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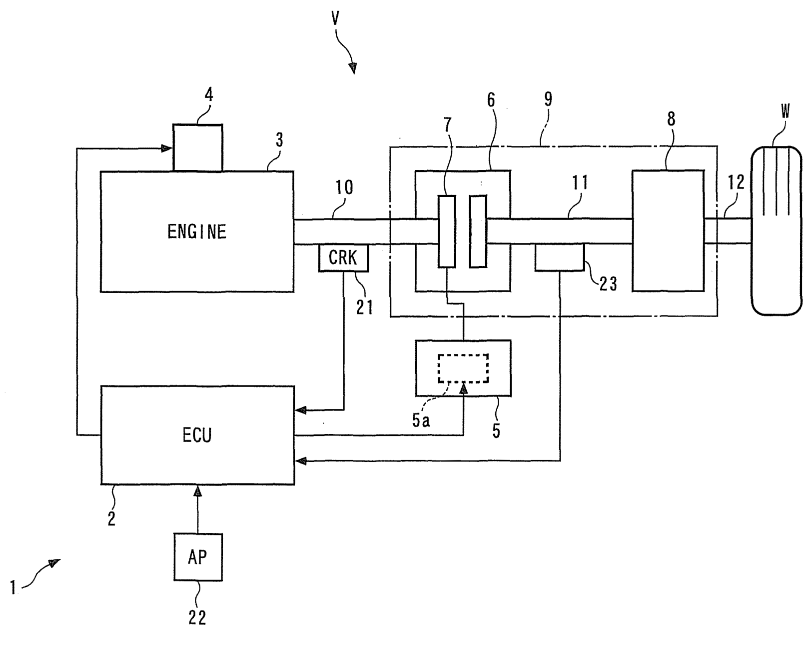
(54) Torque control device and method for internal combustion engine

(57) A torque control device for an internal combustion engine, capable of properly suppressing the vibration of a vehicle by controlling torque output from the engine such that no large variation in the output torque is caused, when the vehicle has a torque converter having a lockup clutch. The torque control device calculates a basic value of a demanded torque for determining the output torque, according to detected operating conditions of the engine, and calculates a filtering characteristic for determining an average torque, and a filtering characteristic for determining a torque correction term, according to a detected degree of engagement of the lockup clutch. The torque control device calculates the demanded torque by filtering correction of the basic value using the filtering characteristics, and calculates a fuel injection amount based on the demanded torque. Torque corresponding to the fuel injection amount is output from the engine.

F I G. 1



EP 2 199 578 A1

Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a torque control device and method for an internal combustion engine, for controlling torque output from the engine.

Description of the Related Art

[0002] Conventionally, there has been proposed a torque control device for an internal combustion engine in Japanese Laid-Open Patent Publication (Kokai) No. 2004-92522. This engine includes a throttle valve for controlling an intake air amount, and is connected to drive wheels of a vehicle via a torque converter having a lockup clutch, and a belt-type stepless transmission (hereinafter referred to as "the transmission"). Further, the torque control device calculates a maximum transmission torque that can be transmitted by the transmission, e.g. based on the transmission gear ratio of the transmission calculated based on an input rotational speed and an output rotational speed of the transmission. Further, when it is determined that an accelerator pedal is suddenly stepped on and at the same time the torque output from the engine to the transmission exceeds the maximum transmission torque, the torque control device causes the opening of the throttle valve to be reduced so as to limit the output torque of the engine such that the output torque becomes smaller than the maximum transmission torque of the transmission, to thereby prevent the belt of the transmission from slipping.

[0003] In the conventional torque control device, however, the output torque of the engine is controlled by controlling the intake air amount via the opening of the throttle valve, and hence there is an inevitable delay of time which occurs after the opening of the throttle valve is changed and before intake air corresponding to the change in the opening of the throttle valve actually flows into cylinders to have the change reflected on an increase/decrease of the output torque of the engine. This makes it impossible to control the output torque in the optimum timing.

[0004] The same applies to a case where the vibration of the vehicle caused by variation in the output torque is suppressed e.g. by controlling the output torque. Further, when the torque converter having the lockup clutch is provided between the engine and the drive wheels of the vehicle, if the degree of engagement of the lockup clutch varies, the magnitude and transmission rate of torque transmitted from the engine to the drive wheels vary to cause variation in the behavior of vibration caused on the vehicle. Therefore, if torque control is performed without taking the degree of engagement of the lockup clutch into consideration, it is impossible to properly suppress the vibration of the vehicle.

SUMMARY OF THE INVENTION

[0005] It is an object of the present invention to provide a torque control device and method for an internal combustion engine, which is capable of properly suppressing the vibration of a vehicle by controlling torque output from the engine such that no large variation in the output torque is caused, when the vehicle has a torque converter having a lockup clutch.

[0006] To attain the above object, in a first aspect of the present invention provides a torque control device for an internal combustion engine, for controlling an output torque which is output from the engine connected to drive wheels of a vehicle via an automatic transmission that has a torque converter having a lockup clutch, characterized by comprising operating condition-detecting means for detecting an operating condition of the engine, basic value-setting means for setting a basic value of a torque parameter which is a parameter for determining the torque output, according to the detected operating condition of the engine, filtering correction means for correcting the basic value by filtering thereof, to thereby set the torque parameter, lockup clutch engagement degree-detecting means for detecting a degree of engagement of the lockup clutch, and filtering characteristic-setting means for setting a filtering characteristic of the filtering correction means according to the detected degree of engagement of the lockup clutch.

[0007] With the configuration of this torque control device according to the first aspect of the present invention, the output torque of the engine is transmitted to the drive wheels of the vehicle via the automatic transmission that has the torque converter having the lockup clutch. Further, according to the torque control device, the basic value of the torque parameter that is a parameter for determining the output torque is set according to the detected operating condition of the engine. Furthermore, the degree of engagement of the lockup clutch is detected, and the filtering characteristic is set according to the detected degree of engagement of the lockup clutch. Then, the torque parameter is set by correcting the basic value of the torque parameter by filtering thereof using the set filtering characteristic, whereby the output torque of the engine is controlled.

[0008] As described above, the torque parameter is set by setting the filtering characteristic according to the degree of engagement of the lockup clutch, and performing filtering correction of the basic value of the torque parameter using the set filtering characteristic. This makes it possible to control the output torque of the engine according to the degree of engagement of the lockup clutch such that no large variation in the output torque is caused, thereby making it possible to properly suppress the vibration of the vehicle.

[0009] Preferably, the filtering correction means includes torque correction term-calculating means for calculating a torque correction term for correction of the basic value, such that a torque in an opposite phase to a state of variation in the output torque from the engine is generated.

[0010] With the configuration of this preferred embodiment, the torque correction term is calculated such that a torque in the opposite phase to the variation in the output torque from the engine is generated, and the basic value of the torque parameter is corrected using the torque correction term. Therefore, it is possible to cancel out the variation in the output torque using the torque in the opposite phase generated by the torque correction term, thereby making it possible to suppress the variation in the output torque and the vibration of the vehicle caused by the variation in the output torque.

[0011] Preferably, the filtering characteristic-setting means sets a gain of the filtering characteristic according to the detected degree of engagement of the lockup clutch.

[0012] With the configuration of this preferred embodiment, the filtering characteristic of the filtering correction means includes a gain, and the gain is set according to the degree of engagement of the lockup clutch. When the degree of engagement of the lockup clutch varies, the magnitude of the output torque transmitted to the drive wheels varies accordingly, so that as described above, by setting the gain of the filtering characteristic according to the degree of engagement of the lockup clutch, it is possible to perform proper filtering correction according to the magnitude of the transmission torque.

[0013] Preferably, the filtering characteristic-setting means sets a time constant of the filtering characteristic according to the detected degree of engagement of the lockup clutch.

[0014] With the configuration of this preferred embodiment, the filtering characteristic of the filtering correction means includes a time constant, and the time constant is set according to the degree of engagement of the lockup clutch. When the degree of engagement of the lockup clutch varies, the transmission rate of the output torque transmitted to the drive wheels varies accordingly, so that as described above, by setting the time constant of the filtering characteristic according to the degree of engagement of the lockup clutch, it is possible to perform proper filtering correction according to the transmission rate of the output torque.

[0015] To attain the above object, in a second aspect of the present invention, there is provided a torque control method for an internal combustion engine, for controlling an output torque which is output from the engine connected to drive wheels of a vehicle via an automatic transmission that has a torque converter having a lockup clutch, characterized by comprising an operating condition-detecting step of detecting an operating condition of the engine, a basic value-setting step of setting a basic value of a torque parameter which is a parameter for determining the torque output, according to the detected operating condition of the engine, a filtering correction step of correcting the basic value by filtering thereof, to thereby set the torque parameter, a lockup clutch engagement degree-detecting step of detecting a degree of engagement of the lockup clutch, and a filtering characteristic-setting step of setting a filtering characteristic in the filtering correction step according to the detected degree of engagement of the lockup clutch.

[0016] With the configuration of the torque control method according to the second aspect of the present invention, it is possible to obtain the same advantageous effects as provided by the first aspect of the present invention.

[0017] Preferably, the filtering correction step includes a torque correction term-calculating step of calculating a torque correction term for correction of the basic value, such that a torque in an opposite phase to a state of variation in the output torque from the engine is generated.

[0018] Preferably, the filtering characteristic-setting step includes setting a gain of the filtering characteristic according to the detected degree of engagement of the lockup clutch.

[0019] Preferably, the filtering characteristic-setting step include setting a time constant of the filtering characteristic according to the detected degree of engagement of the lockup clutch.

[0020] With the configurations of these preferred embodiments, it is possible to obtain the same advantageous effects as provided by the respective corresponding preferred embodiments of the first aspect of the present invention.

[0021] The above and other objects, features, and advantages of the present invention will become more apparent from the following detailed description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022]

FIG. 1 is a schematic diagram of a torque control device according to an embodiment of the present invention, and an internal combustion engine to which is applied the torque control device;

FIG. 2 is a flowchart of a process for calculating a fuel injection amount;

FIG. 3 is a flowchart of a process for calculating an average torque, which is executed as a subroutine in a step in FIG. 2;

FIG. 4 is a flowchart of a process for calculating a torque correction term, which is executed as a subroutine in a step in FIG. 2;

FIG. 5 is a diagram showing an example of an average gain map; and

FIG. 6 is a diagram showing an example of a torque correction gain map.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0023] The invention will now be described in detail with reference to drawings showing a preferred embodiment thereof. FIG. 1 schematically shows a torque control device 1 for an internal combustion engine, according to the present embodiment, and the internal combustion engine (hereinafter simply referred to as the "engine") 3 to which is applied the torque control device 1. The engine 3 is a diesel engine that has e.g. four cylinders, and is installed on a vehicle V.

[0024] Injectors 4 (only one of which is shown) are mounted on the respective cylinders (not shown) of the engine 3. Each injector 4 injects fuel supplied from a fuel supply system (not shown) into an associated one of the cylinders. A fuel injection amount QINJ of the injector 4 is controlled by a drive signal from an ECU 2, referred to hereinafter.

[0025] A crank angle sensor 21 comprised e.g. of a magnet rotor and an MRE pickup is mounted on a crankshaft 10 of the engine 3. The crank angle sensor 21 delivers a CRK signal and a TDC signal, which are both pulse signals, to the ECU 2 in accordance with rotation of the crankshaft 10. The CRK signal is delivered whenever the crankshaft 10 rotates through a predetermined crank angle (e.g. 10°). The ECU 2 calculates a rotational speed NE of the engine 3 (hereinafter referred to as "the engine speed NE") based on the CRK signal. The TDC signal indicates that each piston (not shown) in an associated one of the cylinders of the engine 3 is in a predetermined crank angle position slightly before the TDC position at the start of the intake stroke, and is delivered whenever the crankshaft 10 rotates through 180° when the engine 3 has four cylinders, as in the present embodiment.

[0026] On the other hand, the vehicle V is of a front-engine and front-drive type, and the engine 3 is connected to left and right front wheels W (only one of which is shown), which are drive wheels, via an automatic transmission 9, a final speed reduction gear (not shown), a drive shaft 12, and so forth.

[0027] The automatic transmission 9 is formed by combining a torque converter 6 having a lockup clutch 7 and a stepped transmission 8. The lockup clutch 7 is engaged and disengaged by supply of oil pressure from an oil pressure circuit 5. The oil pressure circuit 5 is provided with an LC (Lockup Clutch) solenoid valve 5a, which is electrically connected to the ECU 2. The ECU 2 controls an operating state of the LC solenoid valve 5a to thereby control the engagement and disengagement of the lockup clutch 7. In this case, in a state where the lockup clutch 7 is completely connected (engaged), the crankshaft 10 of the engine 3 is mechanically directly connected to a driven shaft 11 of the torque converter 6.

[0028] A rotational speed sensor 23 is mounted on the driven shaft 11. Similarly to the crank angle sensor 21, the rotational speed sensor 23 is comprised of a magnet rotor and an MRE pickup, and detects the engine speed NE to deliver a pulse signal indicative of the sensed engine speed NE to the ECU 2, whenever the driven shaft 11 rotates through a predetermined angle. The ECU 2 calculates a rotational speed NS of the driven shaft 11 (hereinafter referred to as "the driven shaft rotational speed NS") based on the signal from the rotational speed sensor 23.

[0029] Further, an accelerator pedal opening sensor 22 detects an amount AP of operation (stepped-on amount) of an accelerator pedal, not shown (hereinafter referred to as "the accelerator pedal opening AP"), and delivers a signal indicative of the sensed accelerator pedal opening AP to the ECU 2.

[0030] Further, the ECU 2 is implemented by a microcomputer comprised of an I/O interface, a CPU, a RAM, and a ROM (none of which are specifically shown). The ECU 2 carries out e.g. engine control including torque control of the engine 3 in response to the signals from the above-described sensors 21 to 23.

[0031] In the present embodiment, the ECU 2 corresponds to basic value-setting means, filtering correction means, filtering characteristic-setting means and torque correction term-calculating means.

[0032] Next, a torque control process executed by the ECU 2 will be described with reference to FIGS. 2 to 4.

[0033] FIG. 2 shows a process for calculating the fuel injection amount QINJ, which is performed by the ECU 2. The present process is executed whenever a predetermined time period elapses. In the present process, the ECU 2 calculates a demanded torque TD according to an operating condition of the engine 3, and calculates the fuel injection amount QINJ based on the calculated demanded torque TD, to thereby control the output torque of the engine 3.

[0034] In the present process, first, in a step 21 (shown as S21 in abbreviated form in FIG. 2; the following steps are also shown in abbreviated form), a basic value TD_BASE of the demanded torque TD is calculated by searching a predetermined map (not shown) according to the detected engine speed NE and accelerator pedal opening AP. In this map, the basic value TD_BASE is set to a larger value as the engine speed NE is higher and the accelerator pedal opening AP is larger.

[0035] Then, in a step 22, it is determined whether or not an LC detection system abnormality flag F_LCNG is equal to 1. This LC detection system abnormality flag F_LCNG is set to 1 when it is determined that a system for detecting a lockup clutch (LC) engagement ratio R_LC, referred to hereinafter, specifically, any of the crank angle sensor 21, the rotational speed sensor 23 and wiring for connecting between the sensors 21 and 23 and the ECU 2, is faulty.

[0036] If the answer to the question of the step 22 is affirmative (YES), i.e. if it is determined that the R_LC detecting system is faulty, there is a fear that no accurate LC engagement ratio R_LC necessary for filtering correction is obtained, and hence the basic value TD_BASE calculated in the step 21 is set as the demanded torque TD (step 23), whereby the basic value TD_BASE is inhibited from being corrected according to the LC engagement ratio R_LC.

[0037] On the other hand, if the answer to the question of the step 22 is negative (NO), i.e. if it is determined that the R_LC detecting system is normal, the basic value TD_BASE is filtered to thereby calculate an average torque TD_A (step 24). The average torque TD_A is obtained by averaging the basic value TD_BASE so as to suppress the vibration of the vehicle V which might be caused by direct reflection of the calculated basic value TD_BASE of the demanded torque TD on the output torque. The process for calculating the average torque TD_A will be described hereinafter.

[0038] Then, a torque correction term CTD_B is calculated (step 25). The torque correction term CTD_B is for correcting the basic value TD_BASE such that a torque in an opposite phase to variation in the output torque of the engine 3 is generated. The process for calculating the torque correction term CTD_B will be described hereinafter.

[0039] Then, the demanded torque TD is calculated by subtracting the torque correction term CTD_B calculated in the step 25 from the average torque TD_A calculated in the above-mentioned step 24 (step 26).

[0040] Then, the fuel injection amount QINJ is calculated by searching a predetermined map (not shown) according to the demanded torque TD calculated in the step 23 or 26 and the engine speed NE (step 27), followed by terminating the present process. Torque corresponding to the fuel injection amount QINJ calculated as above is output from the engine 3.

[0041] FIG. 3 shows the process for calculating the average torque TD_A, which is executed as a subroutine in the step 24 in FIG. 2. In the present process, first, the LC engagement ratio R_LC is calculated as a parameter indicative of the degree of engagement of the lockup clutch 7 by dividing the detected driven shaft rotational speed NS by the engine speed NE (step 31).

[0042] Next, an averaging gain FG_A is calculated by searching an average gain map shown in FIG. 5 according to the calculated LC engagement ratio R_LC (step 32). In this map, the averaging gain FG_A is set to a smaller value as the LC engagement ratio R_LC is higher.

[0043] Next, an averaging time constant FT_A is calculated by searching a predetermined averaging time constant map (not shown) according to the LC engagement ratio R_LC (step 33).

[0044] Next, the average torque TD_A is calculated by the following equation (1) using the calculated averaging gain FG_A, the averaging time constant FT_A and the basic value TD_BASE (step 34), followed by terminating the present process. In the equation (1), Ga(s) represents a transfer function of the average torque TD_A with respect to the basic value TD_BASE, and "s" represents a Laplace operator. More specifically, the reverse Laplace transform of the equation (1) is performed to determine a computing equation of a continuous system, and the average torque TD_A is calculated by using a computing equation of a discrete system which is obtained by approximate transformation of the determined computing equation of the continuous system.

$$Ga(s) = \frac{1 + FT\_A \cdot FG\_A \cdot s}{1 + FT\_A \cdot FG\_A} \quad \cdots\cdots \quad (1)$$

[0045] In the computing equation of the discrete system obtained from the above equation (1), the average torque TD_A is calculated such that it becomes closer to the basic value TD_BASE of the demanded torque TD as the averaging gain FG_A is larger, whereas as the averaging gain FG_A becomes smaller, the difference between the average torque TD_A and the basic value TD_BASE of the demanded torque TD becomes larger.

[0046] Further, as described hereinabove, the averaging gain FG_A is set to a smaller value as the LC engagement ratio R_LC is higher, and hence as the degree of engagement of the lockup clutch 7 is higher, the average torque TD_A is calculated such that the difference between the average torque TD_A and the basic value TD_BASE of the demanded torque TD becomes larger, which makes higher the degree of averaging of the basic value TD_BASE.

[0047] FIG. 4 shows the process for calculating the torque correction term CTD_B, which is executed as a subroutine in the step 25 in FIG. 2. In the present process, first, a torque correction gain FG_B is calculated by searching a torque correction gain map shown in FIG. 6 according to the LC engagement ratio R_LC (step 41). In this map, the torque correction gain FG_B is set to a larger value as the LC engagement ratio R_LC is higher.

[0048] Next, a torque correction time constant FT_B is calculated by searching a predetermined torque correction time constant map (not shown) according to the LC engagement ratio R_LC (step 42).

[0049] Then, the torque correction term CTD_B is calculated by the following equation (2) using the torque correction gain FG_B and the torque correction time constant FT_B, calculated in the above-mentioned steps 41 and 42, respectively, and the engine speed NE (step 43), followed by terminating the present process. In the above equation (2), Gb (s) represents a transfer function of the torque correction term CTD_B with respect to the engine speed NE, and "s" represents a Laplace operator. More specifically, the reverse Laplace transform of the equation (2) is performed to determine a computing equation of a continuous system, and the torque correction term CTD_B is calculated by using a computing equation of a discrete system which is obtained by approximate transformation of the determined computing equation of the continuous system.

$$Gb(s) = \frac{FT\_B^2 \cdot FG\_B^2 \cdot s^2}{(1 + FT\_B \cdot FG\_B)^2} \quad \cdots\cdots (2)$$

[0050] In the computing equation of the discrete system determined by the above equation (2), the torque correction term CTD_B is calculated such that the degree of influence of the engine speed NE on the torque correction term CTD_B becomes larger as the value of the torque correction gain FG_B is larger and the torque correction time constant FT_B is larger.

[0051] Further, as described above, the torque correction gain FG_B is set to a larger value as the LC engagement ratio R_LC is higher, and hence the torque correction term CTD_B is calculated such that it becomes larger as the degree of engagement of the lockup clutch 7 is higher.

[0052] As described hereinabove, according to the present embodiment, the basic value TD_BASE of the demanded torque TD is set according to the detected accelerator pedal opening AP and engine speed NE (step 21 in FIG. 2). Further, the average torque TD_A is calculated by filtering the basic value TD_BASE using the equations (1) and (2) (step 24), and the fuel injection amount QINJ is calculated based on the average torque TD_A (steps 26 and 27). Further, the averaging gain FG_A and the averaging time constant FT_A, which represent characteristics of the above-described filtering, are set according to the LC engagement ratio R_LC indicative of the degree of engagement of the lockup clutch 7 (FIGS. 5 and 6).

[0053] As descried heretofore, since the fuel injection amount QINJ is calculated based on the average torque TD_A calculated by filtering correction of the basic value TD_BASE according to the LC engagement ratio R_LC, it is possible to control the output torque of the engine 3 according to the degree of engagement of the lockup clutch 7 such that no large variation in the output torque of the engine 3 is caused, whereby it is possible to properly suppress the vibration of the vehicle V.

[0054] Further, since the torque correction term CTD_B is calculated (step 25), and the demanded torque TD is calculated by subtracting the torque correction term CTD_B from the average torque TD_A (step 26), it is possible to cancel out the variation in the output torque by the torque in the opposite phase generated by the torque correction term CTD_B, whereby it is possible to suppress the variation in the output torque and the vibration of the vehicle V caused by the variation in the output torque.

[0055] Further, the averaging time constant FT_A used when the average torque TD_A is calculated, and the torque correction time constant FT_B used when the torque correction term CTD_B is calculated are set according to the LC engagement ratio R_LC, so that it is possible to perform proper filtering correction according to the transmission rate of the output torque varying with the degree of engagement of the lockup clutch 7.

[0056] Further, as the LC engagement ratio R_LC is higher, the averaging gain FG_A is set to a smaller value to make higher the degree of averaging of the average torque TD_A, and therefore it is possible to properly suppress the variation in the output torque of the engine 3 according to the degree of engagement of the lockup clutch 7. Similarly, as the LC engagement ratio R_LC is higher, the torque correction gain FG_B is set to a larger value, whereby the torque correction term CTD_B is set to a larger value. This makes it possible to properly cancel out the variation in the output torque by the torque in the opposite phase, in a manner dependent on the degree of engagement of the lockup clutch 7.

[0057] The present invention is by no means limited to the above-described embodiment, but it can be practiced in various forms. For example, although in the above-described embodiment, the basic value TD_BASE of the demanded torque TD is used as a torque parameter for determining the output torque, and is subjected to filtering correction, any other suitable torque parameter, such as the fuel injection amount QINJ, may be employed. Further, the methods of setting the gains FG_A and FG_B and the time constants FT_A and FT_B, which represent characteristics of the filtering, are by no means limited to those in the above-described embodiment but any other suitable methods may be employed. Further, it is possible to use different maps for setting the characteristics of the filtering, depending on whether the engine 3 is in an accelerated state or in a decelerated state.

[0058] Furthermore, although in the above-described embodiment, the LC engagement ratio R_LC calculated based on the engine speed NE and the driven shaft rotational speed NS is used as the parameter indicative of the degree of engagement of the lockup clutch 7, any other suitable parameter may be used.

[0059] Further, although in the above-described embodiment, the present invention is applied to a diesel engine, by way of example, this is not limitative, but it can be applied to various engines other than the diesel engine.

[0060] It is further understood by those skilled in the art that the foregoing are preferred embodiments of the invention, and that various changes and modifications may be made without departing from the spirit and scope thereof.

[0061] A torque control device for an internal combustion engine, capable of properly suppressing the vibration of a vehicle by controlling torque output from the engine such that no large variation in the output torque is caused, when the vehicle has a torque converter having a lockup clutch. The torque control device calculates a basic value of a demanded torque for determining the output torque, according to detected operating conditions of the engine, and calculates a filtering characteristic for determining an average torque, and a filtering characteristic for determining a torque correction term, according to a detected degree of engagement of the lockup clutch. The torque control device calculates the demanded torque by filtering correction of the basic value using the filtering characteristics, and calculates a fuel injection amount based on the demanded torque. Torque corresponding to the fuel injection amount is output from the engine.

Claims

1. A torque control device for an internal combustion engine, for controlling an output torque which is output from the engine connected to drive wheels of a vehicle via an automatic transmission that has a torque converter having a lockup clutch,
characterized by comprising:

   operating condition-detecting means for detecting an operating condition of the engine;
   basic value-setting means for setting a basic value of a torque parameter which is a parameter for determining the torque output, according to the detected operating condition of the engine;
   filtering correction means for correcting the basic value by filtering thereof, to thereby set the torque parameter;
   lockup clutch engagement degree-detecting means for detecting a degree of engagement of the lockup clutch; and
   filtering characteristic-setting means for setting a filtering characteristic of said filtering correction means according to the detected degree of engagement of the lockup clutch.

2. The torque control device as claimed in claim 1, wherein said filtering correction means includes torque correction term-calculating means for calculating a torque correction term for correction of the basic value, such that a torque in an opposite phase to a state of variation in the output torque from the engine is generated.

3. The torque control device as claimed in claim 1, wherein said filtering characteristic-setting means sets a gain of the filtering characteristic according to the detected degree of engagement of the lockup clutch.

4. The torque control device as claimed in claim 1, wherein said filtering characteristic-setting means sets a time constant of the filtering characteristic according to the detected degree of engagement of the lockup clutch.

5. A torque control method for an internal combustion engine, for controlling an output torque which is output from the engine connected to drive wheels of a vehicle via an automatic transmission that has a torque converter having a lockup clutch,
characterized by comprising:

   an operating condition-detecting step of detecting an operating condition of the engine;
   a basic value-setting step of setting a basic value of a torque parameter which is a parameter for determining the torque output, according to the detected operating condition of the engine;
   a filtering correction step of correcting the basic value by filtering thereof, to thereby set the torque parameter;
   a lockup clutch engagement degree-detecting step of detecting a degree of engagement of the lockup clutch; and
   a filtering characteristic-setting step of setting a filtering characteristic in said filtering correction step according to the detected degree of engagement of the lockup clutch.

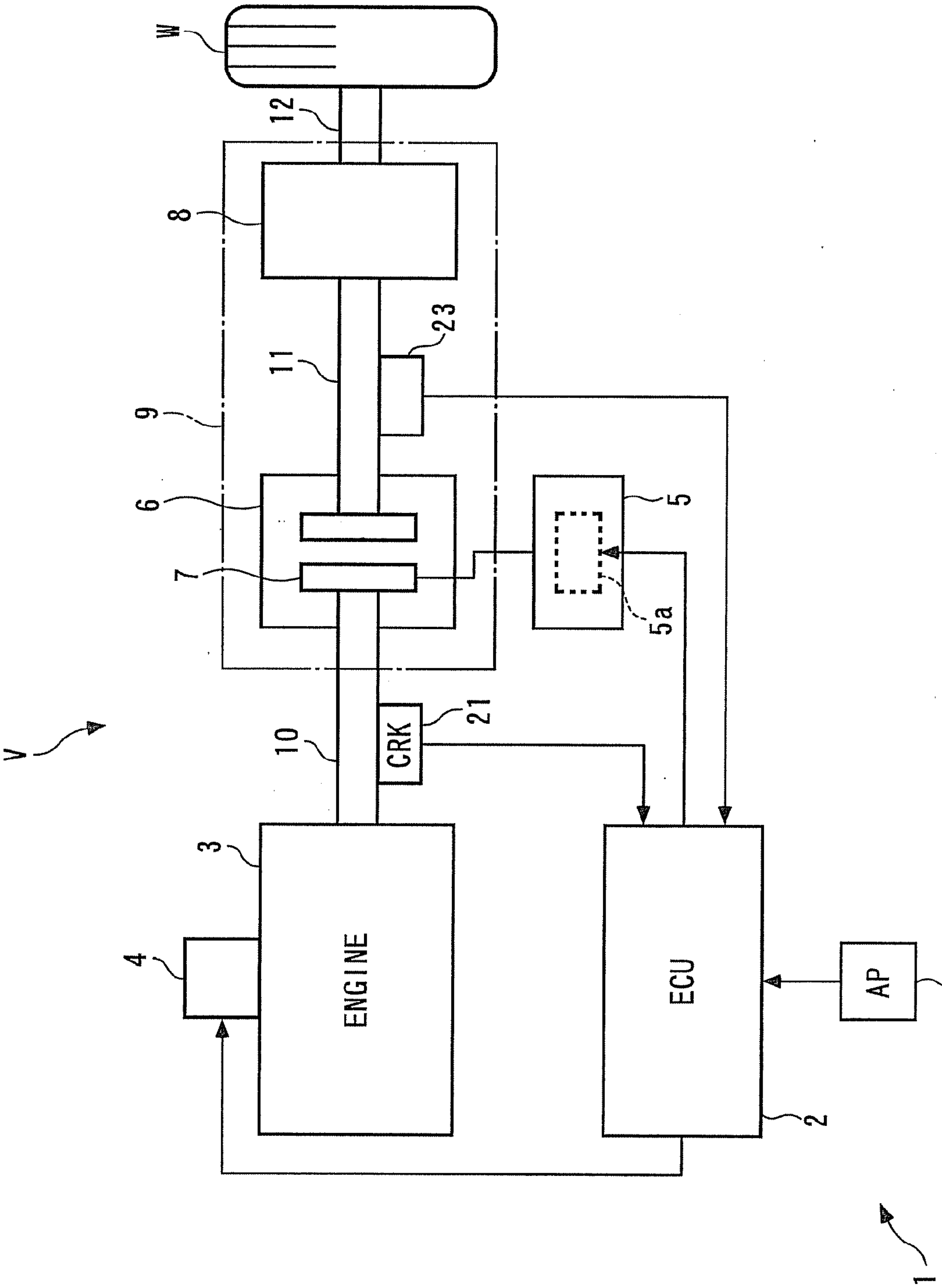
6. The torque control method as claimed in claim 5, wherein said filtering correction step includes a torque correction term-calculating step of calculating a torque correction term for correction of the basic value, such that a torque in an opposite phase to a state of variation in the output torque from the engine is generated.

7. The torque control method as claimed in claim 5, wherein said filtering characteristic-setting step includes setting

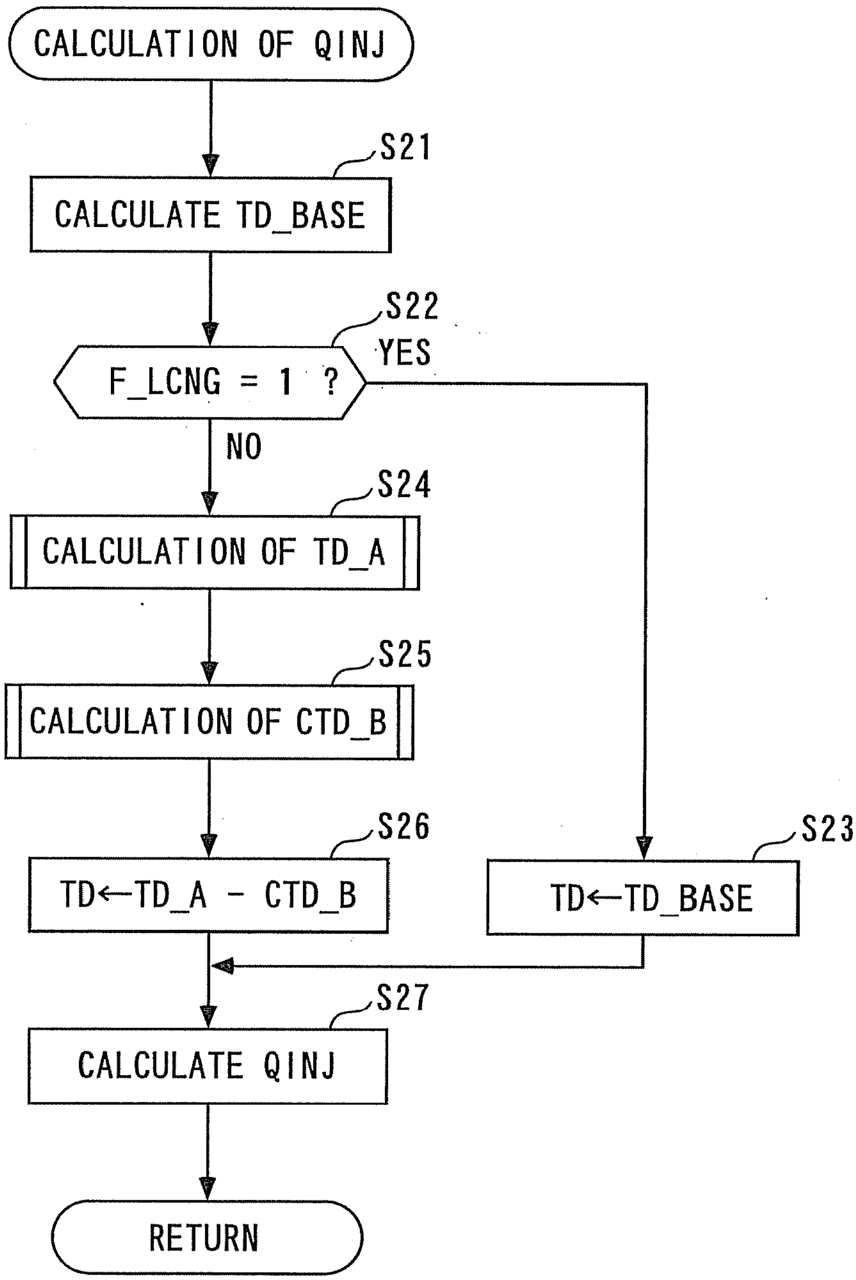
a gain of the filtering characteristic according to the detected degree of engagement of the lockup clutch.

8. The torque control method as claimed in claim 5, wherein said filtering characteristic-setting step include setting a time constant of the filtering characteristic according to the detected degree of engagement of the lockup clutch.

F I G. 1



F I G. 2


CALCULATION OF QINJ
S21
CALCULATE TD_BASE
S22
YES
F_LCNG = 1 ?
NO
S24
CALCULATION OF TD_A
S25
CALCULATION OF CTD_B
S26
TD←TD_A − CTD_B
S23
TD←TD_BASE
S27
CALCULATE QINJ
RETURN

F I G. 3

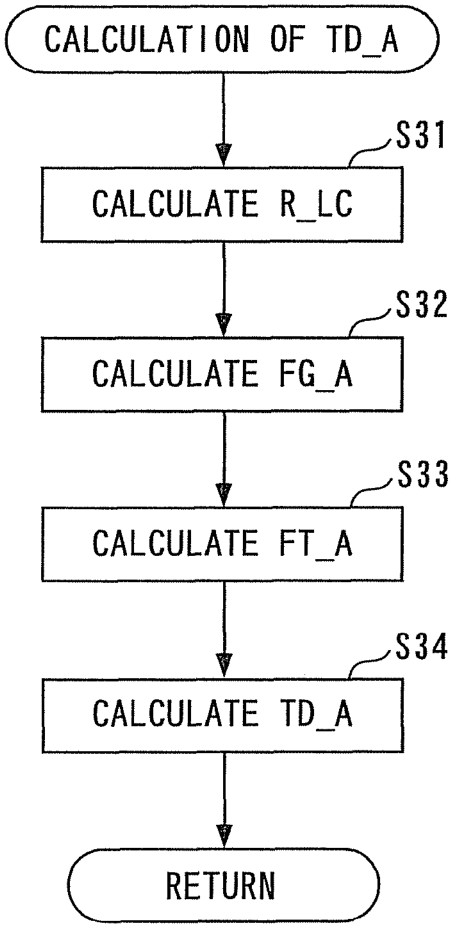
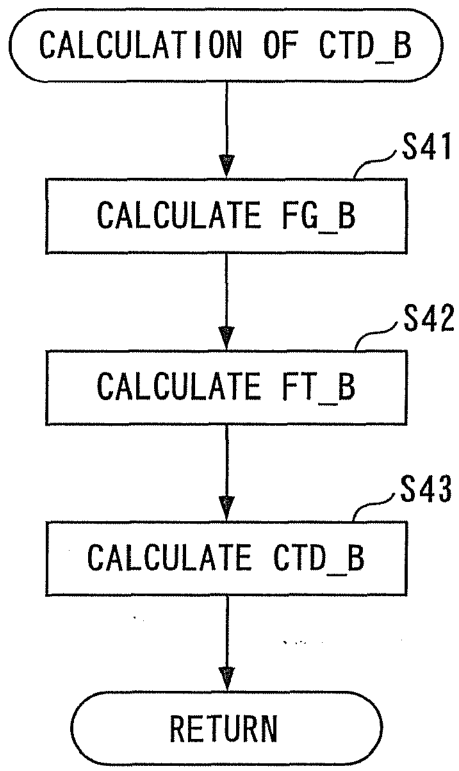
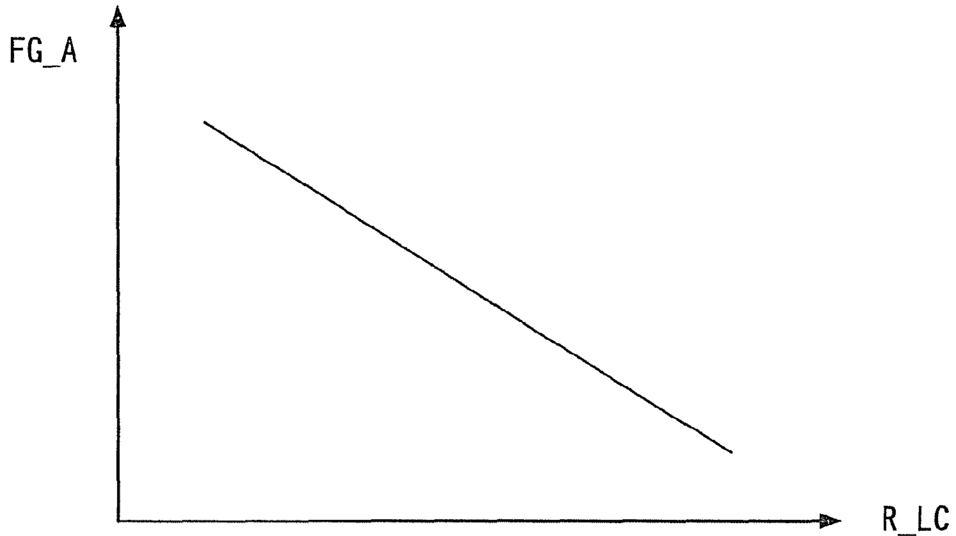

CALCULATION OF TD_A
S31
CALCULATE R_LC
S32
CALCULATE FG_A
S33
CALCULATE FT_A
S34
CALCULATE TD_A
RETURN

FIG. 4


CALCULATION OF CTD_B
S41
CALCULATE FG_B
S42
CALCULATE FT_B
S43
CALCULATE CTD_B
RETURN

F I G. 5



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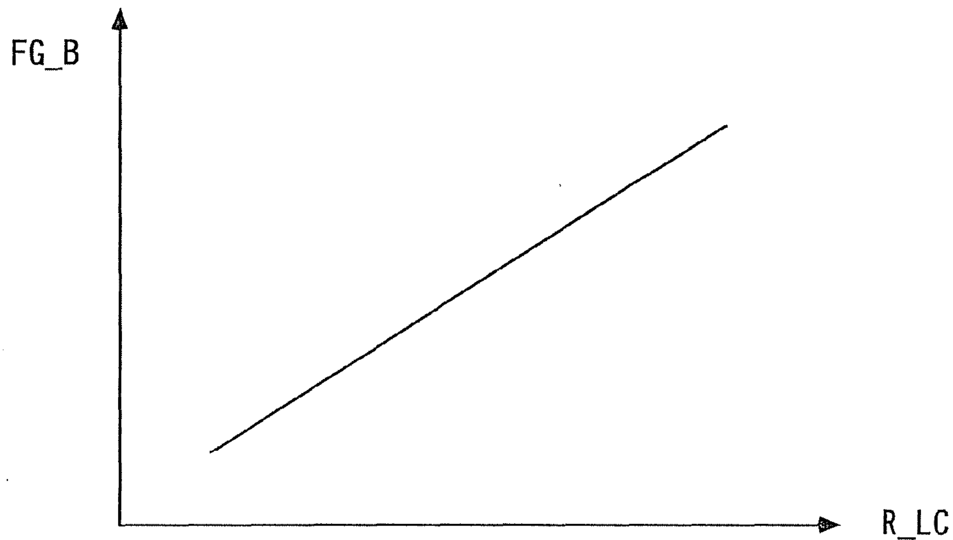

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EUROPEAN SEARCH REPORT

Application Number
EP 09 17 3598

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	DE 195 49 081 A1 (BOSCH GMBH ROBERT [DE]) 3 July 1997 (1997-07-03) * column 5, line 25 - column 6, line 6 * -----	1,5 2-4,6-8	INV. F02D41/02
Y	EP 0 881 376 A2 (DAIMLER BENZ AG [DE] DAIMLER CHRYSLER AG [DE]) 2 December 1998 (1998-12-02) * column 2, line 44 - column 4, line 16 * -----	2-4,6-8	
X	US 2005/054482 A1 (DOERING JEFFREY A [US] ET AL) 10 March 2005 (2005-03-10) * paragraph [0006] * * paragraph [0019] * * paragraphs [0031] - [0034] * -----	1,5	
			TECHNICAL FIELDS SEARCHED (IPC)
			F02D

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	28 January 2010	Röttger, Klaus

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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E : earlier patent document, but published on, or after the filing date
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L : document cited for other reasons

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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 09 17 3598

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The members are as contained in the European Patent Office EDP file on
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28-01-2010

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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