine 2 outputs an engine torque Te to the drive shaft 21 and drives the drive wheels 18R, 18L. In a case where the engine 2 is the gasoline engine, an ignition apparatus (not shown) for igniting an air-fuel mixture gas in the cylinder is provided at a cylinder head of the engine 2.

[0032] The throttle valve 22 is provided in a pathway through which air is taken into the cylinder of the engine 2. The throttle valve 22 is for adjusting an amount of the air taken into the cylinder of the engine 2. The fuel injection apparatus 28 is provided at a pathway through which the air is taken inside the engine 2 or at the cylinder head of the engine 2. The fuel injection apparatus 28 is an apparatus which injects the fuel including, for example, the gasoline or the light oil.

[0033] The engine rotation speed sensor 23 is provided at a position adjacent to the drive shaft 21. The engine rotation speed sensor 23 detects an engine rotation speed Ne which corresponds to a rotation speed of the drive shaft 21 and outputs the detected signal to a control portion 10. The oil temperature sensor 25 detects an oil temperature t of engine oil lubricating the engine 2 and outputs the detection signal to the control portion 10. In the present embodiment, the drive shaft 21 of the engine 2 is connected to a flywheel 31 which is an input member of the clutch 3 which will be described below.

[0034] A generator 26 and a compressor 27a of an air conditioner 27 are connected to the drive shaft 21 of the engine 2 or to a shaft and/or a gear rotated in association with the drive shaft 21. The generator 26 generates electric power necessary for the vehicle 100.

[0035] The clutch 3 is provided between the drive shaft 21 of the engine 2 and an input shaft 41 of the manual transmission 4 which will be described below. The clutch 3 is a manually-operated type clutch which connects or disconnects the drive shaft 21 and the input shaft 41 with each other via the operation of the clutch pedal 53 operated by a driver, and causes the clutch torque Tc (shown in Fig. 2) between the drive shaft 21 and the input shaft 41 to be variable. The clutch 3 includes the flywheel 31, a clutch disc 32, a clutch cover 33, a diaphragm spring 34, a pressure plate 35, a clutch shaft 36, a release bearing 37 and a slave cylinder 38.

[0036] The flywheel 31 is formed in a disc plate shape and is connected to the drive shaft 21. The clutch shaft 36 is connected to the input shaft 41. The clutch disc 32 is formed in a disc plate shape and is provided with a friction material 32a at outer peripheral surfaces of both sides of the clutch disc 32. The friction material 32a is a so-called clutch lining, and is formed from aggregate including metal, and a binder including synthetic resin which binds the aggregate, for example. The clutch disc 32 faces the flywheel 31, and is in spline-fitted with a tip end of the clutch shaft 36 to be movable in an axial direction and not to be rotatable.

[0037] The clutch cover 33 is formed from a cylindrical portion 33a formed in a flattened cylindrical shape and a plate portion 33b extending in a rotation center direction from one end of the cylindrical portion 33a. The other end of the cylindrical portion 33a is connected to the flywheel 31. Therefore, the clutch cover 33 rotates integrally with the flywheel 31. The pressure plate 35 includes a disc shape having a hole at a center thereof. At a side opposite to the flywheel 31, the pressure plate 35 is provided to face the clutch disc 32 and to be movable in the axial direction. The clutch shaft 36 is inserted into the pressure plate 35 at the center of the pressure plate 35.

[0038] The diaphragm spring 34 is formed from a ring portion 34a of a ring shape and plural plate spring portions 34b extending inwardly from an inner peripheral edge of the ring portion 34a. The plate spring portions 34b are gradually inclined towards an inner direction to be positioned at a side of the plate portion 33b. The plate spring portions 34b are elastically deformable in the axial direction. The diaphragm spring 34 is disposed between the pressure plate 35 and the plate portion 33b of the clutch cover 33 in a state where the plate spring portions 34b are compressed in the axial direction. The ring portion 34a is in contact with the pressure plate 35. An intermediate portion of the plate spring portion 34b is connected to an inner peripheral edge of the plate portion 33b. The clutch shaft 36 is inserted into a center of the diaphragm spring 34.

[0039] The release bearing 37 is attached to a housing, which is not shown, of the clutch 3. The clutch shaft 36 is inserted into a center of the release bearing 37 to be movable in the axial direction. The release bearing is constituted by a first member 37a and a second member 37b which oppose each other and are rotatable relative to each other. The first member 37a is in contact with a tip end of the plate portion 33b.

[0040] The slave cylinder 38 includes a push rod 38a which advances and retreats due to the fluid pressure. A tip end of the push rod 38a is in contact with the second member 37b of the release bearing 37. The slave cylinder 38 and the master cylinder 55 are connected with each other with a fluid pressure pipe 58.

[0041] In a state where the clutch pedal 53 is not being depressed, fluid pressure is generated at neither the master cylinder 55 nor the slave cylinder 38. In this state, via the pressure plate 35, the clutch disc 32 is biased by the diaphragm spring 34 towards the flywheel 31 and is pushed against the flywheel 31. Accordingly, due to a friction force of the friction material 32a and the flywheel 31 and a friction force of the friction material 32a and the pressure plate 35, a connected state is established in which the flywheel 31, the clutch disc 32 and the pressure plate 35 rotate integrally with one another, and the drive shaft 21 and the input shaft 41 rotate integrally with each other.

[0042] On the other hand, when the clutch pedal 53 is depressed, the fluid pressure is generated in the master cylinder 55 and the fluid pressure is generated also in the slave cylinder 38. Thus, the push rod 38a of the salve cylinder 38 pushes the release bearing 37 towards the diaphragm spring 34. Then, the plate spring portions 34b are deformed while connecting portions of the plate spring portions 34b at which the plate spring portions 34b are connected with the inner peripheral edge of the plate portion 33b serve as fulcrum points, and the biasing force biasing the clutch disc 32 towards the flywheel 31 decreases and finally becomes 0.

[0043] As shown in Fig. 2, as the clutch stroke Cl corresponding to the stroke of the master cylinder 55 increases, the clutch torque Tc transmitted by the clutch 3 from the drive shaft 21 to the input shaft 41 decreases. When the above-described biasing force becomes 0, the clutch torque Tc becomes 0 and the clutch 3 comes to be in a completely-disconnected state. Thus, as described above, the clutch 3 according to the present embodiment is a normally closed type clutch, in which the clutch 3 is in the connected state when the clutch pedal 53 is not being depressed.

[0044] The manual transmission 4 is provided between the clutch 3 and the differential 17. That is, the manual transmission 4 is provided between the drive shaft 21, and the drive wheels 18R, 18L. The manual transmission 4 is a stepped stage transmission which selectively switches plural speed stages each including a different change gear ratio that is obtained by dividing a rotation speed (an input shaft rotation speed Ni) of the input shaft 41 by a rotation speed (an output shaft rotation speed No) of the output shaft 42. Plural idler gears which are idly rotatable relative to the shaft, and plural fixed gears which mesh with the idler gears and are not idly rotatable relative to the shaft (which are not shown) are attached to either one of the input shaft 41 and the output shaft 42.

[0045] In addition, the manual transmission 4 includes a selection mechanism which selects one idler gear from the plural idler gears and causes the selected idler gear to fit to the shaft to which the idler gear is attached in such a manner that the selected idler gear is not idly rotatable relative to the shaft. Due to such a configuration, the input shaft 41 rotates in association with the drive wheels 18R, 18L. Further, the manual transmission 4 includes a shift operation mechanism (not shown) which converts an operation of the shift lever 45 performed by the driver into a force that operates the selection mechanism.

[0046] An input shaft rotation speed sensor 43 which detects the input shaft rotation speed Ni is arranged at a position adjacent to input shaft 41. The input shaft rotation speed Ni (a clutch rotation speed Nc) detected by the input shaft rotation speed sensor 43 is outputted to the control portion 10.

[0047] The output shaft 42 is rotatably connected to the drive wheels 18R, 18L via the differential 17. An output shaft rotation speed sensor 46 which detects the output shaft rotation speed No is arranged at a position adjacent to the output shaft 42. The output shaft rotation speed No detected by the output shaft rotation speed sensor 46 is outputted to the control portion 10.

[0048] The control portion 10 controls the vehicle 100 in an integrated manner. The control portion 10 includes a storage portion configured by, for example, CPU, RAM, ROM and/or a nonvolatile memory (which are not shown). The CPU executes programs corresponding to the flowcharts shown in Fig. 4, Fig. 5 and Fig. 7. The RAM temporarily stores variables necessary for executing the programs. The storage portion stores the above-described programs and/or the mapping data shown in Fig. 2, Fig. 6, Fig. 8 and Fig. 9.

[0049] On the basis of the accelerator stroke Ac of the acceleration sensor 52 according to an operation of the driver on the accelerator pedal 51, the control portion 10 (a second calculation portion) calculates a required engine torque Ter which corresponds to torque of the engine 2 which is required by the driver. Then, on the basis of the required engine torque Ter, the control portion 10 adjusts an opening degree S of the throttle valve 22 to adjust an amount of intake air, and the control portion 10 adjusts a fuel injection amount of the fuel injection apparatus 28 to control the ignition apparatus.

[0050] Thus, a supply amount of the air-fuel mixture gas including the fuel is adjusted and the engine torque Te outputted by the engine 2 is adjusted to be the required engine torque Ter, and the engine rotation speed Ne is adjusted. In a case where the accelerator pedal 51 is not being depressed (accelerator stroke Ac = 0), the engine rotation speed Ne is maintained at an idling rotation speed (for example, 700 r.p.m.).

[0051] The control portion 10 (a first obtaining portion) calculates the clutch torque Tc which is torque that the clutch 3 can transmit from the drive shaft 21 to the input shaft 41 on the basis of the clutch stroke Cl detected by the clutch sensor 54, while the control portion 10 referring to "Clutch torque mapping data" shown in Fig. 2 and representing a relationship between the clutch stroke Cl and the clutch torque Tc.

[0052] The control portion 10 calculates a vehicle speed V on the basis of the output shaft rotation speed No detected by the output shaft rotation speed sensor 46. The control portion 10 calculates a clutch difference rotation speed Δc which corresponds to a difference rotation speed of the clutch 3 by subtracting the input shaft rotation speed Ni detected by the input shaft rotation speed sensor 43 from the engine rotation speed Ne detected by the engine rotation speed sensor 23. In other words, the clutch difference rotation speed Δc is the difference rotation speed of the clutch 3, that is, a difference rotation speed between the drive shaft 21 and the input shaft 41.

[0053] The control portion 10 (a second obtaining portion) estimates (calculates) and obtains a clutch temperature Tmpc (a temperature of the friction material 32a) on the basis of the vehicle speed V, the oil temperature t, the engine rotation speed Ne and the input shaft rotation speed Ni. A method of estimating the temperature of the clutch 3 is a known technique described in, for example, JP4715132B, and therefore further detailed explanations will be omitted.

[0054] The configuration including the engine 2, the clutch 3, the manual transmission 4, the control portion 10, the clutch pedal 53, the clutch sensor 54, the master cylinder 55, the accelerator pedal 51, the acceleration sensor 52, the brake pedal 56, the brake sensor 57 and the fluid pressure pipe 58 corresponds to the drive device 1 for the vehicle, according to the present embodiment.

[0055] (Overview of the present embodiment) An overview of the present embodiment will be described hereunder with reference to Fig. 3. "Torque down control" is executed in a case where the vehicle speed V is equal to or less than predetermined, the brake pedal 56 is not being depressed, and the clutch difference rotation speed Δc is equal to or more than predetermined, that is, in a case where the vehicle 100 is in a startup state and the clutch 3 is in a clutch half-engaged state.

[0056] As shown in Fig. 3, "Torque down control" is a control under which the engine torque Te is controlled to be reduced as indicated by the solid line in Fig. 3 compared to the required engine torque Ter (the torque indicated by the alternate long and two short dashes line in Fig. 3) calculated on the basis of the operation of the accelerator pedal 51 performed by the driver. As described above, by executing "Torque down control", the clutch 3 is prevented from being overheated in the clutch half-engaged state, the overheating of the clutch 3 attributing to that the engine rotation speed Ne largely exceeds an upper limit value Nl of the startup engine rotation speed as indicated by the alternate long and short dash line in Fig. 3 and that the clutch difference rotation speed Δc increases.

[0057] Specifically, at startup of the vehicle 100, in contrast to the states other than the startup of the vehicle 100, the control portion 10 calculates a startup engine torque Tes on the basis of the following formula (1). Then, the control portion 10 controls the engine 2 so that the engine torque Te becomes the startup engine torque Tes

$$\mathrm{Tes} = \mathrm{Tc} + \mathrm{Ten} + \mathrm{Tk} \ldots (1)$$

Tes = Startup engine torque

Tc = Clutch torque

Ten = Engine rotation speed reduction torque (a negative value)

Tk = Maintaining torque

[0058] The engine rotation speed reduction torque Ten is a negative torque that is needed to reduce the rotation speed of the engine 2 down to the upper limit value Nl of the startup engine rotation speed. The maintaining torque Tk is torque which is necessary, in addition to the clutch torque Tc and the engine rotation speed reduction torque Ten, to maintain the upper limit value Nl of the startup engine rotation speed in a case where "Torque down control is being executed. The maintaining torque Tk is calculated according to load by an auxiliary machine connected to the drive shaft 21 of the engine 2, for example.

[0059] Here, the upper limit value Nl of the startup engine rotation speed is calculated on the basis of the clutch temperature Tmpc. As will be described below, the temperature of the clutch 3 is prevented from further increasing in a state where the clutch 3 is at high temperatures because the upper limit value Nl of the startup engine rotation speed, which decreases more as the temperature of the clutch 3 increases, is set.

[0060] In a case where the driver releases the clutch pedal 53 and accordingly the clutch torque Tc increases, the startup engine torque Tes increases in association with the increase of the clutch torque Tc. That is, in a case where the clutch torque Tc increases, the startup engine torque Tes increases without waiting for the engine rotation speed Ne to decrease. Accordingly, the engine rotation speed Ne is prevented from decreasing.

[0061] On the other hand, in a case where the clutch torque Tc decreases because the driver presses down the clutch pedal 53, the startup engine torque Tes decreases in association with the decrease of the clutch torque Tc. That is, in a case where the clutch torque Tc decreases, the startup engine torque Tes decreases without waiting for the engine rotation speed Ne to increase. Accordingly, the engine rotation speed Ne is prevented from increasing unnecessarily. Further details will be described hereunder with reference to the flowchart shown in Fig. 4.

[0062] (Clutch/engine cooperative control) "Clutch/engine cooperative control" will be described hereunder using the flowchart of Fig. 4. In a case where an ignition key of the vehicle 100 is turned ON and the engine 2 is started, "Clutch/engine cooperative control" starts, and the program proceeds to S 11.

[0063] At S11, in a case where the control portion 10 determines on the basis of the detection signal of the brake sensor 57 that the brake pedal 56 is not being depressed and the braking force is not being generated (brake OFF) at the brake device 19 (S11: YES), the control portion 10 moves the program to S12. On the other hand, in a case where the control portion 10 determines that the brake pedal 56 is being depressed and the braking force is generated (brake ON) at the brake device 19 (S11: NO), the control portion 10 moves the program to S18.

[0064] At S12, in a case where the control portion 10 determines on the basis of the detection signal from the clutch sensor 54 that the clutch torque TC is not 0 (the clutch 3 is not completely disconnected) (S12: YES), the control portion 10 moves the program to S13. On the other hand, at S12, in a case where the control portion 10 determines that the clutch torque Tc is 0 (the clutch 3 is completely disconnected) (S12: NO), the control portion 10 moves the program to S18.

[0065] At S 13, in a case where the control portion 10 determines that the current vehicle speed V is smaller than a specified speed that is predetermined (for example, 20 km/h) (S13: YES), the control portion 10 moves the program to S14. At S13, in a case where the control portion 10 determines that the vehicle speed V is equal to or more than the specified speed (S13: NO), the control portion 10 moves the program to S18.

[0066] At S14, in a case where the control portion 10 determines that the clutch difference rotation speed Δc is equal to or more than a specified difference rotation speed A (for example, 500 r.p.m.) on the basis of the detection signals outputted by the engine rotation speed sensor 23 and the input shaft rotation speed sensor 43 (S14: YES), the control portion 10 moves the program to S 15. On the other hand, in a case where the control portion 10 determines that the clutch difference rotation speed Δc is less than the specified difference rotation speed A (S14: NO), the control portion 10 moves the program to S18.

[0067] At S15, the control portion 10 (an upper limit calculation portion) calculates the upper limit value Nl of the startup engine rotation speed. Specifically, the control portion 10 refers to "Setting data of the upper limit value of the startup engine rotation speed" shown in Fig. 9 and calculates the upper limit value Nl of the startup engine rotation speed on the basis of the clutch temperature Tmpc. "Setting data of the upper limit value of the startup engine rotation speed" is set in such a manner that the upper limit value Nl of the startup engine rotation speed decreases as "Clutch temperature" is higher. In a case where the clutch temperature Tmpc is less than a predetermined temperature (for example, 250 °C), the upper limit value Nl of the startup engine rotation speed is set at a rotation speed limiter value of the engine 2 (for example, 6000 r.p.m.).

[0068] In a case where the clutch temperature Tmpc is between "Clutch temperatures" which are specified in "Setting data of the upper limit value of the startup engine rotation speed", the upper limit value Nl of the startup engine rotation speed is calculated by means of linear interpolation on the basis of the "Clutch temperatures" neighboring the current clutch temperature Tmpc at both sides thereof and on the basis of the current clutch temperature Tmpc. When S15 ends, the program proceeds to S16.

[0069] At S16, in a case where the control portion 10 determines that the engine rotation speed Ne is equal to or more than the upper limit value Nl of the startup engine rotation speed (S16: YES), the control portion 10 moves the program to S17. In a case where the control portion 10 determines that the engine rotation speed Ne is lower than the upper limit value Nl of the startup engine rotation speed (S16: NO), the control portion 10 moves the program to S18.

[0070] At S17, the control portion 10 executes "Torque down control". "Torque down control" will be described with reference to the flowchart shown in Fig. 5. When S17 ends, the program returns to S 11.

[0071] At S18, the control portion 10 ends "Torque down control" in a case where "Torque down control" has been started. Then, the control portion 10 executes "Normal engine control". That is, the control portion 10 controls the engine 2 so that the engine torque Te becomes the required engine torque Ter calculated on the basis of the operation of the accelerator pedal 51 which is performed by the driver. When S18 ends, the program returns to S 11.

[0072] (Torque down control) "Torque down control" will be described hereunder using the flowchart of Fig. 5. When "Torque down control" is started, the program proceeds to S17-1.

[0073] At S17-1, the control portion 10 refers to "Clutch torque mapping data" shown in Fig. 2 and calculates the clutch torque Tc on the basis of the clutch stroke Cl detected by the clutch sensor 54. When S17-1 ends, the program proceeds to S17-2.

[0074] At S17-2, the control portion 10 calculates the upper limit value Nl of the startup engine rotation speed in the same manner as S15 of Fig. 4. When S17-2 ends, the program proceeds to S17-3.

[0075] At S17-3, the control portion 10 calculates the engine rotation speed reduction torque Ten. Specifically, the control portion 10 refers to "Engine rotation speed reduction torque calculation data" shown in Fig. 6 and calculates the engine rotation speed reduction torque Ten on the basis of "Engine difference rotation speed" obtained by subtracting the current engine rotation speed Ne from the upper limit value Nl of the startup engine rotation speed.

[0076] In a case where the value obtained by subtracting the current engine rotation speed Ne from the upper limit value Nl of the startup engine rotation speed is a plus value, that is, in a case where the current engine rotation speed Ne is lower than the upper limit value Nl of the startup engine rotation speed, the engine rotation speed reduction torque Ten is set as 0. The engine rotation speed reduction torque Ten is set in such a manner that the greater an absolute value of the value obtained by subtracting the engine rotation speed reduction torque Ten from the upper limit value Nl of the startup engine rotation speed is, the larger an absolute value of the engine rotation speed reduction torque Ten is. In other words, the engine rotation speed reduction torque Ten is set in such a manner that the higher the current engine rotation speed Ne is than the upper limit value Nl of the startup engine rotation speed, the larger the absolute value of the engine rotation speed reduction torque Ten is.

[0077] In a case where the above-described "Engine difference rotation speed" is between "Difference rotation speeds" specified in "Engine rotation speed reduction torque calculation data" shown in Fig. 6, the engine rotation speed reduction torque Ten is calculated by linearly interpolating "Target engine rotation speeds" which correspond to "Difference rotation speeds" neighboring the current "Engine difference rotation speeds" at both sides thereof. When S17-3 ends, the program proceeds to S17-4.

[0078] At S17-4, the control portion 10 calculates the maintaining torque Tk. The maintaining torque Tk is the torque needed to maintain the upper limit value Nl of the startup engine rotation speed, in addition to the clutch torque Tc and the engine rotation speed reduction torque Ten. The calculation of the maintaining torque Tk will be described using the flowchart of "Maintaining torque calculation process" shown in Fig. 7.

[0079] When "Maintaining torque calculation process" is started, the program proceeds to S31. At S31, the control portion 10 (a load obtaining portion) calculates an engine friction torque Tef on the basis of the current oil temperature t and the current engine rotation speed Ne. When S31 ends, the program proceeds to S32.

[0080] At S32, the control portion 10 (the load obtaining portion) calculates an auxiliary machine torque Ta. The auxiliary machine torque Ta is torque necessary for driving the auxiliary machine connected to the drive shaft 21 of the engine 2, and corresponds to a total torque of a friction torque of the auxiliary machine and an inertia torque of the auxiliary machine. A method of calculating a compressor auxiliary machine torque Tac of the compressor 27a of the air conditioner 27, which is one of the auxiliary machines, will be described hereunder. The control portion 10 refers to "Compressor auxiliary machine torque calculation data" shown in Fig. 8 and representing a relationship between "Engine rotation speed" and "Compressor auxiliary machine torque", and the control portion 10 calculates the compressor auxiliary machine torque Tac on the basis of the current engine rotation speed Ne.

[0081] The higher the engine rotation speed Ne is, the greater the compressor auxiliary machine torque Tac is set. In addition, the compressor auxiliary machine torque Tac is set to be larger when the air conditioner is ON compared to when the air conditioner is OFF. In a case where the current engine rotation speed Ne is between "Engine rotation speeds" specified in "Compressor auxiliary machine torque calculation data" shown in Fig. 8, the compressor auxiliary machine torque Tac is calculating by linearly interpolating "Compressor auxiliary machine torques" which correspond to "Engine rotation speeds" neighboring the current engine rotational speed Ne at both sides thereof.

[0082] In a method similar to the method of calculating the compressor auxiliary machine torque Tac, the control portion 10 calculates a generator auxiliary machine torque Tag of the generator 26 that is one of the auxiliary machines and/or other auxiliary torque of the auxiliary machine connected to the drive shaft 21 of the engine 2. The control portion 10 calculates the sum of, for example, the auxiliary machine torque Ta and/or the generator auxiliary machine torque Tag, and calculates the auxiliary machine torque Ta. When S32 ends, the program proceeds to S33.

[0083] At S33, the control portion 10 (the load obtaining portion) calculates an adjustment torque α. The adjustment torque α is torque needed to maintain the engine rotation speed Ne in addition to the engine friction torque Tef and the auxiliary machine torque Ta, and the adjustment torque α is calculated on the basis of information including, for example, the engine rotation speed Ne. When S33 ends, the program proceeds to S34.

[0084] At S34, the control portion 10 (a third calculation portion) calculates the maintaining torque Tk on the basis of the following formula (2).

$$Tk = Tef + Ta + T\alpha \ldots (2)$$

Tk ... Maintaining torque
Tef ... Engine friction torque
Ta ... Auxiliary machine torque
$T\alpha$ ... Adjustment torque

When S34 ends, S 17-4 of Fig. 5 ends and the program proceeds to S17-5.

[0085] At S17-5, the control portion 10 (a first calculation portion) calculates the startup engine torque Tes on the basis of the above-described formula (1). When S17-5 ends, the program proceeds to S17-6.

[0086] At S17-6, the control portion 10 moves the program to S17-7 in a case where the control portion 10 determines that the startup engine torque Tes is smaller than the required engine torque Ter (S17-6: YES), and the control portion 10 moves the program to S17-8 in a case where the control portion 10 determines that the startup engine torque Tes is equal to or more than the required engine torque Ter (S17-6: NO).

[0087] At S17-7, the control portion 10 controls the throttle valve 22, the fuel injection apparatus 28 and/or the ignition apparatus so that the engine torque Te generated by the engine 2 becomes the startup engine torque Tes calculated at S17-5. When S17-7 ends, the program returns to S11 of Fig. 4.

[0088] At S17-8, the control portion 10 controls the throttle valve 22, the fuel injection apparatus 28 and/or the ignition apparatus so that the engine torque Te generated by the engine 2 becomes the required engine torque Ter. When S17-8 ends, the program returns to S11 of Fig. 4.

[0089] (Explanation of vehicle startup) "Clutch/engine cooperative control" at the startup of the vehicle 100 will be described hereunder using Fig. 3 and Fig. 4. In Fig. 3, "Stopper position" is a position at which each of the pedals 51, 53, 56 is pressed down (operated) maximally. In a case where each of the pedals 51, 53, 56 is at "Stopper position", each stroke is at a maximum.

[0090] (Time elapsed T0) The brake pedal 56 is pressed down in this state, and therefore the determination of NO is made at S11 of Fig. 4, proceeds to S18, and "Normal control" is executed. That is, the control of the engine 2 depends on operation of the accelerator by the driver. The accelerator pedal 51 is not depressed in this state, and therefore the engine rotation speed Ne is at the idling rotation speed (for example, 700 r.p.m.).

[0091] (Time elapsed T1) The clutch 3 is completely disconnected in this state, and therefore the determination of NO is made at S12 of Fig. 4, proceeds to S18, and "Normal control" is executed. That is, the control of the engine 2 depends on the operation of the accelerator by the driver. Because the accelerator pedal 51 is depressed, the engine rotation speed Ne and the engine torque Te which are according to the accelerator stroke Ac are obtained.

[0092] (Time elapsed T2) The clutch 3 is in the clutch half-engaged state in this state, and therefore the determination of YES is made at S12 of Fig. 4. Thereafter, the determination of NO is made at S16 because the engine rotation speed Ne is lower than the upper limit value N1 of the startup engine rotation speed even though the clutch difference rotation speed Δc is equal to or more than the specified difference rotation speed A, then, it proceeds to S18, and "Normal control" is executed.

[0093] (Time elapsed T3) The engine rotation speed Ne is equal to or more than the upper limit value Nl of the startup engine rotation speed in this state, and therefore the determination of YES is made at S16, proceeds to S18, and "Torque down control" is executed. Because the engine rotation speed Ne exceeds the upper limit value Nl of the startup engine rotation speed, the engine rotation speed reduction torque Ten corresponding to a negative value is set and the startup engine torque Tes is reduced. As a result, the engine rotation speed Ne decreases compared to the engine rotation speed (the alternate long and short dash line in Fig. 3) at "Normal control" and is controlled not to significantly exceed the upper limit value Nl of the startup engine rotation speed. As a consequence, the clutch difference rotation speed Δc is restrained from increasing and the clutch temperature Tmpc is restrained from increasing.

[0094] (Time elapsed T4) The engine rotation speed Ne has become slower than the upper limit value Nl of the startup engine rotation speed in this state, and therefore it proceeds to S18 according to the determination at S 14 of Fig. 4, and "Normal control" is executed.

[0095] (Time elapsed T5) In this state, because the clutch difference rotation speed Δc is smaller than the specified difference rotation speed A (for example, 500 r.p.m.), the determination of NO is made at the determination of S14, proceeds to S18, and "Normal control" is executed.

[0096] In contrast, conventionally, at the startup of the vehicle, the engine 2 is controlled to achieve the required engine torque Ter that is based on the operation of the accelerator pedal 51 by the driver (the alternate long and two short dashes line in Fig. 3). Accordingly, in a case where the driver presses down the accelerator pedal 51 at the startup of the vehicle, the engine rotation speed Ne increases as indicated by the alternate long and short dash line in Fig. 3, and as a result, the clutch difference rotation speed Δc increases at the engagement of the clutch 3, and the clutch 3 is overheated.

[0097] (Effects of the present embodiment) As is clear from the above explanation, at the startup of the vehicle 100 (YES at all of S11 through S14 of Fig. 4), the engine 2 is controlled so that the startup engine torque Tes calculated according to the above-described formula (1) on the basis of the clutch torque Tc and the clutch temperature Tmpc is achieved. Because the engine 2 is controlled to achieve the startup engine torque Tes calculated on the basis of the clutch temperature Tmpc as described above, the clutch 3 is prevented from being overheated. That is, as the clutch temperature Tmpc increases, the startup engine torque Tes is restrained from increasing, and consequently, the engine rotation speed Ne is restrained from increasing. As a consequence, the clutch difference rotation speed Δc is restrained from increasing, and the overheating of the clutch 3 is prevented from occurring.

[0098] In addition, because the engine 2 is controlled to achieve the startup engine torque Tes calculated on the basis of the clutch torque Tc, the engine rotation speed Ne is prevented from decreasing. That is, in a case where the driver reduces an operation amount of the clutch pedal 53 and thus the clutch torque Tc increases, the startup engine torque Tes increases in association with the increase of the clutch torque Tc. Consequently, the engine rotation speed Ne is prevented from decreasing and the drive device 1 for the vehicle which includes an excellent drivability can be provided.

[0099] On the other hand, in a case where the driver increases the operation amount of the clutch pedal 53 and thus the clutch torque Tc decreases, the startup engine torque Tes decreases in association with the decrease of the clutch torque Tc. Consequently, the engine rotation speed Ne is prevented from increasing unnecessarily, and occurrence of noises is prevented and/or unnecessary fuel consumption is prevented.

[0100] In addition, at S17-2 of Fig. 5, the control portion 10 (the upper limit calculation portion) calculates the upper limit value Nl of the startup engine rotation speed. The upper limit value Nl of the startup engine rotation speed decreases more as the clutch temperature Tmpc becomes higher. Then, at S17-3 and S17-5, the control portion 10 (the first calculation portion) calculates the startup engine torque Tes on the basis of the clutch torque Tc, and the difference rotation speed between the engine rotation speed Ne and the upper limit value Nl of the startup engine rotation speed. Because the upper limit value Nl of the startup engine rotation speed, which decreases more as the clutch temperature Tmpc becomes higher, is calculated as described above, the startup engine torque Tes is restrained from increasing. Consequently, in a case where the clutch temperature Tmpc is high, the clutch 3 is prevented from further being overheated, and deterioration and/or ablation of the clutch 3 (deterioration and/or ablation of the friction material 32a, in particular) is prevented.

[0101] In addition, at S17-3 of Fig. 5, the control portion 10 sets the engine rotation speed reduction torque Ten as 0 in a case where the current engine rotation speed Ne is lower than the upper limit value Nl of the startup engine rotation speed. Accordingly, the excessive decrease in the engine rotation speed Ne can be prevented and it can be avoided that the driver has a sense of discomfort, and also engine stall can be prevented.

[0102] In addition, in a case where the engine rotation speed Ne is equal to or more than the upper limit value Nl (a predetermined rotation speed) of the startup engine rotation speed (determined as YES at S16 of Fig. 4), the control portion 10 (an engine control portion) controls at S17 the engine 2 so that the startup engine torque Tes is achieved. Accordingly, in a case where the rotation speed of the engine 2 is lower than the upper limit value Nl of the startup engine rotation speed which does not cause the overheating of the clutch 3, the normal engine control is executed, and thus the engine control in accordance with the operation of the accelerator by the driver is executed. As a result, the driver does not feel the sense of discomfort because the engine torque Te does not deviate from an intention of the driver.

[0103] In addition, at "Maintaining torque calculation process" of Fig. 7, the control portion 10 (the third calculation portion) calculates the maintaining torque Tk on the basis of, for example, the load acting on the engine 2. Then, at S17-5 of Fig. 5, the control portion 10 (the first calculation portion) calculates the startup engine torque Tes while adding the maintaining torque Tk. Accordingly, for example, in a case where the auxiliary machine driven by the engine 2 stops and thus the load of the engine 2 decreases, the startup engine torque Tes including the decrease of the load is calculated. Consequently, the engine rotation speed Ne can be prevented from increasing in association with the decrease of the load of the engine 2. On the other hand, for example, in a case where the auxiliary machine is actuated by the engine 2 and thus the load of the engine 2 increases, the startup engine torque Tes including the increase of the load is calculated. Consequently, the engine rotation speed Ne can be prevented from decreasing in association with the increase of the load of the engine 2.

[0104] In addition, the control portion 10 (the engine control portion) controls the engine 2 so that the engine torque Te becomes the required engine torque Ter in a case where the required engine torque Ter is equal to or less than the startup engine torque Tes (determined as NO at S17-6 of Fig. 5). Accordingly, the engine 2 is controlled to achieve the required engine torque Ter that reflects the intension of the driver in a case where the required engine torque Ter is equal to or less than the startup engine torque Tes. Consequently, the engine torque Te does not deviate from the intention of the driver, and thus the excessive increase in the engine rotation speed Ne can be prevented while the feeling of discomfort of the driver is reduced.

[0105] In addition, the clutch stroke Cl, which is the operation amount of the clutch pedal 53 and is detected by the clutch sensor 54 (a first obtaining portion), is detected. Then, the control portion 10 obtains the clutch torque Tc on the basis of the clutch stroke Cl by referring to "Clutch torque mapping data" shown in Fig. 2. Accordingly, the clutch torque Tc can be obtained reliably by means of simple configuration and/or method.

[0106] The control portion 10 executes "Normal control" at S18 in a case where the current vehicle speed V detected at a vehicle speed detection portion is equal to or more than the specified speed that is predetermined (determined as NO at S13 of Fig. 4). Accordingly, the execution of "Torque down control" is prevented in a case where the driver performs the clutch operation after the startup when the vehicle speed V is higher than a specified vehicle speed. As a consequence, it is prevented that the driver feels the sense of discomfort.

[0107] In addition, the control portion 10 controls the engine 2 so that the startup engine torque Tes is achieved only in a case where the brake pedal 56 (the braking force operation member) is not being operated (determined as YES at S11 of Fig. 4). Accordingly, the engine 2 is not controlled in such a manner that the startup engine torque Tes calculated on the basis of the clutch torque Tc is achieved in a case where the brake pedal 56 is being operated. Consequently, the vehicle 100 can be decelerated and/or stopped safely.

[0108] (Second embodiment) A second embodiment will be described hereunder regarding aspects that are different from the above-described embodiment. In the second embodiment, at S17-3 of Fig. 5, the control portion 10 calculates the engine rotation speed reduction torque Ten in the following method instead of using "Engine rotation speed reduction torque calculation data".

[0109] First, the control portion 10 calculates an engine rotation speed change ωe which is time change of the engine rotation speed Ne. Specifically, time Tn which is needed to reduce the engine rotation speed from the current engine rotation speed Ne down to the upper limit value Nl of the startup engine rotation speed is calculated. The time Tn is calculated on the basis of the engine friction torque Tef.

[0110] Next, the control portion 10 calculates the engine rotation speed change ωe by dividing the value, which is obtained by subtracting the current engine rotation speed Ne from the upper limit value Nl of the startup engine rotation speed, by the time Tn described above.

[0111] Next, the control portion 10 calculates the engine rotation speed reduction torque Ten on the basis of the following formula (10).

$$Ten = Ie \times \omega e \ldots (10)$$

Ten ...Engine rotation speed reduction torque Ten
Ie...Engine inertia
ωe...Engine rotation speed change

[0112] An engine inertia Ie is a moment of inertia of rotational members of the engine 2. The rotational members of the engine 2 include the crankshaft, a connecting rod, the piston, the drive shaft 21, the flywheel 31, the clutch cover 33, the pressure plate 35 and the diaphragm spring 34. The engine inertia Ie is set in advance.

[0113] (Other embodiment) An embodiment that is different from the aforementioned embodiments will be described hereunder. In the aforementioned embodiments, "Torque down control" is executed in a case where the engine rotation speed Ne is equal to or more than the upper limit value Nl of the startup engine rotation speed (determined as YES at S16 of Fig. 4). However, an embodiment is applicable in which "Torque down control" is executed in a case where the engine rotation speed Ne is equal to or more than a rotation speed which is lower than the upper limit value Nl of the startup engine rotation speed by a predetermined rotation speed, in a case where the engine rotation speed Ne is equal to or more than a rotation speed which is higher than the upper limit value Nl of the startup engine rotation speed by a predetermined rotation speed, or in a case where the engine rotation speed Ne is equal to or more than a specified rotation speed (for example, 1500 r.p.m.).

[0114] In the aforementioned embodiments, an operation force of the clutch pedal 53 is transmitted to the release bearing 37 via the master cylinder 55, the fluid pressure pipe 58 and the slave cylinder 38. However, an embodiment is applicable in which the operation force of the clutch pedal 53 is transmitted to the release bearing 37 via a mechanical component including a wire, a rod and a gear, for example.

[0115] In the aforementioned embodiments, the control portion 10 calculates the clutch torque Tc on the basis of the clutch stroke Cl detected by the clutch sensor 54, while the control portion 10 referring to "Clutch torque mapping data" that is shown in Fig. 2 and represents the relationship between the clutch stroke Cl and the clutch torque Tc. However, an embodiment is applicable in which the clutch torque Tc is estimated and the required engine torque Ter is estimated, on the basis of an amount of change of the clutch stroke Cl per a period of time, as indicated in JP2008-157184A.

[0116] In the aforementioned embodiments, the clutch torque Tc is calculated on the basis of the detection signal of the clutch sensor 54. However, the clutch torque Tc may be calculated from information including the engine inertia Ie, the engine friction torque Tef, the rotation speed of the input shaft 41 at a start of the engagement, the current rotation speed of the input shaft 41 and a time elapsed from the start of the engagement, for example.

[0117] In the aforementioned embodiments, the clutch sensor 54 detects the stroke amount of the master cylinder 55. However, the clutch sensor 54 may be any of sensors which detect the operation amount of the clutch pedal 53, master pressure of the master cylinder 55, stroke and/or fluid pressure of the slave cylinder 38, and/or a stroke amount of the release bearing 37.

[0118] In the aforementioned embodiments, the control portion 10 calculates the vehicle speed V on the basis of the output shaft rotation speed No detected by the output shaft rotation speed sensor 46. However, an embodiment is applicable in which the control portion 10 calculates the vehicle speed V on the basis of a wheel rotation speed detected by a wheel speed sensor detecting a rotation speed of the wheel, and/or on the basis of other sensor which detects a rotation speed of a shaft rotating in association with the wheel.

[0119] In the aforementioned embodiments, the oil temperature of the oil lubricating the engine 2 is detected by the oil temperature sensor 25. However, an embodiment is applicable in which the oil temperature of the oil is estimated on the basis of a detection signal from a water temperature sensor detecting a water temperature of coolant water circulating inside the engine 2.

[0120] In the aforementioned embodiments, the clutch operation member transmitting the operating force of the driver to the clutch 3 is the clutch pedal 53. However, the clutch operation member is not limited to the clutch pedal 53 and may be a clutch lever, for example. Similarly, instead of the accelerator pedal 51 adjusting the accelerator stroke Ac, for example, an accelerator grip adjusting the accelerator stroke Ac is applicable. Further, in a case where the drive device for the vehicle of the present embodiment is applied to an autobicycle and/or other vehicle, the technical ideas of the present invention are applicable thereto.

[0121] In the aforementioned embodiments, the single control portion 10 controls the engine 2 and executes "Clutch/engine cooperative control" shown in Fig. 4. However, an embodiment is applicable in which the engine control portion controls the engine 2, and the control portion 10 which is connected to the engine control portion via a communication unit including, for example, CAN (Controller Area Nlwork), executes "Clutch/engine cooperative control".

[0122] In the aforementioned embodiments, the control portion 10 estimates the temperature of the clutch 3 (the temperature of the friction material 32a) on the basis of the clutch torque Tc, the vehicle speed V, the oil temperature t, the engine rotation speed Ne and the input shaft rotation speed Ni. However, an embodiment is applicable in which a temperature detection sensor including, for example, a radiation thermometer detecting the temperature of the friction material 32a, is provided at a position adjacent to the friction material 32a to obtain the clutch temperature Tmpc.

[0123] The "at the startup of the vehicle 100" includes circumstances in which the driver performs an operation of appropriately sliding the clutch by using the half-engaged clutch, for example, in a traffic congestion or when parking the vehicle in a garage.

EXPLANATION OF REFERENCE NUMERALS

[0124]

1...drive device for a vehicle, 2... engine, 3...clutch, 10... control portion (second obtaining portion, engine control portion, first calculation portion, second calculation portion, third calculation portion, upper limit calculation portion, load obtaining portion), 19...brake device (braking force generating portion), 21...drive shaft, 25...oil temperature sensor (load obtaining portion), 41...input shaft, 46...output shaft rotation speed sensor (vehicle speed detection portion), 51...accelerator pedal (engine operation member), 52... acceleration sensor, 53...clutch pedal (clutch operation member), 54...clutch sensor (first obtaining portion), 56...brake pedal (braking force operation member), 100...vehicle
t...oil temperature
V...vehicle speed
Nl...upper limit value of a startup engine rotation speed
Δc...clutch difference rotation speed
Te...engine torque
Ter...required engine torque
Tes...startup engine torque (at torque down control)
Tc...clutch torque
Ten...engine rotation speed reduction torque
Tk...maintaining torque
Tef...engine friction torque
Ta... auxiliary machine torque
Tα...adjustment torque

Claims

1. A drive device for a vehicle comprising:

   a clutch provided between a drive shaft of an engine and an input shaft of a manual transmission and making a clutch torque between the drive shaft and the input shaft variable by an operation of a clutch operation member;
   a first obtaining portion obtaining the clutch torque generated by the clutch;
   a second obtaining portion obtaining a temperature of the clutch;
   a first calculation portion calculating a startup engine torque on the basis of the clutch torque obtained by the first obtaining portion and the temperature of the clutch obtained by the second obtaining portion; and
   an engine control portion controlling the engine at startup so that the startup engine torque calculated by the first calculation portion is achieved.

2. The drive device for the vehicle according to claim 1, comprising:

   an upper limit calculation portion calculating an upper limit value of a startup engine rotation speed, wherein
   the upper limit value is set in such a manner that the upper limit value decreases as the clutch temperature becomes higher, and
   the first calculation portion calculates the startup engine torque on the basis of the clutch torque obtained by the first obtaining portion and a difference between a rotation speed of the engine and the upper limit value of the startup engine rotation speed.

3. The drive device for the vehicle according to either claim 1 or 2, wherein, in a case where the rotation speed of the engine is equal to or more than a predetermined value, the engine control portion controls the engine so that the startup engine torque is achieved.

4. The drive device for the vehicle according to any one of claims 1 to 3, comprising:

   a second calculation portion calculating a required engine torque on the basis of an operation amount of an engine operation member operating engine torque outputted by the engine in such a manner that the engine torque is variable, wherein
   in a case where the required engine torque calculated by the second calculation portion is equal to or less than the startup engine torque, the engine control portion controls the engine so that the required engine torque is achieved.

5. The drive device for the vehicle according to any one of claims 1 to 4, comprising:

   a third calculation portion calculating a maintaining torque corresponding to torque needed to maintain the rotation speed of the engine, the third calculation portion calculating the maintaining torque on the basis of a load acting on the engine, wherein
   the first calculation portion calculates the startup engine torque while adding the maintaining torque calculated by the third calculation portion.

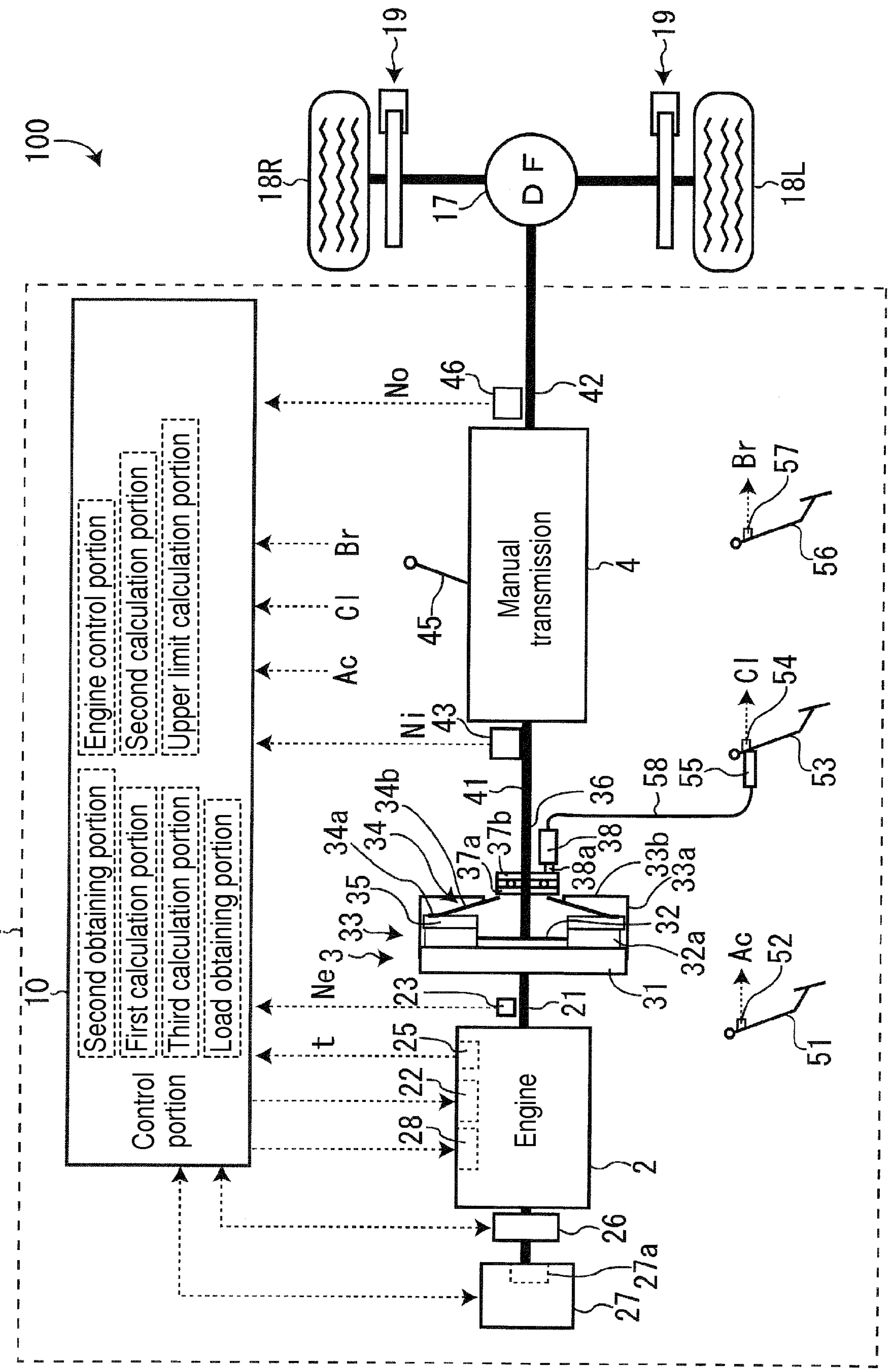
6. The drive device for the vehicle according to any one of claims 1 to 5, wherein the first obtaining portion detects an operation amount of the clutch operation

member.

7. The drive device for the vehicle according to any one of claims 1 to 6, wherein the engine control portion controls the engine so that the startup engine torque is achieved only in a case where a current vehicle speed is smaller than a predetermined speed.

8. The drive device for the vehicle according to any one of claims 1 to 7, wherein the engine control portion controls the engine so that the startup engine torque is achieved only in a case where a braking force operation member is not being operated, the braking force operation member is for operating a braking force of a braking force generating portion in such a manner that the braking force is variable, the braking force generating portion generates the braking force.

FIG. 1


100
Control portion
Second obtaining portion
First calculation portion
Third calculation portion
Load obtaining portion
Engine control portion
Second calculation portion
Upper limit calculation portion
Engine
Manual transmission
D F
Ne
t
Ni
No
Ac
Cl
Br
18R
18L
17
19
1
10
2
3
4
21
22
23
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26
27
27a
28
31
32
32a
33
33a
33b
34
34a
34b
35
36
37a
37b
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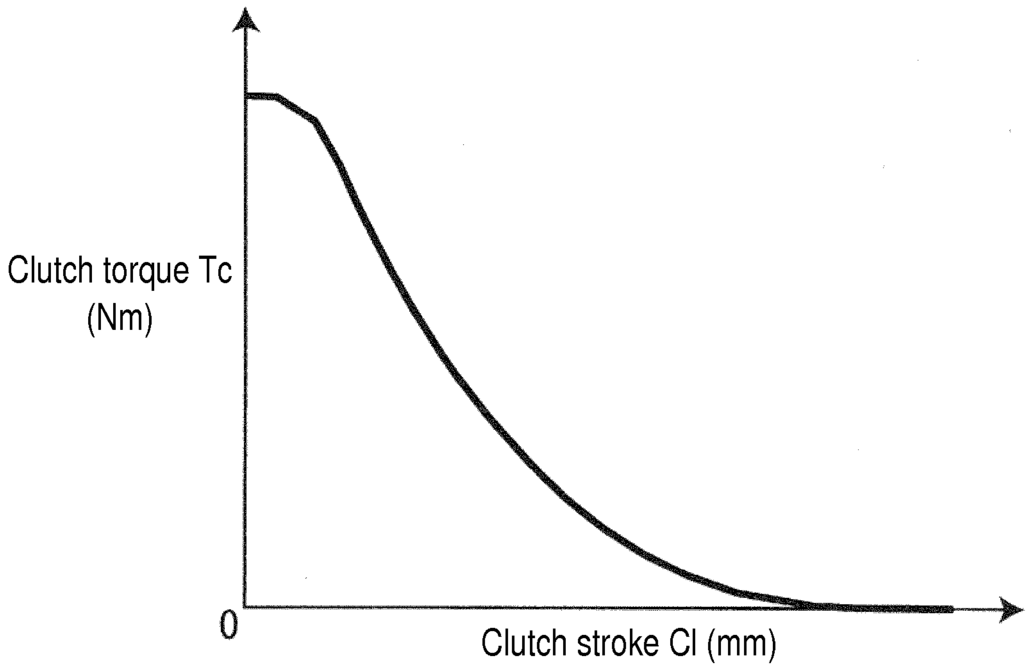
38a
41
42
43
45
46
51
52
53
54
55
56
57
58

FIG. 2



F I G. 3

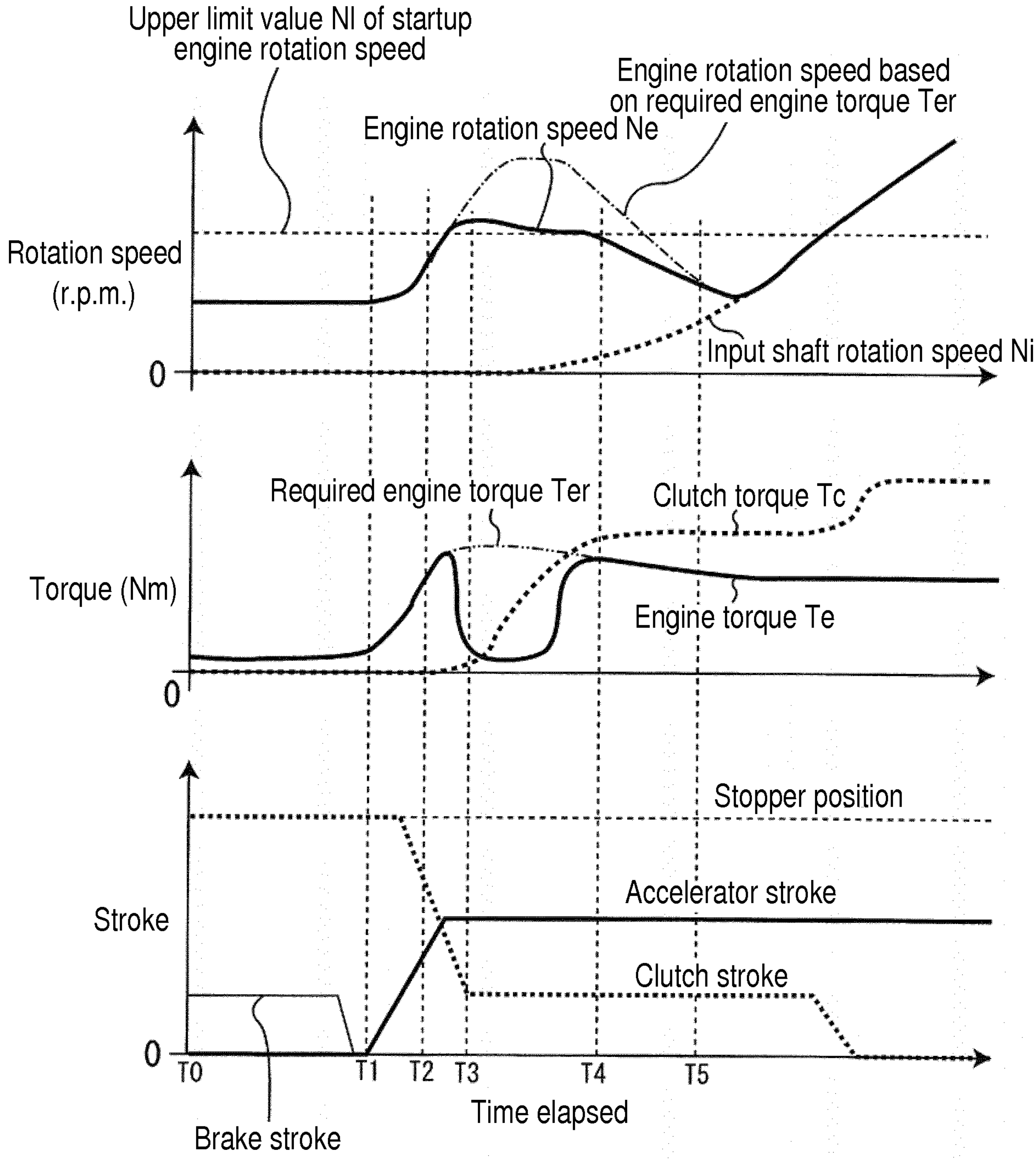

Upper limit value Nl of startup engine rotation speed
Engine rotation speed based on required engine torque Ter
Engine rotation speed Ne
Rotation speed (r.p.m.)
0
Input shaft rotation speed Ni
Required engine torque Ter
Clutch torque Tc
Torque (Nm)
Engine torque Te
0
Stopper position
Accelerator stroke
Stroke
Clutch stroke
0
T0
T1
T2
T3
T4
T5
Time elapsed
Brake stroke

FIG. 4

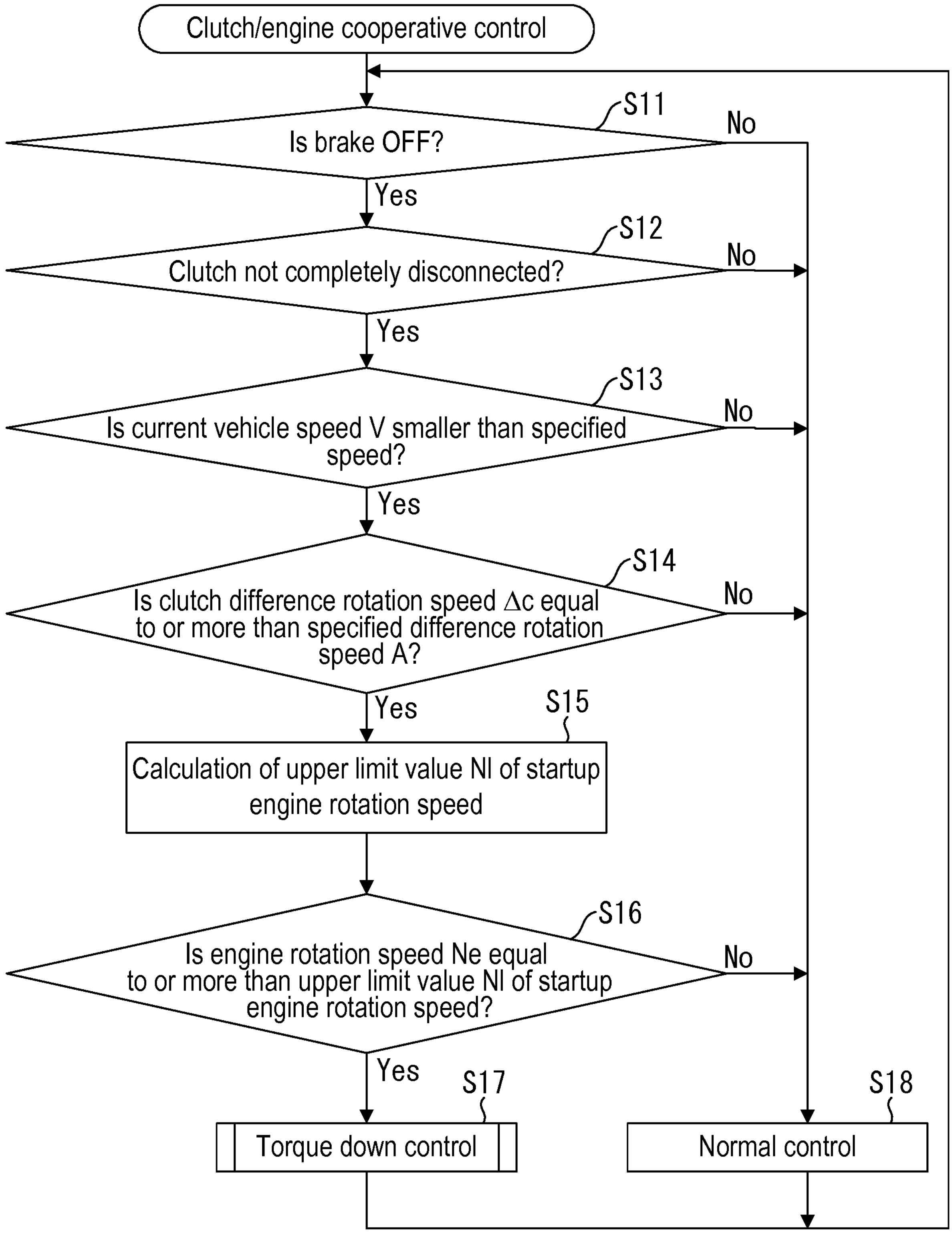
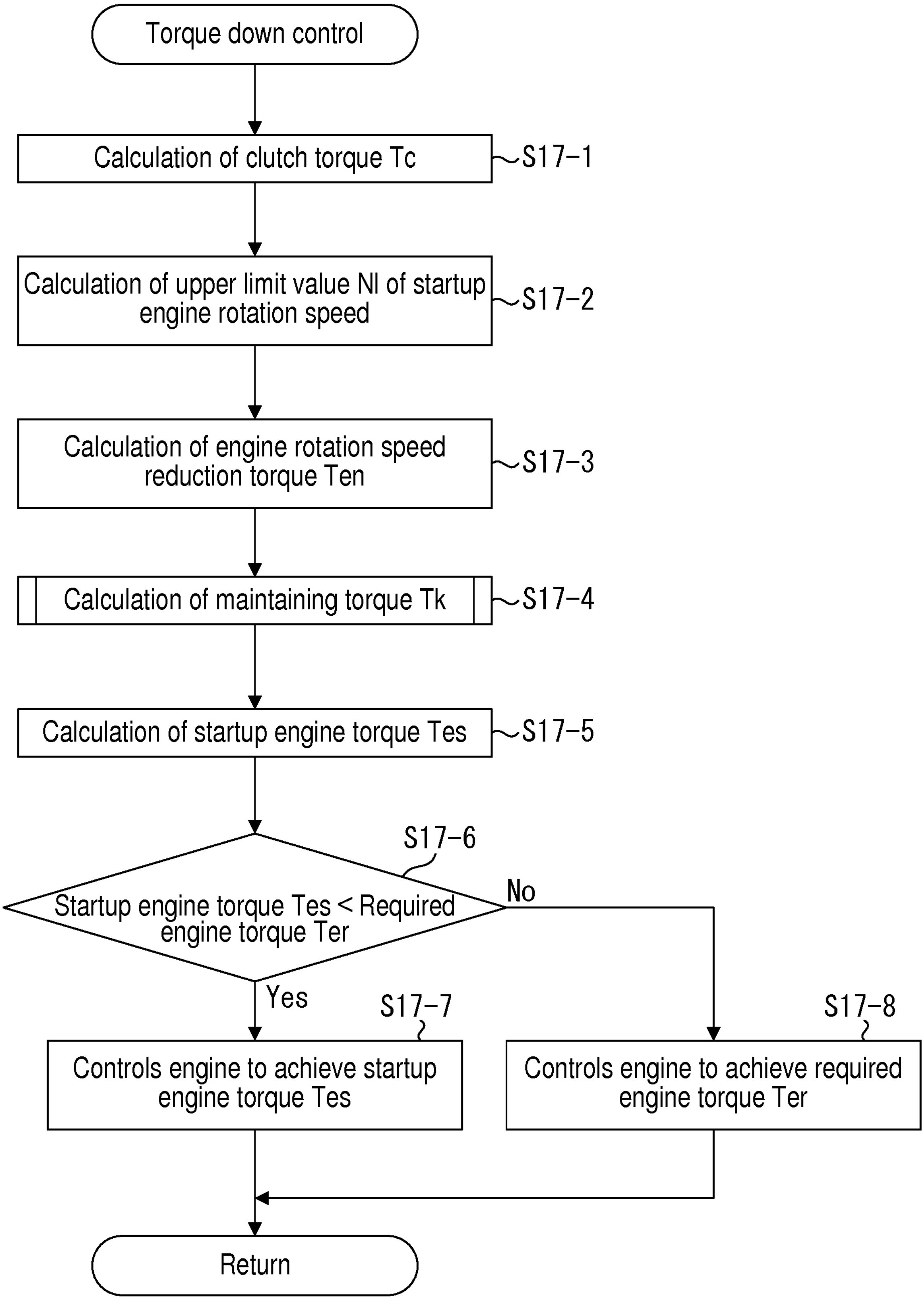

Clutch/engine cooperative control
S11
Is brake OFF?
No
Yes
S12
Clutch not completely disconnected?
No
Yes
S13
Is current vehicle speed V smaller than specified speed?
No
Yes
S14
Is clutch difference rotation speed Δc equal to or more than specified difference rotation speed A?
No
Yes
S15
Calculation of upper limit value Nl of startup engine rotation speed
S16
Is engine rotation speed Ne equal to or more than upper limit value Nl of startup engine rotation speed?
No
Yes
S17
Torque down control
S18
Normal control

FIG. 5



Torque down control
Calculation of clutch torque Tc
S17-1
Calculation of upper limit value Nl of startup engine rotation speed
S17-2
Calculation of engine rotation speed reduction torque Ten
S17-3
Calculation of maintaining torque Tk
S17-4
Calculation of startup engine torque Tes
S17-5
S17-6
Startup engine torque Tes < Required engine torque Ter
No
Yes
S17-7
S17-8
Controls engine to achieve startup engine torque Tes
Controls engine to achieve required engine torque Ter
Return

F I G. 6

Engine rotation speed reduction torque calculation data

Upper limit value NI of startup engine rotation speed (r.p.m) – Current engine rotation speed Ne (r.p.m)	500	250	0	−250	−500
Engine rotation speed reduction torque Ten (Nm)	0	0	0	−10	−25

FIG. 7

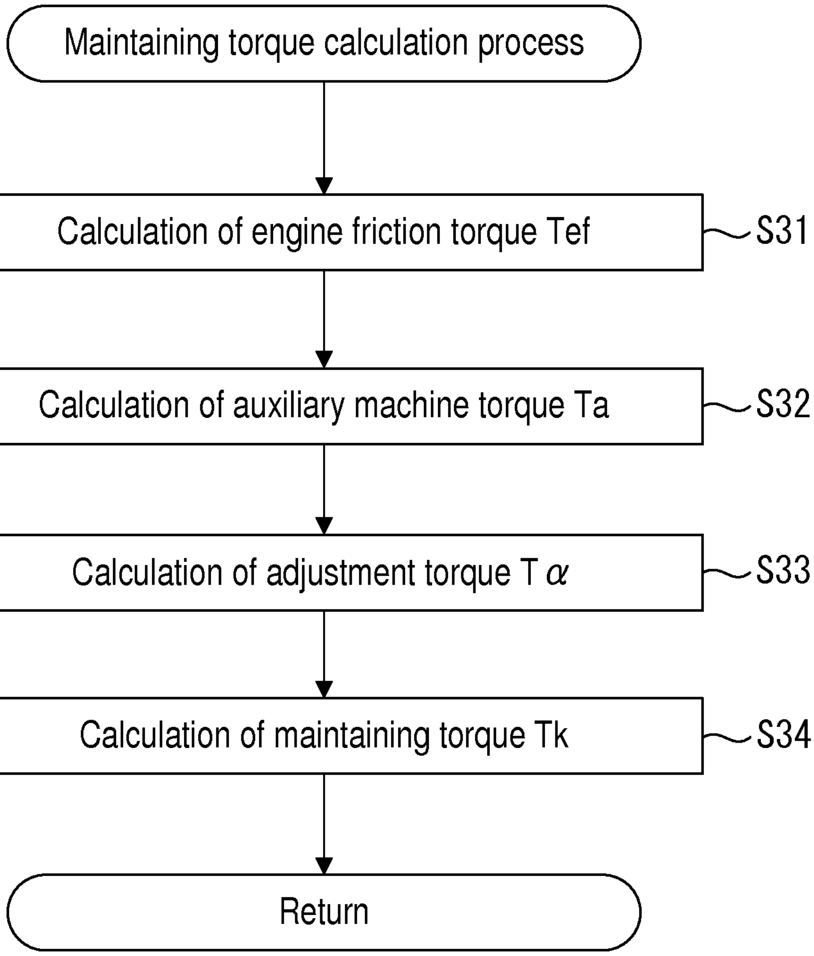

Maintaining torque calculation process
Calculation of engine friction torque Tef
S31
Calculation of auxiliary machine torque Ta
S32
Calculation of adjustment torque Tα
S33
Calculation of maintaining torque Tk
S34
Return

FIG. 8

Compressor auxiliary machine torque calculation data

Engine rotation speed (r.p.m.)	700	1200	1700	2200	2700
Compressor auxiliary machine torque (Nm) (Air conditioner OFF)	5	7	9	10	11
Compressor auxiliary machine torque (Nm) (Air conditioner ON)	13	14	15	16	16

FIG. 9

Setting data of upper limit value of the startup engine rotation speed

Clutch temperature Tmpc (˚C)	Less than 250	250	300	350
Upper limit value Nl of startup engine rotation speed (r.p.m)	Engine rotation speed limiter value	2500	2200	1800

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/057348

A. CLASSIFICATION OF SUBJECT MATTER
F02D29/00(2006.01)i, *F02D41/04*(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F02D29/00, F02D41/04

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2014
Kokai Jitsuyo Shinan Koho	1971-2014	Toroku Jitsuyo Shinan Koho	1994-2014

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2009-127793 A (Nissan Motor Co., Ltd.), 11 June 2009 (11.06.2009), paragraphs [0032] to [0050] (Family: none)	1-4,6-7 5,8
Y	JP 2009-41434 A (Nissan Motor Co., Ltd.), 26 February 2009 (26.02.2009), paragraph [0003] (Family: none)	5
Y	JP 2011-196514 A (Aisin AI Co., Ltd.), 06 October 2011 (06.10.2011), paragraph [0055] & US 2011/0238276 A1	8

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

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"&" document member of the same patent family

Date of the actual completion of the international search 29 May, 2014 (29.05.14)	Date of mailing of the international search report 10 June, 2014 (10.06.14)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/057348

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 8-114144 A (Toyota Motor Corp.), 07 May 1996 (07.05.1996), paragraphs [0001] to [0007] (Family: none)	3,7

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 20080147288 A1 **[0004]**
- JP 4715132 B **[0053]**
- JP 2008157184 A **[0115]**