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(54) **Control device of engine intake throttle valve**

Steuervorrichtung für die Drosselklappe einer Brennkraftmaschine

Appareil de commande pour le papillon de la soupape d'admission d'air dans un moteur à combustion

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- **PATENT ABSTRACTS OF JAPAN vol. 010, no. 231 (M-506), 12 August 1986 (1986-08-12) & JP 61 065046 A (TOYOTA MOTOR CORP), 3 April 1986 (1986-04-03)**

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a control device of an internal combustion engine intake throttle valve according claim 1 which keeps the engine stable after the engine starts.

BACKGROUND OF THE INVENTION

[0002] One example of a control device for controlling an internal combustion engine is disclosed in Japanese Patent No. 2519120. This conventional control device controls an intake throttle valve of a diesel engine, one type of the internal combustion engine. The control device controls the throttle angle of the intake throttle valve of the diesel engine on the basis of atmospheric pressure, intake air temperature, and coolant temperature of the diesel engine, etc. For example, the lower the coolant temperature, the higher the throttle angle of the intake throttle valve is. Then, even during a control in idling condition of the engine, the throttle angle is set to be higher if the coolant temperature is low.

[0003] Just after the engine starts, however, a combustion condition in a combustion chamber of the diesel engine changes swiftly, because a temperature of the combustion chamber increases swiftly. On the contrary, the coolant temperature changes slowly. Therefore, when the engine starts, it is impossible to optimize the combustion condition of the combustion chamber by the controlling method of the conventional control device, because the throttle angle of the intake throttle valve of the engine is controlled on the basis of the coolant temperature which changes slowly.

SUMMARY OF THE INVENTION

[0004] It is thus an object of the present invention to solve the aforementioned problem and to provide a control device of an engine intake throttle valve in which a combustion condition in a combustion chamber of an internal combustion engine can be optimized when the internal combustion engine starts.

[0005] To achieve the aforementioned object, a control device of an engine intake throttle valve according to claim 1 is provided. Preferred embodiments thereof are set forth in the dependent claims.

[0006] In accordance with one aspect of the invention, a control device for controlling an intake throttle valve in an intake air flow passage to a combustion chamber in an internal combustion engine, comprises a combustion chamber temperature estimation means for estimating a temperature of a combustion chamber in said internal combustion engine, and a control means for setting a throttle angle of said intake throttle valve on the basis of the temperature of the combustion chamber estimated by said combustion chamber temperature estimation means after said internal combustion engine starts.

[0007] In the control device, the combustion chamber temperature estimation means may comprise a temperature detection means for detecting a coolant temperature of the internal combustion engine, and a time measuring means for measuring an elapsed time after the internal combustion engine starts, the control means may set the throttle angle of the intake throttle valve on the basis of the coolant temperature detected by the temperature detection means and the elapsed time measured by the time measuring means.

[0008] In this control device, when the engine starts, the throttle angle of the intake throttle valve is controlled by considering not only the coolant temperature of the internal combustion engine, but also the elapsed time after starting the engine. Consequently, although the coolant temperature substantially does not change, the combustion condition of the combustion chamber can be optimized by controlling the throttle angle of the intake throttle valve responsive to the elapsed time after starting the engine.

[0009] In this control device, the shorter the elapsed time measured by the time measuring means becomes, the higher the throttle angle of the intake throttle valve is set.

[0010] If the combustion chamber temperature increases swiftly after the internal combustion engine starts, a combustion condition of the combustion chamber can be optimized by controlling the throttle angle of the intake throttle valve in such a way that the shorter the elapsed time, the higher the throttle angle of the throttle intake valve is.

[0011] In addition to the above-mentioned, the lower the coolant temperature detected by the temperature detection means becomes, the higher the throttle angle of the intake throttle valve is set.

[0012] To determine the throttle angle of the intake throttle valve, this device considers not only the elapsed time after starting the internal combustion engine, but also the detected coolant temperature. That is, the lower the coolant temperature, the higher the throttle angle is. Therefore, a more stable combustion condition of the combustion chamber can be achieved. The throttle angle of the intake throttle valve can be kept constant only until a predetermined time elapses after starting the engine. By this method, a stable combustion condition is realized.

[0013] In this control device, the throttle angle of the intake throttle valve may be kept constant only for a predetermined time after the internal combustion engine starts.

[0014] In this control device, the control means may set a fuel injection timing of the internal combustion engine on the basis of the coolant temperature detected by the temperature detection means and the elapsed time measured by the time measuring means.

[0015] In this control device, the shorter the elapsed time measured by the time measuring means becomes, the more the fuel injection timing is advanced.

[0016] In this control device, the lower the coolant temperature detected by the temperature detection means becomes, the more the fuel timing is advanced.

[0017] Furthermore, the shorter the elapsed time measured by the time measuring means becomes, the higher the throttle angle of the intake throttle valve may be set.

[0018] Furthermore, the lower the coolant temperature detected by the temperature detection means becomes, the higher the throttle angle of the intake throttle valve may be set.

[0019] Furthermore, the fuel injection timing is kept constant after the elapse of the predetermined time subsequent to the start of the internal combustion engine.

[0020] In the control device of the invention, the internal combustion engine may be a diesel engine.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The above and other objects, features, advantages and technical and industrial significance of this invention will be better understood by reading the following detailed description of a presently preferred embodiment of the invention, when considered in connection with the accompanying drawing, in which:

Fig. 1 is a schematic illustration of the overall structure of a control device which is installed, for example, on a diesel engine according to one embodiment of the present invention;
Fig. 2 is a block diagram showing an ECU and input/output signal for the control device of Fig. 1;
Fig. 3 is a flowchart illustrating a target throttle angle setting routine according to the first embodiment of the present invention;
Fig. 4 is a data table showing base throttle angles applied to the first embodiment;
Fig. 5 is a data table showing correction factors of coolant temperatures applied to the first embodiment;
Fig. 6 is a data table showing stabilization times after starting the engine applied to the first embodiment;
Fig. 7 is a graph showing the relationship between a correction factor and an elapsed time after starting the engine applied to a modified embodiment;
Fig. 8 is a flowchart illustrating a target fuel injection timing setting routine according to another embodiment of the present invention;
Fig. 9 is a data table showing base fuel injection timing applied to flowchart in Fig. 8;
Fig. 10 is a data table showing correction factors of the fuel injection timing by coolant temperatures applied to the flowchart in Fig. 8;
Fig. 11 is a graph showing the relationship between the target fuel injection timing and the elapsed time after starting the engine.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0022] In the following and the accompanying drawings, the present invention will be described in more detail in terms of the embodiments. A gasoline engine, a diesel engine, etc. are internal combustion engines. Generally, the present invention is applied to an internal combustion engine, but some part of this invention concerning a fuel injection timing control (later described in detail) particularly relates to a diesel engine. For the convenience of explanation, here a diesel engine is discussed in this embodiment.

[0023] First, FIG. 1 shows the schematic illustration of the overall structure of the control device of an engine intake throttle valve which is installed on a diesel engine according to one embodiment of the present invention. As mentioned above, unless specifically noted, the present invention is not limited to a diesel engine, but applies to all internal combustion engines.

[0024] A diesel engine (hereinafter called engine) 11 has a plurality of cylinders which include combustion chambers 12. In an intake stroke of the engine 11, an intake valve 14 responsive to each combustion chamber 12 intakes ambient air through an intake passage 16 into the combustion chamber 12 by opening an intake port 13. A fuel injection pump 18 pumps fuel and sends the pressured fuel to a fuel injection nozzle 17 through a fuel line 19. The fuel injection nozzle 17 injects the fuel into the combustion chamber 12. In an exhaust stroke of the engine 11, an exhaust valve 23 responsive to each combustion chamber 12 exhausts exhaust gas through an exhaust passage 24 by opening an exhaust port 22.

[0025] A step motor 26 drives an intake throttle valve 25 on the basis of a control signal from an electronic control

unit (hereinafter called ECU) 39 so that a throttle angle of the intake throttle valve 25 is at a desired value. A throttle sensor 58 detects the throttle angle of the intake throttle valve 25.

[0026] An exhaust gas recirculation (hereinafter called EGR) system 40 recirculates part of the exhaust gas exhausted from the combustion chamber 12 to the exhaust passage 24 and returns the exhaust gas to the combustion chamber 12. The EGR system 40 provides an EGR valve 42. The EGR valve 42 regulates the quantity of the exhausted gas which flows through an, EGR passage 41 from the exhaust passage 24 to the intake passage 16.

[0027] The EGR valve 42 has a diaphragm which opens or closes the EGR passage 41 by applying vacuum or atmospheric pressure. The EGR system 40 provides an electric vacuum regulating valve (hereinafter called EVRV) 48 which regulates vacuum and atmospheric pressure introduced into a pressure chamber 46. The EVRV 48 connects a vacuum pump 32 through a vacuum port 51 and atmosphere through an atmosphere port 53, and regulates vacuum pressure supplied to the pressure chamber 46. The ECU 39 controls the EVRV 48 by controlling the electric current. The ECU 39 regulates the EGR valve 42 by controlling the EVRV 48 in response to an operating condition of the engine 11. Therefore, it regulates the quantity of the EGR.

[0028] A crankshaft 21 of the engine 11 rotates a drive shaft 29 of the fuel injection pump 18. A revolution speed sensor 56 attached to the fuel injection pump 18 detects the revolution speed of the drive shaft 29. Therefore it detects the revolution speed of the crankshaft 21, i.e., engine revolutions NE. Furthermore, the revolution speed sensor 56 detects a rotation position of the crankshaft 21.

[0029] A coolant temperature sensor 57 attached on the engine 11 detects a coolant temperature THW of the coolant which cools the engine 11, and it outputs an electric signal responding to the coolant temperature THW to the ECU 39. An intake pressure sensor 59 deposited in the intake passage 16 detects intake pressure PM in the intake passage 16, and an electric signal responding to the intake pressure PM to the ECU 39. An accelerator sensor 61 is positioned close to an accelerator pedal 60, and it outputs an electric signal showing an acceleration stroke ACCP responding to stroke of the accelerator pedal 60.

[0030] Fig. 2 shows a block diagram of the ECU 39 and input/output signal for the control device of Fig. 1. Generally, the ECU 39 includes a central processing unit (i.e. CPU) 63, a read only memory (i.e. ROM) 64, a random access memory (i.e. RAM) 65, a backup random access memory (i.e. backup RAM) 66, an input port 67, an output port 68, an inner bus 69, a plurality of buffers 70, a multiplexer 71, A/D converter 72, a wave-shaping circuit 73, and a couple of drive circuits 74. Electric signals outputted from the respective sensors 57, 58, 59, and 61 are converted from analog signals to digital signals by the A/D converter through buffers 70 and the multiplexer 71, and the digital signals are sent to the input port 67. An electric signal from the revolution speed sensor 56 is corrected by the wave-shaping circuit 73 and sent to the input port 67. Electric signals for driving the step motor 26 and the EVRV 48 are given to the respective drive circuits 74 through the output port 68. After amplifying the electric signals, the respective drive circuits 74 output them to the step motor 26 and the EVRV 48. The input port 67 and the output port 68 are connected to the CPU 63, the ROM 64, the RAM 65, and the backup RAM 66 through the inner bus 69. For example, a control program housed in the ROM 64 calculates parameters. These parameters are indicated by the electric signals inputted to the ECU 39. The control program, thus, executes the control of the intake throttle valve and the EGR.

[0031] In this system of the embodiment, the ECU 39 calculates an amount of fuel injection QFiN on the basis of the engine revolutions NE detected by the revolution speed sensor 56, the acceleration stroke ACCP detected by the accelerator sensor 61, and the intake pressure PM detected by the intake pressure sensor 59. Furthermore, the ECU 39 calculates the target throttle angle LSTRG from the amount of fuel injection QFiN and the engine revolutions NE. The ECU 39 controls the step motor 26 and sets the actual throttle angle of the intake throttle valve 25 detected by the throttle sensor 58, so that the actual throttle angle reaches the target throttle angle LSTRG.

[0032] In this embodiment, the routine shown in the flowchart in Fig. 3 is executed once per e.g. 8 milli-seconds. At each time of the routine processing, the target throttle angle LSTRG is set. When the engine starts in a cooled condition, here, the throttle angle of the intake throttle valve 25 is controlled in response to swift rising of the temperature of the combustion chamber 12, and the combustion condition of the combustion chamber 12 is optimized.

[0033] Next, referring to the flowchart shown in Fig. 3, a process for setting the target throttle angle in this embodiment is described in details as follows.

[0034] By referring to a data table showing base throttle angles in Fig. 4, a base throttle angle LSBSE responsive to the engine revolutions NE and an amount of fuel injection QFiN is given (step S101).

[0035] In the data table showing base throttle angles 111, the vertical line shows the amount of fuel injection QFiN and the horizontal line shows the engine revolutions NE. The base throttle angle LSBSE is given as an integral in the range from 0 to 179. The larger the amount of fuel injection QfiN, the closer to 0 the base throttle angle LSBSE (i.e. higher angle) becomes. Furthermore, the lower the engine revolutions NE, the closer to 179 the base throttle angle LSBSE (i.e. lower angle) becomes.

[0036] The ECU 39 calculates a coolant temperature correction factor mlsthw on the basis of the coolant temperature TWH detected by the coolant temperature sensor 57 and the data table of the coolant temperature correction factor 121 shown in Fig. 5. For instance, if the coolant temperature THW is - 20°C, the coolant temperature correction factor

mlsthw is set to be 0.5 (step S102). In the other case, if the coolant temperature THW is +20°C, the coolant temperature correction factor mlsthw responsive to the THW=+20°C is given by calculating the linear interpolation of the mlsthw=0.5 corresponding to THW=-20°C and the mlsthw=0.76 corresponding to THW=+60°C.

[0037] Subsequently, the ECU 39 determines whether it is just after the engine 11 starts or not (step S103). When it is not just after the engine 11 starts, an elapsed correction factor mlast is set to be 1 (step S105).

[0038] When it is just after the engine 11 starts, the ECU 39 begins to measure the time elapsed after starting the engine 11 by a timer or a time measuring means (not shown in the figures) contained in the ECU 39. Furthermore, the ECU 39 determines a stabilization time tmlast after starting the engine 11, on the basis of the coolant temperature THW and the data table of the stabilization time 131 shown in Fig. 6 (step S104). For example, if the coolant temperature is -20°C, the stabilization time tmlast is set to be 30. If the coolant temperature is +20°C, the stabilization time tmlast corresponding to the THW=+20°C is given by calculating the linear interpolation of the tmlast=10 corresponding to THW=0°C and the tmlast=0 corresponding to THW=+70°C.

[0039] The ECU 39 calculates the elapsed correction factor mlast by substituting the elapsed time cast and the stabilization time tmlast calculated in the step S104 into the following equation (1).

$$\text{(a) when cast} \leq \text{tmlast, mlast} = 0$$

$$\text{(b) when cast} > \text{tmlast, mlast} = (\text{cast} - \text{tmlast}) / k$$

$$\text{here, mlast} \leq 1 \text{ and } k \text{ is constant} \qquad (1)$$

[0040] According to the above-mentioned equation (1), when the elapsed time cast is less than or equal to the stabilization time tmlast, the elapsed correction factor mlast is 0, just after the engine 11 starts. When the elapsed time cast becomes greater than the stabilization time tmlast, the elapsed correction factor mlast increases corresponding to the elapsed time, and finally the value of the mlast reaches 1.

[0041] Subsequently, the ECU 39 yields the target throttle angle LSTRG, substituting the base throttle angle LSBSE, the coolant temperature correction factor mlsthw, and the elapsed correction factor mlast into the following equation (2) (step S106).

$$\text{LSTRG} = \text{LSBSE} \times \text{mlsthw} \times \text{mlast} \qquad (2)$$

[0042] The greater the coolant temperature correction factor mlsthw and/or the elapsed correction factor mlast, the greater (toward the more closed direction) the target throttle angle LSTRG is, according to the equation (2). Consequently, the higher the coolant temperature THW and the longer the elapsed time cast, the more closed (the lower) the target throttle angle LSTRG is set to be. Stated differently, the lower the coolant temperature THW and the shorter the elapsed time cast, the more open (the higher) the target throttle angle LSTRG is set to be.

[0043] After the target throttle angle is determined in the aforementioned procedure, the ECU 39 controls the actual throttle angle 25 to reach the target throttle angle LSTRG by controlling the step motor 26.

[0044] In this control, the target throttle angle LSTRG is set to be more open just after the engine 11 starts, and the target throttle angle LSTRG changes toward the more closed side in response to the elapsed time cast. Therefore the combustion condition of the combustion chamber 12 can be optimized, according to the swift and smooth temperature rise of the combustion chamber 12. Besides, although the coolant temperature THW rises slowly after starting the engine 11, the target throttle angle LSTRG is controlled notwithstanding the coolant temperature THW, and the combustion condition can thus be reliably optimized. Furthermore, the lower the coolant temperature THW, the more open the target throttle angle LSTRG is set to be. This also causes the combustion condition to be optimized. By these above-mentioned advantages, the engine 11 is prevented from misfiring or exhausting white smoke.

[0045] Incidentally, in this embodiment, the target throttle angle is calculated by the equations (1) and (2). However, it is not limited only to this method, and the target throttle angle LSTRG can be calculated by other methods. One example is described as follows referring to Fig. 7. As shown in the graph, a correction factor for the base throttle angle LSBSE (equivalent to mlsthw x mlast in the equation (2)) corresponding to the elapsed time cast is beforehand given as each graph of THW=0°C, THW=40°C, THW=70°C. If the coolant temperature is THW=0°C at starting the engine 11, the correction factor is selected using the graph of THW=0°C in Fig. 7 and the target throttle angle LSTRG is calculated using the correction factor and the elapsed time cast. When the coolant temperature THW is in the middle between 0°C and 40°C or between 40°C and 70°C, the target throttle angle LSTRG is calculated by linear interpolation.

[0046] The present invention is not limited to the aforementioned embodiment and can be modified for many other embodiments. For example, in the equation (2) the base throttle angle LSBSE is corrected by the coolant temperature

correction factor mlsthw and the elapsed correction factor mlast. However, it is also effective to correct the base throttle angle LSBSE by an atmospheric pressure correction factor, an intake air temperature correction factor, the elapsed correction factor mlast, etc., and to give the target throttle angle LSTRG.

[0047] Besides, the data in the data tables in the above-mentioned embodiment is one example, and it is also permissible to modify the data adequately, according to the engine specification. Furthermore, as mentioned above, this embodiment is explained by using the diesel engine 11. However, it is not limited to only diesel engines but also is applicable to all internal combustion engines.

[0048] In the above-mentioned embodiment, in the internal combustion engine starting, the target throttle angle LSTRG is controlled to be more closed in accordance to the elapsed time cast after starting the internal combustion engine. Another embodiment can be realized, however, only in the diesel engine, which is an internal combustion engine. That is, a fuel injection timing to the combustion chamber 12 of the diesel engine 11 is controlled in response to the elapsed time cast.

[0049] A flowchart in Fig. 8 shows a target injection timing setting routine of another embodiment of this invention. First, the ECU 39 determines the base fuel injection timing ABSE, corresponding to the engine revolutions NE and the amount of fuel injection QFiN, referring to the data table of fuel injection timing 211 shown in Fig. 9 (step S201).

[0050] In the data table 211, the vertical line shows an instructed amount of fuel injection QFiN, and the horizontal line shows the engine revolutions NE. The higher the amount of fuel injection QFiN, the more advanced the base fuel injection timing ABSE is. The higher the engine revolutions NE, the more advanced the base fuel injection timing ABSE is.

[0051] Subsequently, the ECU 39 calculates fuel injection cool correction factor ATHW responsive to the engine revolutions NE and the coolant temperature THW detected by the coolant temperature sensor 57, by referring to a data table 221, that shows the fuel injection cool correction factor ATHW corresponding to the coolant temperature in Fig. 10 (step S202).

[0052] In the data table 221, the vertical axis shows the coolant temperature THW, and the horizontal axis shows the engine revolutions NE. The lower the coolant temperature THW, the more advanced the fuel injection timing is. The lower the engine revolutions NE, the more advanced the fuel injection timing is.

[0053] In the next step, the ECU determines whether the engine 11 just started or not (step S203). When the engine 11 has not just started, the ECU 39 sets the fuel injection timing correction factor AAST to 0 (from step S203 to step S205).

[0054] On the other hand, when the engine 11 has just started, the ECU 39 begins to measure the elapsed time cast by the timer (not shown in the figures). Furthermore, the ECU 39 determines the elapsed stabilization time tmlast on the basis the coolant temperature THW detected by the coolant temperature sensor 57 and the data table 131 in Fig. 6 (step S204).

[0055] Next, the ECU 39 calculates a fuel injection timing correction factor AAST by substituting the elapsed time cast and the stabilization time tmlast into the following equation (3).

$$AAST = (tmlast - cast) \times k, \text{ here } AAST \geq 0 \text{ and } k = constant \quad (3)$$

[0056] According to the equation (3), the fuel injection timing correction factor AAST is the greatest when the engine 11 just starts. The AAST changes from the greatest value and finally reaches 0 as the elapsed time cast becomes longer.

[0057] Subsequently, the ECU 39 calculates a target fuel injection timing ATRG by substituting the base fuel injection timing ABSE, the fuel injection cool correction factor ATHW, and the fuel injection timing correction factor AAST into the following equqation (4).

$$ATRG = ABSE + ATHW + AAST \quad (4)$$

[0058] Here, in the starting operation of the engine 11, the base fuel injection timing ABSE is substantially kept constant in a predetermined time, as shown in Fig. 11. The fuel injection cool correction factor ATHW is also substantially kept constant, because the coolant temperature THW changes slowly. The fuel injection timing correction factor AAST, however, changes in response to the elapsed time cast and finally becomes 0. Consequently, the target fuel injection timing ATRG changes according to the fuel injection timing correction factor AAST in starting the engine 11.

[0059] Once the target fuel injection timing ATRG is calculated in this procedure, the ECU 39 determines the target fuel injection timing ATRG on the basis of the rotating position of the crankshaft 21 detected by the revolution speed sensor 56, and directs the fuel injection nozzle 17 to inject the fuel from the fuel injection pump 18 into the combustion chamber 12, at the timing of the target fuel injection timing ATRG.

[0060] In this fuel injection timing control, the fuel injection timing correction factor AAST changes according to the

elapsed time cast, as mentioned above. Consequently, the target fuel injection timing ATRG is set to be advanced when the elapsed time cast is short and is set to be delayed when the elapsed time cast is long. Therefore, the target fuel injection timing ATRG is controlled adequately in response to the swift rising of the temperature of the combustion chamber 12 after starting the engine 11. The combustion condition of the combustion chamber 12 is thus optimized.

[0061] In the above-mentioned embodiment the fuel injection timing is controlled. However, it is also effective that not only the fuel injection timing but also the throttle angle (the above-mentioned control of the target throttle angle LSTRG) and the fuel injection timing are controlled responsive to the elapsed time.

[0062] In the aforementioned embodiment, on the basis of the coolant temperature and the elapsed time after the start of the internal combustion engine, a correction factor for the base throttle angle corresponding to the temperature of the combustion chamber is calculated such that the combustion condition in the combustion chamber is optimized. In the present invention, however, it is not limited to the aforementioned values for calculating the correction factor. Alternatively, the temperature of the combustion chamber can be estimated on the basis of the lubricant temperature and the exhaust gas temperature so as to correct the base throttle angle. It is also possible to calculate the correction factor for the base throttle angle on the basis of the above two temperature values and the elapsed time after the start of the internal combustion engine. Further, in addition to the temperature values of the coolant, lubricant, exhaust gas or the like, for example, the integrated amount of the intake air after the start of the internal combustion engine can be used for determining the correction factor for the base throttle angle corresponding to the temperature of the combustion chamber.

[0063] Furthermore, controlling the quantity of the exhaust gas recirculation and/or the fuel injection ratio just after starting the engine is also effective. In a diesel engine which can conduct pilot fuel injection, such as a common rail type diesel engine, it is also effective to vary the interval between the pilot fuel injection and the main fuel injection. By these controls, the combustion condition of the combustion chamber can also be optimized. Summing up these control, the combustion condition of the combustion chamber can be reliably optimized by adequately combining the respective controls such as the fuel injection timing, the target throttle angle, the quantity of the exhaust gas recirculation, the fuel injection ratio, the interval between the pilot and the main fuel injection, etc.

[0064] The present invention offers a control device of an engine intake throttle valve 25 which optimizes a combustion condition of a combustion chamber 12 when an internal combustion engine 11 starts. The shorter an elapsed time after starting the engine, the higher a target throttle angle of the intake throttle valve 25 is. The target throttle angle changes to be lower in response to swift rising of the temperature of the combustion chamber 12, just after the engine 11 starts. Therefore the combustion condition of the combustion chamber 12 is optimized in the operation of starting the engine 11. Furthermore, the target throttle angle LSTRG is controlled according to the elapsed time after starting the engine 11, even though the coolant temperature changes slowly. Then, the combustion condition of the combustion chamber 12 is reliably optimized.

Claims

1. A control device for controlling an intake throttle valve (25) in an intake air flow passage to a combustion chamber (12) in an internal combustion engine (11), **characterized in that** the control device comprises:

   a combustion chamber temperature estimation means :for estimating a temperature of a combustion chamber in said internal combustion engine; and
   a control means (39) for setting a throttle angle of said intake throttle valve on the basis of the temperature of the combustion chamber estimated by said combustion chamber temperature estimation means after said internal combustion engine starts.

2. A control device for controlling an intake throttle valve according to claim 1, **characterized in that** said combustion chamber temperature estimation means comprises:

   a temperature detection means (57) for detecting a coolant temperature of said internal combustion engine; and
   a time measuring means for measuring an elapsed time after said internal combustion engine starts, wherein said control means sets the throttle angle of said intake throttle valve on the basis of the coolant temperature detected by said temperature detection means and the elapsed time measured by said time measuring means.

3. A control device for controlling an intake throttle valve according to claim 2, **characterized in that** the shorter the elapsed time measured by said time measuring means becomes, the higher the throttle angle of said intake throttle valve is set.

4. A control device for controlling an intake throttle valve according to claim 3, **characterized in that** the lower the coolant temperature detected by said temperature detection means becomes, the higher the throttle angle of said intake throttle valve is set.

5. A control device for controlling an intake throttle valve according to claim 3 or 4, **characterized in that** the throttle angle of said intake throttle valve is kept constant only for a predetermined time after said internal combustion engine starts.

6. A control device for controlling an intake throttle valve according to claim 2, **characterized in that** said control means sets a fuel injection timing of said internal combustion engine on the basis of the coolant temperature detected by said temperature detection means and the elapsed time measured by said time measuring means.

7. A control device for controlling an intake throttle valve according to claim 6, **characterized in that** the shorter the elapsed time measured by said time measuring means becomes, the more said fuel injection timing is advanced.

8. A control device for controlling an intake throttle valve according to claim 6, **characterized in that** the lower the coolant temperature detected by said temperature detection means becomes, the more said fuel timing is advanced.

9. A control device for controlling an intake throttle valve according to claim 7 or 8, **characterized in that** the shorter the elapsed time measured by said time measuring means becomes, the higher the throttle angle of said intake throttle valve is set.

10. A control device for controlling an intake throttle valve according to claim 7 or 8, **characterized in that** the lower the coolant temperature detected by said temperature detection means becomes, the higher the throttle angle of said intake throttle valve is set.

11. A control device for controlling an intake throttle valve according to claim 7 or 8, **characterized in that** said fuel injection timing is kept constant after the elapse of the predetermined time subsequent to the start of said internal combustion engine.

12. A control device for controlling an intake throttle valve according to claim 1, **characterized in that** said internal combustion engine (11) is a diesel engine.

Patentansprüche

1. Ein Steuergerät zur Steuerung eines Ansaugdrosselklappenventils (25) in einem Ansaugluftstromdurchlass zu einer Verbrennungskammer (12) in einem internen Verbrennungsmotor (11),
dadurch gekennzeichnet, dass das Steuergerät aufweist:

eine Verbrennungskammer-Temperaturabschätzungseinrichtung, um eine Temperatur einer Verbrennungskammer in dem internen Verbrennungsmotor abzuschätzen; und
eine Steuereinrichtung (39), um den Drosselklappenwinkel des Ansaugdrosselklappenventils auf Basis der Temperatur der Verbrennungskammer, die von der Verbrennungskammer-Temperaturabschätzungseinrichtung abgeschätzt wird, nachdem der Verbrennungsmotor startet, zu bestimmen.

2. Ein Steuergerät zur Steuerung eines Ansaugdrosselklappenventils gemäß Anspruch 1,
dadurch gekennzeichnet, dass die Verbrennungskammer-Temperaturabschätzungseinrichtung aufweist:

eine Temperaturerfassungseinrichtung (57), um eine Kühlmitteltemperatur des internen Verbrennungsmotors zu erfassen; und
eine Zeitmessungseinrichtung, um eine verstrichene Zeit nachdem der Verbrennungsmotor startet zu messen, wobei
die Steuereinrichtung den Drosselklappenwinkel des Ansaugdrosselklappenventils auf Basis der Kühlmitteltemperatur, die von der Temperaturerfassungseinrichtung erfasst wurde, und der verstrichenen Zeit, die von der Zeitmessungseinrichtung gemessen wurde, bestimmt.

3. Ein Steuergerät zur Steuerung eines Ansaugdrosselklappenventils gemäß Anspruch 2, **dadurch gekennzeichnet, dass** je kürzer die verstrichene Zeit, die von der Zeitmessungseinrichtung gemessen wurde, wird, desto höher der Drosselklappenwinkel des Ansaugdrosselklappenventils bestimmt wird.

4. Ein Steuergerät zur Steuerung eines Ansaugdrosselklappenventils gemäß Anspruch 3, **dadurch gekennzeichnet, dass** je geringer die Kühlmitteltemperatur, die von der Temperaturerfassungseinrichtung erfasst wurde, wird, desto größer der Drosselklappenwinkel des Ansaugdrosselklappenventils bestimmt wird.

5. Ein Steuergerät zur Steuerung eines Ansaugdrosselklappenventils gemäß Anspruch 3 oder 4, **dadurch gekennzeichnet, dass** der Drosselklappenwinkel des Ansaugdrosselklappenventils nur für eine vorbestimmte Zeit, nachdem der interne Verbrennungsmotor startet, konstant gehalten wird.

6. Ein Steuergerät zur Steuerung eines Ansaugdrosselklappenventils gemäß Anspruch 2, **dadurch gekennzeichnet, dass** die Steuereinrichtung eine Treibstoffeinspritzzeit des internen Verbrennungsmotors auf Basis der Kühlmitteltemperatur, die von der Temperaturerfassungseinrichtung erfasst wurde, und der verstrichenen Zeit, die von der Zeiterfassungseinrichtung erfasst wurde, bestimmt.

7. Ein Steuergerät zur Steuerung eines Ansaugdrosselklappenventils gemäß Anspruch 6, **dadurch gekennzeichnet, dass** je kürzer die verstrichene Zeit, die von der Zeitmessungseinrichtung gemessen wurde, wird, desto mehr die Treibstoffeinspritzzeit vorgesetzt wird.

8. Ein Steuergerät zur Steuerung eines Ansaugdrosselklappenventils gemäß Anspruch 6, **dadurch gekennzeichnet, dass** je geringer die Kühlmitteltemperatur, die von der Temperaturerfassungseinrichtung erfasst wurde, wird, desto mehr die Treibstoffeinspritzzeit vorgesetzt wird.

9. Ein Steuergerät zur Steuerung eines Ansaugdrosselklappenventils gemäß Anspruch 7 oder 8, **dadurch gekennzeichnet, dass** je kürzer die verstrichene Zeit, die von der Zeitmessungseinrichtung gemessen wurde, wird, desto größer der Drosselklappenwinkel des Ansaugdrosselklappenventils bestimmt wird.

10. Ein Steuergerät zur Steuerung eines Ansaugdrosselklappenventils gemäß Anspruch 7 oder 8, **dadurch gekennzeichnet, dass** je geringer die Kühlmitteltemperatur, die von der Temperaturerfassungseinrichtung erfasst wurde, wird, desto größer der Drosselklappenwinkel des Ansaugdrosselklappenventils bestimmt wird.

11. Ein Steuergerät zur Steuerung eines Ansaugdrosselklappenventils gemäß Anspruch 7 oder 8, **dadurch gekennzeichnet, dass** die Treibstoffeinspritzzeit nach dem Verstreichen der vorbestimmten Zeit, im Anschluss an den Start des internen Verbrennungsmotors, konstant gehalten wird.

12. Ein Steuergerät zur Steuerung eines Ansaugdrosselklappenventils gemäß Anspruch 1, **dadurch gekennzeichnet, dass** der interne Verbrennungsmotor (11) ein Diesel-Motor ist.

Revendications

1. Appareil de commande pour commander un papillon de soupape d'admission d'air (25) dans un passage d'écoulement d'air d'admission vers une chambre de combustion (12) dans un moteur à combustion interne (11), **caractérisé en ce que** l'appareil de commande comprend :

   un moyen d'estimation de la température de la chambre de combustion pour estimer une température d'une chambre de combustion dans ledit moteur à combustion interne ; et
   un moyen de commande (39) pour définir un angle d'ouverture dudit papillon de soupape d'admission d'air sur la base de la température de la chambre de combustion détectée par ledit moyen d'estimation de la température de la chambre de combustion après que ledit moteur à combustion interne a démarré.

2. Appareil de commande pour commander un papillon de soupape d'admission d'air selon la revendication 1, **caractérisé en ce que** ledit moyen d'estimation de la température de la chambre de combustion comprend :

   un moyen de détection de la température (57) pour détecter une température du liquide de refroidissement dudit moteur à combustion interne ; et

un moyen de mesure du temps pour mesurer un temps écoulé après que ledit moteur à combustion interne a démarré, dans lequel
ledit moyen de commande définit l'angle d'ouverture dudit papillon de soupape d'admission d'air sur la base de la température du liquide de refroidissement détectée par ledit moyen de détection de la température et du temps écoulé mesuré par ledit moyen de mesure du temps.

3. Appareil de commande pour commander un papillon de soupape d'admission d'air selon la revendication 2, **caractérisé en ce que** plus le temps écoulé mesuré par ledit moyen de mesure du temps devient court, plus l'angle d'ouverture dudit papillon de soupape d'admission d'air est défini grand.

4. Appareil de commande pour commander un papillon de soupape d'admission d'air selon la revendication 3, **caractérisé en ce que** plus la température du liquide de refroidissement détectée par ledit moyen de détection de la température devient basse, plus l'angle d'ouverture dudit papillon de soupape d'admission d'air est défini grand.

5. Appareil de commande pour commander un papillon de soupape d'admission d'air selon la revendication 3 ou 4, **caractérisé en ce que** l'angle d'ouverture dudit papillon de soupape d'admission d'air est maintenu constant uniquement pendant un temps prédéterminé après que ledit moteur à combustion interne a démarré.

6. Appareil de commande pour commander un papillon de soupape d'admission d'air selon la revendication 2, **caractérisé en ce que** ledit moyen de commande définit un calage d'injection de carburant dudit moteur à combustion interne sur la base de la température du liquide de refroidissement détectée par ledit moyen de détection de la température et du temps écoulé mesuré par ledit moyen de mesure du temps.

7. Appareil de commande pour commander un papillon de soupape d'admission d'air selon la revendication 6, **caractérisé en ce que** plus le temps écoulé mesuré par ledit moyen de mesure du temps devient court, plus le calage d'injection de carburant est avancé.

8. Appareil de commande pour commander un papillon de soupape d'admission d'air selon la revendication 6, **caractérisé en ce que** plus la température du liquide de refroidissement détectée par ledit moyen de détection de la température devient basse, plus le calage d'injection de carburant est avancé.

9. Appareil de commande pour commander un papillon de soupape d'admission d'air selon la revendication 7 ou 8, **caractérisé en ce que** plus le temps écoulé mesuré par ledit moyen de mesure du temps devient court, plus l'angle d'ouverture dudit papillon de soupape d'admission d'air est défini grand.

10. Appareil de commande pour commander un papillon de soupape d'admission d'air selon la revendication 7 ou 8, **caractérisé en ce que** plus la température du liquide de refroidissement détectée par ledit moyen de détection de la température devient basse, plus l'angle d'ouverture dudit papillon de soupape d'admission d'air est défini grand.

11. Appareil de commande pour commander un papillon de soupape d'admission d'air selon la revendication 7 ou 8, **caractérisé en ce que** ledit calage d'injection de carburant est maintenu constant après l'écoulement du temps prédéterminé après le démarrage dudit moteur à combustion interne.

12. Appareil de commande pour commander un papillon de soupape d'admission d'air selon la revendication 1, **caractérisé en ce que** ledit moteur à combustion interne (11) est un moteur diesel.

FIG. 1

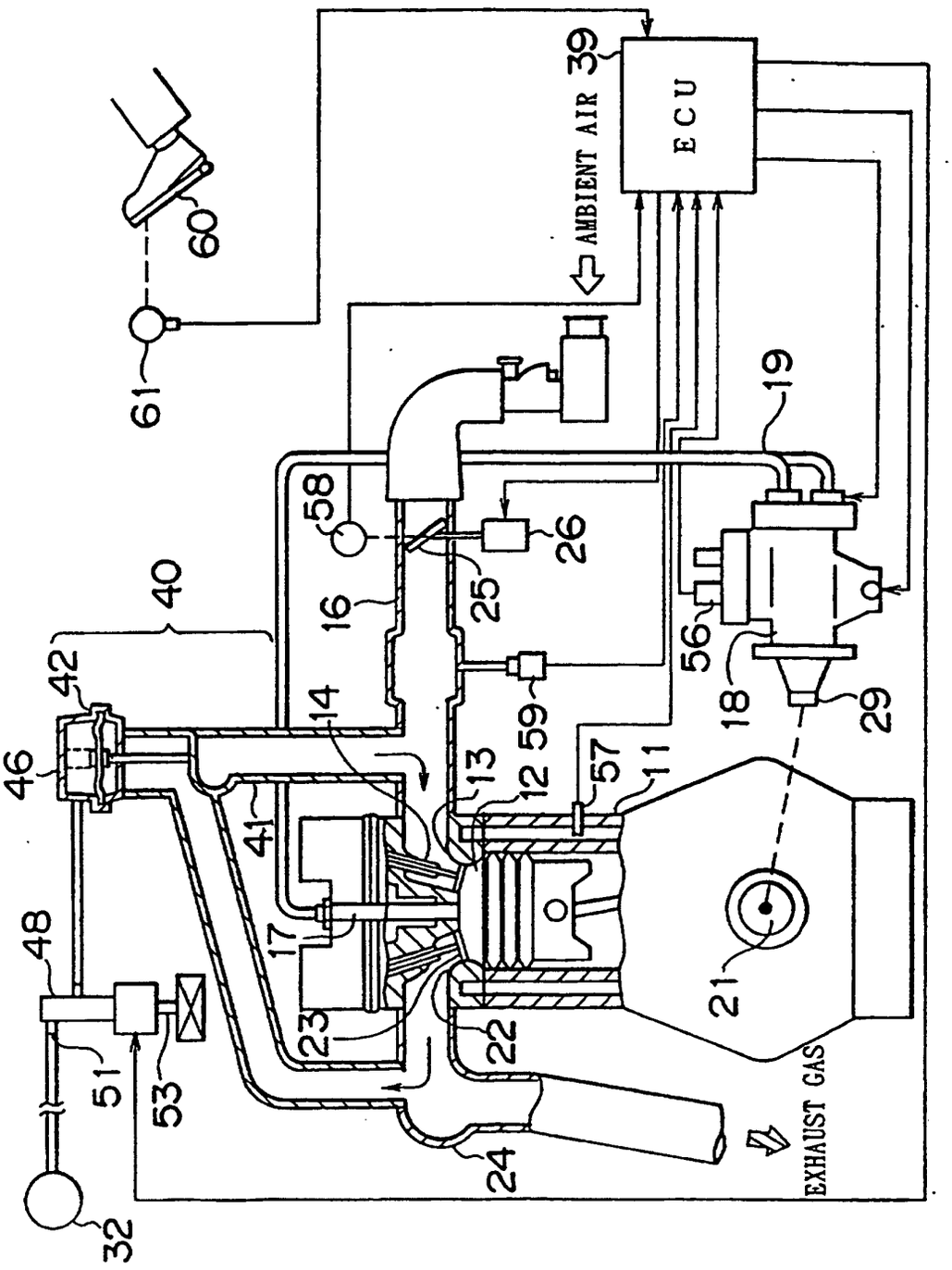

ECU
39
AMBIENT AIR
60
61
19
58
26
25
16
40
42
14
56
18
29
46
13
12
59
57
11
41
48
17
23
22
21
51
53
24
EXHAUST GAS
32

FIG. 2

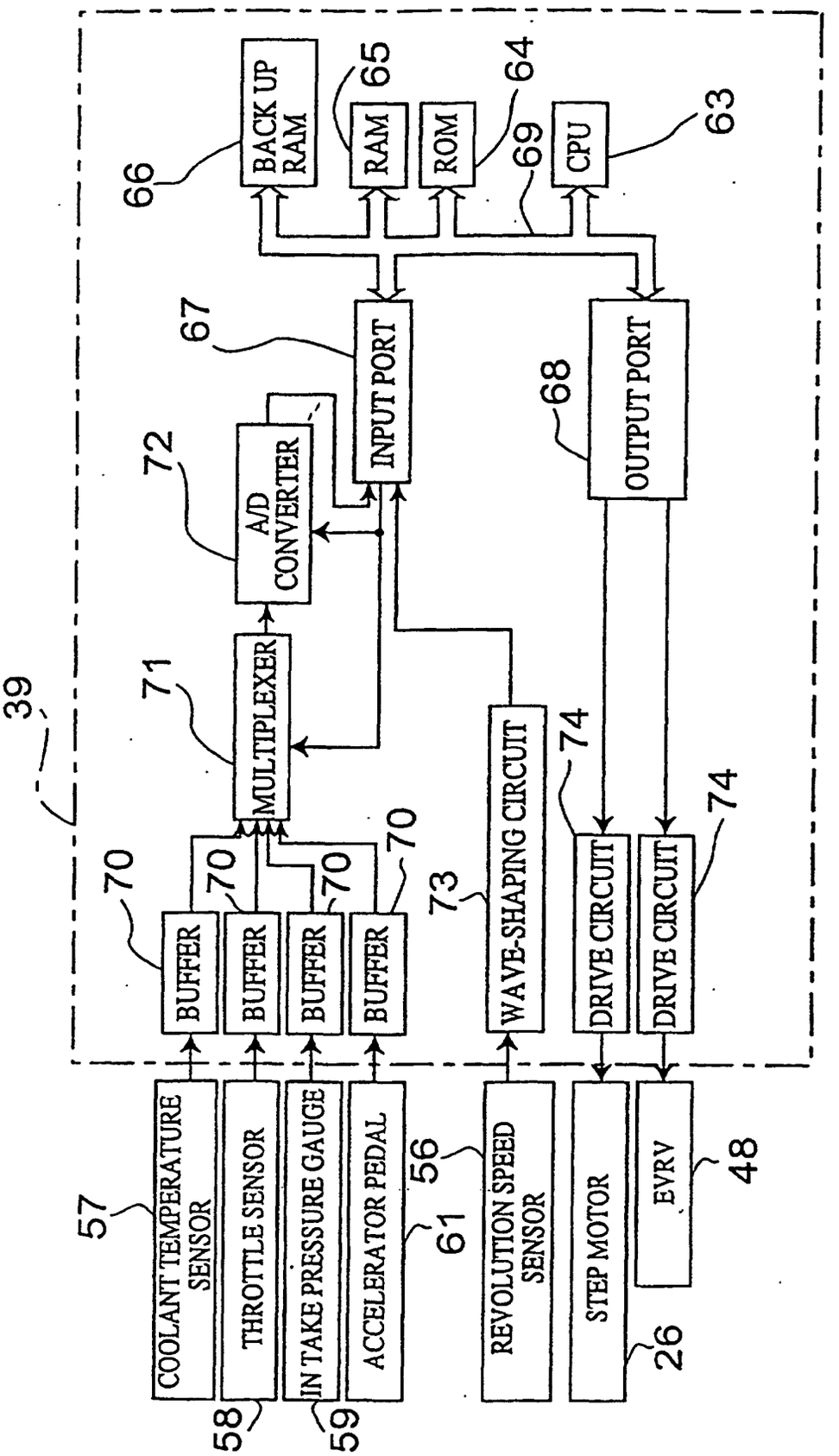

39
BACK UP RAM
66
RAM
65
ROM
64
CPU
63
69
INPUT PORT
67
OUTPUT PORT
68
A/D CONVERTER
72
MULTIPLEXER
71
BUFFER
70
WAVE-SHAPING CIRCUIT
73
DRIVE CIRCUIT
74
COOLANT TEMPERATURE SENSOR
57
THROTTLE SENSOR
58
IN TAKE PRESSURE GAUGE
59
ACCELERATOR PEDAL
61
REVOLUTION SPEED SENSOR
56
STEP MOTOR
26
EVRV
48

FIG. 3

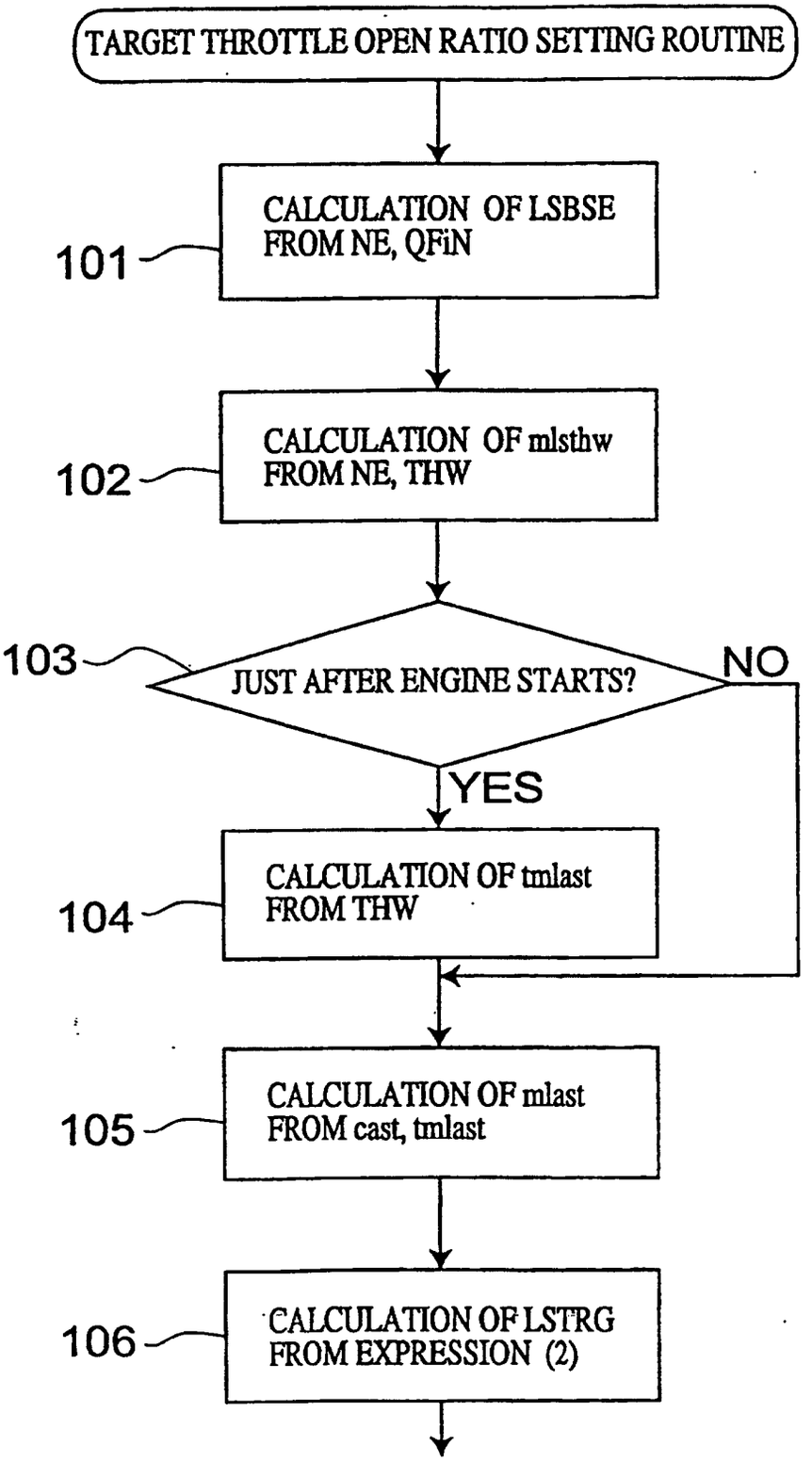

TARGET THROTTLE OPEN RATIO SETTING ROUTINE
101
CALCULATION OF LSBSE FROM NE, QFiN
102
CALCULATION OF mlsthw FROM NE, THW
103
JUST AFTER ENGINE STARTS?
NO
YES
104
CALCULATION OF tmlast FROM THW
105
CALCULATION OF mlast FROM cast, tmlast
106
CALCULATION OF LSTRG FROM EXPRESSION (2)

FIG. 4

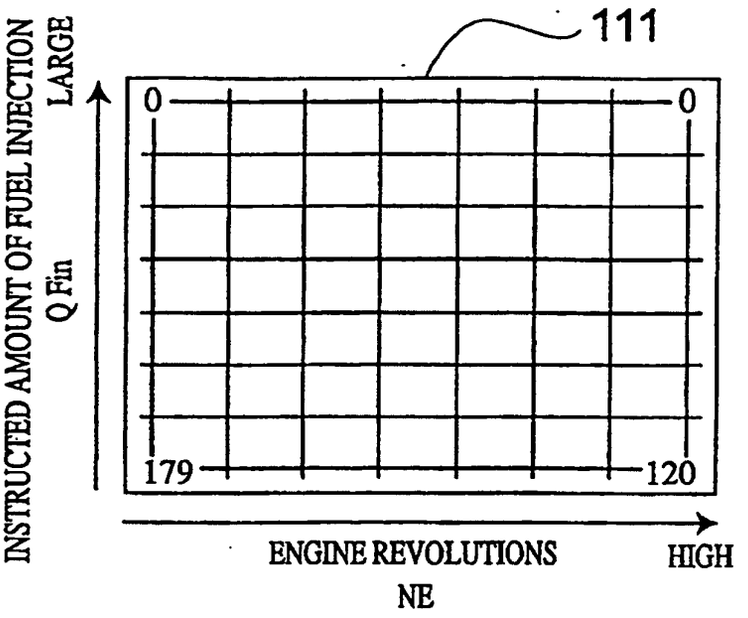


FIG. 5

121

COOLANT TEMPERATURE THW		-20	60	70
COOLANT TEMPERATURE CORRECTION FACTOR	mlsthw	0.5	0.76	1.0

FIG. 6

131

COOLANT TEMPERATURE THW		-20	0	70
TIME FOR STABILIZATION AFTER ENGINE STARTS	tmlast	30	10	0

FIG. 7

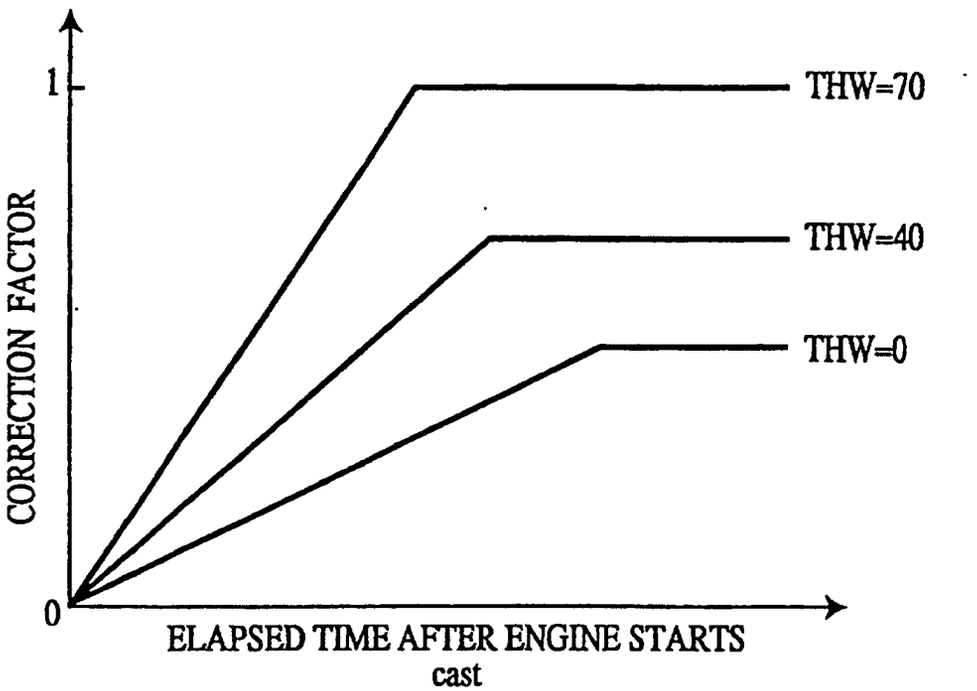

1
0
CORRECTION FACTOR
THW=70
THW=40
THW=0
ELAPSED TIME AFTER ENGINE STARTS
cast

FIG. 8

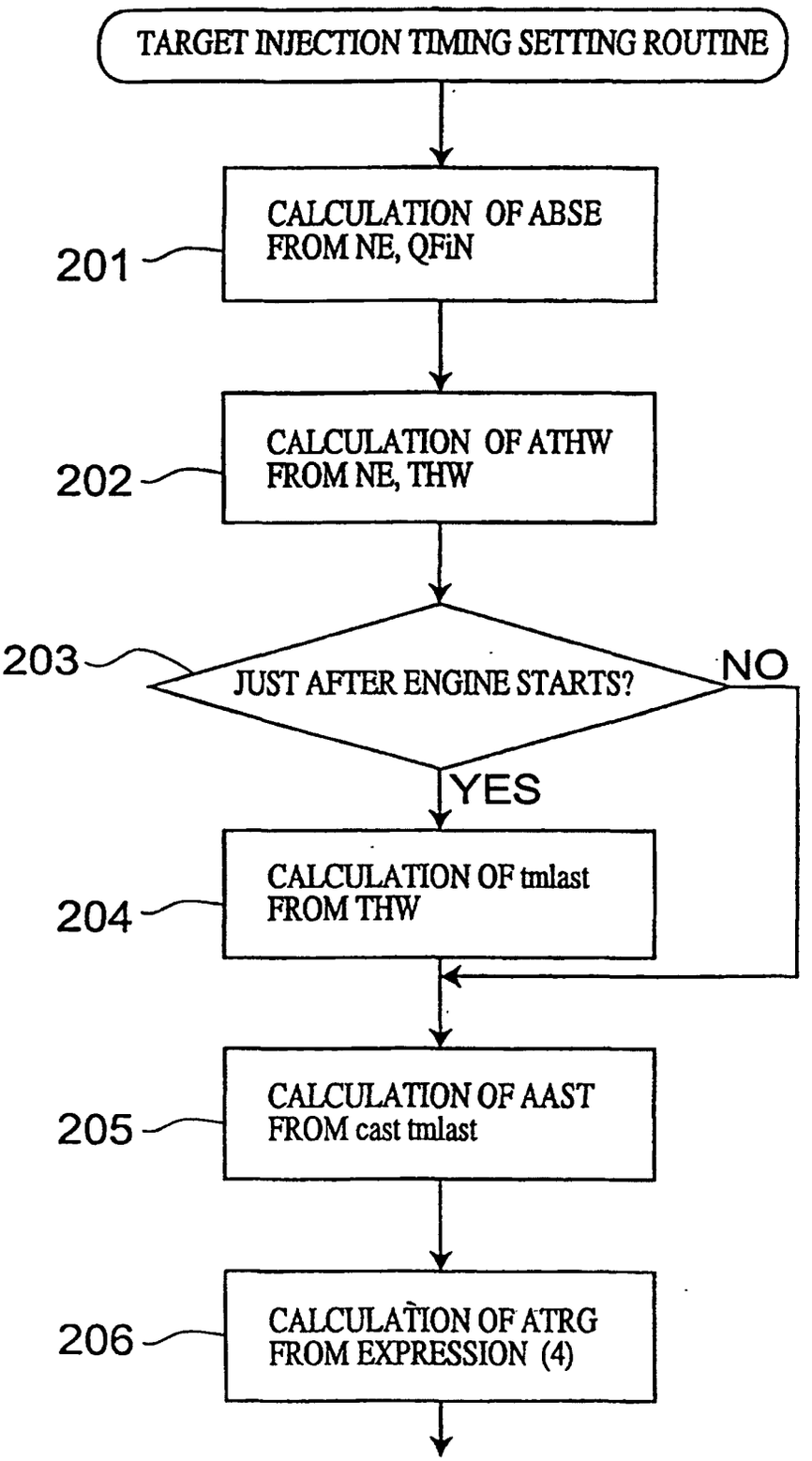

TARGET INJECTION TIMING SETTING ROUTINE
201
CALCULATION OF ABSE FROM NE, QFiN
202
CALCULATION OF ATHW FROM NE, THW
203
JUST AFTER ENGINE STARTS?
NO
YES
204
CALCULATION OF tmlast FROM THW
205
CALCULATION OF AAST FROM cast tmlast
206
CALCULATION OF ATRG FROM EXPRESSION (4)

FIG. 9

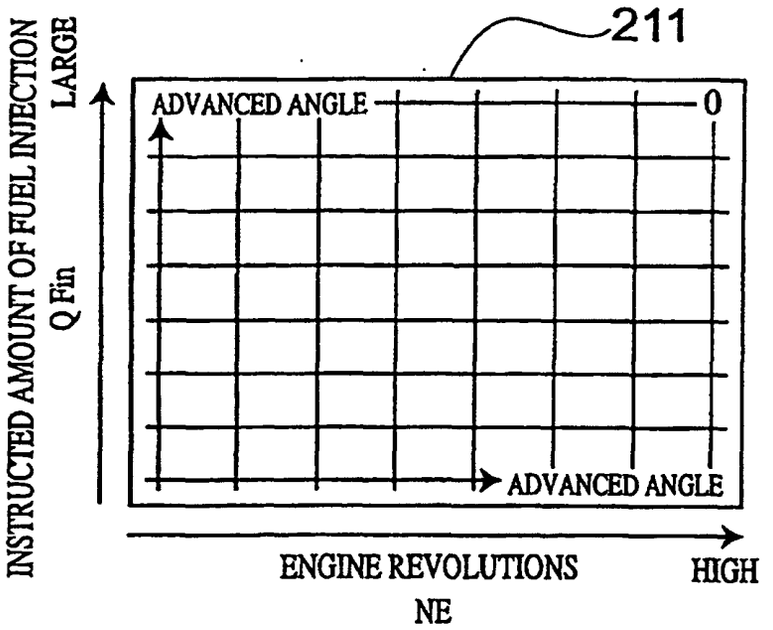

211
ADVANCED ANGLE
0
ADVANCED ANGLE
INSTRUCTED AMOUNT OF FUEL INJECTION
Q Fin
LARGE
ENGINE REVOLUTIONS
NE
HIGH

FIG. 10

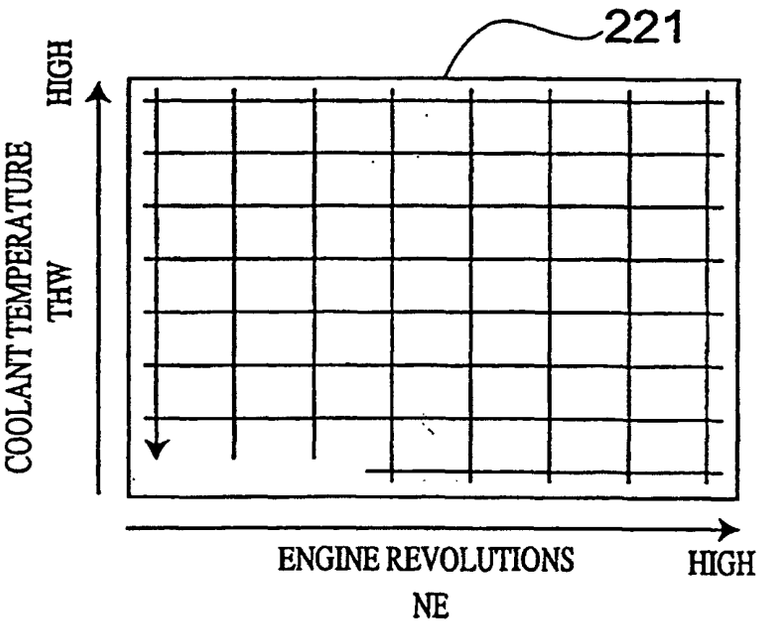
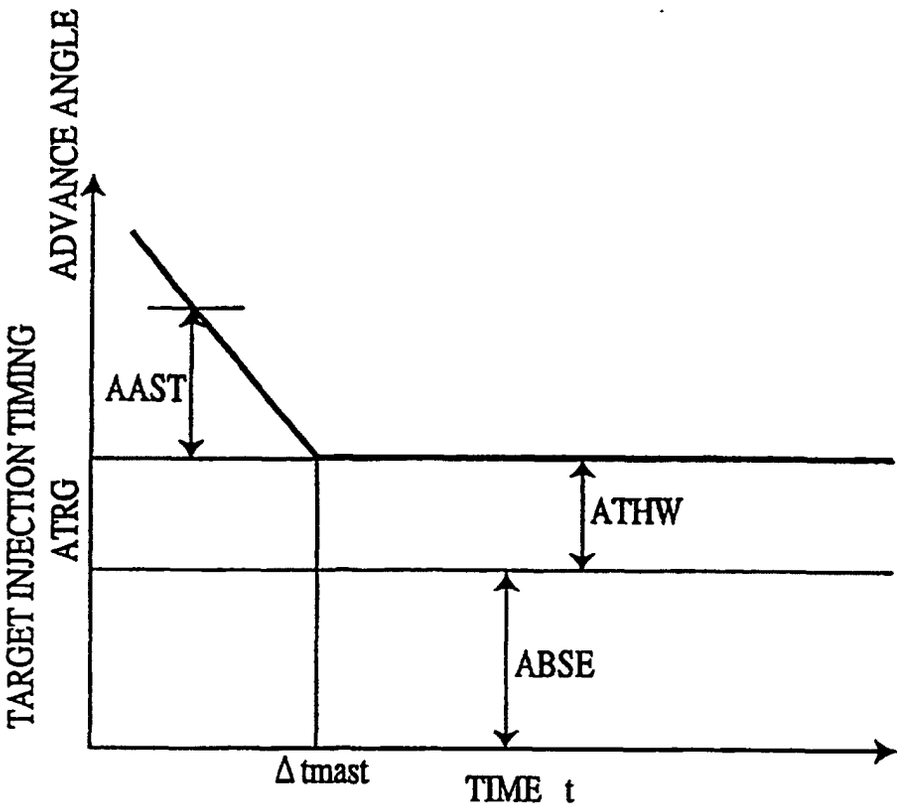

221
HIGH
COOLANT TEMPERATURE
THW
ENGINE REVOLUTIONS
NE
HIGH

FIG. 11


ADVANCE ANGLE
TARGET INJECTION TIMING
ATRG
AAST
ATHW
ABSE
Δ tmast
TIME t