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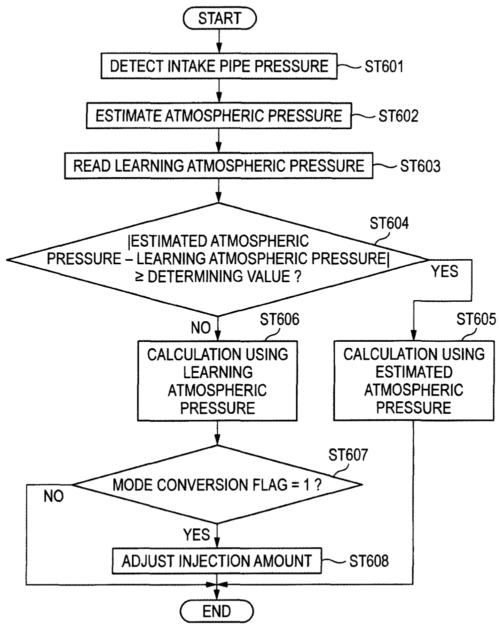
(54) ENGINE CONTROL SYSTEM

(57) An engine control system capable of appropriately controlling fuel injection, irrespective of situations of a throttle opening degree, is provided. A engine control system 1 includes a fuel injection amount calculation unit 33 configured to calculate a fuel injection amount based on an estimated atmospheric pressure estimated from an intake pipe pressure by an atmospheric pressure estimation unit 31 and an engine rotation number detected by an engine rotation number sensor 6. The fuel injection amount calculation unit is configured to compare the estimated atmospheric pressure estimated upon engine start and a learning atmospheric pressure stored in an atmospheric pressure storage unit 32, and calculates a fuel injection amount by using the learning atmospheric pressure when a difference between the estimated atmospheric pressure and the learning atmospheric pressure is smaller than a predetermined value and calculates a fuel injection amount by using the estimated atmospheric pressure when the difference between the estimated atmospheric pressure and the learning atmospheric pressure is equal to or larger than the predetermined value.

FIG. 6



EP 2 963 272 A1

Description

TECHNICAL FIELD

[0001] The invention relates to an engine control system, and more particularly, to an engine control system configured to control an engine having a fuel injection (FI) device configured to adjust a fuel injection amount.

BACKGROUND ART

[0002] In a fuel injection (FI) device configured to estimate an intake amount by using an intake pressure sensor, since an air density is used to control the fuel injection, atmospheric pressure detection is necessarily required. In general, a large-scaled outboard motor having an engine mounted thereto, on which the FI device is mounted, has a battery. For this reason, the intake pressure sensor for atmospheric pressure detection can be fed with power from the battery just after an ignition switch is switched to an on state, so that it can correctly detect an atmospheric pressure.

[0003] In recent years, a small-scaled outboard motor having an engine mounted thereto, on which the FI device is mounted, is also widely used. Also in the small-scaled outboard motor, the atmospheric pressure detection is required so as to appropriately control the fuel injection. However, in some small-scaled outboard motors, a battery is not provided and the engine load is driven only with self-power generation by a generator (AC generator). In these small-scaled outboard motors, the atmospheric pressure is estimated with the intake pressure sensor after the engine is started.

[0004] For example, a control system has been suggested in which a maximum intake pressure upon the engine start is used as an estimated atmospheric pressure, and when an intake pressure (detected intake pressure) detected at a timing at which a throttle opening degree reaches a vicinity of a complete opening is higher than the estimated atmospheric pressure at that time, the detected intake pressure is updated as the estimated atmospheric pressure (for example, refer to Patent Document 1). In this control system, since the intake pressure detected upon the complete opening of the throttle is updated as the estimated atmospheric pressure, it is possible to detect the estimated atmospheric pressure, depending on operating situations of the engine.

PRIOR TECHNICAL DOCUMENTS

PATENT DOCUMENT

[0005] [Patent Document 1] Japanese Patent Application Publication No. 2013-199915A

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0006] However, according to the control system of Patent Document 1, the estimated atmospheric pressure is updated at the timing at which the throttle opening degree reaches the vicinity of the complete opening. For this reason, when the throttle opening degree does not reach the vicinity of the complete opening, a difference between the maximum intake pressure upon the engine start and the actual atmospheric pressure may increase. In this case, the fuel injection is controlled based on the estimated atmospheric pressure having a difference from the actual atmospheric pressure, so that it is difficult to appropriately control the fuel injection.

[0007] It is therefore an object of the present invention to provide an engine control system capable of appropriately controlling fuel injection, irrespective of situations of a throttle opening degree.

MEANS FOR SOLVING THE PROBLEMS

[0008] An engine control system of the present invention includes a rotation number detection means for detecting an engine rotation number; a pressure detection means for detecting an intake pipe pressure downstream of a throttle valve; an atmospheric pressure estimation means for estimating an estimated atmospheric pressure from the intake pipe pressure detected by the pressure detection means; a storage means for storing the estimated atmospheric pressure output from the atmospheric pressure estimation means, as a learning atmospheric pressure, after an engine is stopped; and a fuel injection amount calculation means for calculating a fuel injection amount based on the engine rotation number and the estimated atmospheric pressure, wherein the fuel injection amount calculation means is configured to compare the estimated atmospheric pressure estimated upon engine start and the learning atmospheric pressure stored in the storage means, and calculates a fuel injection amount by using the learning atmospheric pressure when a difference between the estimated atmospheric pressure and the learning atmospheric pressure is smaller than a predetermined value and calculates a fuel injection amount by using the estimated atmospheric pressure when the difference between the estimated atmospheric pressure and the learning atmospheric pressure is equal to or larger than the predetermined value.

[0009] According to the above configuration, the estimated atmospheric pressure estimated upon the engine start and the learning atmospheric pressure stored in the storage means are compared. When a difference thereof is smaller than the predetermined value, the fuel injection amount is calculated using the learning atmospheric pressure stored in the storage means. For this reason, even when the throttle opening degree does not reach a vicinity of the complete opening, for example, it is possible to calculate the fuel injection amount by using the stored learning atmospheric pressure. As a result, it is possible to appropriately control the fuel injection, irrespective of the situations of the throttle opening degree.

[0010] In the engine control system, when the difference between the estimated atmospheric pressure and the learning atmospheric pressure is equal to or larger than the predetermined value, the atmospheric pressure estimation means preferably adjusts the estimated atmospheric pressure, depending on the engine rotation number. In this case, since it is possible to adjust the estimated atmospheric pressure in conformity to the intake pressure varying depending on the engine rotation number, it is possible to update the estimated atmospheric pressure within a more correct and wider range.

[0011] Also, in the engine control system, when the difference between the estimated atmospheric pressure and the learning atmospheric pressure is equal to or smaller than the predetermined value, the fuel injection amount calculation means preferably calculates a fuel injection amount appropriate to a lean burn control from a non-lean burn control. In this case, since the fuel injection amount appropriate to the lean burn control is calculated only when the difference between the estimated atmospheric pressure estimated from the intake pipe pressure and the learning atmospheric pressure is equal to or smaller than the predetermined value, it is possible to realize the shift to the lean burn control while preventing the engine output from being rapidly lowered.

EFFECTS OF THE INVENTION

[0012] According to the engine control system of the present invention, it is possible to appropriately control the fuel injection, irrespective of situations of the throttle opening degree.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Fig. 1 shows a schematic configuration of an engine control system according to an illustrative embodiment.

Fig. 2 is a pictorial view illustrating an intake structure of an engine to which the engine control system of the illustrative embodiment is applied.

Fig. 3 is a flowchart for illustrating an operation outline upon fuel injection control in the engine control system of the illustrative embodiment.

Fig. 4 is a flowchart for illustrating atmospheric pressure learning processing in the engine control system of the illustrative embodiment.

Fig. 5 shows an example of an estimated atmospheric pressure adjusting map that is used in the engine control system of the illustrative embodiment.

Fig. 6 is a flowchart for illustrating injection amount calculating processing in the engine control system of the illustrative embodiment.

EMBODIMENTS FOR CARRYING OUT THE INVENTION

[0014] Hereinafter, an illustrative embodiment will be described in detail with reference to the accompanying drawings. In below descriptions, a case where the engine control system of the present invention is applied to an outboard motor will be described. However, the application target is not limited to the outboard motor and can be appropriately changed. For example, the present invention can also be applied to a vehicle such as an automatic two-wheeled vehicle having a configuration of estimating an atmospheric pressure by an intake pressure sensor. Also, the engine control system of the present invention is appropriately used for an outboard motor having no battery. However, the present invention can also be applied to an outboard motor having a battery mounted thereto.

[0015] Fig. 1 shows a schematic configuration of an engine control system according to an illustrative embodiment. Fig. 2 is a pictorial view illustrating an intake structure of an engine to which the engine control system of the illustrative embodiment is applied. In Fig. 1, only an engine, an ECM (Engine Control Module) and peripheral constitutional elements thereof, which are necessary when applying the present invention, are shown so as to simplify the descriptions, and the other constitutional elements are not shown. The engine control system according to the illustrative embodiment is applied to an outboard motor having no battery, for example.

[0016] As shown in Fig. 1, an engine control system 1 includes an engine 2, which is an internal combustion engine, and an ECM 3 configured to control the engine 2. The engine 2 is provided with a recoil starter 4 and a generator (AC generator) 5. The ECM 3 is connected with an engine rotation number sensor 6, an intake pressure sensor 7, a throttle position sensor 8 and an injector 9. Also, the engine rotation number sensor 6 and the intake pressure sensor 7 configure the rotation number detection means and the pressure detection means defined in the claims, respectively.

[0017] The engine 2 is a direct acting-type DOHC (Double OverHead Camshaft) engine, for example, and has a crankshaft 21, a cylinder 22, a cylinder head 23 and the like (refer to Fig. 2). In the cylinder 22, a piston 24 is accommodated to vertically reciprocate. The crankshaft 21 and the piston 24 are coupled by a connecting rod 25. The piston 24 reciprocates vertically, so that the crankshaft 21 is rotated through the connecting rod 25.

[0018] In the cylinder head 23, a combustion chamber 231 is provided. An intake valve 26 and an exhaust valve 27 are arranged at the cylinder head 23, in correspondence to an intake port and an exhaust port. A pair of rocker arms 28a, 28b is provided in correspondence to the intake valve 26 and the exhaust valve 27. Also, the cylinder head 23 is provided with a camshaft 29 configured to drive the rocker arms 28a, 28b. A cam chain (not shown) is put on the crankshaft 21 and the camshaft 29, and rotation of the crankshaft 21 is transmitted to the camshaft 29 through the cam chain.

[0019] When the camshaft 29 is rotated, the pair of rocker arms 28a, 28b is timely driven, so that the intake valve 26 and the exhaust valve 27 are reciprocally moved towards the combustion chamber 231. In this way, opening and closing timings of the respective intake valve 26 and exhaust valve 27 are adjusted. Also, the cylinder head 23 is provided with an ignition device 30 configured to ignite a mixture gas in the combustion chamber 231. The ignition device 30 is configured to ignite at a predetermined timing based on an ignition signal supplied from the ECM 3.

[0020] The recoil starter 4 is configured to function as a manual starting device, and is provided at one end of the crankshaft 21 of the engine 2. In the recoil starter 4, a pulley (not shown) is accommodated. A rope 41 is wound on the pulley with one end being exposed from a case of the recoil starter 4. When an operator (driver) pulls the end portion of the rope 41 with a hand, a rotating force can be applied to the crankshaft 21 of the engine 2.

[0021] The generator 5 is provided at the same end portion of the crankshaft 21 of the engine 2 at which the recoil starter 4 is provided. For example, the generator 5 consists of an alternating current magnet generator. The alternating current magnet generator includes a permanent magnet provided at the other end of the crankshaft 21 and a power generation coil arranged to face the permanent magnet. As the crankshaft 21 is rotated, the permanent magnet is rotated to generate an electromotive force, so that the power is generated in the power generation coil.

[0022] The ECM 3 includes a calculation means such as a CPU and the like, and a storage means such as a RAM, a ROM and the like. The ECM 3 is driven by the power, which is generated from the generator 5 as the engine 2 is driven. For example, the CPU executes a program stored in the ROM, so that the ECM 3 functions as an atmospheric pressure estimation unit 31, an atmospheric pressure storage unit 32 and a fuel injection amount calculation unit 33. These constitutional elements will be described in detail later. Also, the atmospheric pressure estimation unit 31, the atmospheric pressure storage unit 32 and the fuel injection amount calculation unit 33 configure the atmospheric pressure estimation means, the storage means and the fuel injection amount calculation means defined in the claims, respectively.

[0023] The engine rotation number sensor 6 is arranged to face an outer peripheral edge of a crank magnet 211 configured to integrally rotate with the crankshaft 21, for example (refer to Fig. 2). The crank magnet 211 has a substantial disc shape and is formed on an outer periphery thereof with a plurality of projections 211a. The engine rotation number sensor 6 is configured to detect an engine rotation number based on the number of the projections 211a passing through a detection area as the crankshaft 21 is rotated, for example. The engine rotation number detected by the engine rotation number sensor 6 is output to the ECM 3 (more specifically, the atmospheric pressure estimation unit 31 and the fuel injection amount calculation unit 33).

[0024] The intake pressure sensor 7 is arranged at an intake pipe 201 coupled to the intake port (refer to Fig. 2). The intake pipe 201 is provided with a throttle valve 10. The intake pressure sensor 7 is arranged at the intake pipe 201 positioned downstream (left in Fig. 2) of the throttle valve 10 and between the intake port and the throttle valve, and is configured to detect a pressure (intake pipe pressure) in the intake pipe 201. The intake pipe pressure detected by the intake pressure sensor 7 is output to the ECM 3 (more specifically, the atmospheric pressure estimation unit 31 and the fuel injection amount calculation unit 33).

[0025] The throttle position sensor 8 is arranged at a position of the intake pipe 201 corresponding to the throttle valve 10, for example (refer to Fig. 2). The throttle position sensor 8 is configured to detect an opening degree (throttle opening degree) of the throttle valve 10. The throttle opening degree detected by the throttle position sensor 8 is output to the ECM 3.

[0026] The injector 9 is configured to function as an electronic fuel injection device and is attached to the intake pipe 201 of the engine 2 (refer to Fig. 2). The injector 9 is configured to inject the fuel, which is supplied from a fuel pump (not shown), into the intake pipe 201, in response to a driving signal from the ECM 3.

[0027] The atmospheric pressure estimation unit 31 is configured to estimate an atmospheric pressure (estimated atmospheric pressure) from the pressure (intake pipe pressure) of the intake pipe 201 detected by the intake pressure sensor 7. More specifically, the atmospheric pressure estimation unit 31 is configured to estimate a maximum intake pipe pressure within a predetermined time period from the start of the engine 2, as the estimated atmospheric pressure. The estimated atmospheric pressure estimated by the atmospheric pressure estimation unit 31 is output to the fuel injection amount calculation unit 33, and is also output to the atmospheric pressure storage unit 32 when an update condition of a learning atmospheric pressure (which will be described later) is satisfied.

[0028] The atmospheric pressure storage unit 32 is configured to store therein the estimated atmospheric pressure output from the atmospheric pressure estimation unit 31, as a learning atmospheric pressure. In particular, the atmospheric pressure storage unit 32 is configured to store the estimated atmospheric pressure as the learning atmospheric pressure, after the engine 2 is stopped. The learning atmospheric pressure is used as a comparison target with the estimated atmospheric pressure estimated by the atmospheric pressure estimation unit 31 upon the fuel injection control when the engine 2 is started next time. As the storage means configuring the atmospheric pressure storage unit 32, a non-volatile memory such as an electrically erasable programmable read-only memory (EEPROM) and the like is appropriately used. The atmospheric pressure storage unit 32 is implemented by the EEPROM, so that it is possible to preserve the estimated atmospheric pressure (learning atmospheric pressure) even after the engine is stopped.

[0029] The fuel injection amount calculation unit 33 is configured to calculate a fuel injection amount of the injector 9. The fuel injection amount calculation unit 33 is configured to calculate a fuel injection amount based on the engine rotation number detected by the engine rotation number sensor 6 and the estimated atmospheric pressure estimated by the atmospheric pressure estimation unit 31 or learning atmospheric pressure stored in the atmospheric pressure storage unit 32. More specifically, the fuel injection amount calculation unit 33 is configured to compare the estimated atmospheric pressure estimated by the atmospheric pressure estimation unit 31 and the learning atmospheric pressure stored in the atmospheric pressure storage unit 32, to calculate a fuel injection amount by using the learning atmospheric pressure when a difference thereof is smaller than a predetermined value, and to calculate a fuel injection amount by using the estimated atmospheric pressure estimated based on the intake pipe pressure when the difference is equal to or larger than the predetermined value.

[0030] Also, the fuel injection amount calculation unit 33 converts a control mode (a non-lean burn control, a lean burn control), depending on a calculation result of the fuel injection amount, when a predetermined condition is satisfied. As described in detail later, when the difference between the estimated atmospheric pressure corrected by the atmospheric pressure estimation unit 31 and the learning atmospheric pressure is equal to or smaller than a predetermined value, the fuel injection amount calculation unit shifts from the non-lean burn control mode to the lean burn control mode and adjusts (calculates) the fuel injection amount in conformity to the lean burn control mode.

[0031] In the engine control system 1 having the above configuration according to the illustrative embodiment, the estimated atmospheric pressure estimated by the atmospheric pressure estimation unit 31 and the learning atmospheric pressure stored in the atmospheric pressure storage unit 32 are compared upon the fuel injection control. The fuel injection amount is calculated using the estimated atmospheric pressure or learning atmospheric pressure, depending on the comparison result thereof, so that the fuel injection control is appropriately performed, irrespective of situations of the throttle opening degree.

[0032] Here, operations that are performed upon the fuel injection control in the engine control system 1 according to the illustrative embodiment are described. Fig. 3 is a flowchart for illustrating an operation outline upon the fuel injection control in the engine control system 1 of the illustrative embodiment.

[0033] In the engine control system 1 of the illustrative embodiment, the fuel injection control is performed with reference to the learning atmospheric pressure stored upon the previous engine stop. To this end, as shown in Fig. 3, the fuel injection control of the engine control system 1 includes atmospheric pressure learning processing (step (hereinafter, referred to as 'ST') 301), fuel injection amount calculating processing (injection amount calculating processing: ST302) and fuel injection processing (injection processing: ST303).

[0034] Also, Fig. 3 illustrates that the injection amount calculating processing and the injection processing denoted with ST302 and ST303 are executed after the atmospheric pressure learning processing denoted with ST301 is executed, for convenience of explanations. However, actually, the injection amount calculating processing and the injection processing denoted with ST302 and ST303 are executed in parallel with the atmospheric pressure learning processing denoted with ST301.

[0035] In the engine control system 1, while the engine 2 is operating, the atmospheric pressure learning processing is executed (S301). The atmospheric pressure learning processing is processing of learning a learning atmospheric pressure that is to be referred to upon the fuel injection control. In the atmospheric pressure learning processing, the learning atmospheric pressure is learned (updated) when a predetermined update condition is satisfied. When the engine 2 is stopped, the learning atmospheric pressure at that time is stored in the atmospheric pressure storage unit 32.

[0036] The injection amount calculating processing is executed in parallel with the atmospheric pressure learning processing (ST302). The injection amount calculating processing is processing of calculating a fuel injection amount of the injector 9 based on a difference between the learning atmospheric pressure stored in the atmospheric pressure storage unit 32 and the estimated atmospheric pressure (the estimated atmospheric pressure based on the intake pipe pressure detected by the intake pressure sensor 7) estimated by the atmospheric pressure estimation unit 31.

[0037] Also, in the injection amount calculating processing, the fuel injection amount is calculated and it is also determined whether the control mode is converted (shifted). Based on a result of the determination, the fuel injection amount is adjusted. More specifically, when a difference between the estimated atmospheric pressure corrected by the atmospheric pressure estimation unit 31 and the learning atmospheric pressure is equal to or smaller than a predetermined value, the control mode is converted from the non-lean burn control mode to the lean burn control mode and the fuel injection amount is adjusted in conformity to the lean burn control mode.

[0038] After the fuel injection amount is calculated by the injection amount calculating processing, the injection processing is executed (ST303). In the injection processing, the fuel is injected from the injector 9 based on the fuel injection amount calculated in the injection amount calculating processing. The injection amount calculating processing and the injection processing denoted with ST302 and ST303 are repeatedly executed during the operation of the engine 2.

[0039] Here, the atmospheric pressure learning processing denoted with ST301 is described in detail. Fig. 4 is a flowchart for illustrating the atmospheric pressure learning processing in the engine control system 1 of the illustrative embodiment. As shown in Fig. 4, in the atmospheric pressure learning processing, the pressure (intake pipe pressure) in the intake pipe 201 is first detected by the intake pressure sensor 7 (ST401). The detected intake pipe pressure is output to the atmospheric pressure estimation unit 31 of the ECM 3. When the intake pipe pressure is received from the intake pressure sensor 7, the atmospheric pressure estimation unit 31 estimates a maximum intake pipe pressure within a predetermined time period from the start of the engine 2, as a current atmospheric pressure, and obtains the estimated atmospheric pressure (ST402).

[0040] When the estimated atmospheric pressure is estimated by the atmospheric pressure estimation unit 31 in ST402 of Fig. 4, the fuel injection amount calculation unit 33 reads out the learning atmospheric pressure stored in the atmospheric pressure storage unit 32 (more specifically, the learning atmospheric pressure stored in the atmospheric pressure storage unit 32 upon the previous operation stop) (ST403). Then, the fuel injection amount calculation unit 33 determines whether a difference between the estimated atmospheric pressure estimated in ST402 and the learning atmospheric pressure stored upon the previous operation stop is equal to or larger than a predetermined atmospheric pressure update determining value (hereinafter, simply referred to as 'determining value') (ST404).

[0041] Here, when the difference between the estimated atmospheric pressure and the learning atmospheric pressure is equal to or larger than the predetermined determining value, it is determined by the throttle position sensor 8 whether the throttle opening degree is at a complete opening state (WOT: Wide Open Throttle) continuously for a predetermined time period (ST405). Here, when the WOT state continues for a predetermined time period, '1' is set for a flag (hereinafter, referred to as 'learning execution flag') indicating whether or not to execute the learning of the learning atmospheric pressure (ST406). '1' is set for the learning execution flag, so that it is permitted to learn (update) the learning atmospheric pressure by using the estimated atmospheric pressure estimated in ST402. In this case, the estimated atmospheric pressure estimated in ST402 is recorded in the atmospheric pressure storage unit 32. ST404 and ST405 are processing of determining the update condition of the learning atmospheric pressure. When all results of the determinations are positive, the update condition of the learning atmospheric pressure is satisfied. Also, when the WOT state is not or when the WOT state does not continue for a predetermined time period, the determination of ST405 is repeated.

[0042] When repeating the determination of ST405 in this way, it is preferably to adjust the estimated atmospheric pressure in the atmospheric pressure estimation unit 31, depending on the engine rotation number, as an illustrative embodiment. In this case, the atmospheric pressure estimation unit 31 can adjust the estimated atmospheric pressure based on an estimated atmospheric pressure adjusting map shown in Fig. 5. Fig. 5 shows an example of the estimated atmospheric pressure adjusting map that is used in the engine control system 1 of the illustrative embodiment.

[0043] As shown in Fig. 5, in the estimated atmospheric pressure adjusting map, a detection value Pb by the intake pressure sensor 7 corresponds to a vertical axis, and an engine rotation number Ne by the engine rotation number sensor 6 corresponds to a horizontal axis. When the intake pipe pressure is received from the intake pressure sensor 7, the atmospheric pressure estimation unit 31 can adjust the same based on the estimated atmospheric pressure adjusting map shown in Fig. 5, depending on the engine rotation number received from the engine rotation number sensor 6.

[0044] For example, in a case where '70 kPa' is received from the intake pressure sensor 7, as the intake pipe pressure, when the engine rotation number received from the engine rotation number sensor 6 is '2500 r/min', the atmospheric pressure estimation unit 31 can adjust the estimated atmospheric pressure to '68 kPa' (refer to Pb4 and Ne2 in Fig. 5). Also, in a case where '80 kPa' is received from the intake pressure sensor 7, as the intake pipe pressure, when the engine rotation number received from the engine rotation number sensor 6 is '5000 r/min', the atmospheric pressure estimation unit 31 can adjust the estimated atmospheric pressure to '83 kPa' (refer to Pb5 and Ne7 in Fig. 5).

[0045] In this way, when the difference between the estimated atmospheric pressure and the learning atmospheric pressure is equal to or larger than the predetermined value, the atmospheric pressure estimation unit 31 adjusts the estimated atmospheric pressure, depending on the engine rotation number, so that it is possible to adjust the estimated atmospheric pressure in conformity to the intake pipe pressure varying depending on the engine rotation number.

Thereby, it is possible to obtain the estimated atmospheric pressure within a more correct and wider range, in conformity to the intake pipe pressure varying depending on the engine rotation number.

[0046] After '1' is set for the learning execution flag in ST406, the atmospheric pressure estimation unit 31 executes correction processing of the estimated atmospheric pressure (estimated atmospheric pressure correcting processing) (ST407). In the estimated atmospheric pressure correcting processing, the estimated atmospheric pressure (estimated atmospheric pressure estimated in ST402) is corrected based on a predetermined atmospheric pressure learning filter value and the learning atmospheric pressure. For example, a corrected estimated atmospheric pressure X that is to be corrected by the estimated atmospheric pressure correcting processing is calculated based on the following (Equation 1). Here, 'F1' indicates the atmospheric pressure learning filter value.

$$X = F1 \times \text{learning atmospheric pressure} + (1-F1) \times \text{estimated atmospheric pressure (Equation 1)}$$

[0047] After the estimated atmospheric pressure correcting processing is executed, the fuel injection amount calculation unit 33 determines whether a difference between the estimated atmospheric pressure after the correction (corrected estimated atmospheric pressure) and the current estimated atmospheric pressure estimated from the intake pipe pressure is equal to or smaller than the determining value (ST408). When the difference between the corrected estimated atmospheric pressure and the current estimated atmospheric pressure is not equal to or smaller than the determining value, the processing returns to ST405 and the processing of ST405 to ST408 is again executed.

[0048] In contrast, when the difference between the corrected estimated atmospheric pressure and the current estimated atmospheric pressure is equal to or smaller than the determining value, '1' is set for a flag (hereinafter, referred to as 'mode conversion flag') indicating whether or not to permit the conversion to the lean burn control mode (ST409). '1' is set for the mode conversion flag in this way, so that the conversion from the non-lean burn control mode to the lean burn control mode is permitted. That is, the shift to the lean burn control mode is permitted only when the difference between the corrected estimated atmospheric pressure and the current estimated atmospheric pressure is equal to or smaller than the determining value.

[0049] After '1' is set for the mode conversion flag, it is determined whether the ignition switch is kept at the on state (power supply on) (ST410). When the ignition switch is kept at the on state, the processing returns to ST401 and the processing of ST401 to ST410 is again executed. That is, when the power supply on state is kept, the estimated atmospheric pressure based on the intake pipe pressure detected by the intake pressure sensor 7 and the learning atmospheric pressure are compared and the learning atmospheric pressure is learned depending on the comparison result. On the other hand, when the ignition switch is switched to an off state, the estimated atmospheric pressure estimated in ST402 just before is again recorded in the atmospheric pressure storage unit 32, as the learning atmospheric pressure, so that the learning atmospheric pressure is updated (ST411).

[0050] On the other hand, when it is determined in the determination of ST404 that the difference between the estimated atmospheric pressure and the learning atmospheric pressure is smaller than the determining value (atmospheric pressure update determining value), the processing of ST409 and thereafter is executed. That is, after '1' is set for the mode conversion flag in ST409, it is determined in ST410 whether the ignition switch is on or not, and when the ignition switch is off, the learning atmospheric pressure is updated in ST411. After the learning atmospheric pressure is updated in ST411 via the series of processing, the atmospheric pressure learning processing is over.

[0051] Subsequently, the injection amount calculating processing denoted with ST302 is described. Fig. 6 is a flowchart for illustrating the injection amount calculating processing in the engine control system of the illustrative embodiment. As shown in Fig. 6, in the injection amount calculating processing, the pressure (intake pipe pressure) in the intake pipe 201 is first detected by the intake pressure sensor 7 (ST601). The detected intake pipe pressure is output to the atmospheric pressure estimation unit 31 of the ECM 3. When the intake pipe pressure is received from the intake pressure sensor 7, the atmospheric pressure estimation unit 31 estimates a maximum intake pipe pressure within a predetermined time period from the start of the engine 2, as a current atmospheric pressure, and obtains the estimated atmospheric pressure (ST602).

[0052] When the estimated atmospheric pressure is estimated by the atmospheric pressure estimation unit 31, the fuel injection amount calculation unit 33 reads out the learning atmospheric pressure stored in the atmospheric pressure storage unit 32 (ST603). Then, the fuel injection amount calculation unit 33 determines whether a difference between the estimated atmospheric pressure estimated in ST402 and the learning atmospheric pressure is equal to or larger than the determining value (atmospheric pressure update determining value) (ST604).

[0053] Here, when the difference between the learning atmospheric pressure and the detected intake pressure is equal to or larger than the determining value, the fuel injection amount calculation unit 33 calculates a fuel injection amount by using the estimated atmospheric pressure estimated in ST602 (ST605). On the other hand, when the difference between the learning atmospheric pressure and the detected intake pressure is smaller than the determining value, the fuel injection amount calculation unit 33 calculates a fuel injection amount by using the learning atmospheric pressure stored in the atmospheric pressure storage unit 32 (ST606).

[0054] After calculating the fuel injection amount by using the learning atmospheric pressure in ST606, the fuel injection amount calculation unit 33 determines whether '1' is set for the mode conversion flag (ST607). This determination is to determine whether the shift from the non-lean burn control mode to the lean burn control mode is permitted.

[0055] Here, when '1' is set for the mode conversion flag, the fuel injection amount calculation unit 33 adjusts the fuel injection amount calculated in ST606 to a fuel injection amount appropriate to the lean burn control mode (ST608). That is, the fuel injection amount is adjusted so that an air-fuel ratio of which a fuel ratio is smaller than an ideal air-fuel ratio by the non-lean burn control mode is made. On the other hand, when '0' is set for the mode conversion flag, the fuel injection amount calculation unit 33 skips over ST608 and does not adjust the fuel injection amount to a fuel injection amount appropriate to the lean burn control mode.

[0056] In this way, when the fuel injection amount is calculated in ST605 or ST606 or when the fuel injection amount is adjusted in ST608, the injection amount calculating processing is over. The fuel injection amount calculated (adjusted) in the injection amount calculating processing is used in the injection processing denoted with ST303 in Fig. 3, and the fuel corresponding to the fuel injection amount is injected to the intake pipe 201 from the injector 9. Thereby, the fuel injection amount calculated based on any one of the estimated atmospheric pressure based on the intake pipe pressure and the learning atmospheric pressure stored in the atmospheric pressure storage unit 32 is injected.

[0057] As described above, according to the engine control system 1 of the illustrative embodiment, the estimated atmospheric pressure estimated upon the engine start and the learning atmospheric pressure stored in the atmospheric pressure storage unit 32 are compared. When the difference thereof is smaller than the predetermined value (determining value), the fuel injection amount is calculated using the learning atmospheric pressure. On the other hand, when the difference is equal to or larger than the predetermined value (determining value), the fuel injection amount is calculated using the estimated atmospheric pressure estimated from the intake pipe pressure. For this reason, even when the throttle opening degree does not reach a vicinity of the complete opening, for example, it is possible to calculate the fuel injection amount by using the stored learning atmospheric pressure. As a result, it is possible to appropriately control the fuel injection, irrespective of the situations of the throttle opening degree.

[0058] Also, according to the engine control system 1 of the illustrative embodiment, the fuel injection amount calculation unit 33 calculates the fuel injection amount appropriate to the lean burn control from the non-lean burn control when the difference between the estimated atmospheric pressure and the learning atmospheric pressure is equal to or smaller than the predetermined value (determining value). Thereby, since the fuel injection amount appropriate to the lean burn control is calculated only when the difference between the estimated atmospheric pressure and the learning atmospheric pressure is equal to or smaller than the predetermined value, it is possible to realize the lean burn operation while preventing the engine output from being rapidly lowered.

[0059] Also, the present invention is not limited to the above illustrative embodiment and can be variously changed. In the above illustrative embodiment, the circuit configuration, the control flow and the like are not limited to the accompanying drawings and can be appropriately changed within the scope in which the effects of the present invention are accomplished. In addition, the illustrative embodiment can be appropriately changed and implemented without departing from the scope of the present invention.

[0060] For example, in the above illustrative embodiment, the learning atmospheric pressure is updated all the time in the atmospheric pressure storage unit 32 upon the engine stop. However, the timing at which the learning atmospheric pressure is always updated is not limited to upon the engine stop, and can be appropriately changed. For example, when an emergency stop switch is operated by an operator (driver) (i.e., the emergency stop switch is on), the learning atmospheric pressure may be updated.

INDUSTRIAL APPLICABILITY

[0061] As described above, the present invention can accomplish the effect of appropriately controlling the fuel injection, irrespective of the situations of the throttle opening degree, and is particularly useful for an outboard motor, an automatic two-wheeled vehicle and the like in which a battery is not provided and an engine configured to drive a fuel injection device configured to adjust a fuel injection amount with the power generated from a generator is mounted thereto.

[0062] The application is based on Japanese Patent Application No. 2014-066490 filed on March 27, 2014, the entire contents of which are incorporated herein for all purposes by this reference.

Claims

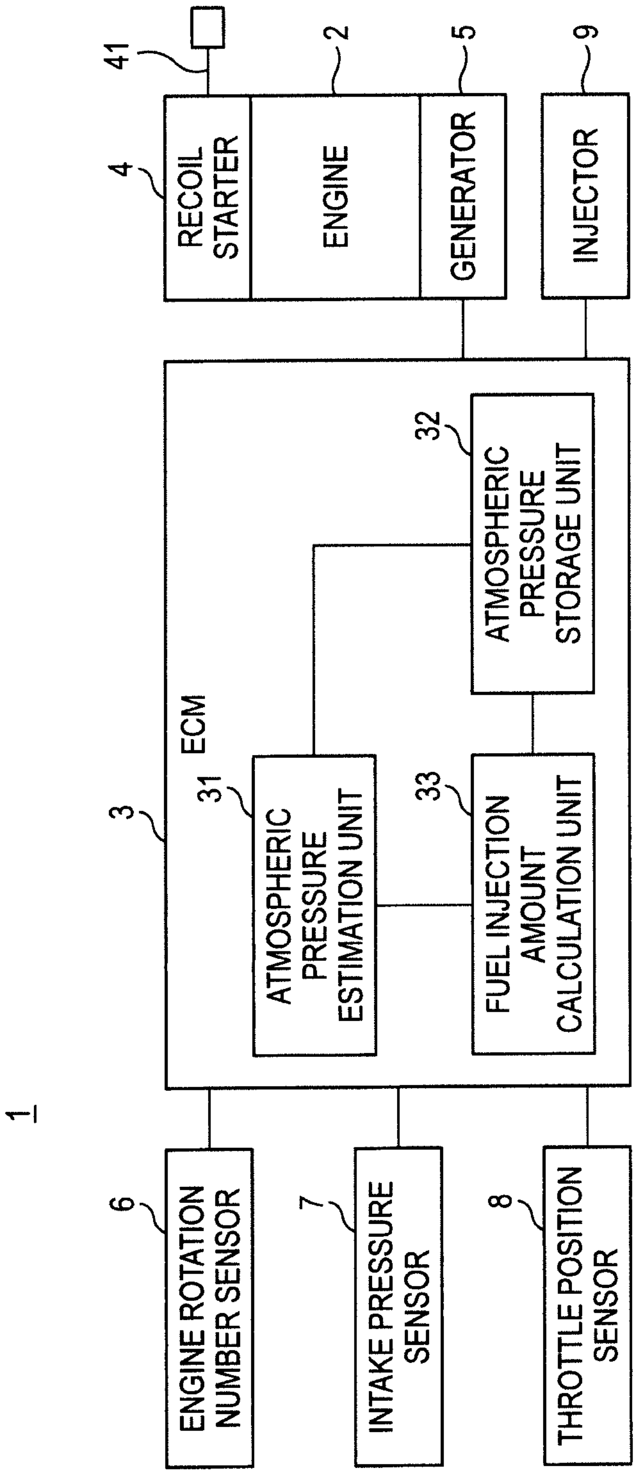
1. An engine control system comprising: a rotation number detection means for detecting an engine rotation number; a pressure detection means for detecting an intake pipe pressure downstream of a throttle valve; an atmospheric

pressure estimation means for estimating an estimated atmospheric pressure from the intake pipe pressure detected by the pressure detection means; a storage means for storing the estimated atmospheric pressure output from the atmospheric pressure estimation means, as a learning atmospheric pressure, after an engine is stopped; and a fuel injection amount calculation means for calculating a fuel injection amount based on the engine rotation number and the estimated atmospheric pressure,
wherein the fuel injection amount calculation means is configured to compare the estimated atmospheric pressure estimated upon engine start and the learning atmospheric pressure stored in the storage means, and calculates a fuel injection amount by using the learning atmospheric pressure when a difference between the estimated atmospheric pressure and the learning atmospheric pressure is smaller than a predetermined value and calculates a fuel injection amount by using the estimated atmospheric pressure when the difference between the estimated atmospheric pressure and the learning atmospheric pressure is equal to or larger than the predetermined value.

2. The engine control system according to claim 1, wherein when the difference between the estimated atmospheric pressure and the learning atmospheric pressure is equal to or larger than the predetermined value, the atmospheric pressure estimation means adjusts the estimated atmospheric pressure, depending on the engine rotation number.

3. The engine control system according to claim 1 or 2, wherein when the difference between the estimated atmospheric pressure and the learning atmospheric pressure is equal to or smaller than the predetermined value, the fuel injection amount calculation means calculates a fuel injection amount appropriate to a lean burn control from a non-lean burn control.

FIG. 1


1
ENGINE ROTATION NUMBER SENSOR
6
INTAKE PRESSURE SENSOR
7
THROTTLE POSITION SENSOR
8
3
ECM
ATMOSPHERIC PRESSURE ESTIMATION UNIT
31
FUEL INJECTION AMOUNT CALCULATION UNIT
33
ATMOSPHERIC PRESSURE STORAGE UNIT
32
RECOIL STARTER
4
41
ENGINE
2
GENERATOR
5
INJECTOR
9

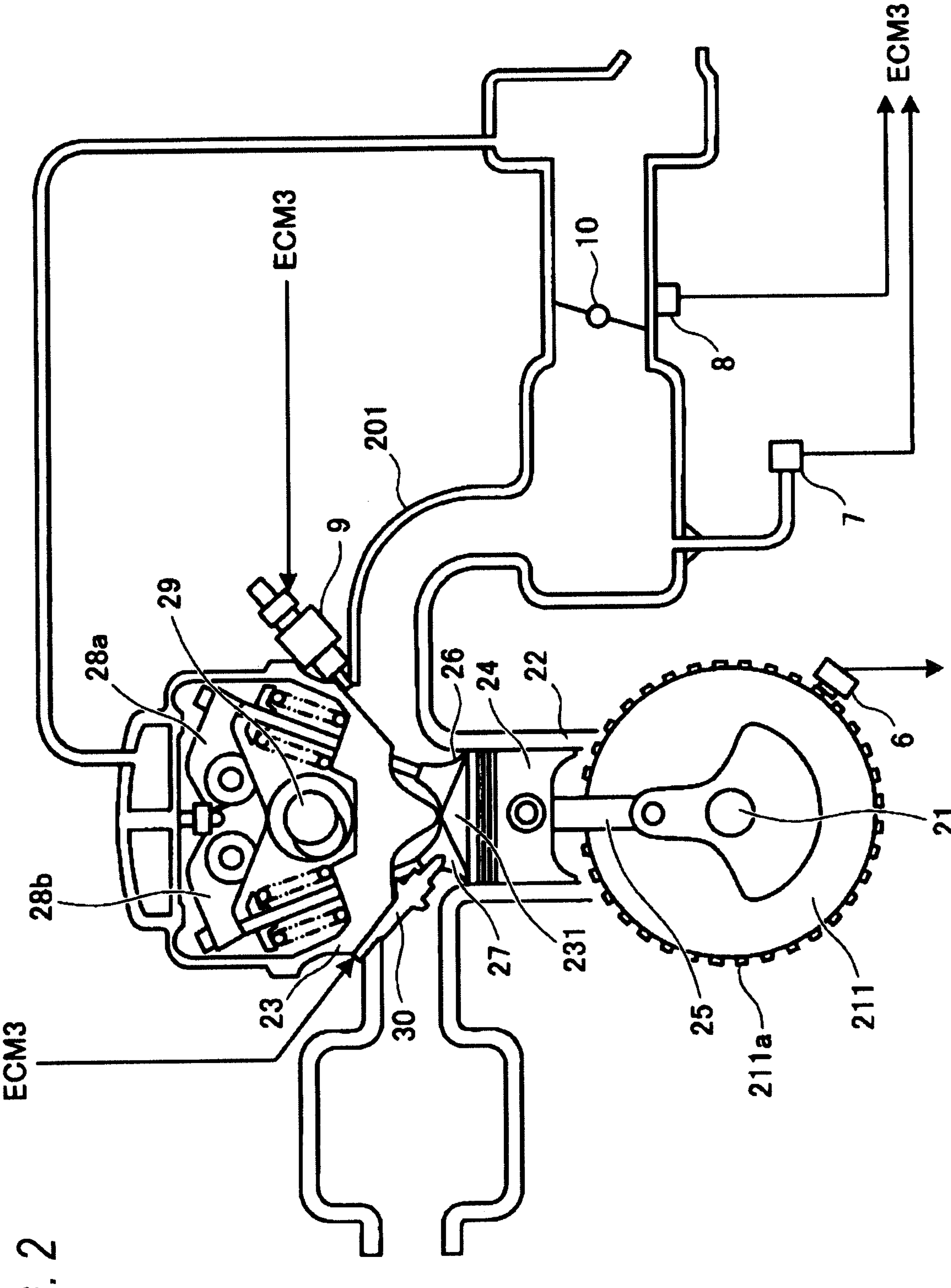

ECM3
ECM3
10
8
7
201
9
ECM3
29
28a
28b
26
24
22
6
ECM3
21
211
211a
25
231
27
30
23
ECM3

FIG. 2

FIG. 3

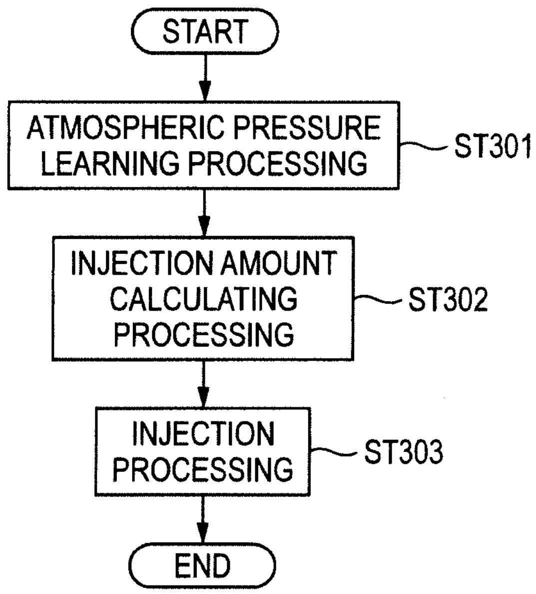

START
ATMOSPHERIC PRESSURE LEARNING PROCESSING
ST301
INJECTION AMOUNT CALCULATING PROCESSING
ST302
INJECTION PROCESSING
ST303
END

FIG. 4

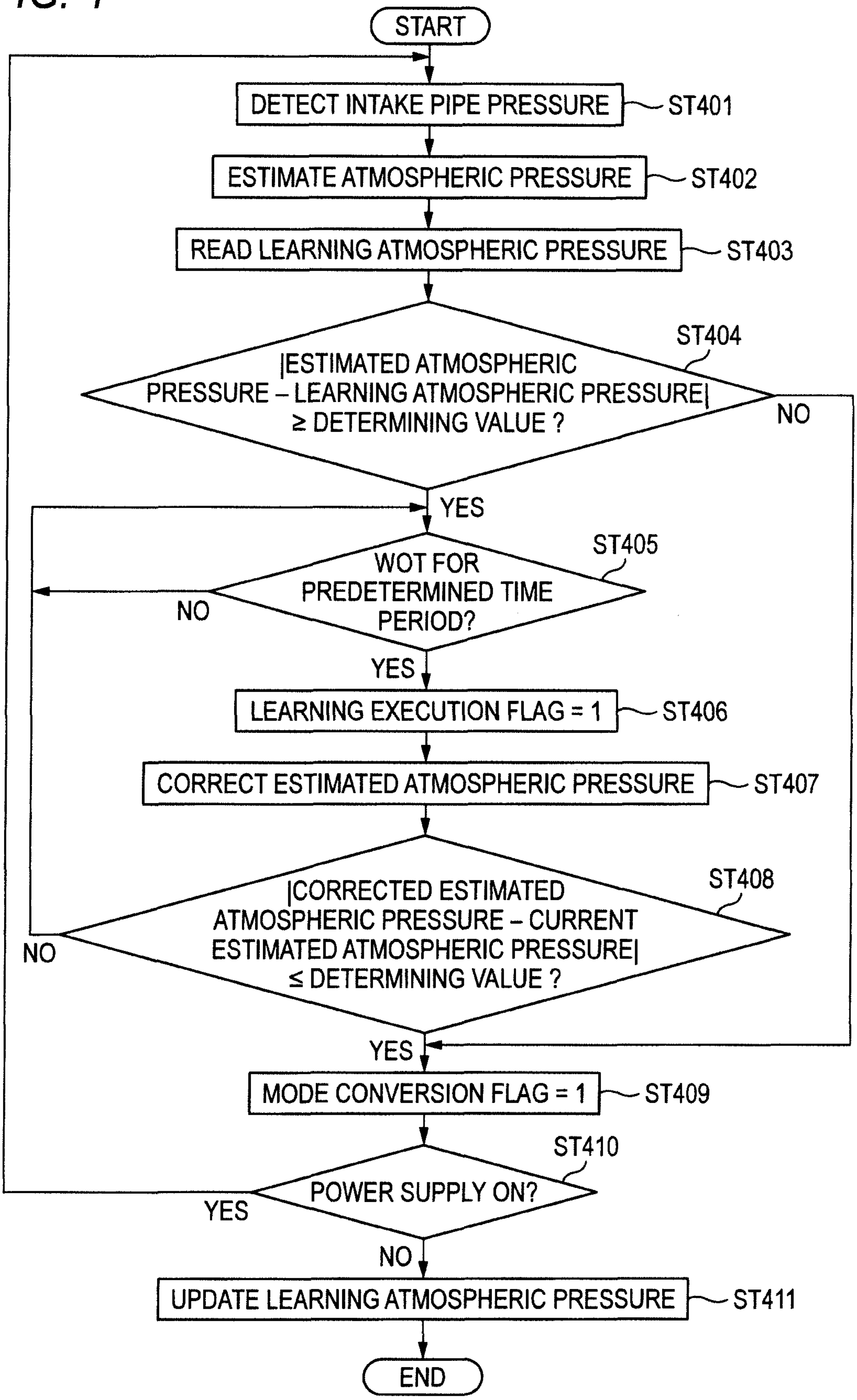
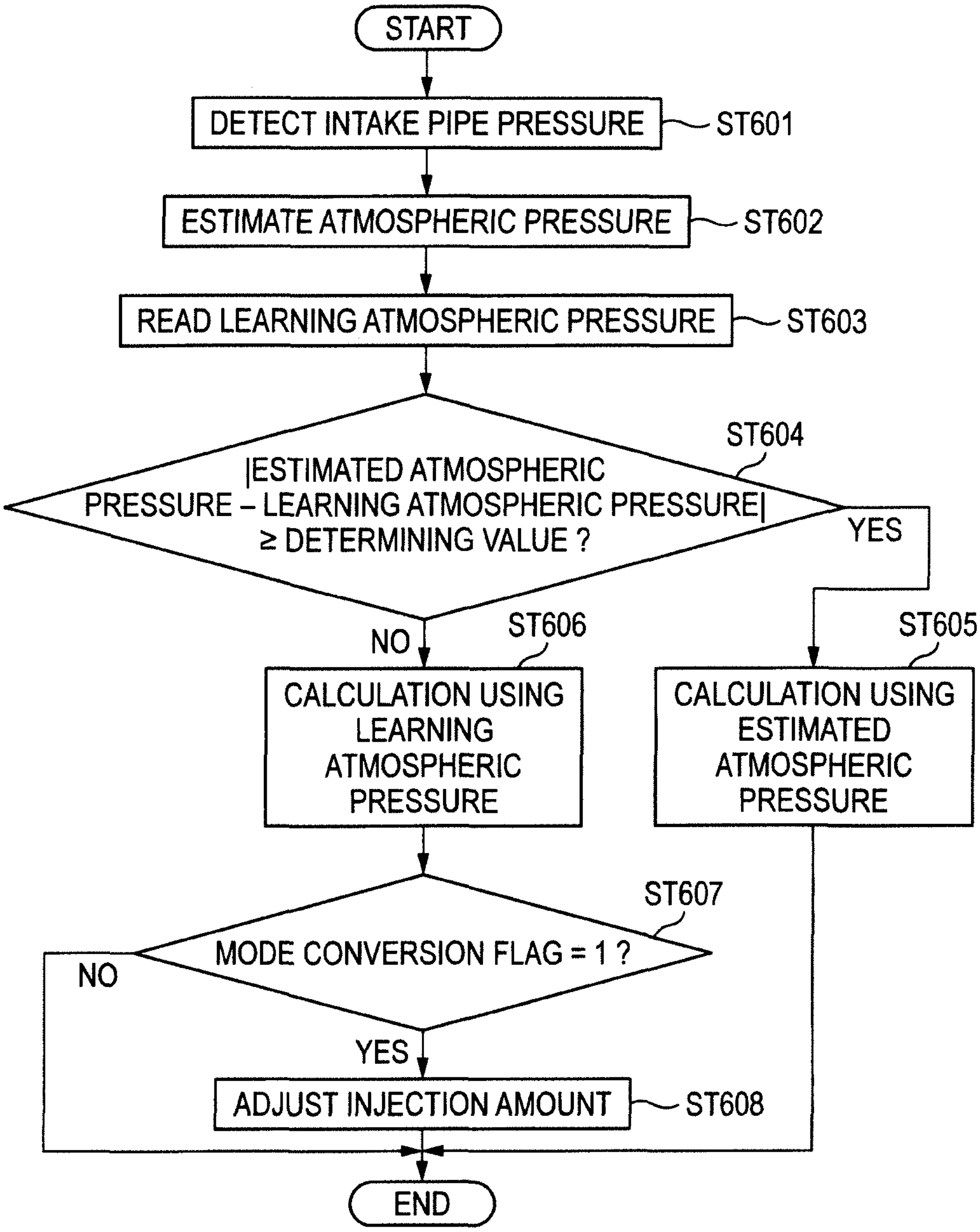

START
DETECT INTAKE PIPE PRESSURE
ST401
ESTIMATE ATMOSPHERIC PRESSURE
ST402
READ LEARNING ATMOSPHERIC PRESSURE
ST403
|ESTIMATED ATMOSPHERIC PRESSURE – LEARNING ATMOSPHERIC PRESSURE| ≥ DETERMINING VALUE ?
ST404
NO
YES
WOT FOR PREDETERMINED TIME PERIOD?
ST405
NO
YES
LEARNING EXECUTION FLAG = 1
ST406
CORRECT ESTIMATED ATMOSPHERIC PRESSURE
ST407
|CORRECTED ESTIMATED ATMOSPHERIC PRESSURE – CURRENT ESTIMATED ATMOSPHERIC PRESSURE| ≤ DETERMINING VALUE ?
ST408
NO
YES
MODE CONVERSION FLAG = 1
ST409
POWER SUPPLY ON?
ST410
YES
NO
UPDATE LEARNING ATMOSPHERIC PRESSURE
ST411
END

FIG. 5

INTAKE PIPE PRESSURE \ ROTATION NUMBER		Ne1	Ne2	Ne3	Ne4	Ne5	Ne6	Ne7
		2000r/min	2500r/min	3000r/min	3500r/min	4000r/min	4500r/min	5000r/min
Pb1	60kPa	57kPa	58kPa	59kPa	60kPa	61kPa	62kPa	63kPa
Pb2	65kPa	62kPa	63kPa	64kPa	65kPa	66kPa	67kPa	68kPa
Pb3	70kPa	67kPa	68kPa	69kPa	70kPa	71kPa	72kPa	73kPa
Pb4	75kPa	72kPa	73kPa	74kPa	75kPa	76kPa	77kPa	78kPa
Pb5	80kPa	77kPa	78kPa	79kPa	80kPa	81kPa	82kPa	83kPa
Pb6	85kPa	82kPa	83kPa	84kPa	85kPa	86kPa	87kPa	88kPa
Pb7	90kPa	87kPa	88kPa	89kPa	90kPa	91kPa	92kPa	93kPa

FIG. 6


START
DETECT INTAKE PIPE PRESSURE
ST601
ESTIMATE ATMOSPHERIC PRESSURE
ST602
READ LEARNING ATMOSPHERIC PRESSURE
ST603
|ESTIMATED ATMOSPHERIC PRESSURE – LEARNING ATMOSPHERIC PRESSURE| ≥ DETERMINING VALUE ?
ST604
YES
NO
ST606
CALCULATION USING LEARNING ATMOSPHERIC PRESSURE
ST605
CALCULATION USING ESTIMATED ATMOSPHERIC PRESSURE
MODE CONVERSION FLAG = 1 ?
ST607
NO
YES
ADJUST INJECTION AMOUNT
ST608
END

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/054366

A. CLASSIFICATION OF SUBJECT MATTER
F02D41/04(2006.01)i, *F02D41/02*(2006.01)i, *F02D45/00*(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)
F02D41/04, F02D41/02, F02D45/00

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	1996-2015
Kokai Jitsuyo Shinan Koho	1971-2015	Toroku Jitsuyo Shinan Koho	1994-2015

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.
Y A	JP 2013-194532 A (Hitachi Automotive Systems, Ltd.), 30 September 2013 (30.09.2013), paragraphs [0016] to [0017], [0026] to [0027]; fig. 1 (Family: none)	1-2 3
Y A	JP 2004-36462 A (Toyota Motor Corp.), 05 February 2004 (05.02.2004), paragraphs [0005], [0011] to [0016]; fig. 1 to 3 (Family: none)	1-2 3
A	JP 11-280528 A (Unisia Jecs Corp.), 12 October 1999 (12.10.1999), paragraphs [0026] to [0029]; fig. 4 (Family: none)	1-3

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
08 May 2015 (08.05.15)	19 May 2015 (19.05.15)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/054366

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2011-106315 A (Toyota Motor Corp.), 02 June 2011 (02.06.2011), paragraph [0021] (Family: none)	2

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2013199915 A **[0005]**
- JP 2014066490 A **[0062]**