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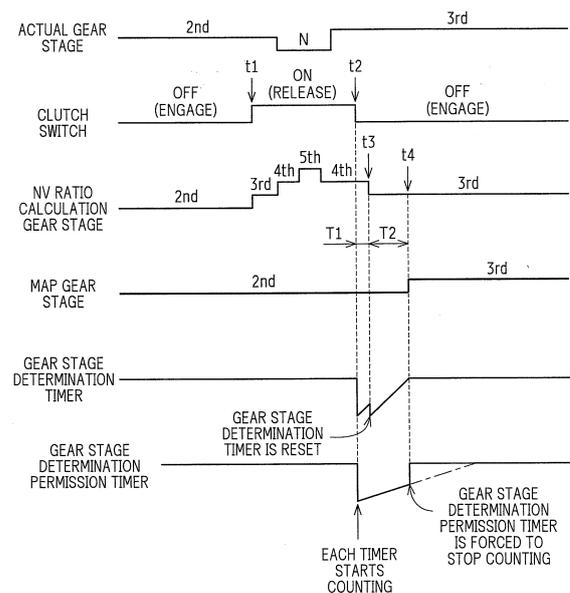
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(54) **CONTROL DEVICE FOR VEHICLE EQUIPPED WITH MANUAL TRANSMISSION**

(57) A plurality of engine characteristics is stored to change the output characteristic of the engine in accordance with a gear stage established in a manual transmission. A gear stage determination permission timer and a gear stage determination timer each start counting at a time when a clutch apparatus is engaged due to the completion of the shift manipulation. In a period up until the gear stage determination permission timer finishes counting, when a condition where an NV ratio calculation gear stage is different from a map gear stage and the NV ratio calculation gear stage is not changed continues for a period up until the gear stage determination timer finishes counting, the map gear stage corresponding to the NV ratio calculation gear stage is selected, and the engine characteristic corresponding to the map gear stage is extracted so as to change the engine characteristic.

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-

established, 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.

Summary of the Invention

20 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 a general shift manipulation, as is described above, the clutch release manipulation, the gear stage switching manipulation, and the clutch engagement manipulation are carried out in this order. However, during the clutch engagement manipulation after the completion of the gear stage switching manipulation, or immediately after the completion of the clutch engagement manipulation, the NV ratio calculation gear stage might be different from the actual gear stage (the NV ratio calculation gear stage does not match the actual gear stage).

[0009] For example, in cases of a sudden acceleration by the depressing an accelerator pedal and a sudden

braking by the depressing of brake pedal, the detection accuracy of the vehicle speed cannot sufficiently be obtained or a delay in the detection timing might occur. Accordingly, the NV ratio matching the NV ratio of the actual gear stage might not be able to be calculated, and a delay in timing at which an appropriate NV ratio (value matching the NV ratio of the actual gear stage) is calculated might occur. This results in the NV ratio calculation gear stage being different from the actual gear stage (the NV ratio calculation gear stage derived from information on the vehicle speed does not match the actual gear stage). Also, when the engine revolution fluctuates due to the clutch engagement manipulation, or in a state of an incomplete clutch engagement operation, that is, when the engine revolution is not obtained in accordance with the actual gear stage and the vehicle speed in a state where the clutch is being slid (so-called, half-clutch state), the NV ratio matching the NV ratio of the actual gear stage cannot be calculated, and the NV ratio calculation gear stage differs from the actual gear stage (the NV ratio calculation gear stage derived from information on the engine revolution does not match the actual gear stage).

[0010] Under these circumstances, the NV ratio calculation gear stage fluctuates in a short period of time due to the fluctuation in the vehicle speed and the engine revolution to be detected. Thus, when the map gear stage is sequentially shifted in accordance with the NV ratio calculation gear stage, the map gear stage is also fluctuated in a short period of time. For example, this might lead to a case (hunting of map gear stage) that the map gear stage is switched for plural times in a period from the middle of the clutch engagement manipulation to immediately after the completion of the clutch engagement manipulation. Hereinafter, this condition is referred to as "busy state of the map gear stage update".

[0011] The output characteristic map is used for obtaining the required torque for the engine in accordance with the accelerator opening degree and carrying out engine control (control of the throttle opening degree in patent document 2) in a manner as to obtain the required torque. Thus, when the update of the map gear stage selected from the output characteristic map is in a busy state, the engine torque fluctuates in a corresponding manner as well. That is, when the map gear stage is switched for plural times in a short period of time, the torque level difference might be produced each time of switching, which leads to a movement of a vehicle. Thus, a sense of discomfort might be given to an occupant.

[0012] A possible way of solving this problem is that the update of the map gear stage is prohibited in a period in which the update of the map gear stage might fall into the busy state. However, in this case, the map gear stage might be changed after the stable traveling state of the vehicle is achieved after a predetermined time passes after the completion of the shift manipulation. When the output characteristic of the engine is changed and the torque level difference is produced after the stable traveling state of the vehicle is achieved, an even greater

degree of sense of discomfort is given to the occupant.

[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 shift timing of the map gear stage.

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. A shift timing of the map gear stage is optimized by limiting the shift timing of the map gear stage (shift stage targeted by shift stage corresponding characteristic). Also, the shift timing of the map gear stage is limited to a predetermined period from a time when the clutch is engaged. When the NV ratio calculation gear stage with a high degree of a reliability (shift stage obtained based on the result of the determination) is required in the predetermined period, the map gear stage corresponding to the NV ratio calculation gear stage is selected to change the output characteristic of the engine (traveling drive source).

-Solution Means-

[0015] Specifically, the present invention presupposes a control apparatus for a vehicle. The vehicle includes a manual transmission configured to transmit a drive force from a traveling drive source to drive wheels and with which any one of a plurality of shift stages is selected through a manual shift manipulation of a driver. The control apparatus is configured to determine a shift stage selected and change output characteristics of the traveling drive source in accordance with the result of the determination. The control apparatus for the vehicle is configured such that change of the output characteristics of the traveling drive source executed in accordance with the result of the determination of the manual transmission, is carried out after manual shift manipulation of the manual transmission and in a predetermined time from a time point at which transmission of the drive force starts from the traveling drive source to the drive wheels is started.

[0016] Also, a plurality of shift stage corresponding characteristics to set the output characteristics of the traveling drive source in accordance with the shift stages may be stored, and in the predetermined time in which the output characteristic of the traveling drive source is changed, the shift stage corresponding characteristic may be changed to correspond to the shift stage obtained based on the result of the determination only when a condition where a shift stage targeted by the shift stage corresponding characteristic currently set is different

from a shift stage obtained based on the result of the determination and the shift stage obtained based on the determination result is maintained continues for a predetermined first determination time.

[0017] Also, in the predetermined time in which the output characteristic of the traveling drive source is changed, in a state where the shift stage targeted by the shift stage corresponding characteristic currently set is different from the shift stage obtained based on the determination result, when the shift stage obtained based on the result of the determination is changed before the first determination time passes, the shift stage corresponding characteristic may be changed to correspond to the shift stage obtained based on the result of the determination only when a condition where the changed shift stage is different from the shift stage targeted by the shift stage corresponding characteristic currently set and the changed shift stage after is maintained continues for the first determination time during the predetermined time.

[0018] According to these particular matters, although the result of the determination is likely to fluctuate in the predetermined time from the time point at which the transmission of the drive force from the traveling drive source to the drive wheels starts, during the period, when the shift stage targeted by the shift stage corresponding characteristic currently set is different from the shift stage obtained based on the result of the determination and the shift stage obtained based on the result of the determination is maintained for the first determination time, the reliability of the shift stage obtained based on the determination result is deemed to be sufficiently secured, and the shift stage corresponding characteristic is changed to correspond to the shift stage obtained based on the result of the determination. Accordingly, the shift stage corresponding characteristic in accordance with the driving state of the vehicle can be realized promptly and highly reliably. As a result, such a case can be avoided that the output characteristic of the traveling drive source is frequently switched, and a torque level difference occurs each time the engine characteristic is switched. Furthermore, such a case can be avoided that the output characteristic of the traveling drive source cannot be switched before the stable traveling state of the vehicle is achieved. Thus, a sense of discomfort can be prevented from being given to an occupant.

[0019] Moreover, when the shift stage obtained based on the result of the determination is changed before the first determination time passes, the operation to change the shift stage corresponding characteristics similar to the one described above is carried out for the changed shift stage. Accordingly, the operation to change the shift stage corresponding characteristics can be carried out using the shift stage with a higher degree of reliability (shift stage obtained based on the determination result), and the shift stage corresponding characteristics can appropriately be obtained.

[0020] The specific control operations include the following. Specifically, the number of times the shift stage

corresponding characteristics is changed in the predetermined time in which the output characteristic of the traveling drive source is changed may be limited.

[0021] Specifically, the number of times the shift stage corresponding characteristics is changed in the predetermined time in which the output characteristic of the traveling drive source is changed, may be limited to once.

[0022] More specifically, when the shift stage targeted by the shift stage corresponding characteristic currently set is different from the shift stage obtained based on the result of the determination and the shift stage obtained based on the result of the determination is maintained for the first determination time, the predetermined time in which the output characteristic of the traveling drive source is changed may be forced to be stopped at a time point when the shift stage corresponding characteristic is changed to correspond to the shift stage obtained based on the result of the determination.

[0023] According to these particular matters, the shift stage corresponding characteristics can be prevented from changing for plural times in the predetermined time. Thus, the busy state in which the shift stage corresponding characteristics are switched for plural times in a short period of time can be surely avoided. Accordingly, sense of discomfort due to the shift stage corresponding characteristics being switched for plural times can be prevented from being given to an occupant.

[0024] The configuration to enhance the reliability of the shift stage corresponding characteristics includes the following. Specifically, after a lapse of the predetermined time in which the output characteristic of the traveling drive source is changed, the shift stage corresponding characteristic may be changed to correspond to the shift stage obtained based on the result of the determination only when a condition where the shift stage obtained based on the result of the determination result is deviated on a low gear side from the shift stage targeted by the shift stage corresponding characteristic currently set and the shift stage obtained based on the result of the determination is maintained continues for a predetermined second determination time.

[0025] Also, after the predetermined time in which the output characteristic of the traveling drive source is changed passes, in a state where the shift stage obtained based on the result of the determination is deviated on a low gear side from the shift stage targeted by the shift stage corresponding characteristic currently set, when the shift stage obtained based on the result of the determination is changed before the second determination time passes, the shift stage corresponding characteristic may be changed to correspond to the shift stage obtained based on the result of the determination only when a condition where the changed shift stage is deviated to the low gear side from the shift stage targeted by the shift stage corresponding characteristic currently set continues for the second determination time.

[0026] In this case, the second determination time may be set longer than the first determination time.

[0027] Accordingly, even if the shift stage corresponding characteristic changed based on the first determination time is obtained by erroneous determination, the shift stage corresponding characteristic can be changed based on the second determination time later on. Thus, the reliability of the shift stage corresponding characteristic can be enhanced. Also, after the predetermined time passes, the shift stage corresponding characteristic can be changed only when the shift stage obtained by the result of the determination result is deviated to the low gear side from the shift stage targeted by the shift stage corresponding characteristic currently set. That is, the shift stage corresponding characteristic only on the low gear side can be changed. Generally, regarding 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. Thus, the change of the shift stage corresponding characteristic on the high gear side is prohibited so as to avoid the occurrence of a sense to the effect that a vehicle body rushes due to a rapid increase in output of the traveling drive source after the predetermined time passes. Further, the second determination time is set longer than the first determination time, so that the change of the shift stage corresponding characteristic after the predetermined time passes can be carried out with a higher degree of the reliability.

Effect of the Invention

[0028] According to an aspect of the present invention, the change of the output characteristic of a traveling drive source executed in accordance with a result of determination a shift stage, is carried out in a predetermined time from a time point at which transmission of a drive force from a traveling drive source to drive wheels starts. Accordingly, such a case that the output characteristics of the traveling drive source cannot be switched before the stable traveling state of the vehicle is achieved. Thus, no sense of discomfort is given to an occupant.

Brief Description of the Drawings

[0029]

[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 for an engine characteristics switching operation in a first embodiment.

[FIG. 8] FIG. 8 is a timing chart diagram illustrating respective variations of an actual gear stage, a clutch switch, an NV ratio calculation gear stage, and a map gear stage, and the respective operating states of a gear stage determination timer and a gear stage determination permission timer in a case where an up-shift manipulation is carried out from a second shift stage to a third shift stage in the first embodiment.

[FIG. 9] FIG. 9 is a flowchart diagram illustrating a former half of a procedure for the engine characteristics switching operation in a second embodiment.

[FIG. 10] FIG. 10 is a flowchart diagram illustrating a latter half of the procedure for the engine characteristics switching operation in the second embodiment.

[FIG. 11] FIG. 11 is a timing chart diagram illustrating respective variations of the actual gear stage, the clutch switch, the NV ratio calculation gear stage, and the map gear stage, as well as the respective operating states of the gear stage determination timer, the gear stage determination permission timer, and an irregular gear stage determination timer in a case where a downshift manipulation is carried out from a fourth shift stage to the second shift stage by a clutch manipulation in the second embodiment.

[FIG. 12] FIG. 12 is a timing chart diagram illustrating respective variations of the actual gear stage, the clutch switch, the NV ratio calculation gear stage, and the map gear stage, as well as the respective operating states of the gear stage determination timer, the gear stage determination permission timer, and the irregular gear stage determination timer in a case where the downshift manipulation is carried out from the fourth shift stage to the second shift stage by the clutch manipulation in the second embodiment.

45 Modes for Carrying out the Invention

[0030] 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.

[0031] 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).

[0032] 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.

[0033] 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-

[0034] 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.

[0035] 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.

[0036] 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.

[0037] 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.

[0038] An intake port 51 and an exhaust port 52 that are opened to the combustion chamber 4 are formed in the cylinder head 5.

[0039] 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).

[0040] 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.

[0041] 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.

[0042] 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.

[0043] 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.

[0044] 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-

[0045] 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.

[0046] 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.

[0047] 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.

[0048] 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.

[0049] 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).

[0050] 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.

[0051] 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.

[0052] 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.

[0053] 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.

[0054] 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 amount of depressing manipulation of the clutch pedal 70, a clutch engaging force (clutch transmission capacity) of the clutch mechanism portion 60 is adjusted.

[0055] 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).

[0056] 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 in-

creases, 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).

[0057] 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.

[0058] 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 vehicle speed can be calculated.

-Shift Pattern-

[0059] 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.

[0060] 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.

[0061] 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.

[0062] 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.

[0063] 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.

[0064] 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.

[0065] 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 estab-

lishing the backward drive stage.

-Control System-

[0066] The 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 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.

[0067] 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.

[0068] 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.

[0069] 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.

[0070] 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.

[0071] 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).

5 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.

10 **[0072]** 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.

15 **[0073]** 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.

20 **[0074]** 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.

25 **[0075]** 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.

[0076] 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.

[0077] 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.

[0078] 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

[0079] 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 injection 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-

[0080] 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.

[0081] 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.

[0082] 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.

[0083] 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".

-Engine Characteristics Switching Operation-

(First Embodiment)

[0084] Next, a first embodiment of 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 which one of various engine characteristics described above is extracted, and the engine 1 is controlled in accordance with the engine characteristic.

[0085] First, the outline of the engine characteristics switching operation will be described. A predetermined period from a time point when the shift operation of the manual transmission MT is completed, that is, a time point when the clutch apparatus 6 is engaged after the gear stage is shifted by the manipulation of the shift lever L (a time point when transmission of the drive force from the traveling drive source to the drive wheels is started, as referred to in the present invention) is set as a gear stage determination permission time. The gear stage de-

termination permission time is a time during which the engine characteristic to be extracted out of the plurality of engine characteristics can be switched, that is, a time during which the engine characteristic can be changed.

5 Also, the gear stage determination permission time is set as a period ending when the detection value of the engine revolution and the detection value of the vehicle speed are secured with high accuracy after the clutch apparatus 6 is engaged, that is, an approximately same period as a period during which the NV ratio might change in a short time (period during which "a busy state of the map gear stage update" might occur described above). That is, immediately after the clutch apparatus 6 is engaged or while the clutch apparatus 6 is engaged, there is a possibility that the NV ratio matching the gear stage actually selected cannot be calculated for the following reasons. Specifically, the engine revolution fluctuates in accordance with the vehicle speed (the revolution is increased attributing to the non-drive state of the engine 1, and the like), and the detection accuracy of the vehicle speed cannot sufficiently be obtained and a delay in the detection timing occurs due to sudden acceleration by increasing the amount of depressing of the accelerator pedal 11 and due to sudden braking by depressing the brake pedal. The gear stage determination permission time is set as a period during which these conditions above might occur. Specifically, a period during which the NV ratio matching the actual gear stage cannot be calculated is obtained by an experiment or a simulation.

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The period is set as the gear stage determination permission time.

[0086] In the gear stage determination permission time, only when a condition where the NV ratio calculation gear stage ("shift stage obtained based on the determination result", as referred to in the present invention) is different from the map gear stage ("shift stage targeted by the shift stage corresponding characteristic currently set", as referred to in the present invention) is maintained for a predetermined time (gear stage determination time; "first determination time", as referred to in the present invention), an operation of switching to the map gear stage corresponding to the NV ratio calculation gear stage is carried out ("an operation of changing the shift stage corresponding characteristic to correspond to the shift stage obtained based on the result of the determination", as referred to in the present invention). That is, in the predetermined period from the time point when the clutch apparatus 6 is engaged, the NV ratio calculation gear stage might change for plural times in a short period of time. However, even in the period, only when a condition where the NV ratio calculation gear stage is different from the map gear stage is maintained for the predetermined time, the reliability of the NV ratio calculation gear stage calculated is deemed to be high, and the operation of switching to the map gear ratio corresponding to the NV ratio calculation gear stage (engine characteristics switching operation) is carried out.

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[0087] Regarding a relation between the gear stage

determination permission time and the gear stage determination time, it is preferable that the gear stage determination permission time be set to a sufficiently long time with respect to the gear stage determination time.

[0088] 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.

[0089] 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.

[0090] In contrast, when the clutch apparatus 6 is released, and thus it is determined to be YES at step ST1, the process proceeds to step ST2 where it is determined whether the clutch apparatus 6 is engaged. That is, the shift manipulation in the manual transmission MT starts, and subsequently, it is determined whether the shift manipulation is completed. Specifically, it is determined whether the amount of depressing of the clutch pedal 70 by the driver is returned to a predetermined amount so that the output of the ON signal by the clutch switch 9A is halted (OFF). When the clutch apparatus 6 is still in a release state, and thus it is determined to be NO at step ST2, it is determined that the shift manipulation is still in progress, and the process waits until the clutch apparatus 6 is engaged (the shift manipulation is completed).

[0091] When the clutch apparatus 6 is in an engagement state, and thus it is determined to be YES at step ST2, the process proceeds to step ST3 where it is determined whether the NV ratio calculation gear stage (the NV ratio calculation gear stage calculated in a state where the clutch apparatus 6 is engaged) and the map gear stage (currently selected map gear stage) are different (NV ratio calculation gear stage \neq map gear stage).

[0092] When the NV ratio calculation gear stage is not different from the map gear stage, that is, when the NV ratio calculation gear stage matches the map gear stage, and thus it is determined to be NO at step ST3, the process returns without carrying out the engine characteristics switching operation, that is, while the engine characteristic currently selected (engine characteristic of the map gear stage corresponding to the NV ratio calculation gear stage) is maintained. For example, when the clutch release manipulation is carried out, and the clutch engagement manipulation is carried out without shifting the gear stages, it is determined to be NO at step ST3 as described above.

[0093] In contrast, when the NV ratio calculation gear stage is different from the map gear stage, and thus it is determined to be YES at step ST3, the process proceeds to step ST4, where a gear stage determination permission timer provided in the ECU 100 in advance starts counting in order to count the gear stage determination permission time. After starting the counting, the gear stage determination permission timer finishes counting at a time point when the gear stage determination permission time passes. Also, as described above, the gear stage determination permission time is set in advance based on an experiment or a simulation as a period during which "busy state of the map gear stage update" might occur so that the NV ratio calculation gear stage fluctuates in a short period of time due to the fluctuation of the vehicle speed and the engine revolution to be detected.

[0094] Thus, after the gear stage determination permission timer starts counting, the process proceeds to step ST5 where a gear stage determination timer provided in the ECU 100 in advance starts counting. The gear stage determination timer continues to count while a condition continues where the NV ratio calculation gear stage is different from the map gear stage and the NV ratio calculation gear stage is not changed. The gear stage determination timer finishes counting when the condition continues for a predetermined time (gear stage determination time). Also, when the NV ratio calculation gear stage is different from the map gear stage, but the NV ratio calculation gear stage is changed, the gear stage determination timer is reset and subsequently starts counting again (a specific operation of the gear stage determination timer will be described later). The gear stage determination time measured by the gear stage determination timer (time starting when the gear stage determination timer starts counting and ending when the counting is finished) is set as a time during which the reliability of calculation results of the NV ratio calculation gear stage is sufficiently secured (time during which the reliability that the NV ratio calculation gear stage matches the actual gear stage is sufficiently secured), and specifically is set based on an experiment or a simulation. More specifically, in view of various road conditions and various driving states made by a driver, the gear stage determination time is set by obtaining a time during which the reliability that the NV ratio calculation gear stage matches the actual gear stage is sufficiently secured, based on the experiment or the simulation.

[0095] Thus, after the gear stage determination timer starts counting, the process returns to step ST6 where it is determined whether the current time point is within the gear stage determination permission time (whether the gear stage determination permission timer has not yet finished counting).

[0096] When the determination is made at first at step ST6 immediately after the gear stage determination permission timer starts counting, the current time point is within the gear stage determination permission time, and thus it is determined to be YES at step ST6, and the

process proceeds to step ST7. At step ST7, it is determined whether a condition where the NV ratio calculation gear stage is different from the map gear stage has continued for the gear stage determination time or more. When the state where the NV ratio calculation gear stage is different from the map gear stage has not continued for the gear stage determination time or more, and thus it is determined to be NO at step ST7, the process proceeds to step ST8 where it is determined whether the NV ratio calculation gear stage is changed. That is, it is determined whether the detection values of the engine revolution and the vehicle speed are changed, and the NV ratio calculation gear stage is changed. That is, as described above, during the gear stage determination permission time, the detection values of the engine revolution and the vehicle speed might change, and the reliability of the NV ratio calculation gear stage might not be sufficiently obtained. Thus, determination at step ST8 is made to confirm the reliability of the NV ratio calculation gear stage.

[0097] When the NV ratio calculation gear stage is not changed, and thus it is determined to be NO at step ST8, the process returns to step ST6, and it is determined whether the current time point is still within the gear stage determination permission time. When the current time point is within the gear stage determination permission time, at step ST 7, it is again determined whether the condition where the NV ratio calculation gear stage is different from the map gear stage has continued for the gear stage determination time or more. When the NV ratio calculation gear stage does not change, the operations at step ST6, ST7, and ST8 are repeated. When the condition where the NV ratio calculation gear stage is different from the map gear stage, and the NV ratio calculation gear stage is not changed has continued for the gear stage determination time or more, before the gear stage determination permission time passes (before the gear stage determination permission timer finishes counting), it is determined to be YES at step ST7, and the process proceeds to step ST9 where the map gear stage corresponding to the currently calculated NV ratio calculation gear stage is updated, and a throttle opening degree (engine characteristic) corresponding to the map gear stage is extracted, and the throttle opening degree is adjusted. That is, the throttle opening degree corresponding to the accelerator opening degree is obtained in accordance with the engine characteristic extracted, and the adjustment is made to obtain the throttle opening degree.

[0098] Thus, after the map gear stage is renewed, the process proceeds to step ST10 where the gear stage determination permission timer is forced to stop counting. This prevents a case that there appears the state where the NV ratio calculation gear stage is different from the map gear stage and the NV ratio calculation gear stage is not changed again (appears again in the gear stage determination permission time on the assumption that the gear stage determination permission timer is not

forced to stop counting), and the map gear stage is switched again in a short period of time.

[0099] In contrast, when the gear stage determination permission time has passed (the gear stage determination permission timer finishes counting) before the condition where the NV ratio calculation gear stage is different from the map gear stage continues for the gear stage determination time or more, it is determined to be NO at step ST6, and the process returns while the engine characteristic currently selected is maintained. That is, the gear stage determination permission time passes without the reliability of the calculation results of the NV ratio calculation gear stage being sufficiently secured. Thus, the present engine characteristic is maintained without changing the engine characteristic.

[0100] In the determination at step ST8, when the NV ratio calculation gear stage is changed, and thus it is determined to be YES, the process returns to step ST5 where the gear stage determination timer is reset, and the gear stage determination timer restarts counting. That is, the determination at step ST7 of whether the condition where the NV ratio calculation gear stage (changed NV ratio calculation gear stage) is different from the map gear stage continues for the gear stage determination time or more, is restarted. Then, as in the case described above, when the condition where the changed NV ratio calculation gear stage is different from the NV ratio calculation gear stage and the NV ratio calculation gear stage is not changed continues for the gear stage determination time or more, it is determined to be YES at step ST7, and the map gear stage corresponding to the NV ratio calculation gear stage currently calculated is updated at step ST9, and the process proceeds to step ST10 where the gear stage determination permission timer is forced to stop counting.

[0101] The engine characteristics switching operation in the above-described manner is carried out every time the shift manipulation of the transmission MT is executed, and during the gear stage determination permission time, the engine characteristics are changed only once only if the reliability of the calculation result of the NV ratio calculation gear stage is sufficiently secured (the number of times the shift stage corresponding characteristics are changed is limited to once).

[0102] 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 respective variations of the actual gear stage, the clutch switch 9A, the NV ratio calculation gear stage, and the map gear stage, as well as the respective operating states of the gear stage determination timer and the gear stage determination permission timer in the case where an upshift manipulation is carried out from the second shift stage (2nd) to the third shift stage (3rd).

[0103] First, at timing t1, a clutch release manipulation following the depressing of the clutch pedal 70 is started (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 (clutch release signal is output). The driver operates the shift lever L from the second shift stage 2nd to the third shift stage 3rd in the clutch release state (see a shift pattern in FIG. 4). During the clutch release including the operating period of the shift lever L (period from timing t1 to timing t2 in the diagram), as the NV ratio calculation gear stage, the NV ratio calculation gear stage on the high gear side where the shift ratio is on a small side is calculated due to the reduction of the engine revolution and the like. In FIG. 8, in the period from timing t1 to timing t2, the NV ratio calculation gear stage changes in order of the third shift stage (3rd), the fourth shift stage (4th), the fifth shift stage (5th), and the fourth shift stage (4th).

[0104] The manipulation of the shift lever L is completed, and at timing t2 a clutch engagement manipulation accompanying the release of the depressing of the clutch pedal 70 is started (corresponding to the case where thus it is determined to be YES at step ST2 in the flowchart of FIG. 7), and thus, the clutch switch 9A is turned off (the clutch release signal is stopped). The engagement of the clutch causes the gear stage determination permission timer and the gear stage determination timer to start counting (corresponding to step ST4 and step ST5 in the flowchart in FIG. 7). In FIG. 8, after these timers start counting, the NV ratio calculation gear stage changes at timing t3, and the gear stage determination timer is reset (corresponding to the case where it is determined to be YES at step ST8, and the gear stage determination timer restarts counting at step ST5 in the flowchart in FIG. 7). That is, the change of the NV ratio calculation gear stage before the gear stage determination permission time during the gear stage determination permission time passes (T1 in the diagram shows a duration time of the state where the NV ratio calculation gear stage is different from the map gear stage) leads to the start of the operation of determination on whether the condition where the changed NV ratio calculation gear stage (the third shift stage (3rd) in FIG. 8) is different from the map gear stage (the second shift stage (2nd) in FIG. 8) continues for the gear stage determination time or more by resetting the gear stage determination timer without selecting the map gear corresponding to the NV ratio calculation gear stage at the time of the clutch engagement (the fourth shift stage (4th) in FIG. 8).

[0105] Then, the changed NV ratio calculation gear stage is maintained, and the condition where the NV ratio calculation gear stage is different from the map gear stage and the NV ratio calculation gear stage is not changed continues only for the gear stage determination time (time T2 in the diagram), and the gear stage determination timer finishes counting at timing t4 (corresponding to the case where it is determined to be YES at step ST7 in the flowchart in FIG. 7), and the map gear stage is switched from the second shift stage (2nd) to the third shift stage (3rd). Thus, the engine characteristic is switched from the second shift stage engine characteristic to the third shift stage engine characteristic (corre-

sponding to step ST9 in the flowchart in FIG. 7). It is to be noted that the gear stage determination permission time is set to a sufficiently long time with respect to the gear stage determination time, and subsequently, it is possible to secure the gear stage determination time until the gear stage determination permission timer finishes counting, even if the gear stage determination timer is reset during the gear stage determination permission time as described above. A dashed-dotted line in FIG. 8 shows a counting operation of the gear stage determination permission timer in the case where the gear stage determination permission timer is not forced to stop counting.

[0106] Also, when the engine characteristics are switched, the gear stage determination permission timer is forced to stop counting (corresponding to step ST10 in the flowchart in FIG. 7).

[0107] The engine characteristics switching operation is carried out in the manner described above.

[0108] As has been described hereinbefore, in this embodiment, although the NV ratio calculation gear stage is likely to fluctuate in a predetermined time after the clutch apparatus 6 is engaged (gear stage determination permission time), during the period, when the NV ratio calculation gear stage is different from the map gear stage and the NV ratio calculation gear stage is not changed for the gear stage determination time, the reliability of the NV ratio calculation gear stage is deemed to be sufficiently secured, and the map gear stage is shifted to correspond to the NV ratio calculation gear stage, and the engine characteristic is switched accordingly. Thus, the engine characteristic suitable for the driving state of the vehicle can be obtained promptly and highly reliably. As a result, a torque level difference produced each time the engine characteristic is switched by the frequent switching of the engine characteristics can be prevented. Moreover, an occurrence of the torque level difference due to switching of the engine characteristics after the stable traveling state is achieved can be prevented. Thus, a sense of discomfort due to the occurrence of the torque level difference can be prevented from being given to an occupant.

(Second Embodiment)

[0109] Next, a second embodiment of the engine characteristics switching operation above in which one of various engine characteristics is extracted will be described. In this embodiment, the description common to that of the first embodiment is omitted, and the difference from the first embodiment will mainly be described.

[0110] In the engine characteristics switching operation according to this embodiment, after the gear stage determination permission time (including the case where the counting is forcibly stopped) passes, when the condition where the NV ratio calculation gear stage is different from the map gear stage continues for a predetermined time (irregular gear stage determination time de-

scribed later; "second determination time" as referred to in the present invention), the operation of switching to the map gear stage corresponding to the NV ratio calculation gear stage is carried out. That is, when switching to another engine characteristic is required after the engine characteristics are switched by the engine characteristics switching operation during the gear stage determination permission time according to the first embodiment described above, the engine characteristic is switched again accordingly.

[0111] Next, a specific operation of the engine characteristics switching described above will be described by referring to flowcharts in FIGs. 9 and 10. The flowcharts are executed every several milliseconds after the start of a vehicle. Also, the operations of step ST1 to step ST10 in the flowchart in FIG. 9 are similar to the operations of step ST1 to step ST10 in the flowchart in FIG. 7 in the first embodiment described above, and accordingly the description will be omitted.

[0112] After the gear stage determination permission timer is forced to stop counting at step ST10 or when it is determined to be NO at step ST1 (when the clutch apparatus 6 is not released), the process proceeds to step ST11 (FIG. 10) where it is determined whether the NV ratio calculation gear stage is a lower gear stage (gear stage on the low gear side) than the map gear stage (whether "the shift stage obtained by determination results is deviated to the low gear side from the shift stage targeted by the shift stage corresponding characteristic currently set", as referred to in the present invention).

[0113] When the NV ratio calculation gear stage is not a lower gear stage than the map gear stage, and thus it is determined to be NO at step ST11, the process returns without carrying out the engine characteristics switching operation, that is, while the currently selected engine characteristic (the engine characteristic of the map gear stage corresponding to the NV ratio calculation gear stage) is maintained. This is to prevent the map gear stage from shifting to a gear stage on the high gear side, even if the NV ratio calculation gear stage is obtained with high accuracy, when the NV ratio calculation gear stage is a higher gear stage (gear stage on the high gear side) than the map gear stage. That is, with the engine characteristic, the engine characteristics is prevented from switching to the gear stage on the high gear side where the required output is set high, compared with the gear stage on the low gear side. Thus, the occurrence of a sense to the effect that the vehicle rushes due to a rapid increase in engine output can be avoided.

[0114] In contrast, the NV ratio calculation gear stage is a lower gear stage than the map gear stage, and thus it is determined to be YES at step ST11, the process proceeds to step ST12 where an irregular gear stage determination timer provided in the ECU 100 in advance starts counting. The irregular gear stage determination timer continues counting, when the condition is maintained where the NV ratio calculation gear stage is a lower gear stage than the map gear stage and the NV ratio

calculation gear stage is not changed, and finishes counting when the condition continues for a predetermined time (irregular gear stage determination time). Also, when the NV ratio calculation gear stage is changed even when the NV ratio calculation gear stage is a lower gear stage than the map gear stage, the irregular gear stage determination timer is reset and then starts counting again (specific operation of the irregular gear stage determination timer will be described later). The irregular gear stage determination time measured by the irregular gear stage determination timer (time starting when the irregular gear stage determination timer starts counting and ending when the counting is finished) is set as a time during which the reliability of calculation results of the NV ratio calculation gear stage is sufficiently secured (time during which the reliability that the NV ratio calculation gear stage matches the actual gear stage is sufficiently secured), and specifically is set based on an experiment or a simulation. More specifically, in view of various road conditions and various driving states made by a driver, the irregular gear stage determination time is set as a time during which the reliability that the NV ratio calculation gear stage matches the actual gear stage is sufficiently secured. Also, the irregular gear stage determination time is set longer than the gear stage determination time. For example, the irregular gear stage determination time is set to be longer than the gear stage determination time by 10%. This value can appropriately be set. This is because the higher degree of reliability is required in the gear stage determination based on the irregular gear stage determination time, than in the gear stage determination based on the gear stage determination time. That is, shifting from the map gear stage that is determined once by the gear stage determination based on the gear stage determination time to another map gear stage requires the higher degree of reliability in the determination, and for this reason, the irregular gear stage determination time is set longer than the gear stage determination time.

[0115] Thus, after the irregular gear stage determination timer starts counting, the process proceeds to step ST13. At step ST13, it is determined whether a condition where the NV ratio calculation gear stage is a lower gear stage than the map gear stage (NV ratio calculation gear stage < map gear stage) continues for the irregular gear stage determination time or more. When the condition where the NV ratio calculation gear stage is a lower gear stage than the map gear stage does not continue for the irregular gear stage determination time more, and thus it is determined to be NO at step ST13, the process proceeds to step ST14 where it is determined whether the NV ratio calculation gear stage is changed. That is, it is determined whether the NV ratio calculation gear stage is changed due to the variation of the detection value of the engine revolution or the vehicle speed.

[0116] When the NV ratio calculation gear stage is not changed, and thus it is determined to be NO at step ST14, the process returns to step ST13 where it is determined

whether the condition where the NV ratio calculation gear stage is a lower gear stage than the map gear stage continues for the irregular gear stage determination or more again. When the NV ratio calculation gear stage does not change, the operations of steps ST13 and ST14 are repeated, and when the condition where the NV ratio calculation gear stage is a lower gear stage than the map gear stage, and the NV ratio calculation gear stage is not changed continues for the irregular gear stage determination time or more, it is determined to be YES at the step ST13, and the process proceeds to step ST15 where the map gear stage corresponding to the currently calculated NV ratio calculation gear stage is updated, and a throttle opening degree (engine characteristic) corresponding to the map gear stage is extracted, and the throttle opening degree is adjusted. That is, the throttle opening degree corresponding to the accelerator opening degree is obtained in accordance with the engine characteristic extracted, and the adjustment is made to obtain the throttle opening degree.

[0117] Also, in the determination at step ST14, when the NV ratio calculation gear stage changes, and thus it is determined to be YES, the process returns to step ST11 where it is determined whether the NV ratio calculation gear stage is still a lower gear stage than the map gear stage, and when the NV ratio calculation gear stage matches the map gear stage, or when the NV ratio calculation gear stage is still a higher gear stage than the map gear stage, and thus it is determined to be NO, the process returns while the engine characteristic currently selected is maintained.

[0118] In contrast, when the NV ratio calculation gear stage is still a lower gear stage than the map gear stage, and thus it is determined to be YES at step ST11, the irregular gear stage determination timer is reset at step ST12, and the irregular gear stage determination timer restarts counting. That is, at step ST13, the determination on whether the condition where the NV ratio calculation gear stage is a lower gear stage than the map gear stage continues for the irregular gear stage determination time or more is again started. Then, as in the case described above, when the condition where the NV ratio calculation gear stage is a lower gear stage than the map gear stage, and the NV ratio calculation gear stage is not changed continues for the irregular gear stage determination time or more, it is determined to be YES at step ST13, and the map gear stage corresponding to the NV ratio calculation gear stage is updated at step ST15.

[0119] The engine characteristics switching operation in the above-described manner is carried out, and even after the gear stage determination permission time has passed, the engine characteristic is switched to the engine characteristic on the low gear side only when the NV ratio calculation gear stage is a lower gear stage than the map gear stage, and the reliability of the calculation result of the NV ratio calculation gear stage is sufficiently secured.

[0120] FIGs. 11 and 12 are timing chart diagrams illus-

trating the engine characteristics switching operation described above and timing chart diagrams illustrating respective variations of the actual gear stage, the clutch switch 9A, the NV ratio calculation gear stage, the map gear stage, as well as the respective operating states of the gear stage determination timer, the gear stage determination permission timer, and the irregular gear stage determination timer in the case where a downshift manipulation is carried out from the fourth shift stage (4th) to the second shift stage (2nd).

[0121] Also, FIG. 11 is a timing chart diagram of the case where the NV ratio calculation gear stage is switched to the second shift stage (2nd) after the map gear stage is switched to the third shift stage (3rd) by the engine characteristics switching operation according to the first embodiment described above. FIG. 12 is a timing chart diagram of the case where the downshift manipulation is carried out from the fourth shift stage (4th) to the second shift stage (2nd) without carrying out the clutch manipulation.

[0122] First, the case where the operation shown in FIG. 11 is carried out will be described. The operations up until the map gear stage is switched to the third shift stage (3rd) are similar to those of the operations shown in the timing chart of FIG. 8 in the first embodiment, and accordingly, the description will be omitted. It is to be noted that timings t1 to t4 in FIG. 11 match timings t1 to t4 in FIG. 8.

[0123] When the NV ratio calculation gear stage is changed to the second shift stage (2nd) at timing t5 after the map gear stage is switched to the third shift stage (3rd) at timing t4, the irregular gear stage determination timer starts counting (corresponding to step ST12 in the flowchart of FIG. 10).

[0124] Then, when the changed NV ratio calculation gear stage is maintained, and a condition where the changed NV ratio calculation gear stage is a lower gear stage than the map gear stage and the NV ratio calculation gear stage is not changed thereafter continues only for the irregular gear stage determination time (time T3 in the diagram), and the irregular gear stage determination timer finishes counting at timing t6 (corresponding to the case where it is determined to be YES at step ST13 in the flowchart of FIG. 10), the map gear stage is switched from the third shift stage (3rd) to the second shift stage (2nd). In response to this, the engine characteristic is switched from the third shift stage engine characteristic to the second shift stage engine characteristic (corresponding to step ST15 in the flowchart in FIG. 10). Thus, the map gear stage that is once determined by the gear stage determination based on the gear stage determination time is changed by the gear stage determination based on the irregular gear stage determination time, so that the map gear stage is shifted with a higher degree of reliability, and thus switching to the optimal engine characteristic is achieved.

[0125] Next, the case where the operation shown in FIG. 12 is carried out will be described. In this operation,

the downshift manipulation is carried out from the fourth shift stage (4th) to the second shift stage (2nd) without carrying out the clutch manipulation. In the flowcharts in FIGs. 9 and 10, it is determined to be NO at step ST1, and the process proceeds to step ST11 and operations at and after step ST11 are executed (the gear stage determination based on the irregular gear stage determination time is carried out without carrying out the gear stage determination based on the gear stage determination time).

[0126] Specifically, when the downshift manipulation is carried out from the fourth shift stage (4th) to the second shift stage (2nd) without carrying out the clutch manipulation, first, the NV ratio calculation gear stage is shifted to the third shift stage (3rd) at timing t7, along with the manipulation. In response to this, the irregular gear stage determination timer starts counting (corresponding to step ST12 in the flowchart of FIG. 10).

[0127] Subsequently, before the irregular gear stage determination timer finishes counting, the NV ratio calculation gear stage is shifted to the second shift stage (2nd) at timing t8 (T4 in the diagram shows a duration time of the state where the NV ratio calculation gear stage is the third shift stage (3rd), and the map gear stage is the fourth shift stage (4th), as shown in FIG. 12), the irregular gear stage determination timer is reset. That is, the operation of determining whether the condition where the changed NV ratio calculation gear stage (second shift stage (2nd) in FIG. 12) is a lower gear stage than the map gear stage (fourth shift stage (4th) in FIG. 12) continues for the irregular gear stage determination time or more is executed again.

[0128] Then, when the changed NV ratio calculation gear stage is maintained, and the condition where the changed NV ratio calculation gear stage is a lower gear stage than the map gear stage continues only for the irregular gear stage determination time (time T5 in the diagram), and the irregular gear stage determination timer finishes counting at timing t9 (corresponding to the case where thus it is determined to be YES at step ST13 in the flowchart of FIG. 10), the map gear stage is switched from the fourth shift stage (4th) to the second shift stage (2nd). In response to this, the engine characteristic is switched from the fourth shift stage engine characteristic to the second shift stage engine characteristic (corresponding to step ST15 in the flowchart in FIG. 10).

[0129] The engine characteristics switching operation is carried out in the manner described above.

[0130] As has been described, in this embodiment, after the gear stage determination permission time passes, when the condition where the changed NV ratio calculation gear stage is a lower gear stage than the map gear stage, and the NV ratio calculation gear stage is not changed continues only for the irregular gear stage determination time, the reliability of the NV ratio calculation gear stage is deemed to be sufficiently secured, and the map gear stage is shifted corresponding to the NV ratio calculation gear stage, and the engine characteristic can

be switched in accordance with the change. Accordingly, even if erroneous determination occurs in the determination based on the gear stage determination time, the erroneous determination can be corrected with high accuracy, and switching to the optimal engine characteristic can be achieved.

-Other Embodiments-

[0131] The embodiments above describe 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.

[0132] Also, in the embodiments, 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).

[0133] Also, in the first embodiment, there has been described the engine characteristics switching operation in the case where the upshift manipulation is carried out. However, even in the case where the downshift manipulation is carried out, the engine characteristics switching operation is carried out under the similar operation.

[0134] Also, in the embodiments 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. The present invention is not limited to this, but 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.

Industrial Applicability

[0135] 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

[0136]

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 change of the output characteristics of the traveling drive source executed in accordance with the result of the determination of the shift stage is carried out after the manual shift manipulation of the manual transmission and in a predetermined time from a time point at which transmission of the drive force from the traveling drive source to the drive wheels is started.
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 characteristics of the traveling drive source in accordance with the shift stages is stored, and wherein, in the predetermined time in which the output characteristic of the traveling drive source is changed, the shift stage corresponding characteristic is changed to correspond to the shift stage obtained based on the result of the determination only when a condition where a shift stage targeted by the shift stage corresponding characteristic currently set is different from a shift stage obtained based on the result of the determination and the shift stage obtained based on the result of the determination is maintained continues for a predetermined first determination time.
3. The control apparatus for the vehicle comprising the manual transmission according to claim 2, wherein, in the predetermined time in which the output characteristic of the traveling drive source is changed, in a state where the shift stage targeted by the shift stage corresponding characteristic currently set is different from the shift stage obtained based on the result of the determination, when the shift stage obtained based on the result of the determination is changed before the first determination time passes, the shift stage corresponding characteristic is changed to correspond to the changed shift stage only when a condition where the changed shift stage is different from the shift stage targeted by the shift stage corresponding characteristic currently set and the changed shift stage is maintained continues for the first determination time during the predetermined time.
4. The control apparatus for the vehicle comprising the manual transmission according to claim 2 or 3, wherein number of times the shift stage corresponding characteristics are changed in the predetermined time in which the output characteristic of the traveling drive source is changed is limited.
5. The control apparatus for the vehicle comprising the manual transmission according to claim 4, wherein the number of times the shift stage corresponding characteristics is changed in the predetermined time in which the output characteristic of the traveling drive source is changed is limited to once.
6. The control apparatus for the vehicle comprising the manual transmission according to claim 5, wherein, when the shift stage targeted by the shift stage corresponding characteristic currently set is different from the shift stage obtained based on the result of the determination and the shift stage obtained based on the determination result is maintained for the first determination time, the predetermined time in which the output characteristic of the traveling drive source is changed is forcibly terminated at a time point when the shift stage corresponding characteristic is changed to correspond to the shift stage obtained based on the result of the determination.
7. The control apparatus for the vehicle comprising the manual transmission according to claim 2 or 3, wherein, after the predetermined time in which the output characteristic of the traveling drive source is changed passes, the shift stage corresponding characteristic is changed to correspond to the shift stage obtained based on the result of the determination only when a condition where the shift stage obtained based on the result of the determination is deviated to a low gear side from the shift stage targeted by the shift stage corresponding characteristic currently set and the shift stage obtained based on the result of the determination result is maintained continues for a predetermined second determination time.
8. The control apparatus for the vehicle comprising the manual transmission according to claim 7, wherein, after the predetermined time in which the output characteristic of the traveling drive source is changed passes, in a state where the shift stage obtained based on the result of the determination is

deviated to the low gear side from the shift stage targeted by the shift stage corresponding characteristic currently set, when the shift stage obtained based on the result of the determination is changed before the second determination time passes, the shift stage corresponding characteristic is changed to correspond to the changed shift stage only when a condition where the changed shift stage is deviated to the low gear side from the shift stage targeted by the shift stage corresponding characteristic currently set continues for the second determination time.

9. The control apparatus for the vehicle comprising the manual transmission according to claim 7 or 8, wherein the second determination time is set longer than the first determination time.

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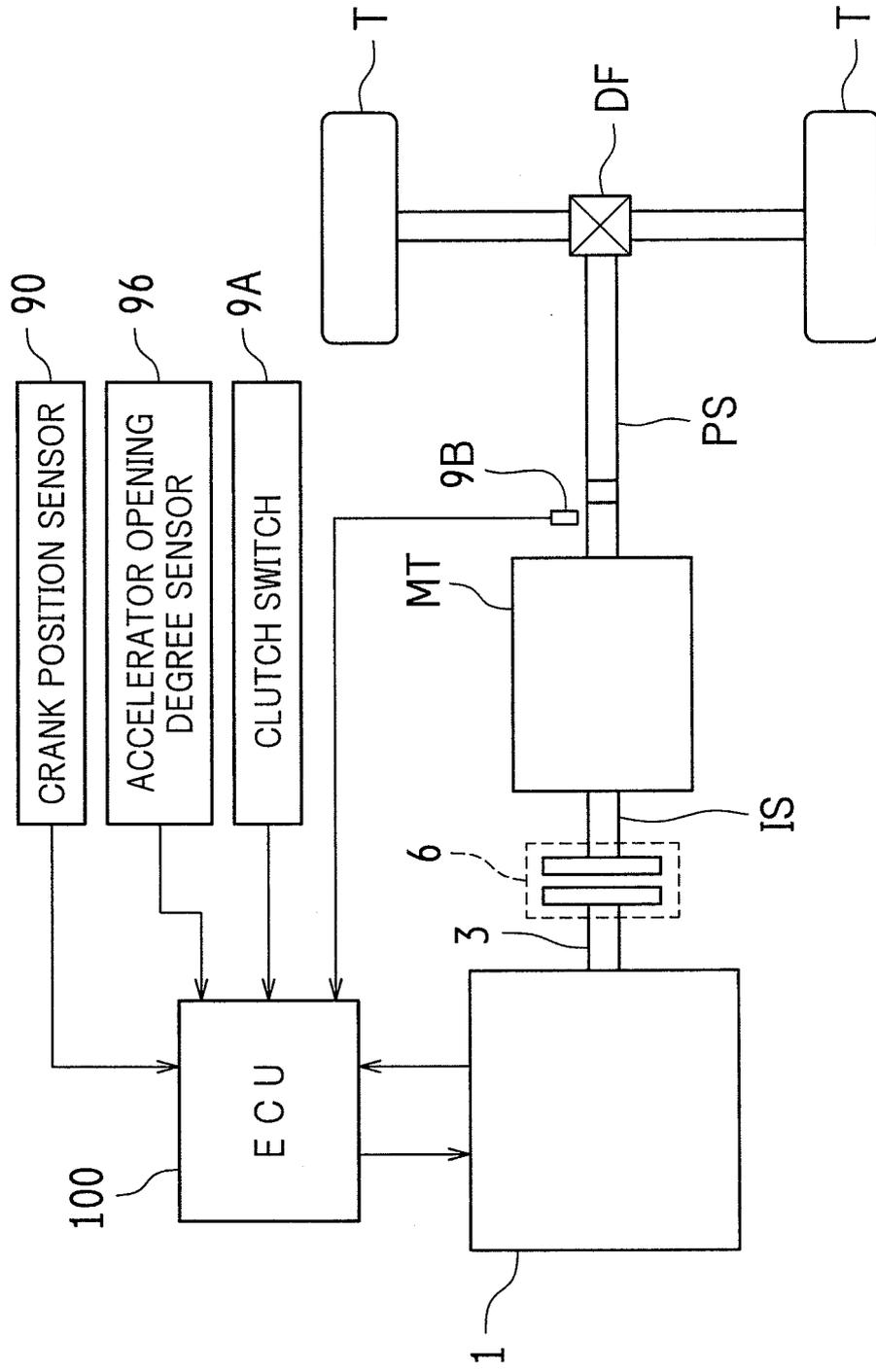
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FIG.1



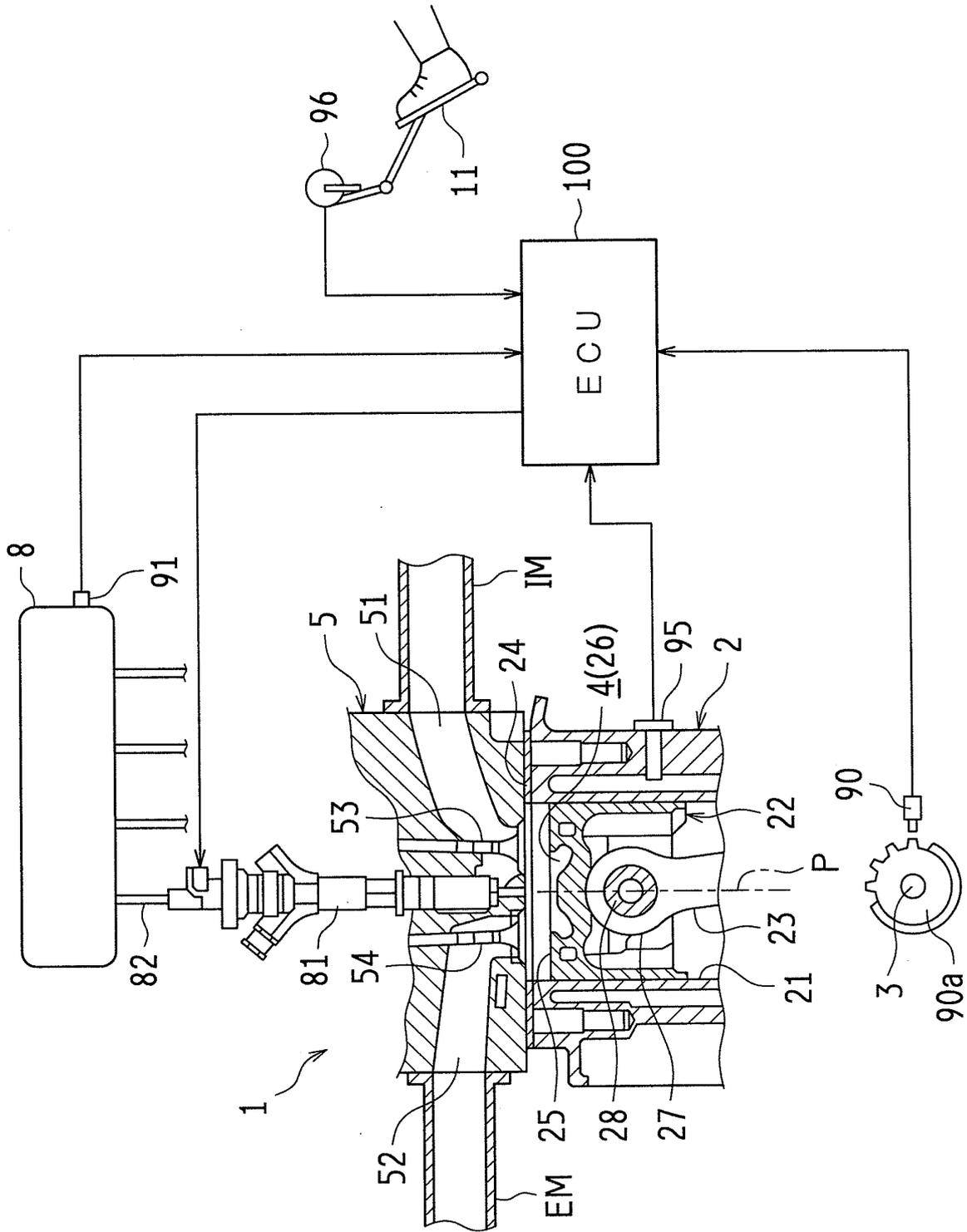


FIG. 2

FIG.3

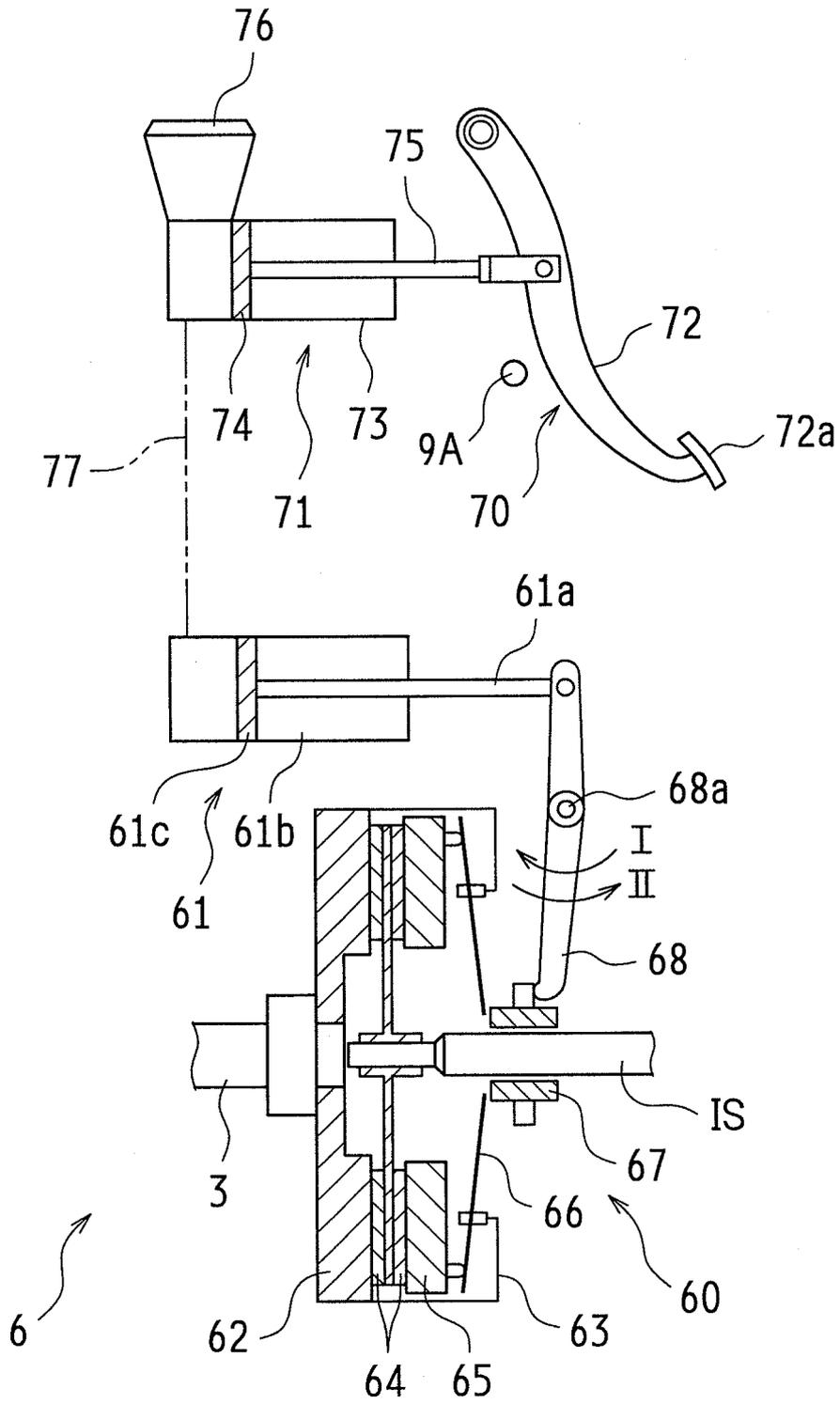


FIG.4

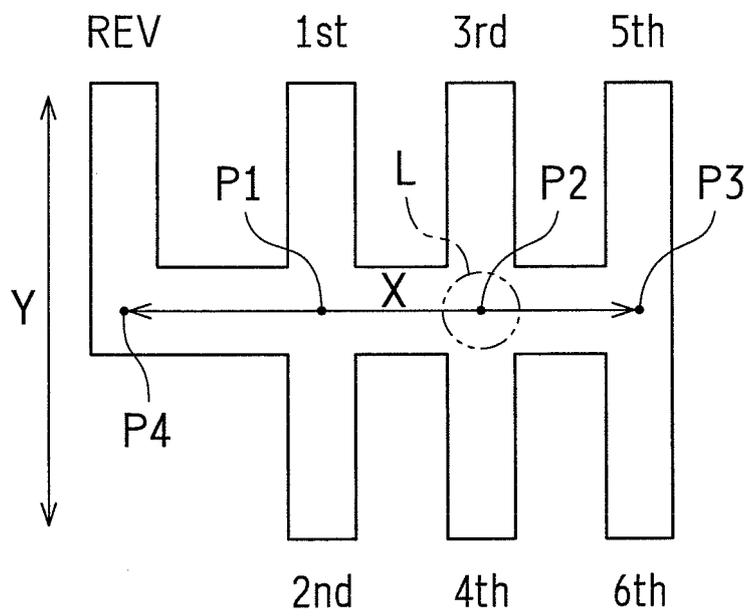


FIG.5

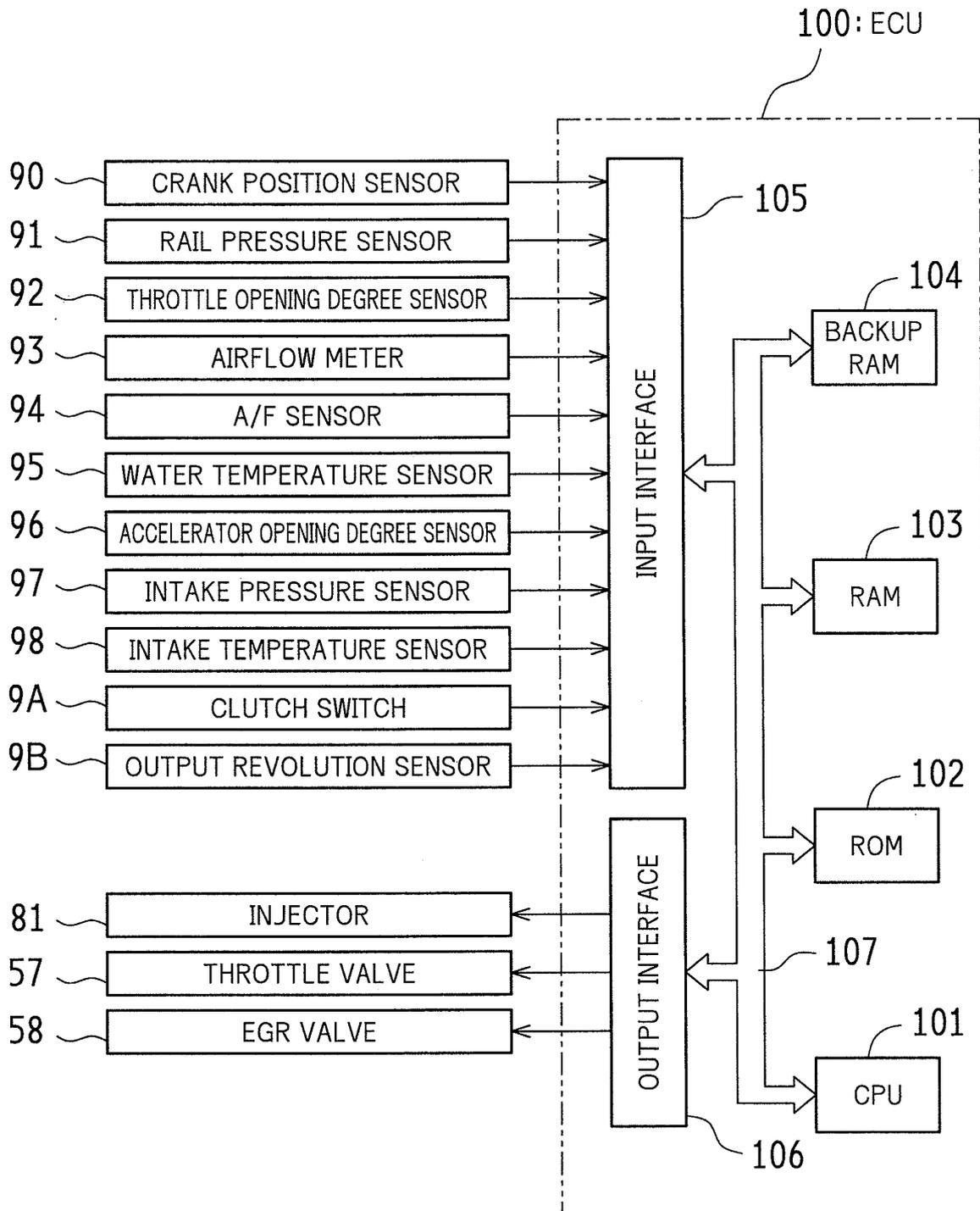
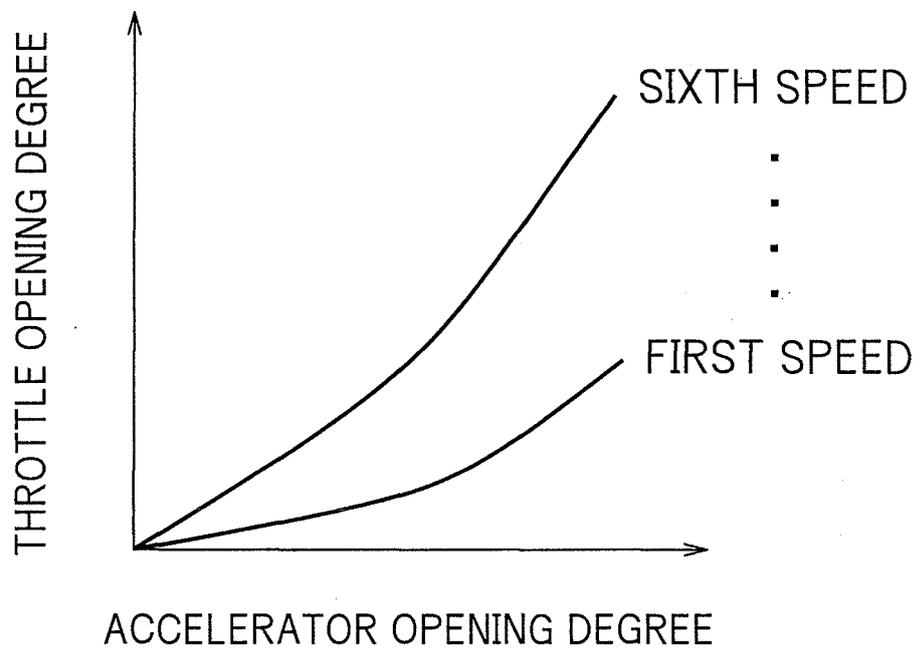


FIG.6



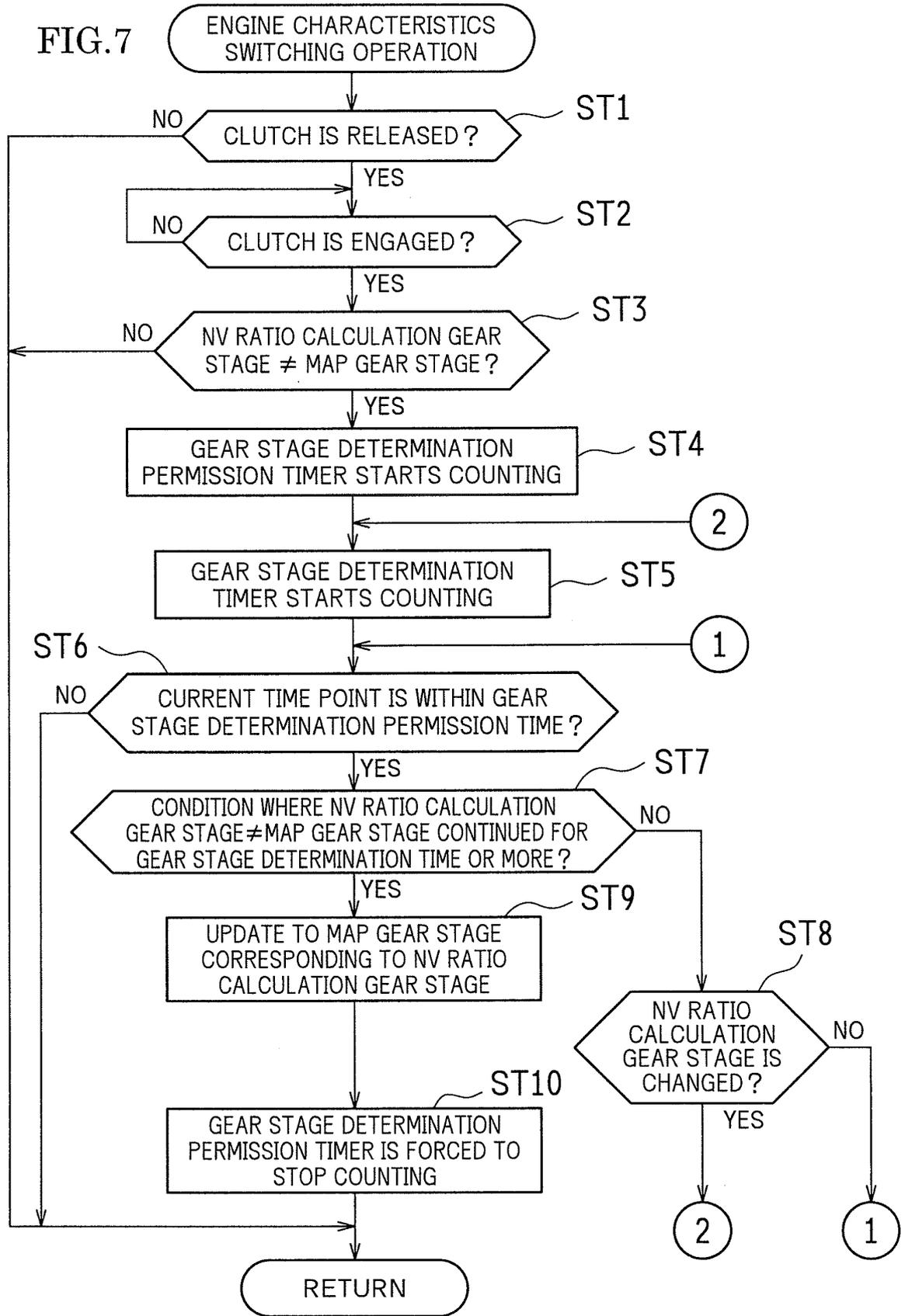


FIG. 8

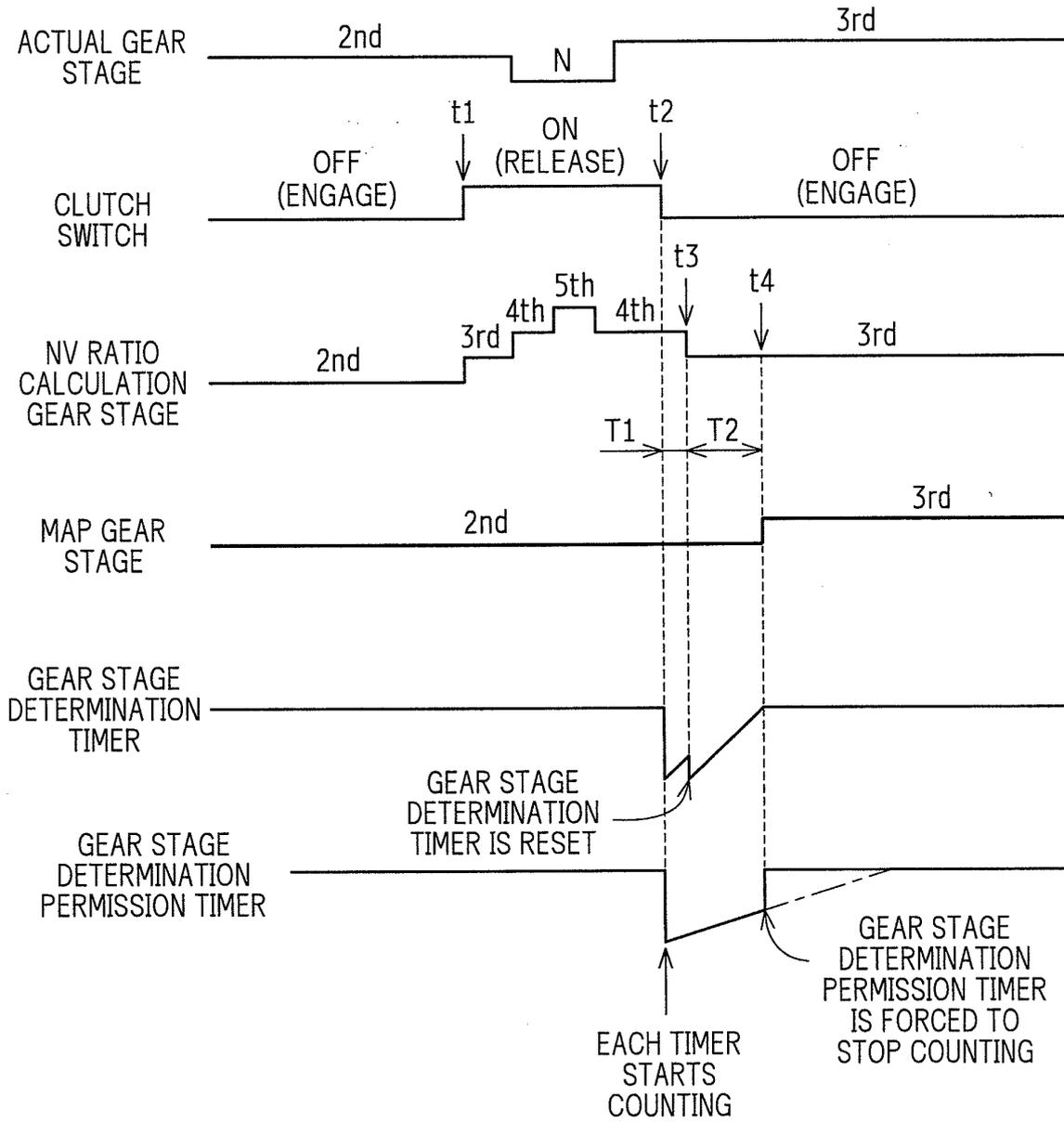


FIG.9

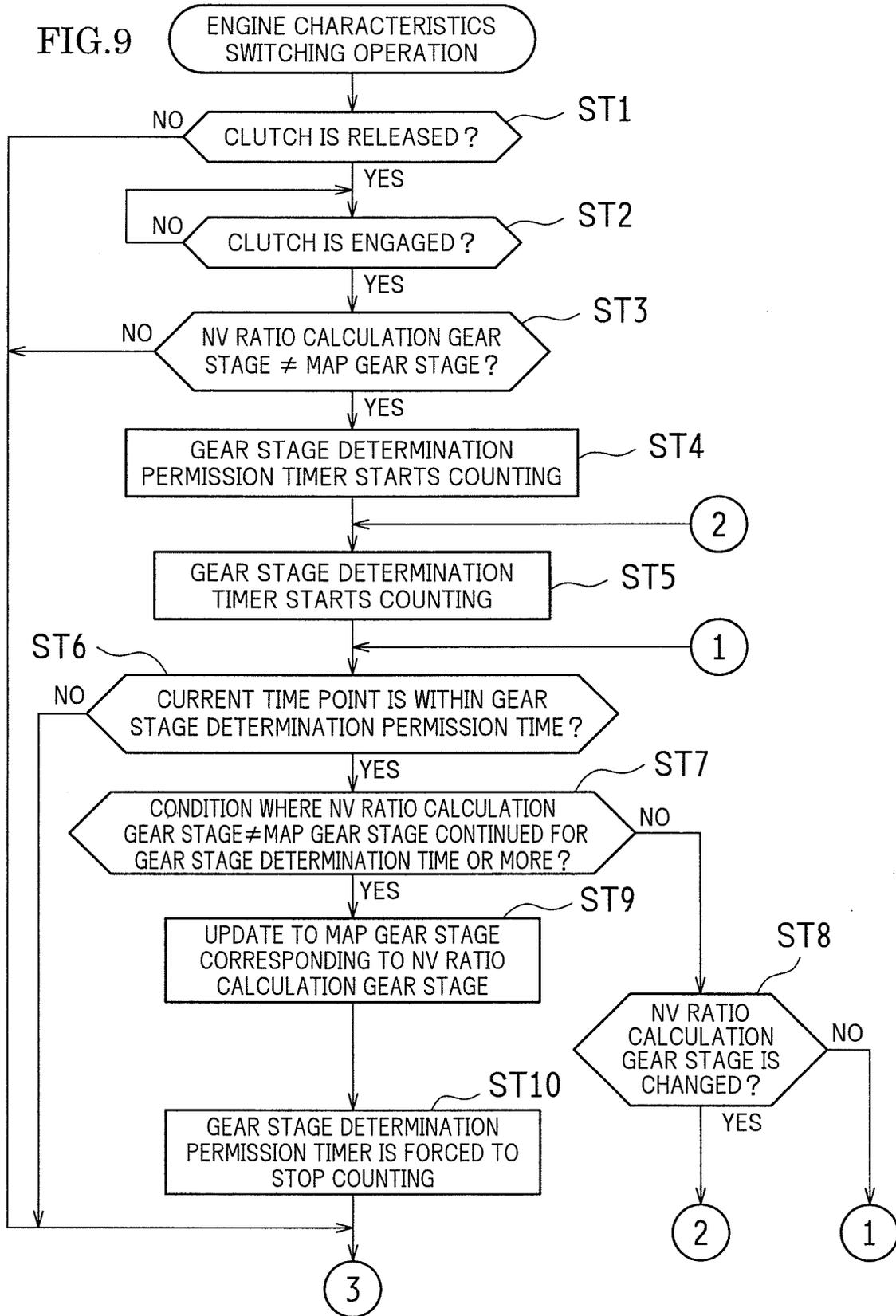


FIG.10

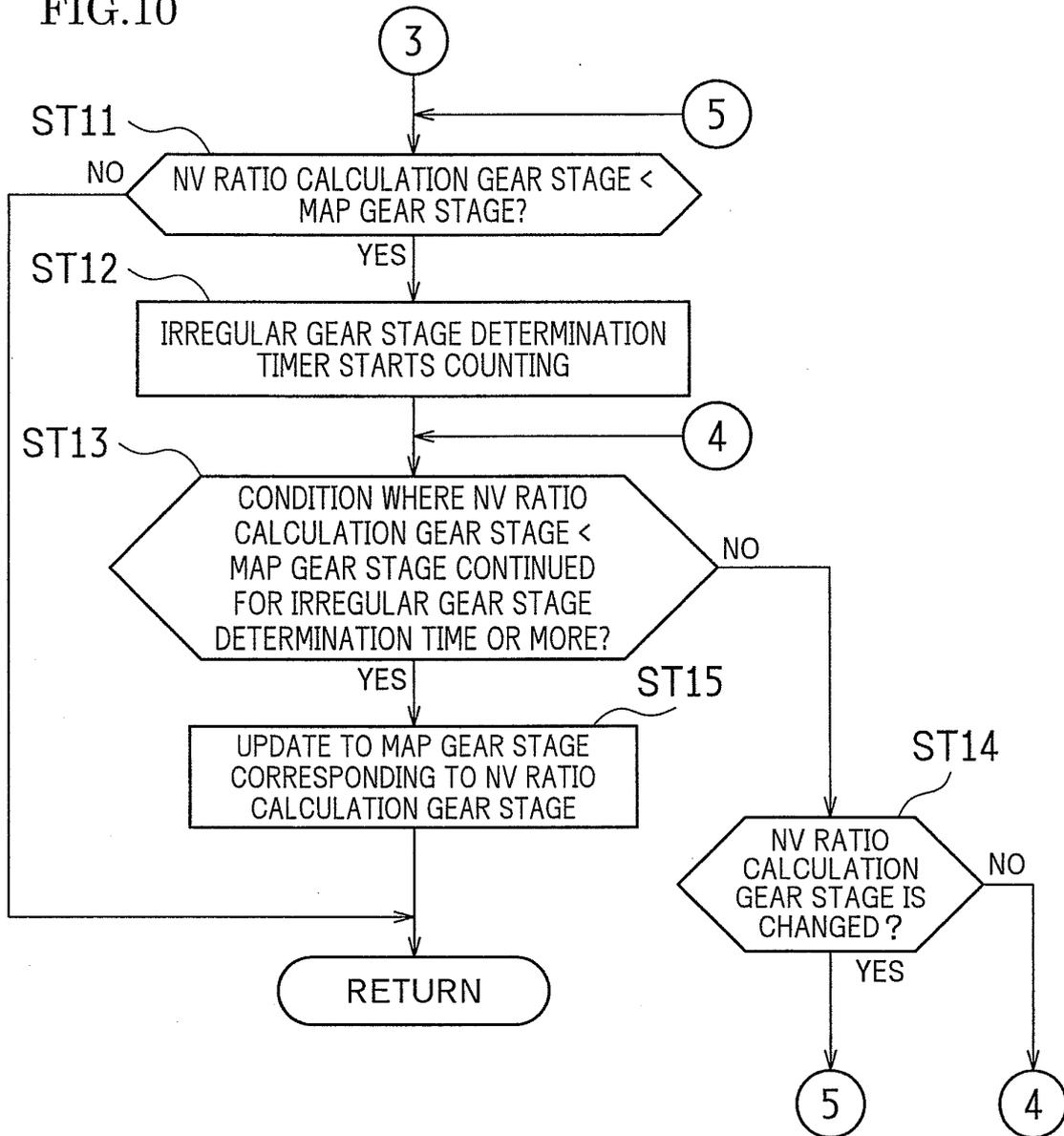


FIG.11

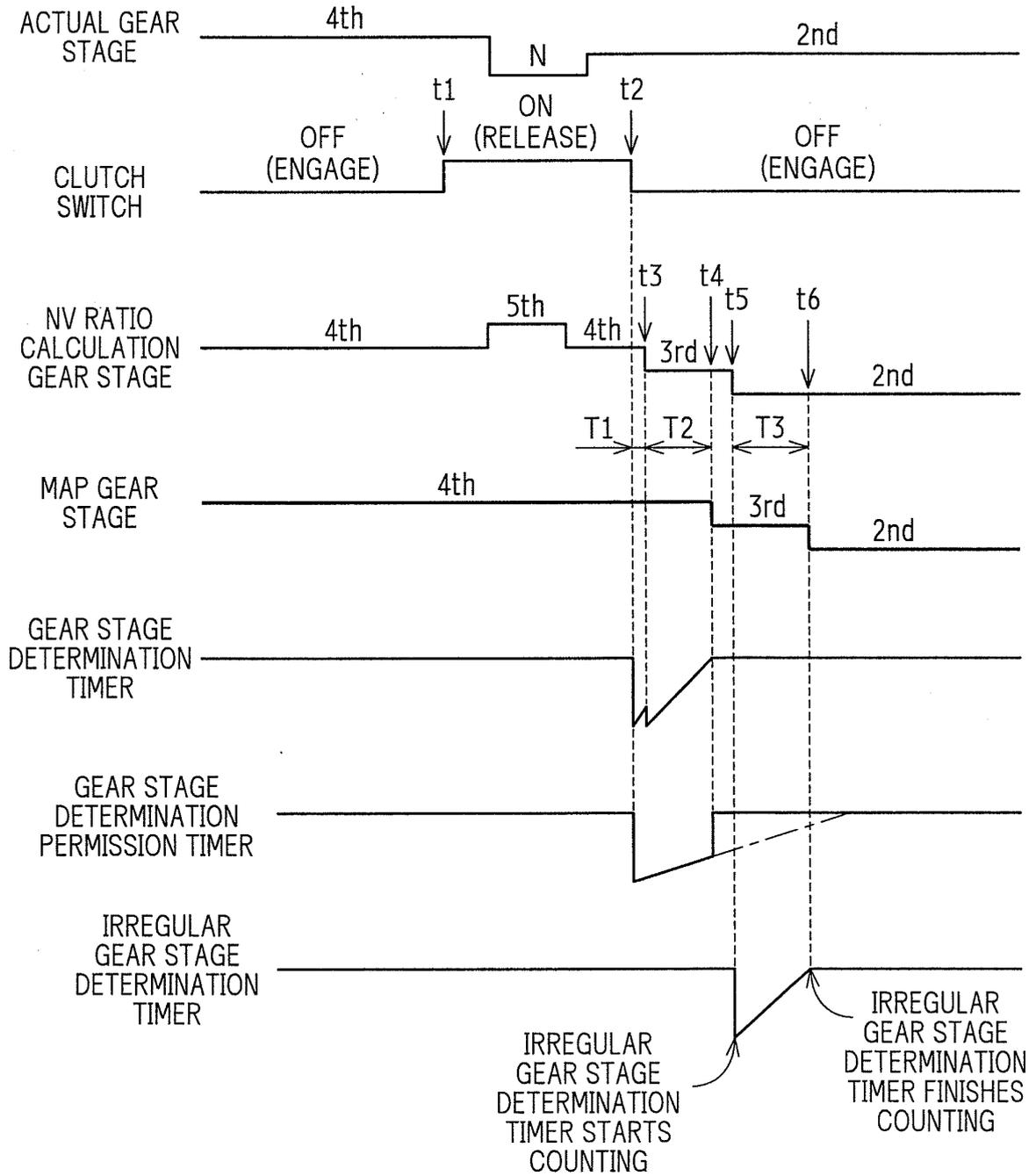
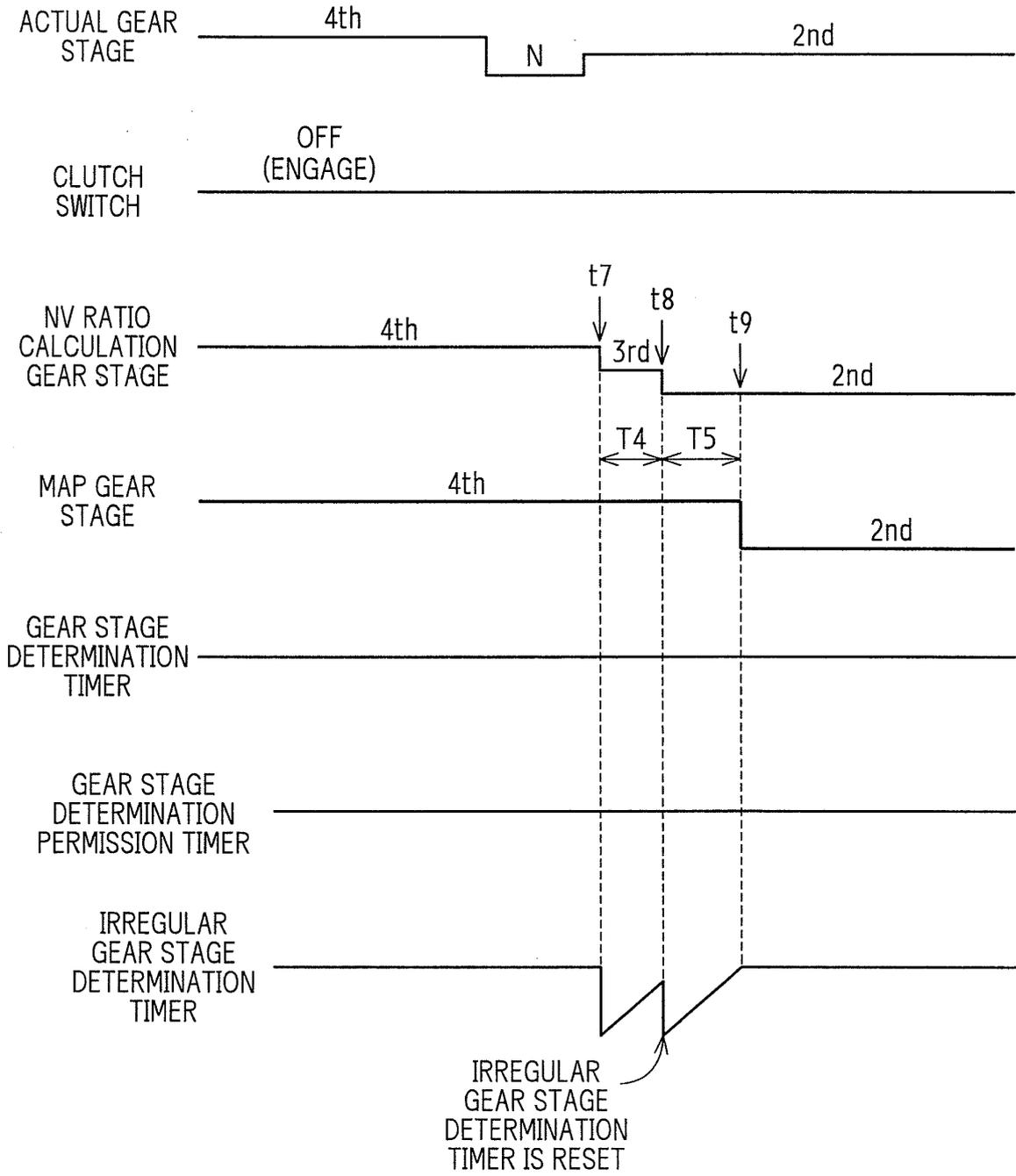


FIG.12



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/068958

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) F02D29/00		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2011 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 2005-90452 A (Nissan Motor Co., Ltd.), 07 April 2005 (07.04.2005), entire text; all drawings (Family: none)	1-9
A	JP 2008-169896 A (Toyota Motor Corp.), 24 July 2008 (24.07.2008), entire text; all drawings & EP 1944529 A2	1-9
A	JP 2010-274843 A (Toyota Motor Corp.), 09 December 2010 (09.12.2010), entire text; all drawings & WO 2010/136858 A2	1-9
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> 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)
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