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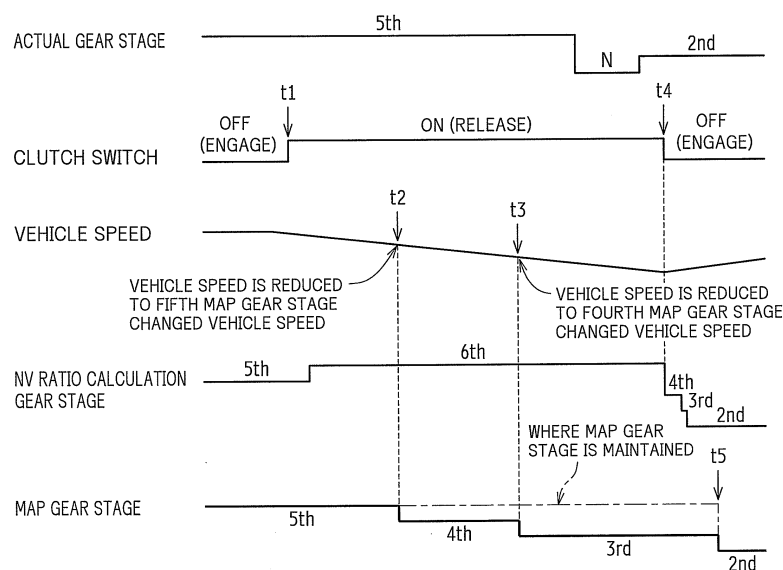
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(54) **CONTROL DEVICE FOR VEHICLE EQUIPPED WITH MANUAL TRANSMISSION**

(57) A plurality of engine characteristics corresponding to a gear stage is stored to change an engine required output in accordance with an accelerator opening degree corresponding to a gear stage established in a manual transmission. A map gear stage changed vehicle speed to switch the engine characteristic to an engine characteristic on a low gear side is allocated to each engine

characteristic. In a clutch release state where the shift manipulation of the manual transmission is in progress, when the vehicle speed is reduced and the vehicle speed is reduced to the map gear stage changed vehicle speed allocated to the engine characteristic currently selected, the engine characteristic is switched to the engine characteristic on the low gear side.

FIG.8



Description

Technical Field

[0001] The present invention relates to a control apparatus for a vehicle including a manual transmission. In particular, the present invention relates to an improvement in control of changing output characteristics of a traveling drive source (for example, internal combustion engine) changed in accordance with a shift stage established in the manual transmission.

Background Art

[0002] Conventionally, for example, as is disclosed in patent document 1 below, a shift stage is selected (shifted) through a shift manipulation of a driver (driver) in a vehicle in which a manual transmission is installed. Specifically, a clutch release manipulation (depressing manipulation of clutch pedal), a switching manipulation of the shift stage (manual manipulation of shift lever; select manipulation and shift manipulation), and a clutch engagement manipulation (depressing release manipulation of clutch pedal) are carried out in this order. Thus, the selected shift stage is established, and the rotational speed of an engine is changed and transmitted to drive wheels.

[0003] Also, there has been proposed that the output characteristics of the engine are changed in accordance with the shift stage established in a vehicle including the manual transmission (see patent document 2 below).

[0004] In patent document 2, an output characteristic map used for changing the output characteristic in accordance with the established (selected) shift stage is provided in view of the following problems. Specifically, in a condition in which the shift stage on a low gear side is established where a shift ratio is relatively large, output torque from the engine is large due to the large shift ratio and is transmitted to the drive wheels. Thus, an excessive traveling drive force might be generated. In a condition in which the shift stage is on a high gear side is established where the shift ratio is relatively small, an increase in the output torque from the engine cannot be expected due to the small shift ratio. Thus, it is difficult to sufficiently obtain a sense of acceleration that a driver demands. The output characteristic of the engine is changed by reading out the output characteristics suitable for the established shift stage from the output characteristic map.

[0005] Specifically, even when an accelerator opening degree is the same, the output characteristic (throttle opening degree set in accordance with the accelerator opening degree) in the case where the shift stage on the high gear side is established is set higher than the output characteristic in the case where the shift stage on the low gear side is established. That is, the problems above are solved by the following mechanism. Specifically, when the shift stage on the low gear side where the excessive traveling drive force might be generated is es-

tablished, the throttle opening degree is relatively set small so as to reduce the output torque of the engine, whereas when the shift stage on the high gear side where the increase in the output torque from the engine cannot be expected is established, the throttle opening degree is relatively set large so as to increase the output torque.

Related Art Documents

10 Patent Documents

[0006]

15 Patent Document 1: Japanese Unexamined Patent Application Publication No 2008-138818.

Patent Document 2: Japanese Unexamined Patent Application Publication No 2005-90452.

20 Summary of the Invention

Problems to be Solved by the Invention

[0007] In the structure described above in which the output characteristic map used for changing the output characteristic of the engine in accordance with the shift stage is provided, and the output characteristic of the engine is switched in accordance with the established shift stage, when the established shift stage (may also be referred to as "gear stage" below) is obtained based on a ratio of engine revolution to vehicle speed (hereinafter referred to as "NV ratio"), there is a problem described below. It is to be noted that the gear stage corresponding to the output characteristic of the engine that is read out from the output characteristic map is referred to as "map gear stage (that is, a gear stage selected in the output characteristic map)". Furthermore, a gear stage obtained based on the NV ratio calculated from the engine revolution and the vehicle speed is referred to as "NV ratio calculation gear stage". That is, when the engine revolution and the vehicle speed are detected with high accuracy, a gear stage actually established in the transmission (hereinafter, referred to as "actual gear stage") matches the NV ratio calculation gear stage, and an appropriate map gear stage is selected, and thereby the output characteristic of the engine suitable for the actual gear stage is obtained.

[0008] As described above, as a general shift manipulation, a clutch release manipulation, a gear stage switching manipulation, and a clutch engagement manipulation are carried out in this order. In a period starting when the clutch is released and ending when the clutch is engaged, the NV ratio calculation gear stage fluctuates due to the reduction of engine revolution and the like. For example, when the engine revolution is notably reduced when the change of the vehicle speed is slight, a gear stage on a high gear side (side where a shift ratio is small) is obtained as the NV ratio calculation gear stage. In this

case, even if the map gear stage is sequentially shifted in accordance with the NV ratio calculation gear stage, there is no guarantee that the map gear stage matching the actual gear stage selected in the gear stage switching manipulation (manipulation of shift lever) is obtained. Specifically, when a driver carries out a downshift manipulation, a gear stage on the lower gear side than the gear stage prior to the shift manipulation is selected as the actual gear stage. However, a gear stage on the high gear side is calculated, as the NV ratio calculation gear stage as described above, and a gear stage on the high gear side is selected as the map gear stage. This leads to large deviation between the actual gear stage and the map gear stage.

[0009] A possible method of solving this problem is maintaining the current map gear stage (map gear stage prior to the execution of the clutch release manipulation) until the clutch engagement manipulation is carried out.

[0010] However, even when the map gear stage is maintained in this way, there is a possibility that the actual gear stage at a time point when the clutch engagement manipulation is carried out is deviated from the map gear stage maintained, and there occurs a movement of a vehicle after the completion of the shift manipulation. For example, when the actual gear stage prior to the shift manipulation is the fifth speed stage (5th), and the actual gear stage after the shift manipulation is the second speed stage (2nd), the map gear stage is maintained as the fifth speed stage (5th) until the clutch engagement manipulation is carried out, and after the clutch engagement (after the completion of the shift manipulation), the map gear stage is shifted from the fifth speed stage (5th) to the second speed stage (2nd).

[0011] The output characteristic map is used to obtain the required torque for the engine in accordance with the accelerator opening degree and carry out the engine control (control of the throttle opening degree in patent document 2) in such a manner as to obtain the required torque. As described above, when the map gear stage is notably changed after the clutch engagement, the engine output characteristic selected corresponding to the map gear stage is notably reduced along with change of the map gear stage, which leads to a large torque level difference, and there is the possibility that there occurs the movement of a vehicle that gives a sense of discomfort to an occupant.

[0012] In the case of the example described above, the map gear stage is shifted from the fifth speed stage (5th) to the second speed stage (2nd) after the clutch engagement, and the map gear stage is the fifth speed stage (5th) immediately after the clutch engagement, and the output characteristic corresponding to the gear stage is obtained, so that the output torque of the engine is sufficiently obtained. However, subsequently, the map gear stage is shifted to the second speed stage (2nd), and the output characteristic corresponding to the gear stage is obtained, so that the output torque of the engine is reduced, and there is the possibility that there occurs

a large torque level difference.

[0013] The present invention has been achieved in view of the above circumstances, and it is an object of the present invention to provide a control apparatus for a vehicle configured to change the output characteristic of a traveling drive source in accordance with a gear stage established in a manual transmission and can achieve appropriate adjustment of a map gear stage to be selected.

Means of Solving the Problems

-Principle of Solution to the Problems-

[0014] The principle of solution of the present invention to achieve the above object is as follows. When a drive force of an engine (traveling drive source) is not transmitted to drive wheels by release of a clutch and the like, a map gear stage (shift stage corresponding characteristics to set output characteristics of the traveling drive source) is changed in accordance with vehicle speed, and when the drive force of the engine is transmitted to the drive wheels due to engagement of the clutch and the like, a map gear stage with which deviation from an actual gear stage is small (gear stage actually established in the transmission) is selected.

-Solution Means-

[0015] Specifically, the present invention presupposes control apparatus for a vehicle including a manual transmission, the manual transmission being configured to transmit a drive force from a traveling drive source to drive wheels and allowing any one of a plurality of shift stages to be selected through a manual shift manipulation of a driver, the control apparatus being configured to determine a shift stage selected and change output characteristics of the traveling drive source in accordance with a result of the determination. When the vehicle travels in a state where transmission of the drive force from the traveling drive source to the drive wheels is blocked, the output characteristic of the traveling drive source may be set to an output characteristic on a lower shift stage side as a vehicle speed is lower.

[0016] According to this particular matter, during the shift in the manual transmission and the like, when the vehicle travels in the state where the transmission of the drive force from the traveling drive source to the drive wheels is blocked, the output characteristic of the traveling drive source may set to the output characteristic on the lower shift stage side as the vehicle speed is lower. That is, in the state where the transmission of the drive force from the traveling drive source to the drive wheels is not yet started, a change is made to set the output characteristic of the traveling drive source low, and subsequently, when the transmission of the drive force from the traveling drive source to the drive wheels is started by the release of the clutch and the like, the output char-

acteristic of the traveling drive source targeting a shift stage whose deviation from the actual shift stage is small or same is obtained. This avoids the condition where the output characteristic of the traveling drive source is largely changed after the transmission of the drive force from the traveling drive source to the drive wheels is started, and thus suppresses the occurrence of a large torque level difference, so that the movement of a vehicle can be prevented.

[0017] A more specific configuration includes the following. That is, a plurality of shift stage corresponding characteristics to set the output characteristic of the traveling drive source in accordance with each shift stage may be stored. When the vehicle travels in the state where the transmission of the drive force from the traveling drive source to the drive wheels is blocked, a shift stage corresponding characteristic to be selected out of the plurality of shift stage corresponding characteristics is switched to a shift stage to set a lower output characteristic of the traveling drive source as the vehicle speed is lower.

[0018] In this case, a shift stage corresponding characteristic changed vehicle speed serving as a threshold value to switch to a shift stage corresponding characteristic on a side where the output characteristic of the traveling drive source is set lower as the vehicle speed is lower may be set for each shift stage corresponding characteristic, except for a shift stage corresponding characteristic by which the output characteristic of the traveling drive source is set lowest out of the plurality of shift stage corresponding characteristics. Then, when the vehicle travels in the state where the transmission of the drive force from the traveling drive source to the drive wheels is blocked, every time an actual vehicle speed is reduced to the shift stage corresponding characteristic changed vehicle speed set for a current shift stage corresponding characteristic, the shift stage corresponding characteristic may be switched to a shift stage corresponding characteristic on the side where the output characteristic of the traveling drive source is set low.

[0019] According to these particular matters, the switching timing of the shift stage corresponding characteristic (timing of switching the shift stage corresponding characteristics in accordance with the change of the vehicle speed) can appropriately be specified for each shift stage, and the shift stage corresponding characteristic can be updated to be suitable for the vehicle speed.

[0020] The shift stage corresponding characteristic changed vehicle speed set for each shift stage corresponding characteristic may be set to a vehicle speed in a case where revolution of the traveling drive source is assumed to be at an upper limit value of a range of non-self-rotatable revolution or a vicinity of the upper limit value, and the shift stage of the manual transmission is assumed to be at a shift stage targeted by the shift stage corresponding characteristic.

[0021] At the shift stage corresponding to the shift stage corresponding characteristic currently set, when

the vehicle speed is non-self-operable vehicle speed for the traveling drive source (for example, which leads to the engine stall), a shift stage on the lower gear side (shift stage on a side where the shift ratio is high) than the non-self-operable shift stage is likely to be selected as the actual shift stage after the shift manipulation. Thus, the shift stage corresponding characteristic is changed to the shift stage corresponding characteristic on the low gear side. Consequently, the shift stage corresponding characteristic can appropriately be selected in accordance with the shift stage after the shift manipulation.

[0022] Also, the shift stage corresponding characteristic may be prohibited from switching to a shift stage corresponding characteristic on a side where the output characteristic of the traveling drive source is set high, when the transmission of the drive force from the traveling drive source to the drive wheels is started.

[0023] Generally, as the shift stage corresponding characteristic, the output characteristic in the case where the shift stage on the high gear side is established is set higher than the output characteristic in the case where the shift stage on the low gear side is established. Accordingly, the shift stage corresponding characteristic is prohibited from shifting to the shift stage corresponding characteristic on the high gear side, and thus the occurrence of a sense to the effect that a vehicle rushes due to a rapid increase in engine output after the transmission of the drive force from the traveling drive source to the drive wheels is started can be prevented, and a sense of discomfort can be prevented from being given to an occupant due to the movement of a vehicle.

[0024] When a clutch apparatus is arranged between the traveling drive source and the manual transmission, the clutch apparatus being configured to switch the transmission and blockage of the drive force between the traveling drive source and the manual transmission, the state where the transmission of the drive force from the traveling drive source to the drive wheels is blocked may be at least any one of states where the transmission of the drive force is blocked by the clutch apparatus, and a neutral state where the shift stage of the manual transmission is not established.

Effect of the Invention

[0025] In the present invention, when the vehicle travels in the state where the transmission of the drive force from the traveling drive source to the drive wheels is blocked, the output characteristic of the traveling drive source is set lower as the vehicle speed is lower. This avoids the condition where the output characteristic of the traveling drive source is largely changed after the transmission of the drive force from the traveling drive source to the drive wheels is started.

Brief Description of the Drawings

[0026]

[FIG. 1] FIG. 1 is a diagram illustrating a schematic configuration of a power train mounted in a vehicle according to an embodiment of the present invention.

[FIG. 2] FIG. 2 is a diagram illustrating a cross section of a diesel engine and a schematic configuration of a control system.

[FIG. 3] FIG. 3 is a diagram illustrating a schematic configuration of a clutch apparatus.

[FIG. 4] FIG. 4 is a diagram schematically illustrating a shift pattern of a manual transmission having six shift stages.

[FIG. 5] FIG. 5 is a block diagram illustrating a configuration of a control system such as an ECU.

[FIG. 6] FIG. 6 is a map illustrating an engine characteristic map.

[FIG. 7] FIG. 7 is a flowchart diagram illustrating a procedure of an engine characteristics switching operation.

[FIG. 8] FIG. 8 is a timing chart diagram illustrating variations of an actual gear stage, a clutch switch, vehicle speed, an NV ratio calculation gear stage, and a map gear stage in a case where a downshift manipulation is carried out from a fifth speed stage to a second speed stage.

Modes for Carrying out the Invention

[0027] Hereinafter, embodiments of the present invention will be described below by referring to the drawings. In the embodiments, description will be given with regard to a case where the present invention is applied to an FR-type (front engine rear drive) vehicle. It is to be noted that the present invention can be applied to an FF-type (front engine front drive) vehicle.

[0028] FIG. 1 shows a schematic configuration of a power train mounted in a vehicle according to the embodiment. In FIG. 1, reference numeral 1 denotes an engine (traveling drive source), MT denotes a manual transmission, 6 denotes a clutch apparatus, and 100 denotes an ECU (Electronic Control Unit).

[0029] In the power train shown in FIG. 1, a rotational driving force (torque) generated in the engine 1 is input to the manual transmission MT via the clutch apparatus 6. The manual transmission MT shifts the rotational driving force at an appropriate shift ratio (shift ratio associated with a shift stage selected through manipulation of a shift lever by a driver). The shifted rotational driving force is transmitted to left and right rear wheels (drive wheels) T, T via a propeller shaft PS and a differential gear DF. It is to be noted that the manual transmission MT mounted in the vehicle according to the embodiment is a synchro-mesh manual transmission having six forward shift stages and one backward shift stage.

[0030] Hereinafter, the configuration of the engine 1, the configuration of the clutch apparatus 6, shift patterns of a shift lever, and a control system will be described.

-Configuration of Engine 1-

[0031] FIG. 2 is a diagram illustrating a schematic configuration of the engine 1 and a control system for the engine 1. It is to be noted that FIG. 2 shows the configuration of only one cylinder of the engine 1.

[0032] The engine 1 of the embodiment is a common rail in-cylinder direct injection multi-cylinder (for example, inline four-cylinder) diesel engine, and a piston 22 is accommodated in a cylinder 21 formed in a cylinder block 2, and the reciprocating movement of the piston 22 within the cylinder 21 is transmitted to a crankshaft 3 as a rotational movement of the crankshaft 3 via a connecting rod 23.

[0033] On an upper end surface of the cylinder block 2, a cylinder head 5 that forms a combustion chamber 4 on the upper side of the piston 22 is secured. Specifically, the combustion chamber 4 is defined by a lower surface of the cylinder head 5 attached to the upper portion of the cylinder block 2 via a gasket 24, an inner wall surface of the cylinder block 21, and a top face 25 of the piston 22. In approximately the center of the top face 25 of the piston 22, a cavity (a recessed unit) 26 is disposed in the form of a depression, and the cavity 26 also constitutes part of the combustion chamber 4.

[0034] A small end 27 of the connecting rod 23 is linked to the piston 22 via a piston pin 28, while a large end of the connecting rod 23 is linked to a crankshaft 3 serving as an engine output shaft. This ensures that the reciprocating movement of the piston 22 within the cylinder 21 is transmitted to the crankshaft 3 via the connecting rod 23, which causes the crankshaft 3 to rotate so as to obtain engine output.

[0035] An intake port 51 and an exhaust port 52 that are opened to the combustion chamber 4 are formed in the cylinder head 5.

[0036] The intake port 51 and the exhaust port 52 are respectively opened and closed by an intake valve 53 and an exhaust valve 54 that are driven by cams (not shown).

[0037] The intake port 51 is coupled to an intake manifold IM that draws in outside air. In the intake process in which the intake valve 53 opens the intake port 51, when the piston 22 descends in the cylinder 21 so as to generate in-cylinder negative pressure, the outside air passing through an intake tube not shown and the intake manifold IM flows into the cylinder via the intake port 51.

[0038] Also, the exhaust port 52 is connected to an exhaust manifold EM that discharges combustion gas. In the exhaust process in which the exhaust valve 54 opens the exhaust port 52, the ascent of the piston 22 allows the combustion gas pushed out from the combustion chamber 4 (in-cylinder) to be discharged into an exhaust tube not shown via the exhaust port 52 and the exhaust manifold EM.

[0039] A fuel supply system includes a common rail 8 to accumulate high pressure fuel, a fuel supply pump (not shown) to compress and transfer the high pressure fuel

to the common rail 8, and an injector 81 for each cylinder that injects the high pressure fuel accumulated in the common rail 8 into the combustion chamber 4. The fuel supply pump and the injector 81 are controlled by the ECU 100.

[0040] The common rail 8 accumulates the high pressure fuel supplied from the fuel supply pump at predetermined target rail pressure, and the high pressure fuel accumulated is supplied to the injector 81 via a fuel pipe 82. The target rail pressure of the common rail 8 is set by the ECU 100. Specifically, the operating state of the engine 1 is detected based on an accelerator opening degree (engine load), engine revolution, and the like, and the target rail pressure corresponding to the operating state is set.

[0041] The injector 81 is disposed in approximately the center above the combustion chamber 4 in upright orientation to be aligned with a cylinder center line P, and injects fuel introduced from the common rail 8 toward the combustion chamber 4 at a predetermined timing.

-Clutch Apparatus 6-

[0042] FIG. 3 shows a schematic configuration of the clutch apparatus 6. As shown in FIG. 3, the clutch apparatus 6 includes a clutch mechanism portion 60, a clutch pedal 70, a clutch master cylinder 71, and a clutch release cylinder 61.

[0043] The clutch mechanism portion 60 is interposed between the crankshaft 3 and an input shaft (input shaft) IS of the manual transmission MT (see FIG. 1). The clutch mechanism portion 60 transmits and disconnects the drive force from the crankshaft 3 to the input shaft IS, thus changing transmission states of the drive force. In this embodiment, the clutch mechanism portion 60 is a dry-type single plate friction clutch. It is also possible to employ any other configuration for the clutch mechanism portion 60.

[0044] Specifically, a flywheel 62 and a clutch cover 63 are integrally rotatably attached to the crankshaft 3, which is the input shaft of the clutch mechanism portion 60. A clutch disc 64 is splined to the input shaft IS, which is the output shaft of the clutch mechanism portion 60. This allows the clutch disc 64 to rotate integrally with the input shaft IS while being slidably shiftable in the axial direction (left and right direction in FIG. 3). A pressure plate 65 is disposed between the clutch disc 64 and the clutch cover 63. The pressure plate 65 is in contact with an outer end portion of a diaphragm spring 66 to be biased against the side of the flywheel 62 by the diaphragm spring 66.

[0045] Also, a release bearing 67 is slidably attached to the input shaft IS in the axial direction. Adjacent to the release bearing 67, a release fork 68 is rotatably supported about a shaft 68a. One end portion (lower end portion in FIG. 3) of the release fork 68 is in contact with the release bearing 67. The other end portion (upper end portion in FIG. 3) of the release fork 68 is coupled to one

end portion (right end portion in FIG. 3) of a rod 61a of the clutch release cylinder 61. The release fork 68 is activated to cause the engagement and release operations of the clutch mechanism portion 60.

[0046] The clutch pedal 70 includes a pedal lever 72 and a pedal portion 72a serving as a depressing portion and integrally formed at the lower end portion of the pedal lever 72. A position of the pedal lever 72 adjacent to its top end is supported rotatably about a horizontal axis by a clutch pedal bracket, not shown, attached to a dash panel that delimits the passenger compartment and the engine compartment. A pedal return spring, not shown, makes the pedal lever 72 biased in a rotating direction toward the incoming side (the driver side). The driver's depressing manipulation of the pedal portion 72a against the bias of the pedal return spring causes the release operation of the clutch mechanism portion 60. The driver's release of the depressing manipulation of the pedal portion 72a causes the engagement operation of the clutch mechanism portion 60 (these engagement and release operations will be described later).

[0047] The clutch master cylinder 71 includes a cylinder body 73 and a piston 74 built inside the cylinder body 73. The piston 74 is coupled to one end portion (left end portion in FIG. 3) of a rod 75, and the other end portion (right end portion in FIG. 3) of the rod 75 is coupled to an intermediate portion of the pedal lever 72. A reserve tank 76 to supply clutch fluid (oil), which is working fluid, to the cylinder body 73 is disposed above the cylinder body 73.

[0048] When the clutch master cylinder 71 receives a manipulation force through the depressing manipulation of the clutch pedal 70 manipulated by the driver, the piston 74 moves in the cylinder body 73 to generate oil pressure. Specifically, the manipulation force caused by the driver is transmitted from the intermediate portion of the pedal lever 72 to the rod 75, thus generating oil pressure in the cylinder body 73. The oil pressure generated in the clutch master cylinder 71 is adjusted in accordance with the stroke position of the piston 74 in the cylinder body 73.

[0049] The oil pressure generated in the clutch master cylinder 71 is transmitted to the clutch release cylinder 61 through oil in an oil pressure piping 77.

[0050] Similarly to the clutch master cylinder 71, the clutch release cylinder 61 includes a cylinder body 61b and a piston 61c built inside the cylinder body 61b. The piston 61c is coupled to the other end portion (left end portion in FIG. 3) of the rod 61a. The stroke position of the piston 61c is adjusted in accordance with the oil pressure that the piston 61c receives.

[0051] In the clutch apparatus 6, the release fork 68 is activated in accordance with the oil pressure in the clutch release cylinder 61, causing the engagement and release operations of the clutch mechanism portion 60. In this respect, in accordance with the mount of depressing manipulation of the clutch pedal 70, a clutch engaging force (clutch transmission capacity) of the clutch mechanism portion 60 is adjusted.

[0052] Specifically, when the amount of depressing manipulation of the clutch pedal 70 is increased, oil is supplied from the clutch master cylinder 71 to the clutch release cylinder 61, and the oil pressure in the clutch release cylinder 61 is increased, then the piston 61c and the rod 61a are moved in the right direction of FIG. 3, the release fork 68 coupled to the rod 61a is rotated (see an arrow I in FIG. 3), and the release bearing 67 is pressed to the side of the flywheel 62. Further, the movement of the release bearing 67 in the right direction causes the inner end portion of the diaphragm spring 66 to be elastically deformed in the right direction. This reduces the bias of the diaphragm spring 66 against the pressure plate 65. This results in half-clutch state, where the pressure plate 65, the clutch disc 64, and the flywheel 62 are engaged while being slipped. When the bias is further reduced, the pressure plate 65, the clutch disc 64, and the flywheel 62 are detached from each other, turning the clutch mechanism portion 60 into a release state. This disconnects the transmission of power from the engine 1 to the manual transmission MT. In this respect, when the amount of depressing manipulation of the clutch pedal 70 exceeds a predetermined amount, the clutch mechanism portion 60 turns into a full release state, where the clutch mechanism portion 60 is fully detached (state of 0% clutch transmission capacity).

[0053] In contrast, when the amount of depressing manipulation of the clutch pedal 70 is decreased, the oil returns from the clutch release cylinder 61 to the clutch master cylinder 71. When the oil pressure in the clutch release cylinder 61 is decreased, the piston 61c and the rod 61a are moved in the left direction of FIG. 3. This rotates the release fork 68 to move the release bearing 67 to the side away from the flywheel 62 (see an arrow II in FIG. 3). This increases the bias of the outer end portion of the diaphragm spring 66 against the pressure plate 65. In this respect, a frictional force, that is, a clutch engaging force is generated between the pressure plate 65 and the clutch disc 64 and between the clutch disc 64 and the flywheel 62. When the clutch engaging force increases, the clutch mechanism portion 60 is engaged, which integrally rotates the pressure plate 65, the clutch disc 64, and the flywheel 62. This results in direct coupling between the engine 1 and the manual transmission MT. In this respect, when the amount of depressing manipulation of the clutch pedal 70 falls below a predetermined amount, the clutch mechanism portion 60 turns into a full engagement state, where the clutch mechanism portion 60 is fully engaged (state of 100% clutch transmission capacity).

[0054] A clutch switch 9A is disposed in the vicinity of the pedal lever 72. The clutch switch 9A detects that the amount of depressing of the pedal lever 72 by a driver has reached a predetermined amount. That is, when the driver starts the shift manipulation, and the amount of depressing of the pedal lever 72 reaches the predetermined amount, the clutch switch 9A outputs an ON signal, and when the driver completes the manipulation of the

shift lever L (see FIG. 4), and the amount of depressing of the pedal lever 72 is returned to a predetermined amount, the clutch switch 9A stops outputting the ON signal. That is, the start and completion of the shift manipulation can be detected based on the output and the stoppage of the output of the ON signal by the clutch switch 9A. It is to be noted that a clutch stroke sensor that can detect a position of the clutch pedal 70 and a stroke sensor that can detect a slide position of the release bearing 67 can be used instead of the clutch switch 9A. Also, two clutch switches may be provided in order to enhance the accuracy of detection of the start and completion of the shift manipulation. That is, there are provided a release side clutch switch to output the ON signal in the case where the pedal lever 72 is pressed to a position that the clutch mechanism portion 60 is fully released, and an engagement side clutch switch to output the ON signal in the case where the depressing of the pedal lever 72 is released to a position that the clutch mechanism portion 60 is fully engaged. Here, the start and completion of the shift manipulation can be detected based on the signals.

[0055] Also, an output revolution sensor 9B (see FIG. 1) is disposed in the vicinity of an output shaft (shaft connecting to the propeller shaft PS) of the manual transmission MT. The output revolution sensor 9B detects the revolution of the output shaft (output shaft revolution, output shaft rotation speed) and outputs a revolution speed signal to the ECU 100. It is to be noted that the revolution of rear wheels T can be obtained by dividing the revolution of the output shaft detected by the output revolution sensor 9B by the gear ratio (final deceleration ratio) of the differential gear DF, and thus the velocity of the vehicle can be calculated.

-Shift Pattern-

[0056] Next, description will be given with regard to a shift pattern (shift gate shape) of a shift gate that is disposed on the floor in the passenger compartment and guides the movement of the shift lever.

[0057] FIG. 4 is a schematic diagram illustrating a shift pattern of the manual transmission MT having six shift stages according to this embodiment. The shift lever L, which is shown in a dashed double-dotted line, is configured to perform a select manipulation shown in the direction of the arrow X in FIG. 4, and a shift manipulation shown in the direction of the arrow Y, which is orthogonal to the select manipulation direction.

[0058] In the select manipulation direction, a first-speed and second-speed select position P1, a third-speed and fourth-speed select position P2, a fifth-speed and sixth-speed select position P3, and a reverse select position P4 are arranged in a row.

[0059] By the shift manipulation (manipulation in the direction of the arrow Y) at the first-speed and second-speed select position P1, the shift lever L is shifted to a first speed position 1st or a second speed position 2nd.

When the shift lever L is manipulated to the first speed position 1st, a first synchro-mesh mechanism disposed in the transmission mechanism of the manual transmission MT is operated to the establishment side of the first speed, thus establishing the first speed stage. When the shift lever L is manipulated to the second speed position 2nd, the first synchro-mesh mechanism is operated to the establishment side of the second speed, thus establishing the second speed stage.

[0060] Similarly, by the shift manipulation at the third-speed and fourth-speed select position P2, the shift lever L is shifted to a third speed position 3rd or a fourth speed position 4th. When the shift lever L is manipulated to the third speed position 3rd, a second synchro-mesh mechanism disposed in the transmission mechanism of the manual transmission MT is operated to the establishment side of the third speed, thus establishing the third speed stage. When the shift lever L is manipulated to the fourth speed position 4th, the second synchro-mesh mechanism is operated to the establishment side of the fourth speed, thus establishing the fourth speed stage.

[0061] By the shift manipulation at the fifth-speed and sixth-speed select position P3, the shift lever L is shifted to a fifth speed position 5th or a sixth speed position 6th. When the shift lever L is manipulated to the fifth speed position 5th, a third synchro-mesh mechanism disposed in the transmission mechanism of the manual transmission MT is operated to the establishment side of the fifth speed, thus establishing the fifth speed stage. When the shift lever L is manipulated to the sixth speed position 6th, the third synchro-mesh mechanism is operated to the establishment side of the sixth speed, thus establishing the sixth speed stage.

[0062] Further, by the shift manipulation at the reverse select position P4, the shift lever L is shifted to a reverse position REV. When the shift lever L is manipulated to the reverse position REV, all of the above-described synchro-mesh mechanisms turn into neutral state, and a reverse idler gear disposed in the transmission mechanism of the manual transmission MT is operated, thus establishing the backward drive stage.

-Control System-

[0063] The engine ECU 100 controls various kinds of control such as the control of the operating state of the engine 1. As shown in FIG. 5, the engine ECU 100 includes a CPU (Central Processing Unit) 101, a ROM (Read Only Memory) 102, a RAM (Random Access Memory) 103, and a backup RAM 104.

[0064] The ROM 102 stores various control programs, maps that are referred to when executing those various control programs, and the like. The CPU 101 executes various kinds of arithmetic processing based on the various control programs and maps stored in the ROM 102. The RAM 103 is a memory that temporarily stores results of arithmetic operations of the CPU 101 and data input from each of the sensors, and the like. For example, the

backup RAM 104 is a nonvolatile memory that stores data and the like that need storing when the engine 1 is stopped.

[0065] The CPU 101, the ROM 102, the RAM 103, and the backup RAM 104 are coupled to each other via a bus 107, and are coupled to an input interface 105 and an output interface 106.

[0066] The input interface 105 is coupled to a crank position sensor 90, a rail pressure sensor 91, a throttle opening degree sensor 92, an airflow meter 93, an A/F sensor 94, a water temperature sensor 95, an accelerator opening degree sensor 96, an intake pressure sensor 97, an intake temperature sensor 98, the clutch switch 9A, and the output revolution sensor 9B.

[0067] The crank position sensor 90 outputs a pulse signal for every predetermined crank angle (for example, 10°). One example of a detection method of the crank angle by the crank position sensor 90 is such that external teeth are formed at predetermined angles apart on an outer circumferential surface of a rotor (NE rotor) 90a that is rotatably integrated with the crank shaft 3 (see FIG. 2), and the crank position sensor 90 formed of an electromagnetic pickup is disposed facing the external teeth. Then, the crank position sensor 90 is configured to generate an output pulse when the external tooth passes the vicinity of the crank position sensor 90 due to the rotation of the crank shaft 3.

[0068] The rail pressure sensor 91 outputs a detection signal corresponding to pressure of fuel accumulated in the common rail 8. The throttle opening degree sensor 92 detects the opening degree of the throttle valve (diesel throttle) not shown and provided in the intake tube. The airflow meter 93 outputs a detection signal corresponding to an intake air flow amount (intake air amount) on the upstream of the throttle valve in the intake tube. The A/F sensor 94 outputs a detection signal that continuously changes in accordance with the oxygen concentration in exhaust on the downstream side of a catalyst not shown and provided in the exhaust tube. The water temperature sensor 95 outputs a detection signal corresponding to the coolant temperature of the engine 1. The accelerator opening degree sensor 96 outputs a detection signal corresponding to the amount of depressing (accelerator opening degree) of an accelerator pedal 11 (see FIG. 2). The intake pressure sensor 97 is disposed in the intake tube and outputs a detection signal corresponding to the intake air pressure. The intake temperature sensor 98 is disposed in the intake tube and outputs a detection signal corresponding to the temperature of intake air. As described above, the clutch switch 9A outputs the ON signal when the amount of depressing of the clutch pedal 70 by a driver has reached a predetermined amount, and stops outputting the ON signal when the amount of depressing is returned to a predetermined amount. The output revolution sensor 9B detects and outputs the revolution of the output shaft coupled to the propeller shaft PS as described above.

[0069] In contrast, the output interface 106 is coupled

to the injector 81, a throttle valve 57, an EGR valve 58 provided in an EGR apparatus (Exhaust Gas Recirculation) not shown, and the like.

[0070] The ECU 100 executes various control of the engine 1 based on the output of the sensors described above. For example, the ECU 100 executes pilot injection (auxiliary injection) and main injection (main injection) as fuel injection control of the injector 81.

[0071] The pilot injection is an operation of pre-injecting a small amount of fuel prior to the main injection from the injector 81. Also, the pilot injection, which is also referred to as auxiliary injection, is an injection operation for preventing an ignition delay of fuel in the main injection, for achieving stable diffusion combustion. Also, the pilot injection according to this embodiment not only serves the function of suppressing an initial combustion speed in the main injection as described above, but also serves a function of performing preheating to raise the temperature inside the cylinder. That is, after execution of the pilot injection, fuel injection is temporarily stopped, and the temperature of compressed gas (temperature in the cylinder) is adequately increased to reach the fuel self-ignition temperature (for example, 1000K) before the main injection is started. This ensures satisfactory ignition of fuel injected in the main injection.

[0072] The main injection is an injection operation for generating torque of the engine 1 (torque-generating fuel supply operation). The amount of injection in the main injection is basically determined to obtain a required torque in accordance with the driving state, such as engine revolution, amount of accelerator manipulation, coolant temperature, and intake air temperature. For example, a higher torque required value of the engine 1 is obtained as the engine revolution (engine revolution calculated based on the detection value of the crank position sensor 90) increases, and as the accelerator manipulation amount (amount of depressing of accelerator pedal 11 detected by the accelerator opening degree sensor 96) increases (as the accelerator opening degree increases). Accordingly, a large fuel injection amount is set in the main injection. In the embodiment, it is to be noted that required output (required power) set in response to the amount of depressing of the accelerator pedal 11 is changed in accordance with a shift stage selected in the manual transmission MT (also referred to as "gear stage"). That is, the output characteristic of the engine 1 is changed in accordance with the gear stage. An operation to change the output characteristic of the engine 1 in accordance with the gear stage will be described later.

[0073] It is to be noted that, in addition to the pilot injection and main injection described above, after-injection and post-injection are executed as needed. The after-injection is an injection operation for increasing the exhaust gas temperature. Also, the post-injection is an injection operation for achieving an increase in temperature of the catalyst by directly introducing fuel to the exhaust system.

[0074] The pressure control of fuel injected from the

injector 81 is for controlling fuel pressure accumulated in the common rail 8, and feedback control is carried out for the amount of fuel discharged by a fuel supply pump (pump discharging amount) in such a manner that actual rail pressure detected by the rail pressure sensor 91 matches the target rail pressure.

[0075] Specifically, the common rail internal pressure is generally such that the target value of the fuel pressure supplied from the common rail 8 to the injector 81, that is, the target rail pressure, is set to increase as the engine load (engine load) increases, and as the engine revolution (engine revolution) increases. That is, when the engine load is high, a large amount of air is drawn into the combustion chamber 4, so that it is necessary to inject a large amount of fuel into the combustion chamber 4 from the injector 81. This necessitates high injection pressure from the injector 81. When the engine revolution is high, the period during which injection is executable is short, so that it is necessary to inject a large amount of fuel per unit time. This necessitates high injection pressure from the injector 81. Thus, the target rail pressure is generally set based on the engine load and the engine revolution. It is to be noted that the target rail pressure is, for example, set in accordance with a fuel pressure setting map stored in the ROM 102. That is, a valve opening period (injection rate waveform) of the injector 81 is controlled by determining the fuel pressure in accordance with the fuel pressure setting map. Thus, a fuel injection amount during the valve opening period can be determined.

[0076] Also, the injection amount control of the injector 81 is for controlling an injection time and the injection amount of injection from the injector 81. Specifically, an optimal injection amount and injection time corresponding to the operating state of the engine 1 are calculated and an electromagnetic valve of the injector 81 is driven in accordance with the results of the calculation. Also, in the embodiment, the injection amount and the injection time of the fuel injected from the injector 81 are controlled along with the operation to change the output characteristic of the engine 1 in accordance with the gear stage described above.

-Engine Characteristic Map-

[0077] As is described above, in the engine 1 according to the embodiment, the required output (required power) set in response to the amount of depressing of the accelerator pedal 11 is changed in accordance with the gear stage established in the manual transmission MT. The required output is set in accordance with an engine characteristic map shown in FIG. 6 (map in which "a plurality of shift stage corresponding characteristics to set the output characteristic of traveling drive source corresponding to each shift stage" as referred to in the present invention is stored). That is, the engine characteristic corresponding to the gear stage established in the manual transmission MT (more specifically, a map gear stage set based on an NV ratio calculation gear stage described

later) is extracted and adjusted to a throttle opening degree read out from the engine characteristic map. As shown in FIG. 6, in the engine characteristic map, the throttle opening degree (required output) is set larger as the accelerator opening degree increases. Also, when comparing the shift stages, even if the accelerator opening degree is the same, the throttle opening degree (required output) in the case where the gear stage on a high gear side (gear stage on the side where a shift ratio is small) is selected is set higher than the throttle opening degree (required output) in the case where the gear stage on a low gear side (gear stage on the side where the shift ratio is large) is selected. This configuration is provided in view of the following problems. Specifically, in a case in which the gear stage on the low gear side where the shift ratio is relatively large is established, there is a possibility that the output torque from the engine 1 is increased due to a large shift ratio and transmitted to rear wheels (drive wheels) T, T and an excessive traveling drive force is generated. In a case in which the gear stage on the high gear side where the shift ratio is relatively small is established, the output torque from the engine 1 is not expected to be increased due to a small shift ratio, and thus it is difficult to obtain a sense of acceleration that a driver demands. That is, the problems above are solved by the following mechanism. Specifically, when the gear stage is established on the low gear side where there is the possibility that the excessive drive force is generated, the throttle opening degree (required output) is set small, whereas when the gear stage is established on the high gear side where an increase of the output torque from the engine 1 cannot be expected, the throttle opening degree (required output) is set large.

[0078] Thus, the engine characteristic map is stored in the ROM 102, and a suitable engine characteristic that is extracted in accordance with the state of the vehicle (for example, gear stage to be established), and the throttle opening degree (required output) is adjusted in accordance with the current amount of depressing of the accelerator pedal 11. Thus, traveling of the vehicle can be achieved with the engine characteristic that the driver demands.

[0079] Also, in the embodiment, as a method of recognizing the gear stage established in the manual transmission MT (method of determining the shift stage selected as referred to in the present invention), a ratio (NV ratio) of the engine revolution to the vehicle speed is utilized. That is, the engine revolution is calculated based on the detection value of the crank position sensor 90, and the revolution of the rear wheels T is obtained by dividing the revolution of the output shaft detected by the output revolution sensor 9B by a gear ratio of the differential gear DF (final deceleration ratio) so as to calculate the vehicle speed, and the gear stage established in the manual transmission MT is recognized by dividing the engine revolution by the vehicle speed (revolution of the rear wheels T). Also, it may be such that the shift ratio in the manual transmission MT is obtained by dividing the

engine revolution by the revolution of the output shaft, and a gear ratio matching the shift ratio is recognized as a gear stage established in the manual transmission MT.

[0080] In the description below, among the plurality of engine characteristics described above, a gear stage targeted for the engine characteristic to be extracted is referred to as "map gear stage (meaning the gear stage targeted for output characteristic)". For example, when the map gear stage is first-speed stage (1st), a first-speed stage engine characteristic is extracted. Also, when the map gear stage is sixth-speed stage (6th), a sixth-speed stage engine characteristic is extracted. Also, a gear stage that is obtained from the NV ratio calculated based on the engine revolution and the vehicle speed (or the revolution of the output shaft) is referred to as "NV ratio calculation gear stage". Further, a gear stage that is actually established in the manual transmission MT is referred to as "actual gear stage".

20 -Engine Characteristics Switching Operation-

[0081] Next, an engine characteristics switching operation (change of the output characteristic of the traveling drive source, as referred to in the present invention) will be described. In the engine characteristics switching operation, one of various engine characteristics is extracted, and the engine 1 is controlled in accordance with the engine characteristic.

[0082] First, the outline of the engine characteristics switching operation will be described. When the clutch apparatus 6 is released along with the start of the shift operation of the manual transmission MT, the engine revolution is reduced to idling engine revolution by the release of the depressing manipulation of the accelerator pedal 11. Also, the rear wheels (drive wheels) T, T are in slowing down rotation and thus the vehicle speed gradually reduces. In this release state of the clutch apparatus 6, the vehicle speed is detected, and as the vehicle speed reduces, the engine characteristic to be extracted from the plurality of the engine characteristics, is switched to the engine characteristic on the low gear side. That is, as the vehicle speed is reduced, the output characteristic of the engine 1 is set to the output characteristic on the low gear side (lower shift stage side).

[0083] In a period during which the clutch apparatus 6 is released, generally, a reduction speed of the engine revolution is larger than a reduction speed of the vehicle speed, and the NV ratio calculation gear stage is shifted on the high gear side. However, in the engine characteristics switching operation of this embodiment, even though the NV ratio calculation gear stage is shifted on the high gear side, the vehicle speed to be reduced is detected, and the map gear stage is changed to the low gear side in accordance with the vehicle speed. Accordingly, the engine characteristic is switched to the engine characteristic on the low gear side before the clutch apparatus 6 is engaged (in a period during which the clutch apparatus 6 is released). That is, at a time point when

the clutch apparatus 6 is engaged after the completion of the shift manipulation while the vehicle speed is reduced, it is assumed that the actual gear stage of the manual transmission MT is likely to be switched on the low gear side, and thus the map gear stage is changed on the low gear side, and the engine characteristic is switched to the engine characteristic on the low gear side. More specifically, a vehicle speed (hereinafter referred to as "map gear stage changed vehicle speed" (shift stage corresponding characteristics changed vehicle speed as referred to in the present invention)) that serves as a threshold value to shift to the map gear stage on the low gear side is allocated to each map gear stage (specifically, map gear stages from the second speed stage to the sixth speed stage; gear stages other than the gear stage having the maximum shift ratio (the first speed stage)), and at a time point when the actual vehicle speed is reduced to the map gear stage changed vehicle speed allocated to the map gear stage currently set, the map gear stage is changed only by one stage to the map gear stage on the low gear side. In response to this, the engine characteristic is switched to the engine characteristic on the low gear side. This operation is repeated while the vehicle speed is reduced and until the clutch apparatus 6 is engaged.

[0084] In the engine characteristics switching operation, even if the NV ratio calculation gear stage after the completion of shift manipulation is on the higher gear side than the map gear stage, the map gear stage is prohibited from shifting on the high gear side. This is because regarding each engine characteristic described above, the output characteristic in the case where the gear stage on the high gear side is established is set higher than the output characteristic (required output) in the case where the gear stage on the low gear side is established, and thus the map gear stage is prohibited from shifting on the high gear side so as to avoid the occurrence of a sense to the effect that a vehicle rushes due to a rapid increase in engine output after the completion of the shift manipulation.

[0085] Next, a specific operation of the engine characteristics switching described above will be described referring with a flowchart in FIG. 7. The flowchart is executed every several milliseconds after a vehicle is started.

[0086] First, at step ST1, it is determined whether the clutch apparatus 6 is released. That is, it is determined whether the shift manipulation in the manual transmission MT is started. Specifically, it is determined whether the clutch switch 9A has output the ON signal with the amount of depressing of the clutch pedal 70 by the driver reaching a predetermined amount. When the clutch apparatus 6 is not released, and thus it is determined to be NO at step ST1, it is determined that the shift manipulation is not carried out, and the current gear stage is maintained, that is, the process returns without carrying out the engine characteristics switching operation, that is, while the engine characteristic currently selected is maintained.

[0087] In contrast, when the clutch apparatus 6 is released, and it is determined to be YES at step ST1, the process proceeds to step ST2 where the map gear stage changed vehicle speed allocated to the current map gear stage is read out.

[0088] One example of the map gear stage changed vehicle speed allocated to each map gear stage is specifically defined as follows.

The map gear stage is the sixth speed stage (6th) → map gear stage changed vehicle speed: 50 km/h
 The map gear stage is the fifth speed stage (5th) → map gear stage changed vehicle speed: 40 km/h
 The map gear stage is the fourth speed stage (4th) → map gear stage changed vehicle speed: 33 km/h
 The map gear stage is the third speed stage (3rd) → map gear stage changed vehicle speed: 25 km/h
 The map gear stage is the second speed stage (2nd) → map gear stage changed vehicle speed: 15 km/h

[0089] The values are not limited to this, but can be set as desired.

[0090] It is to be noted that technical concept in setting the map gear stage changed vehicle speed is as follows.

[0091] When it is assumed that the engine revolution is slightly less than the idling engine revolution (non-self-operable revolution), each map gear stage changed vehicle speed described above is set as the vehicle speed in the case where the map gear stage corresponding to the actual gear stage is established, and the clutch apparatus 6 is engaged. In other words, each map gear stage changed vehicle speed is set as an engine stall limit vehicle speed of each map gear stage (the maximum vehicle speed out of the vehicle speeds that lead to the engine stall). Specifically, the map gear stage changed vehicle speeds are set as vehicle speed in the case where each gear stage is established when it is assumed that the engine revolution is 700 rpm (an upper limit value of the non-self-operable revolution (leads to the engine stall) or in the vicinity of the upper limit value). That is, when the gear stage (actual gear stage) corresponding to the present map gear stage brings the vehicle speed leading to the engine stall, a gear stage on the lower gear side than the gear stage that might lead to the engine stall is likely to be selected as the actual gear stage after the shift manipulation (the gear stage on the low gear side does not lead to the engine stall even if the vehicle speed is the same). Thus, the map gear stage is shifted to the map gear stage on the low gear side.

[0092] After the map gear stage changed vehicle speed allocated to the current map gear stage is read out at step ST2 as described above, the process proceeds to step ST3 where it is determined whether the vehicle speed to be calculated (actual vehicle speed) is reduced to the map gear stage changed vehicle speed that is read out at step ST2 (map gear stage changed vehicle speed ≤ actual vehicle speed).

[0093] When the actual vehicle speed is not reduced

to the map gear stage changed vehicle speed, and thus it is determined to be NO at step ST3, the process proceeds to step ST5 while the engine characteristic currently selected is maintained, and it is determined whether the clutch apparatus 6 is engaged. That is, it is determined whether the shift manipulation of the manual transmission MT is completed. Specifically, it is determined whether the amount of depressing of the clutch pedal 70 by a driver is returned to a predetermined amount so that the output of the ON signal by the clutch switch 9A is halted (OFF).

[0094] When the clutch apparatus 6 is still in a release state, and thus it is determined to be NO at step ST5, it is assumed that the shift manipulation is still in progress, and the process returns to step ST2.

[0095] In contrast, when the actual vehicle speed is reduced to the map gear stage changed vehicle speed, and thus it is determined to be YES at step ST3, the process proceeds to step ST4 where the map gear stage is shifted to a map gear stage that is one stage lower than the map gear stage currently set, and the process proceeds to step ST5. Accordingly, the engine characteristic corresponding to the map gear stage is extracted, and the throttle opening degree is adjusted in a manner that the required output of the engine 1 that is acquired based on the engine characteristic is obtained. That is, the required output corresponding to the throttle opening degree is obtained in accordance with the engine characteristic extracted, and the throttle opening degree is adjusted in a manner that the required output is obtained.

[0096] For example, when the map gear stage is the fifth speed stage (5th), and the actual vehicle speed is reduced to the map gear stage changed vehicle speed (for example, 40 km/h) allocated to the fifth speed stage (5th), the map gear stage is shifted to the fourth speed stage (4th), and the engine characteristic to be selected is switched from the fifth speed stage engine characteristic to the fourth speed stage engine characteristic.

[0097] This shift of the map gear stage corresponding to the actual vehicle speed and the accompanying engine characteristics switching operation along are repeated until the clutch apparatus 6 is engaged (until it is determined to be YES at step ST5). That is, when the clutch apparatus 6 is in a release state, the map gear stage is sequentially shifted to a map gear stage that is one stage lower, every time the actual vehicle speed is reduced to each map gear stage changed vehicle speed, and accordingly the engine characteristic is switched.

[0098] When the clutch apparatus 6 is engaged, and it is determined to be YES at step ST5, the engine characteristics switching operation regarding the shift manipulation of this time is completed, and the process returns.

[0099] The engine characteristics switching operation in the above-described manner is carried out every time the shift manipulation of the manual transmission MT is executed. At a time point when the drive force of the engine 1 through the engagement of the clutch apparatus 6 is transmitted to the rear wheels (drive wheels) T, T,

the map gear stage whose deviation from the actual gear stage is small (gear stage actually established in the manual transmission MT) is selected, and the engine characteristic is switched to the engine characteristic corresponding to the map gear stage.

[0100] FIG. 8 is a timing chart diagram illustrating one example of the engine characteristics switching operation described above and is a timing chart diagram illustrating the variations of the actual gear stage, the clutch switch 9A, the vehicle speed, the NV ratio calculation gear stage, and the map gear stage in the case where the downshift manipulation is carried out from the fifth speed stage (5th) to the second speed stage (2nd).

[0101] First, at timing t1, the clutch release manipulation by the depressing of the clutch pedal 70 starts (corresponding to the case where it is determined to be YES at step ST1 in the flowchart of FIG. 7), and thus, the clutch switch 9A is turned on (a clutch release signal is output). In the clutch release state, a driver manipulates the shift lever L from the fifth speed position 5th to the second speed position 2nd (see the shift pattern in FIG. 4). During the clutch release that includes the manipulation period of the shift lever L (in a period from timing t1 to timing t4 in the diagram), along with the reduction of the engine revolution and the like, the NV ratio calculation gear stage on the high gear side where the shift ratio is small is calculated as the NV ratio calculation gear stage. In FIG. 8, the NV ratio calculation gear stage is changed from the fifth speed stage (5th) to the sixth speed stage (6th).

[0102] In the clutch release manipulation, the vehicle speed is gradually reduced, and at timing t2 in the diagram, the actual vehicle speed is reduced to the map gear stage changed vehicle speed allocated to the fifth speed stage (5th) (for example, 40 km/h), and the map gear stage is shifted from the fifth speed stage (5th), which is the current map gear stage, to the fourth speed stage (4th), which is one stage lower than the current map gear stage. Thus, the engine characteristic is switched from the fifth speed stage engine characteristic to the fourth speed stage engine characteristic (corresponding to the case where it is determined to be YES at step ST3 in the flowchart of FIG. 7).

[0103] Then, in the clutch release manipulation, the vehicle speed is further reduced, and at timing t3 in the diagram, the actual vehicle speed is reduced to the map gear stage changed vehicle speed allocated to the fourth speed stage (4th) (for example, 33 km/h), and the map gear stage is shifted from the fourth speed stage (4th), which is the current map gear stage, to the third speed stage (3rd), which is one stage lower than the current map gear stage. Thus, the engine characteristic is switched from the fourth speed stage engine characteristic to the third speed stage engine characteristic (corresponding to the case where it is determined to be YES at step ST3 after it is determined to be NO at step ST5 in the flowchart of FIG. 7).

[0104] Then, the manipulation of the shift lever L is completed, and at timing t4, the clutch engagement ma-

nipulation by the release of the depressing of the clutch pedal 70 starts (corresponding to the case where it is determined to be YES at step ST5 in the flowchart of FIG. 7), and thus, the clutch switch 9A is turned off (clutch release signal is stopped). The engine revolution increases by the clutch engagement, and the NV ratio calculation gear stage is shifted in order of the fourth speed stage (4th), the third speed stage (3rd), and the second speed stage (2nd). Also, the vehicle speed increases along with the depressing manipulation of the accelerator pedal 11. In this case, the map gear stage has already shifted to the third speed stage (3rd), and at timing t5, the map gear stage is shifted from the third speed stage (3rd) to the second speed stage (2nd), and the engine characteristic is switched from the third speed stage engine characteristic to the second speed stage engine characteristic.

[0105] Immediately after the clutch engagement, the NV ratio calculation gear stage is the fourth speed stage (4th), and the map gear stage is the third speed stage (3rd). As described above, the map gear stage is prohibited from shifting on the high gear side, and thus the map gear stage is prevented from shifting to the fourth speed stage (4th). This avoids the occurrence of a sense to the effect that a vehicle rushes due to a rapid increase in engine output after the completion of the shift manipulation.

[0106] The engine characteristics switching operation is carried out in the manner described above.

[0107] As has been described hereinbefore, in this embodiment, during the release of the clutch apparatus 6, the map gear stage is shifted along with the reduction of the vehicle speed, and the engine characteristic is switched in accordance with the shift. This prevents the occurrence of a large torque level difference due to an increase of change of the map gear stage after the completion of the shift manipulation, whereby suppressing a sense of discomfort given to an occupant due to the occurrence of the torque level difference. It is to be noted that the change of the map gear stage shown in a dashed-dotted line in FIG. 8 is a case where the current map gear stage (map gear stage before the execution of the clutch release manipulation) is maintained until the clutch engagement manipulation is carried out (until the shift manipulation is completed). In this case, there has been the possibility that a large torque level difference occurs because the map gear stage is shifted from the fifth speed stage (5th) to the second speed stage (2nd) at timing t5. In this embodiment, as shown in a solid line in FIG. 8, the map gear stage is shifted on the low gear side during the release of the clutch, so that a torque level difference after the engagement of the clutch can be reduced, and a sense of discomfort given to an occupant along with the occurrence of the torque level difference can be suppressed.

-Other Embodiment-

[0108] The embodiment above describes a case

where the present invention is applied to the diesel engine, as the traveling drive source, mounted in an automobile. The present invention is not limited to this, and can be applied to a vehicle in which a gasoline engine is installed. Also, as long as it is the vehicle in which the manual transmission MT is installed, the present invention can be applied to a hybrid vehicle in which an engine (internal combustion engine) and an electric motor (for example, a traveling motor, a motor generator, and the like) as the traveling drive source are installed.

[0109] Also, in the embodiment, the case has been described where the present invention is applied to the vehicle in which the manual transmission MT having six forward shift stages is installed. The present invention is not limited to this, but can be applied to a vehicle in which a manual transmission having any shift stages is installed, (for example, five forward shift stages).

[0110] Also, in the present embodiment described above, as the method of recognizing the gear stage established in the manual transmission MT, the NV ratio, which is the ratio of the engine revolution to the vehicle speed, is used. This should not be construed in a limiting manner and the gear stage established in the manual transmission MT may be recognized based on a ratio of the revolution of the input shaft to the revolution of the output shaft of the manual transmission MT.

[0111] Further, in the embodiment described above, as a state where transmission of the drive force from the engine 1 to the rear wheels (drive wheels) T, T is blocked, the case where the clutch apparatus 6 is in the release state is exemplified. The present invention is not limited to this, and the map gear stage may be shifted in accordance with the reduction of the vehicle speed, and the engine characteristic may be switched accordingly as described above, in a case where the clutch apparatus 6 is in the engagement state and the manual transmission MT is in a neutral state (state where the gear stage is not established) or a case where the clutch apparatus 6 is in the release state and the manual transmission MT is in the neutral state.

Industrial Applicability

[0112] The present invention can be applied to engine characteristics switching control in a vehicle in which engine characteristics are switched in accordance with shift stage established in a manual transmission.

Description of the Reference Numeral

[0113]

1	Engine (Traveling drive source)
6	Clutch apparatus
90	Crank position sensor
9A	Clutch switch
9B	Output revolution sensor
100	ECU

MT Manual transmission
 T Rear wheel (Drive wheel)
 L Shift lever

Claims

1. A control apparatus for a vehicle comprising a manual transmission, the manual transmission being configured to transmit a drive force from a traveling drive source to drive wheels and allowing any one of a plurality of shift stages to be selected through a manual shift manipulation of a driver, the control apparatus being configured to determine a shift stage selected and change output characteristics of the traveling drive source in accordance with a result of the determination,
 wherein, when the vehicle travels in a state where transmission of the drive force from the traveling drive source to the drive wheels is blocked, the output characteristic of the traveling drive source is set to an output characteristic on a lower shift stage side as a vehicle speed is lower.
2. The control apparatus for the vehicle comprising the manual transmission according to claim 1,
 wherein a plurality of shift stage corresponding characteristics to set the output characteristic of the traveling drive source in accordance with each shift stage are stored, and
 wherein when the vehicle travels in the state where the transmission of the drive force from the traveling drive source to the drive wheels is blocked, a shift stage corresponding characteristic to be selected out of the plurality of shift stage corresponding characteristics is switched to a shift stage to set a lower output characteristic of the traveling drive source as the vehicle speed is lower.
3. The control apparatus for the vehicle comprising the manual transmission according to claim 2,
 wherein a shift stage corresponding characteristic changed vehicle speed serving as a threshold value to switch to a shift stage corresponding characteristic on a side where the output characteristic of the traveling drive source is set lower as the vehicle speed is lower is set for each shift stage corresponding characteristic, except for a shift stage corresponding characteristic by which the output characteristic of the traveling drive source is set lowest, out of the plurality of shift stage corresponding characteristics, and
 wherein when the vehicle travels in the state where the transmission of the drive force from the traveling drive source to the drive wheels is blocked, every time an actual vehicle speed is reduced to the shift stage corresponding characteristic changed vehicle speed set for a current shift stage corresponding

characteristic, the shift stage corresponding characteristic is switched to a shift stage corresponding characteristic on the side where the output characteristic of the traveling drive source is set low.

4. The control apparatus for the vehicle comprising the manual transmission according to claim 3,
 wherein the shift stage corresponding characteristic changed vehicle speed set for each shift stage corresponding characteristic is set to a vehicle speed in a case where revolution of the traveling drive source is assumed to be at an upper limit value of a range of non-self-rotatable revolution or a vicinity of the upper limit value, and the shift stage of the manual transmission is assumed to be at a shift stage targeted by the shift stage corresponding characteristic.
5. The control apparatus for the vehicle comprising the manual transmission according to claim 2, 3, or 4,
 wherein, the shift stage corresponding characteristic is prohibited from switching to a shift stage corresponding characteristic on a side where the output characteristic of the traveling drive source is set high, when the transmission of the drive force from the traveling drive source to the drive wheels is started.
6. The control apparatus for the vehicle comprising the manual transmission according to any one of claims 1 to 5,
 wherein a clutch apparatus is arranged between the traveling drive source and the manual transmission, the clutch apparatus being configured to switch the transmission and blockage of the drive force between the traveling drive source and the manual transmission, and
 wherein the state where the transmission of the drive force from the traveling drive source to the drive wheels is blocked is at least any one of states where the transmission of the drive force is blocked by the clutch apparatus, and a neutral state where the shift stage of the manual transmission is not established.

FIG.1

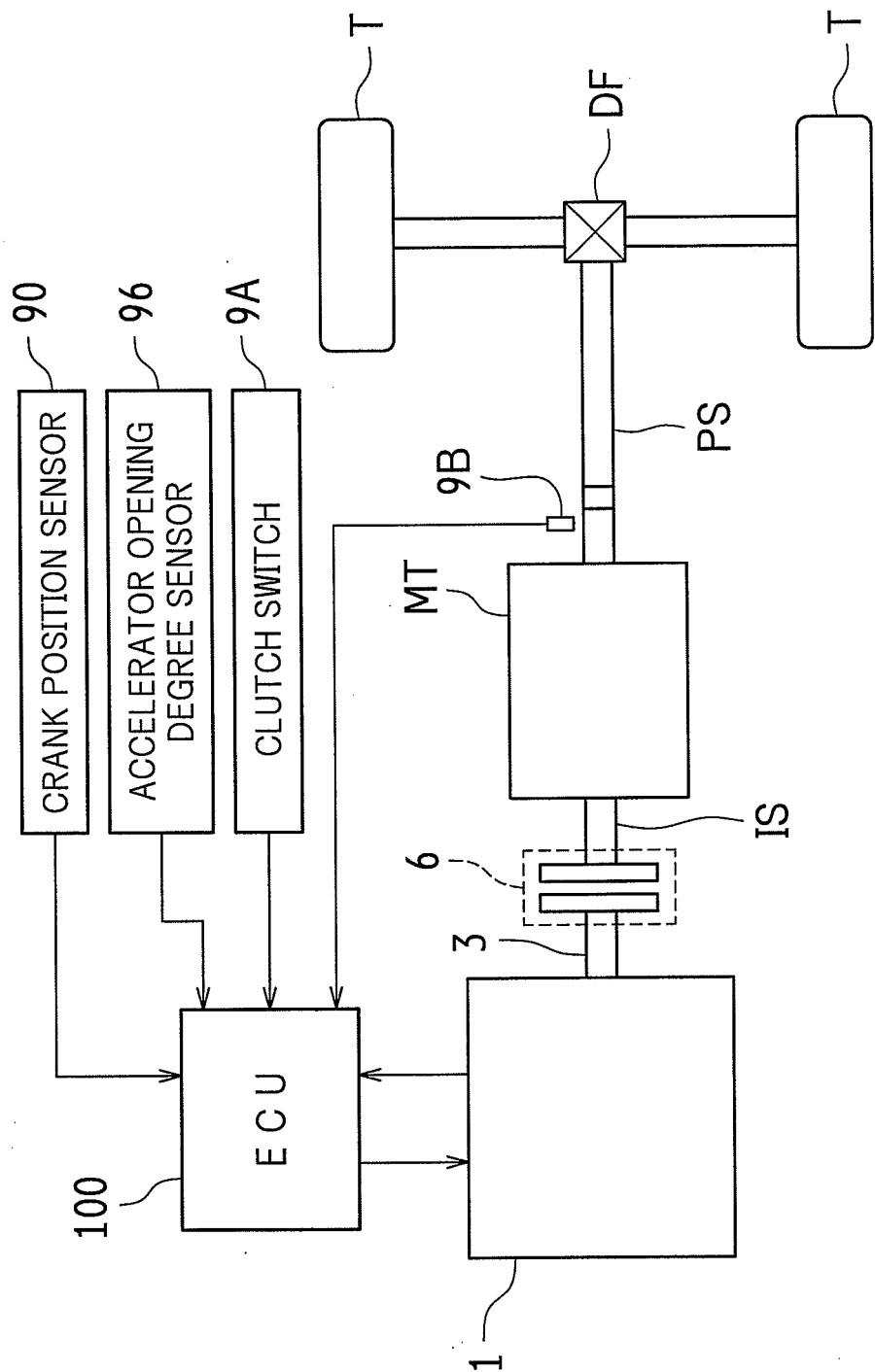


FIG.2

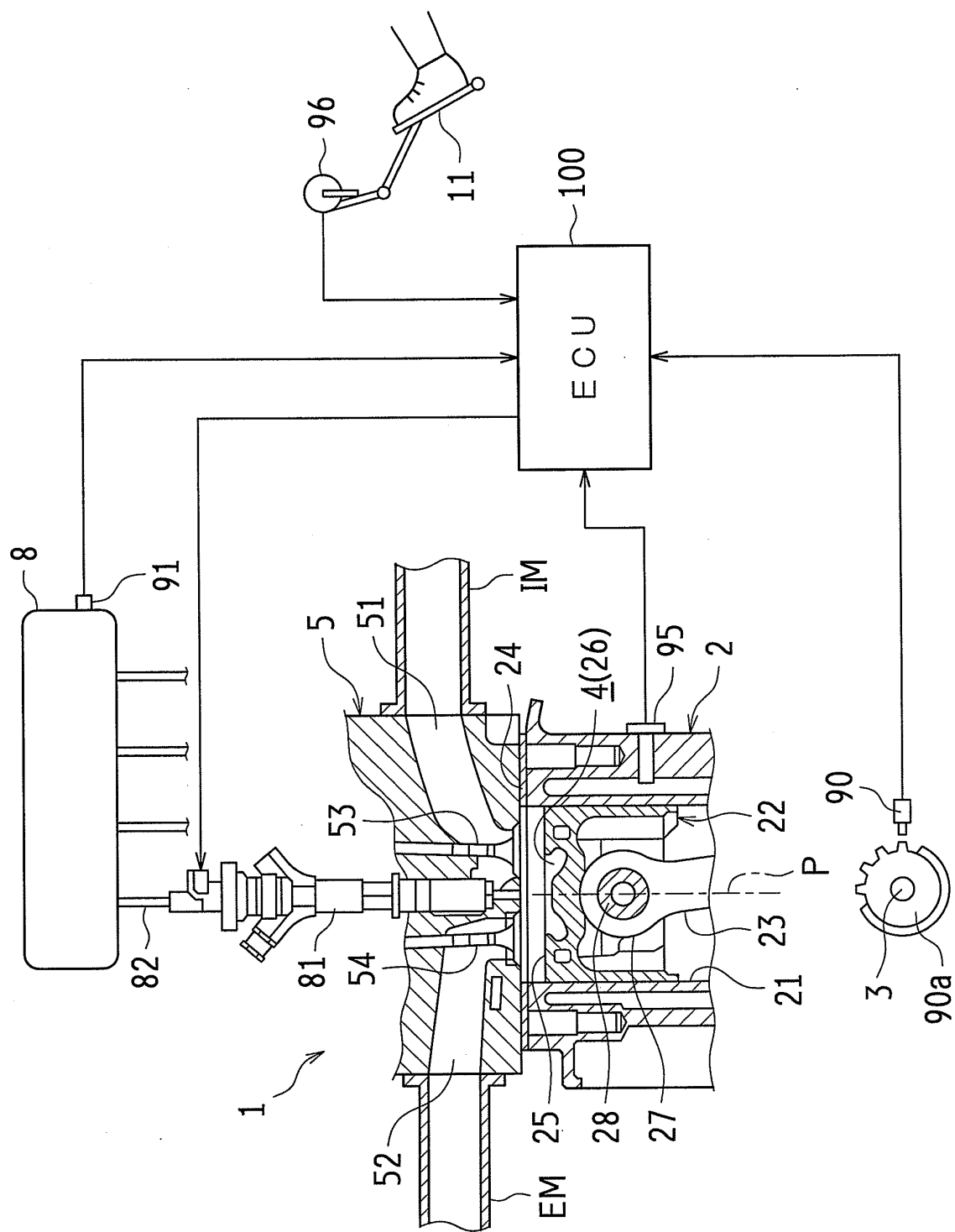


FIG.3

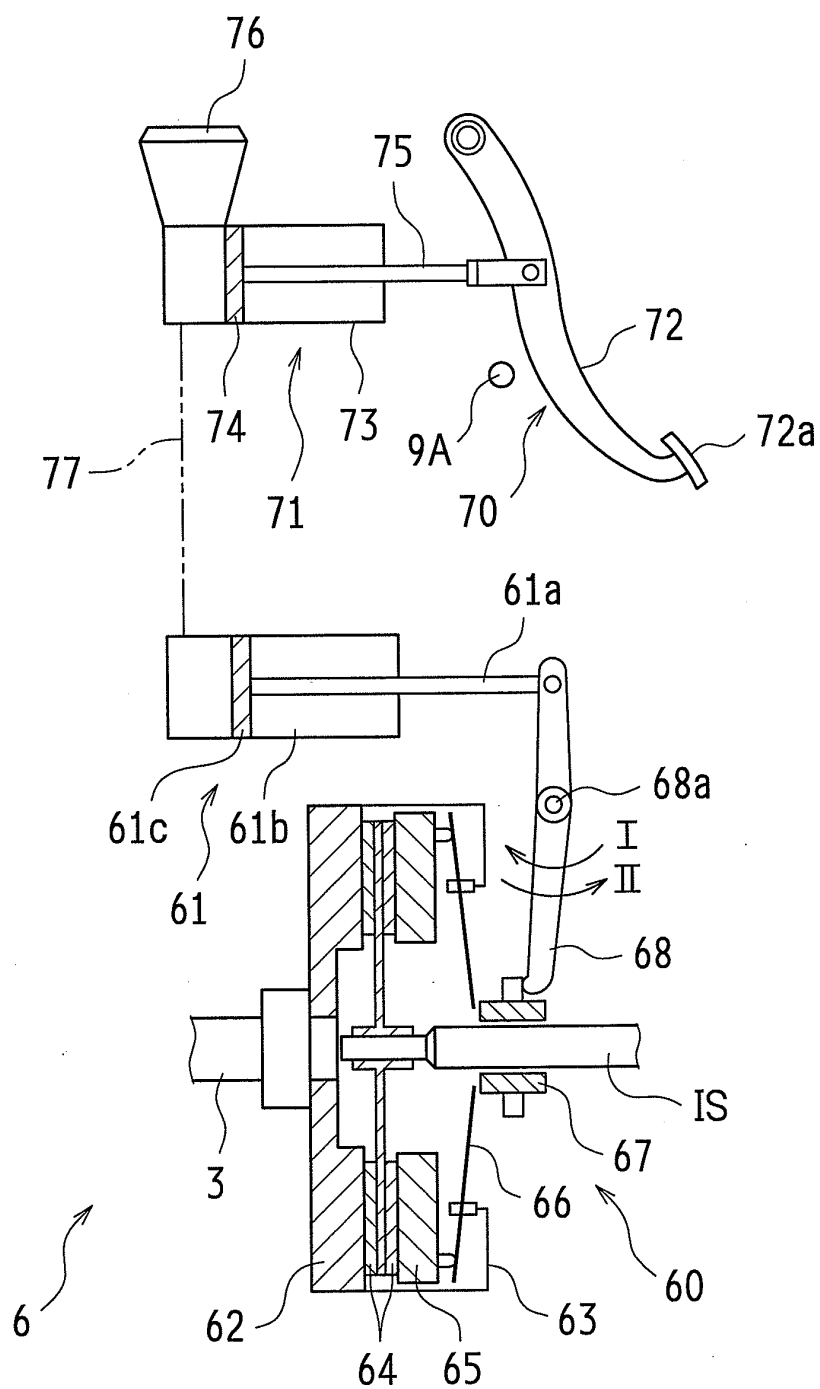


FIG.4

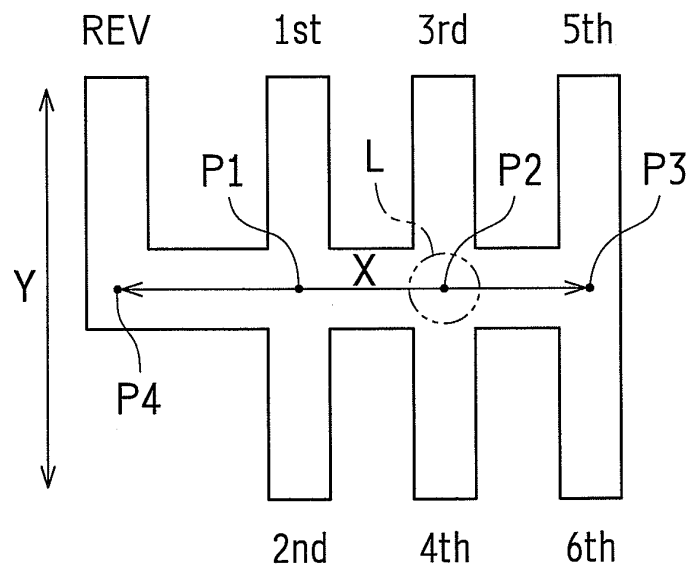


FIG.5

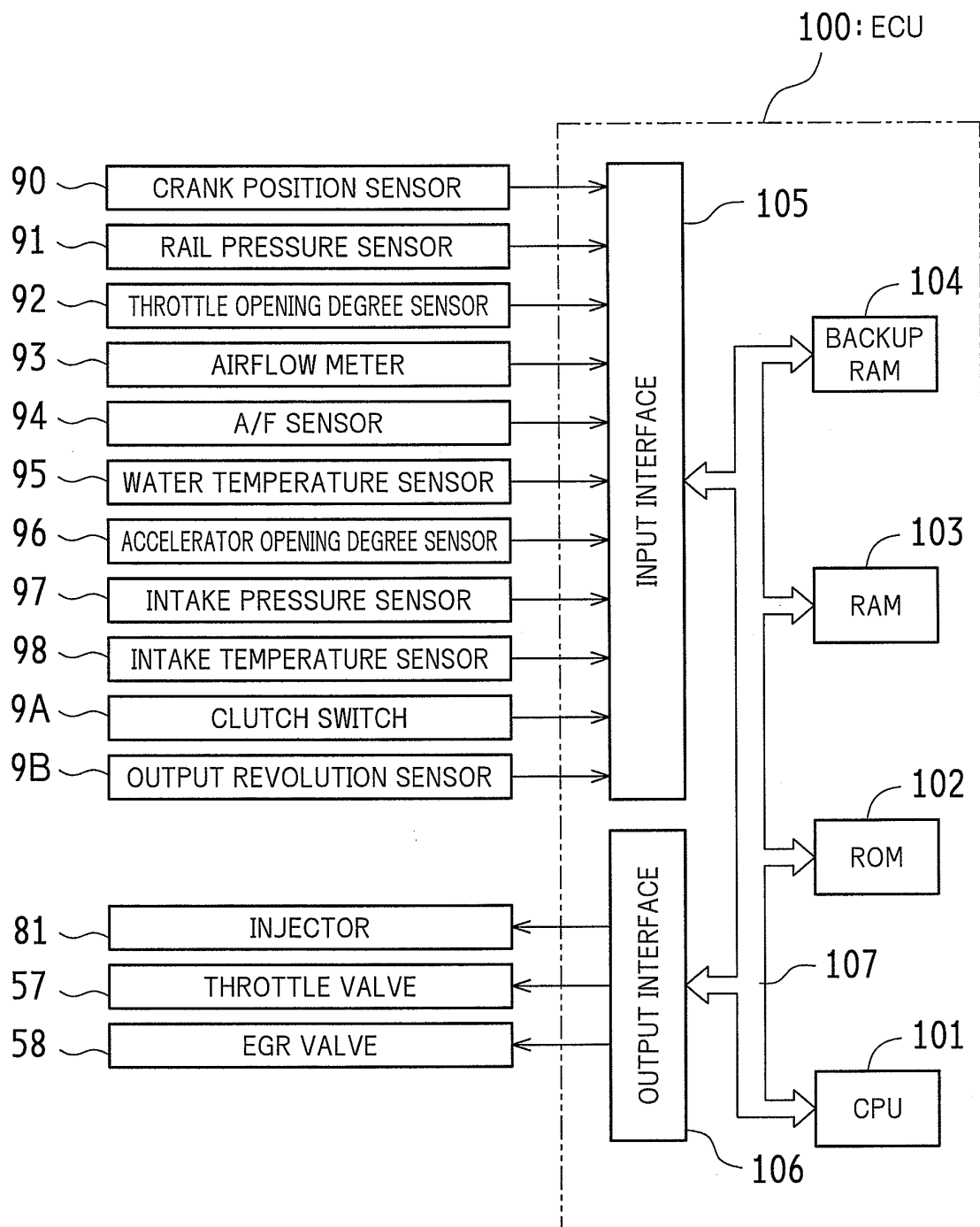


FIG.6

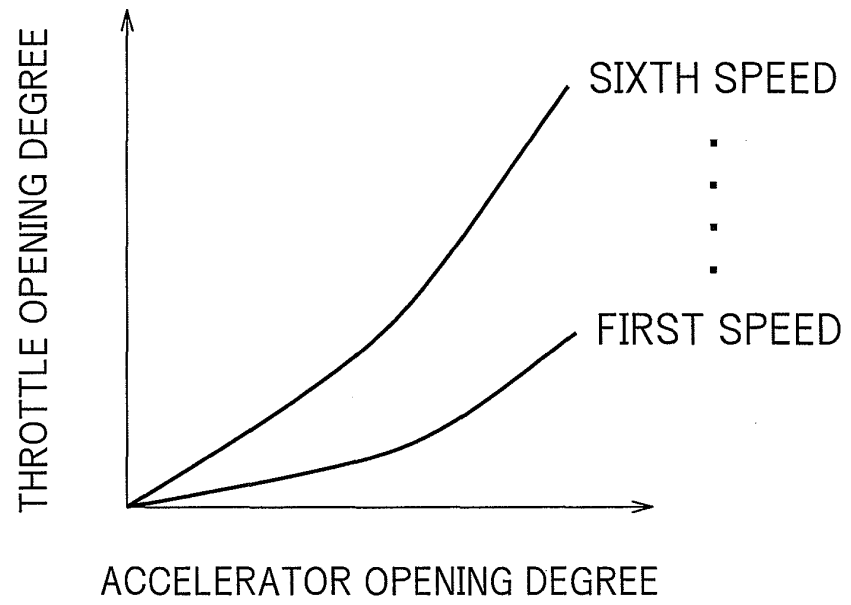


FIG.7

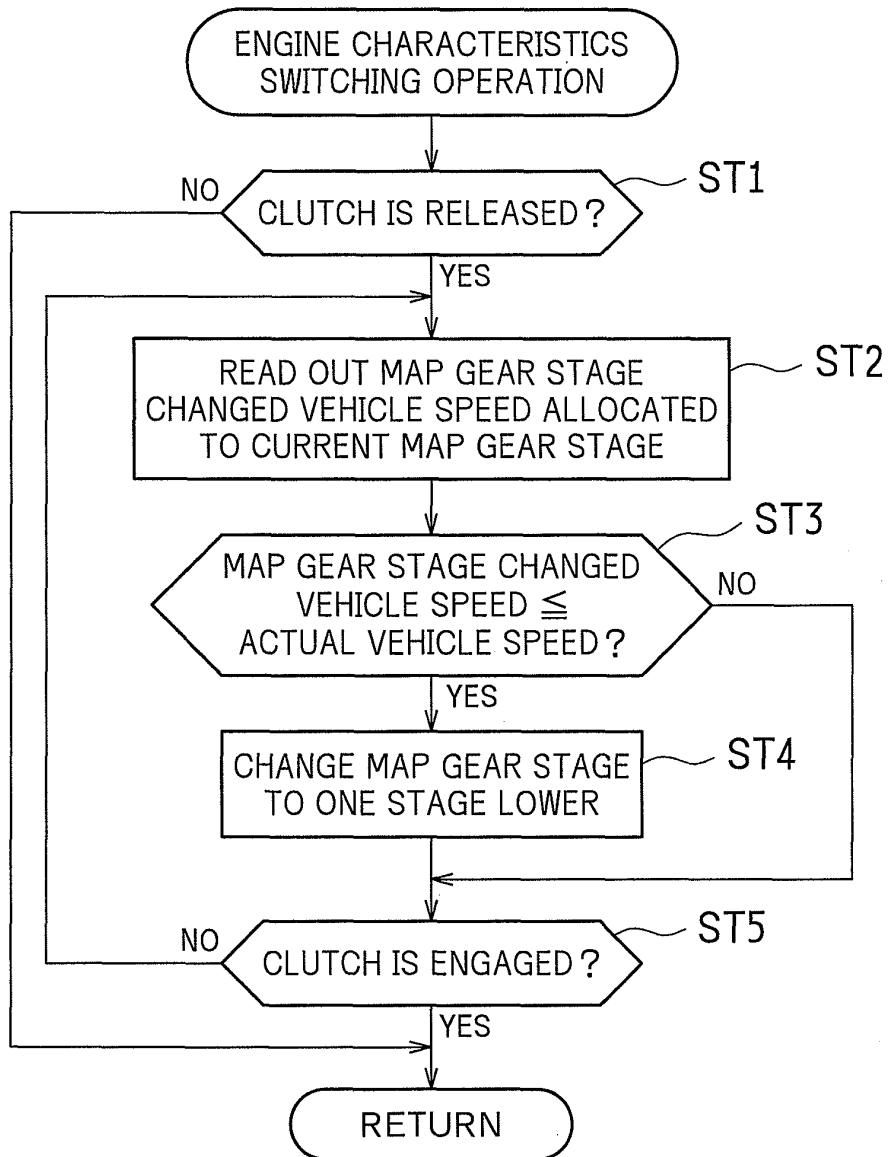
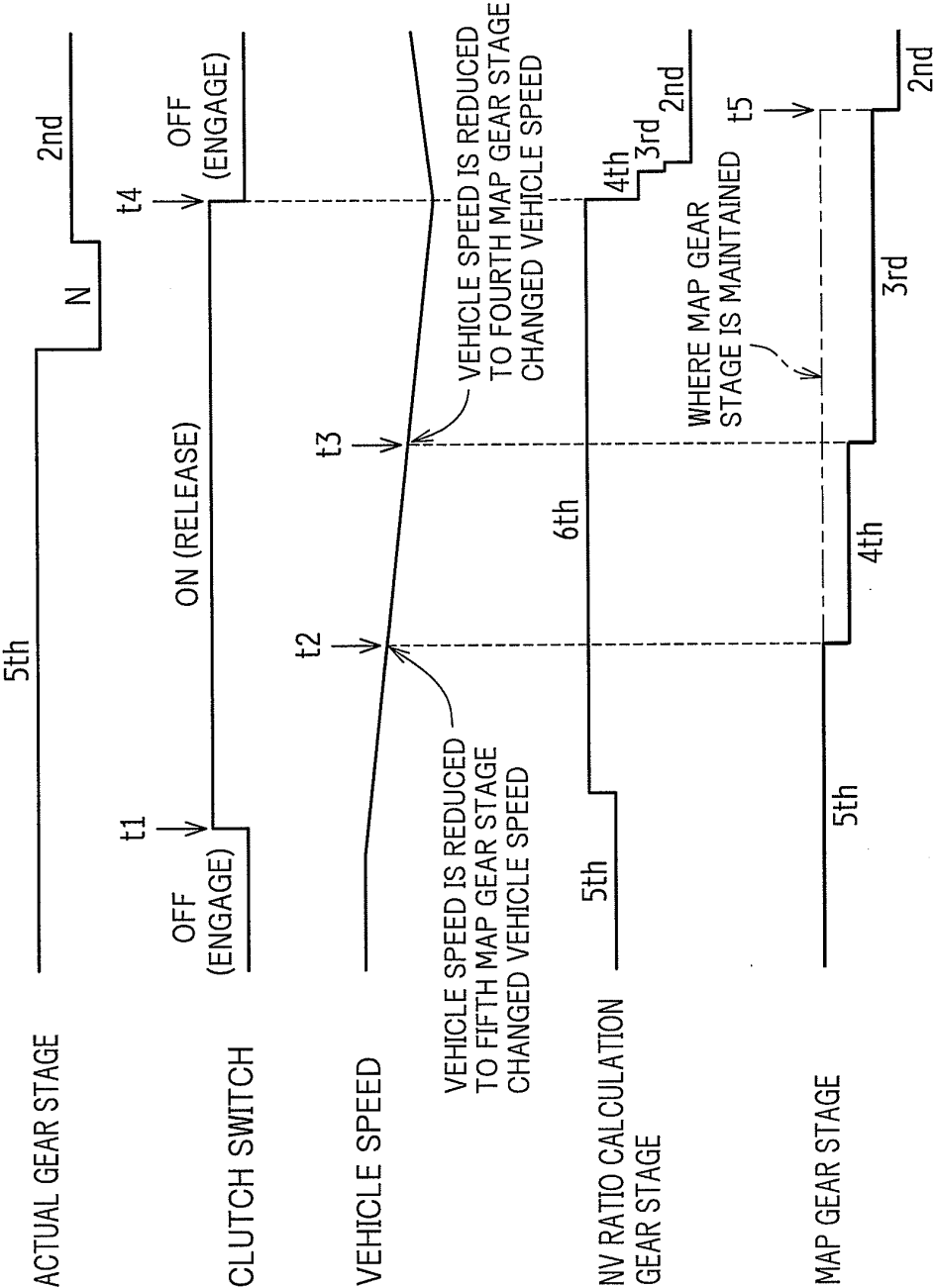


FIG. 8



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/068956

A. CLASSIFICATION OF SUBJECT MATTER
F02D29/00 (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)
F02D29/00Documentation 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 1996-2011
Kokai Jitsuyo Shinan Koho 1971-2011 Toroku Jitsuyo Shinan Koho 1994-2011

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.
A	JP 2009-248810 A (Toyota Motor Corp.), 29 October 2009 (29.10.2009), entire text; all drawings (Family: none)	1-6
A	JP 2008-169896 A (Toyota Motor Corp.), 24 July 2008 (24.07.2008), entire text; all drawings & EP 1944529 A2	1-6
A	JP 2007-46674 A (Nissan Motor Co., Ltd.), 22 February 2007 (22.02.2007), entire text; all drawings (Family: none)	1-6

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

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Date of the actual completion of the international search
07 September, 2011 (07.09.11)Date of mailing of the international search report
20 September, 2011 (20.09.11)Name and mailing address of the ISA/
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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2008138818 A [0006]
- JP 2005090452 A [0006]