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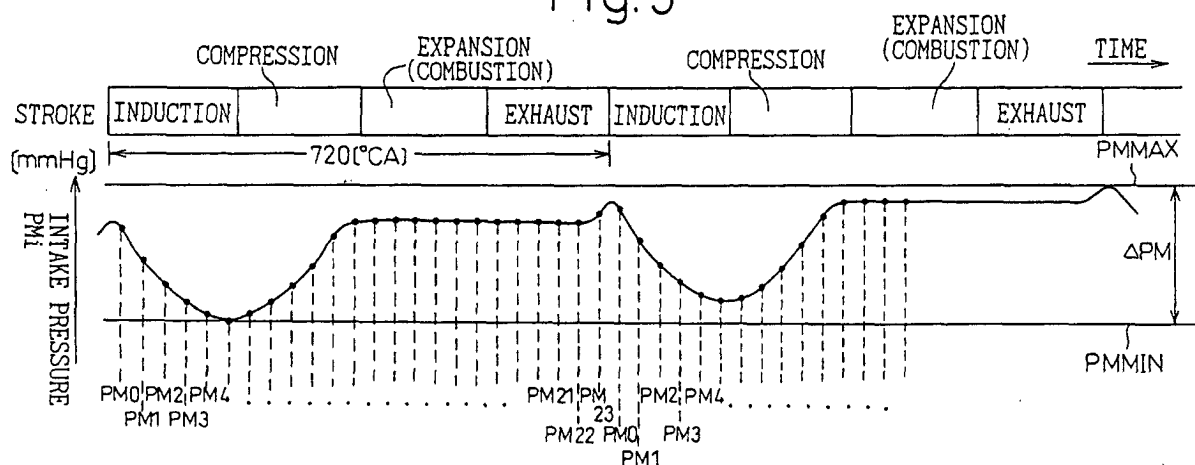
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(54) **ATMOSPHERIC PRESSURE DETECTOR OF INTERNAL COMBUSTION ENGINE**

(57) Intake pressures PM_i [mmHg] are detected at each crank angle position of 30° [°CA (Crank Angle)] after an internal combustion engine 1 is started, and the intake pressures PM_i are smoothed according to transition conditions thereof so as to be obtained as an atmospheric pressure. As this occurs, the plurality of intake pressures PM_i are smoothed provided that a differ-

ence ΔPM between the maximum PM_{MAX} and minimum PM_{MIN} of the plurality of intake pressures PM_i is small enough to fall within a predetermined value. As an atmospheric pressure, when intake pressures PM_i are stable, can be obtained by the plurality of samplings at the crank angle positions, the reliability of an atmospheric pressure detector for an internal combustion engine can be increased.

Fig. 3



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Description

Technical Field

[0001] The present invention relates to an atmospheric pressure detector for an internal combustion engine for detecting an atmospheric pressure in the environment of the internal combustion engine and, for example, by knowing a change in atmospheric pressure, the amount of fuel that is injected for supply to the internal combustion engine can be adjusted.

Background Art

[0002] A known conventional atmospheric pressure detector for an internal combustion engine is disclosed in Japanese Unexamined Patent Publication (Kokai) No. 5-1615. This publication is regarded as a prior art reference for atmospheric pressure detectors for internal combustion engines. Described in this prior art reference is a technique for approximating a pressure resulting within an intake manifold immediately after the generation of a start signal, as an atmospheric pressure, without using an atmospheric pressure sensor by paying attention to the fact that some time is needed from the operation of a starter switch to the actual start of an internal combustion engine.

[0003] Incidentally, with this technique, although an atmospheric pressure immediately after the start of the internal combustion engine can be obtained, an atmospheric pressure at other points in time after, the start of the engine, cannot be obtained. Namely, no atmospheric pressure can be indicated which results when there occurs a change in atmospheric pressure after the internal combustion engine is started. Due to this, even when there occurs a change in atmospheric pressure after the internal combustion engine has been started, the change cannot be reflected to the intake pressure, leading to, for example, a problem that a preferred fuel injection amount according to the intake pressure cannot be obtained.

Disclosure of the Invention

[0004] The present invention was made with a view to solving the problem, and an object thereof is to provide an atmospheric pressure detector for an internal combustion engine for detecting an atmospheric pressure in the environment of the internal combustion engine.

[0005] According to an aspect of the present invention, there is provided an atmospheric pressure detector for an internal combustion engine, wherein intake pressures at predetermined crank angle positions detected by a crank angle detecting means after the start of the internal combustion engine are detected by an intake pressure detecting means, and wherein the plurality of intake pressures so detected are smoothed according

to the transition conditions by an atmospheric pressure calculating means to thereby be obtained as an atmospheric pressure. As changes in intake pressure can suitably be averaged to obtain an atmospheric pressure by a plurality of samplings at the predetermined crank angle positions, the reliability can be increased.

[0006] According to another aspect of the present invention, there is provided an atmospheric pressure detector for an internal combustion engine wherein the atmospheric pressure calculating means smoothes the plurality of intake pressures obtained relative to the predetermined crank angle positions provided that a difference between the maximum and the minimum of the plurality of intake pressures so obtained falls within a predetermined value. As the atmospheric pressure, when the intake pressure is stable, can be obtained by the plurality of samplings at the predetermined crank angle positions, the reliability can be increased.

[0007] According to a further aspect of the present invention, there is provided an atmospheric pressure detector for an internal combustion engine wherein the atmospheric pressure calculating means smoothes the plurality of intake pressures obtained relative to the predetermined crank angle positions from an expansion stroke to an exhaust stroke of the internal combustion engine provided that a difference between the maximum and the minimum of the plurality of intake pressures so obtained falls within a predetermined value. As, even if there occurs a change in load in the internal combustion engine, the atmospheric pressure when the intake pressure is stable can be obtained by the plurality of samplings at the predetermined crank angle positions, the reliability can be increased.

[0008] According to an aspect of the present invention, there is provided an atmospheric pressure detector for an internal combustion engine wherein the atmospheric pressure calculating means smoothes the plurality of intake pressures obtained relative to the predetermined crank angle positions from an induction stroke to an exhaust stroke of the internal combustion engine provided that a difference between the maximum and the minimum of the plurality of intake pressures so obtained falls within a predetermined value. As, even if there occurs a change in load in the internal combustion engine, the atmospheric pressure when the intake pressure is stable can be obtained by the plurality of samplings at the predetermined crank angle positions, the reliability can be increased.

[0009] According to another aspect of the present invention, there is provided an atmospheric pressure detector for an internal combustion engine, wherein an intake pressure smoothing means smoothes a plurality of intake pressures detected by an intake pressure detecting means provided that a variation in the plurality of intake pressures so detected falls within a predetermined value, whereby the intake pressures so smoothed are obtained as an atmospheric pressure by an atmospheric pressure calculating means. As the in-

take pressures can be obtained in a stable fashion by the plurality of samplings when the variation in intake pressures falls within the predetermined value and an accurate atmospheric pressure can be obtained by using the intake pressure resulting from the smoothing of those intake pressures, the reliability can be increased.

[0010] According to a further aspect of the present invention, there is provided an atmospheric pressure detector for an internal combustion engine wherein intake pressures can be obtained in a stable fashion by the plurality of sampling when a difference between the average based on the intake pressures detected by the intake pressure detecting means and the peak of the intake pressures detected by the intake pressure detecting means falls within a predetermined value, and wherein an accurate atmospheric pressure can be obtained by using the intake pressure resulting from the smoothing of the intake pressures so obtained, whereby the reliability can be increased.

[0011] According to another aspect of the present invention, there is provided an atmospheric pressure detector for an internal combustion engine, wherein intake pressures detected by an intake pressure detecting means during a predetermined period of time including at least an exhaust stroke detected by an exhaust stroke detecting means are smoothed by a intake pressure smoothing means, and wherein the intake pressures so smoothed can be obtained as an atmospheric pressure by an atmospheric pressure calculating means. As the intake pressures can be obtained in a stable fashion by the plurality of sampling during the predetermined period of time including at least the exhaust stroke and an accurate atmospheric pressure can be obtained by using the intake pressure resulting from the smoothing of the intake pressures so obtained, the reliability can be increased.

[0012] The present invention can be understood more sufficiently from the accompanying drawings and the description of a preferred embodiment of the invention.

Brief Description of the Drawings

[0013]

Fig. 1 is a schematic diagram showing the configuration of an internal combustion engine and its peripheral equipment to which an atmospheric pressure detector according to an embodiment of the present invention is applied.

Fig. 2 is a flowchart showing a processing procedure for atmospheric pressure calculation used in a CPU within an ECU used in the atmospheric pressure detector according to the embodiment of the present invention.

Fig. 3 is a time chart showing transition conditions of intake pressures read every time an N signal interruption occurs corresponding to the processing in Fig. 2.

Fig. 4 is a flowchart showing a first modification made to the processing procedure for atmospheric pressure calculation used in a CPU within an ECU used in the atmospheric pressure detector according to the embodiment of the present invention.

Fig. 5 is a flowchart showing a second modification made to the processing procedure for atmospheric pressure calculation used in a CPU within an ECU used in the atmospheric pressure detector according to the embodiment of the present invention.

Fig. 6 is a flowchart showing a third modification made to the processing procedure for atmospheric pressure calculation used in a CPU within an ECU used in the atmospheric pressure detector according to the embodiment of the present invention.

Fig. 7 is a flowchart showing a fourth modification made to the processing procedure for atmospheric pressure calculation used in a CPU within an ECU used in the atmospheric pressure detector according to the embodiment of the present invention.

Best Mode for Carrying out the Invention

[0014] A mode for carrying out the invention will be described based on an embodiment.

[0015] Fig. 1 is a schematic diagram showing the configuration of an internal combustion engine and its peripheral equipment to which an atmospheric pressure detector according to an embodiment of the present invention is applied.

[0016] In Fig. 1, reference numeral 1 denotes a single-cylinder water-cooled internal combustion engine (an engine), and air from an air cleaner 3 is introduced into an intake air passage 2 of the internal combustion engine 1. Provided at a position along the length of the intake air passage 2 is a throttle valve 11 adapted to be opened and closed in conjunction with the operation of an accelerator pedal or the like, which is not shown. The amount of intake air (the amount of air to be taken in) to the intake air passage 2 is regulated by opening or closing the throttle valve 11. In addition, fuel is injected and supplied into the internal combustion engine 1 from an injector (a fuel injection valve) 5 provided in the intake air passage 2 at a position near an intake port 4 together with intake air so introduced into the intake air passage 2. Then, air-fuel mixture comprising a predetermined amount of fuel and a predetermined amount of intake air is drawn into a combustion chamber 7 via an intake valve 6.

[0017] In addition, an intake pressure sensor 21 for detecting the intake pressure PM [mmHg] within the intake air passage 2 is provided on a downstream side of the throttle valve 11 and in the intake air passage. Then, a crank angle sensor 22 for detecting the crank angle [°CA (Crank Angle)] of a crankshaft 12 of the internal combustion engine 1 is provided at the crankshaft 12. The engine speed NE of the internal combustion engine 1 is calculated according to crank angles detected by

the crank angle sensor 22.

[0018] Additionally, a spark plug 13 is disposed in such a manner as to be directed toward the interior of the combustion chamber 7 in the internal combustion engine 1. A high voltage from an ignition coil/igniter 14 is applied to the spark plug 13 in synchronism with a crank angle detected by the crank angle sensor 22 based on an ignition command signal outputted from an ECU (Electronic Control Unit) 30, which will be described later, whereby an air-fuel mixture within the combustion chamber 7 is ignited for combustion. Thus, an air-fuel mixture within the combustion chamber 7 is burned (expanded) so that a driving force can be obtained, and exhaust gases, after the combustion, are introduced into an exhaust gas passage 9 from an exhaust manifold via an exhaust valve 8 for discharge to the outside.

[0019] The ECU 30 is configured as a logic arithmetic circuit comprising a CPU as a central processing unit for executing known various types of arithmetic processing, a ROM 32 for storing control programs, a RAM 33 for storing various types of data, a B/U (back-up line) RAM 34, an input/output circuit 35 and a bus line 36 for connecting those constituent components. Intake pressures PM from the intake pressure sensor 21, crank angles from the crank angle sensor 22 and so on are inputted into the ECU 30. Then, the injector 5, which is associated with fuel injection timings and fuel injection amounts, and the spark plug 13 and the ignition coil/igniter 14 which are associated with ignition timings, and so on are appropriately controlled based on output signals sent out from the ECU 30 based on various types of sensor information.

[0020] Next, referring to Fig. 3, a processing procedure for calculating atmospheric pressures used in the CPU 31 in the ECU 30 used in turn in an atmospheric pressure detector for an internal combustion engine according to an embodiment of the invention will be described based on a flowchart shown in Fig. 2. Here, Fig. 3 is a time chart showing transition conditions of intake pressures P_{mi} ($i=0, 1, 2, \dots, 23$) [mmHg] read every time an N signal interruption occurs corresponding to processes shown in Fig. 2. This N signal is a signal for representing each of crank angle positions "0" to "23" given every 30 [°CA] relative to a crank angle of 720 [°CA] comprising 4 cycles (induction stroke → compression stroke → expansion (combustion) stroke → exhaust stroke) with a reference crank angle position detected by the crank angle sensor 22 of the crankshaft 12 of the internal combustion engine 1 being "0". Note that this atmospheric arithmetic subroutine is repeatedly executed by the CPU 31 every time a predetermined time elapses.

[0021] In Fig. 2, firstly, in step S101, whether or not there is an N signal interruption is determined. If a determination condition for step S101 is met or it is determined that an N signal interruption exists, the flow advances to step S102, where intake pressures PM read

by the intake pressure sensor 21 are regarded as intake pressures P_{mi} ($i=0, 1, 2, \dots, 23$) (refer to Fig. 3). Next, the flow then advances to step S103, and whether or not the number of samplings of intake pressures P_{mi} is equal to or greater than a predetermined number A is determined. If a determination condition for step S103 is met or it is determined that the number of samplings of intake pressures P_{mi} is equal to or greater than the predetermined number A, then the procedure moves to step S104, where the maximum of the plurality of intake pressures P_{mi} so read is determined as the intake pressure maximum PMMAX. Next, the flow advances to step S105, where the minimum of the plurality of intake pressures P_{mi} so read is determined as the intake pressure minimum PMMIN.

[0022] Next, the flow moves to step S106, and whether or not a difference, resulting when the intake pressure minimum PMMIN obtained in step S105 is subtracted from the intake pressure maximum PMMAX obtained in step S105, falls within a predetermined value α is determined. In case a determination condition for step S106 is met or it is determined that the difference ΔPM (refer to Fig. 3) between the intake pressure maximum PMMAX and the intake pressure minimum PMMIN falls within the predetermined value α , then the flow moves to step S107, and the total of the intake pressures read in step S102 is divided by the predetermined number A to obtain an intake pressure average PMAV. Then, the procedure advances to step S108, where the intake pressure average PMAV obtained in step S107 is determined as an atmospheric pressure PA and the routine ends.

[0023] On the other hand, if the determination condition for step S101 is not met and it is determined that there is no N signal, or if the determination condition for step S103 is not met and it is determined that the number of samplings of intake pressures P_{mi} is small enough to be less than the predetermined number A, no accurate atmospheric pressure can be calculated, or, if the determination condition for step S106 is not met and the difference ΔPM between the intake pressure maximum PMMAX and the intake pressure minimum PMMIN is large enough to exceed the predetermined value α , the intake pressure in the internal combustion engine 1 varies largely, and therefore, it is determined that the condition is not suitable for calculation of atmospheric pressure PA, and the routine ends without doing anything.

[0024] Thus, the atmospheric pressure detector for an internal combustion engine according to the embodiment comprises the intake pressure sensor 21 functioning as the intake pressure detecting means for detecting intake pressures P_{mi} [mmHg] which are pressures of intake air introduced to the downstream side of the throttle valve 11 disposed in the intake air passage 2 of the internal combustion engine 1, the crank angle sensor 22 functioning as the crank angle detecting means for detecting crank angle positions every time the internal

combustion engine 1 turns through 30° [°CA] and the atmospheric pressure calculating means which is attained by the CPU 31 within the ECU 30 for smoothing intake pressures PMi detected by the intake pressure sensor 21 relative to crank angle positions detected every time the internal combustion engine 1 turns through 30° [°CA] according to their transition conditions for calculation as an atmospheric pressure PA.

[0025] In addition, the atmospheric pressure calculating means of the atmospheric pressure detector for an internal combustion engine according to the embodiment which is attained by the CPU 31 in the ECU 30 is designed to smooth intake pressures PMi in case the difference ΔPM between the maximum PMMAX and the minimum PMMIN of the plurality of intake pressures PMi [mmHg] detected by the intake pressure sensor 21 every 30° [°CA] which is the predetermined crank angle position detected by the crank angle sensor 22 falls within the predetermined value α .

[0026] Namely, intake pressures PMi are detected at each predetermined crank angle position of every 30° [°CA] after the internal combustion engine 1 is started, and the intake pressures PMi so detected are smoothed according to the transition conditions and the result is obtained as the atmospheric pressure PA. As this occurs, if the difference ΔPM between the maximum PMMAX and the minimum PMMIN of the plurality of intake pressures PMi is small enough to fall within the predetermined value α , the plurality of intake pressures PMi are smoothed. As the atmospheric pressure PA, when the intake pressures PMi are stable, can be obtained by the plurality of samplings at the crank angle positions, the reliability can be increased.

[0027] Next, a first modification to the processing procedure for calculating an atmospheric pressure used by the CPU 31 in the ECU 30 used in the atmospheric pressure detector for an internal combustion engine according to the embodiment of the invention will be described based on a flowchart shown in Fig. 4 which illustrates the modified procedure. Note that this atmospheric pressure arithmetic routine is repeatedly executed every predetermined time by the CPU 31.

[0028] In Fig. 4, as steps S201 to S206 correspond to the steps S101 to 106 described above with respect to the embodiment, the detailed description of those steps will be omitted. Here, if a determination condition for step S206 is met and it is determined that a difference ΔPM between the intake pressure maximum PMMAX obtained in step S204 and the intake pressure minimum PMMIN obtained in step S205 falls within the predetermined value α , the flow advances to step S207 where, of the intake pressures PMi read in step S202, the total of the intake pressures read every 30° [°CA] from 360° [°CA] to 720° [°CA] are divided by the number (B) of intake pressures, and the result is determined as an intake pressure average PMAV. Next, the flow moves to step S208, where the intake pressure average PMAV obtained in step S207 is determined as an atmospheric

pressure PA, and the routine ends.

[0029] On the other hand, if the determination condition for step S201 is not met and it is determined that there is no N signal, or if the determination condition for step S203 is not met and it is determined that the number of samplings of intake pressures PMi is small enough to be less than the predetermined number A, no accurate atmospheric pressure PA can be calculated, or, if the determination condition for step S206 is not met and the difference ΔPM between the intake pressure maximum PMMAX and the intake pressure minimum PMMIN is large enough to exceed the predetermined value α , the intake pressure in the internal combustion engine 1 varies largely and, therefore, it is determined that the condition is not suitable for calculation of atmospheric pressure PA, and the routine ends without doing anything.

[0030] Thus, the atmospheric pressure calculating means of the atmospheric pressure detector for an internal combustion engine according to the first modification which is attained by the CPU 31 in the ECU 30 is designed to smooth intake pressures PMi in case the difference ΔPM between the maximum PMMAX and the minimum PMMIN of the plurality of intake pressures PMi [mmHg], detected by the intake pressure sensor 21 at predetermined crank angle positions from the expansion stroke to the exhaust stroke of the internal combustion engine 1 which are detected by the crank angle sensor 22 of every 30° [°CA] from 360° [°CA] to 720° [°CA], falls within the predetermined value α .

[0031] Namely, it is understood that even if there occurs a change in load in the internal combustion engine 1, a change in intake pressures PMi is relatively small from 360° [°CA] to 720° [°CA] which are regarded as the predetermined crank angle positions from the expansion stroke to the exhaust stroke of the internal combustion engine 1. If the difference ΔPM between the maximum PMMAX and the minimum PMMIN of the intake pressures PMi obtained relative to the crank angle positions is small enough to fall within the predetermined value α , the intake pressures PMi so obtained are then smoothed. As the atmospheric pressure, when the intake pressures PMi are stable, can be obtained by the samplings at the predetermined crank angle positions, the reliability of the atmospheric pressure detector so modified can be increased.

[0032] Next, a second modification to the processing procedure, for calculating an atmospheric pressure, used by the CPU 31 in the ECU 30 used in the atmospheric pressure detector for an internal combustion engine according to the embodiment of the invention, will be described based on a flowchart shown in Fig. 5 which illustrates the modified procedure. Note that this atmospheric pressure arithmetic routine is repeatedly executed every predetermined time by the CPU 31.

[0033] In Fig. 5, as steps S301 to S306 correspond to the steps S101 to 106 described above with respect to the embodiment, a detailed description of those steps

will be omitted. Here, if a determination condition for step S306 is met and it is determined that a difference ΔPM between the intake pressure maximum PM_{MAX} obtained in step S304 and the intake pressure minimum PM_{MIN} obtained in step S305 falls within the predetermined value α , the flow advances to step S307, where of intake pressures PM_i read in step S302, the total of the intake pressures at predetermined crank angles such as X° [$^\circ CA$], Y° [$^\circ CA$], Z° [$^\circ CA$] are divided by the number C of predetermined crank angles, and the result is determined as an intake pressure average PM_{AV} . Next, the flow moves to step S308, where the intake pressure average PM_{AV} obtained in step S307 is determined as an atmospheric pressure PA , and the routine ends.

[0034] On the other hand, if the determination condition for step S301 is not met and it is determined that there is no N signal, or if the determination condition for step S303 is not met and it is determined that the number of samplings of intake pressures PM_i is small enough to be less than the predetermined number A , no accurate atmospheric pressure PA can be calculated, or, in case the determination condition for step S306 is not met and the difference ΔPM between the intake pressure maximum PM_{MAX} and the intake pressure minimum PM_{MIN} is large enough to exceed the predetermined value α , the intake pressure in the internal combustion engine 1 varies largely and, therefore, it is determined that the condition is not suitable for calculation of atmospheric pressure PA , and the routine ends without doing anything.

[0035] Thus, the atmospheric pressure calculating means of the atmospheric pressure detector for an internal combustion engine according to the second modification which is attained by the CPU 31 in the ECU 30 is designed to smooth intake pressures PM_i in case the difference ΔPM between the maximum PM_{MAX} and the minimum PM_{MIN} of the plurality of intake pressures PM_i [mmHg] detected by the intake pressure sensor 21 relative to the plurality of optional crank angle positions X° , Y° , Z° [$^\circ CA$] from the expansion stroke to the exhaust stroke of the internal combustion engine 1 which are detected by the crank angle sensor 22, falls within the predetermined value α .

[0036] Namely, it is understood that even if there occurs a change in load in the internal combustion engine 1, a change in intake pressures PM_i is relatively small at the predetermined crank angle positions X° , Y° , Z° [$^\circ CA$] from the expansion stroke to the exhaust stroke of the internal combustion engine 1. If the difference ΔPM between the maximum PM_{MAX} and the minimum PM_{MIN} of the intake pressures PM_i obtained relative to the crank angle positions X° , Y° , Z° [$^\circ CA$] is small enough to fall within the predetermined value α , the intake pressures PM_i so obtained are then smoothed. As the atmospheric pressure, when the intake pressures PM_i are stable, can be obtained by the samplings at the crank angle positions, the reliability of the atmospheric

pressure detector so modified can be increased.

[0037] Next, a third modification to the processing procedure for calculating an atmospheric pressure used by the CPU 31 in the ECU 30 used in the atmospheric pressure detector for an internal combustion engine according to the embodiment of the invention will be described based on a flowchart shown in Fig. 6 which illustrates the modified procedure. Note that this atmospheric pressure arithmetic routine is repeatedly executed every predetermined time by the CPU 31.

[0038] In Fig. 6, as steps S401 to S406 correspond to the steps S101 to 106 described above with respect to the embodiment, a detailed description of those steps will be omitted. Here, in step S406, the total of intake pressures PM_i read in step S402 is divided by a predetermined number A and the result is determined as an intake pressure average PM_{AV} .

[0039] Next, the flow moves to step S407, and whether or not a difference, resulting when the intake pressure average PM_{AV} obtained in step S406 is subtracted from the intake pressure maximum PM_{MAX} obtained in step S404, falls within a predetermined value β is determined. If a determination condition for step S407 is met and it is determined that the difference between the intake pressure maximum PM_{MAX} and the intake pressure average PM_{AV} falls within the predetermined value β , then the flow advances to step S408, where whether or not a difference, resulting when the intake pressure minimum PM_{MIN} obtained in step S405 is subtracted from the intake pressure average PM_{AV} obtained in step S406, falls within a predetermined value γ is determined. If a determination condition for step S408 is met and it is determined that the difference between the intake pressure average PM_{AV} and the intake pressure minimum PM_{MIN} falls within the predetermined value γ , the flow then advances to step S409, where the intake pressure average PM_{AV} obtained in step S406 is determined as an atmospheric pressure PA , and the routine ends.

[0040] On the other hand, if the determination condition for step S401 is not met and it is determined that there is no N signal, or if the determination condition for step S403 is not met and it is determined that the number of samplings of intake pressures PM_i is small enough to be less than the predetermined number A , no accurate atmospheric pressure PA can be calculated, or, if the determination condition for step S407 is not met and it is determined that the difference between the intake pressure maximum PM_{MAX} and the intake pressure average PM_{AV} is large enough to exceed the predetermined value β , as a change in intake pressure in the internal combustion engine 1 is large, it is determined that the condition is not suitable for calculation of an atmospheric pressure PA , or if a determination condition for step S408 is not met and it is determined that the difference between the intake pressure average PM_{AV} and the intake pressure minimum PM_{MIN} is large enough to exceed the predetermined value γ , as a

change in intake pressures in the internal combustion engine 1 is large, it is determined that the condition is not suitable for calculation of an atmospheric pressure PA, and the routine ends without doing anything.

[0041] Thus, the atmospheric pressure detector for an internal combustion engine according to the third modification comprises the intake pressure sensor 21 functioning as the intake pressure detecting means for detecting intake pressures PMi [mmHg] which are pressures of intake air introduced into the downstream side of the throttle valve 11 disposed in the intake air passage 2 of the internal combustion engine 1, the intake pressure smoothing means attained by the CPU 31 in the ECU 30 for smoothing intake pressures PMi in case the variation in the intake pressures PMi detected by the intake sensor 21 attained by the CPU 31 in the ECU 30 falls within the predetermined value, and the atmospheric pressure calculating means attained by the CPU 31 in the ECU 30 for calculating the smoothed intake pressure average PMAV as an atmospheric pressure PA.

[0042] Namely, natural intake pressures PMi can be obtained in a stable fashion by the samplings resulting when the variation in the intake pressures PMi detected by the intake pressure sensor 21 falls within the predetermined value, and the accurate atmospheric pressure PA can be obtained using the intake pressure average PMAV obtained from the smoothed intake pressures PMi, and therefore, the reliability of the atmospheric pressure detector so modified can be increased.

[0043] In addition, the intake pressure smoothing means attained by the CPU 31 in the ECU 30 of the atmospheric pressure detector for an internal combustion engine according to the third modification is designed to smooth intake pressures PMi in case the differences between the intake pressure average PMAV which is the average of the intake pressures PMi detected by the intake pressure sensor 21 and the intake pressure maximum PMMAX which is the peak of the intake pressures PMi detected by the intake pressure sensor 21 and the intake pressure minimum PMMIN fall within β , γ , respectively.

[0044] Namely, if the differences between the intake pressure average PMAV, which is based upon the intake pressures PMi detected by the intake pressure sensor 21, and the intake pressure maximum PMMAX and the intake pressure minimum PMMIN are small enough to fall within β , γ , respectively, the intake pressures PMi sampled are stable, and the accurate atmospheric pressure PA can be obtained using the intake pressure average PMAV resulting when the intake pressures PMi so sampled are smoothed, and therefore, the reliability of the atmospheric pressure detector so modified can be increased.

[0045] Next, a fourth modification to the processing procedure for calculating an atmospheric pressure used by the CPU 31 in the ECU 30 used in the atmospheric pressure detector for an internal combustion engine according to the embodiment of the invention will be de-

scribed based on a flowchart shown in Fig. 7 which illustrates the modified procedure. Note that this atmospheric pressure arithmetic routine is repeatedly executed every predetermined time by the CPU 31.

[0046] In Fig. 7, firstly, in step S501, whether or not an exhaust stroke is about to start is determined. If a determination condition for step S501 is met and it is determined that an exhaust stroke of the internal combustion engine 1 is about to be started, the flow moves to step S502, and intake pressures PM read by the intake pressure sensor 21 are determined as intake pressures PMi ($i=0, 1, 2, \dots$). Next, the procedure advances to step S503, where whether or not the exhaust stroke ends is determined. If a determination condition for step S503 is met and it is determined that the exhaust stroke of the internal combustion engine 1 is about to end, the flow advances to step S504, where the maximum of the plurality of intake pressures PMi so read is determined the intake pressure maximum PMMAX. Next, the flow advances to step S505, where the minimum of the plurality of intake pressures PMi so read is determined as the intake pressure minimum PMMIN. Next, the flow moves to step S506, where the total of the intake pressures PMi read in step S502 is divided by a predetermined number D, and the result is determined as an intake pressure average PMAV.

[0047] Next, the flow advances to step S507, and whether or not a difference resulting when the intake pressure average PMAV obtained in step S506 is subtracted from the intake pressure maximum PMMAX obtained in step S504 falls within a predetermined value δ is determined. If a determination condition for step S507 is met and it is determined that the difference between the intake pressure maximum PMMAX and the intake pressure average PMAV falls within the predetermined value δ , then the flow advances to step S508, and whether or not a difference resulting when the intake pressure minimum PMMIN obtained in step S505 is subtracted from the intake pressure average PMAV obtained in step S506 falls within a predetermined value ϵ is determined. If a determination condition for step S508 is met and it is determined that the difference between the intake pressure average PMAV and the intake pressure minimum PMMIN falls within ϵ , then the flow advances to step S509, where the intake pressure average PMAV obtained in step S506 is determined as an atmospheric pressure PA, and the routine ends.

[0048] On the other hand, if a determination condition for step S501 is not met and it is determined that the exhaust stroke has not yet been reached, or if a determination condition for step S503 is not met and it is determined that the exhaust stroke has ended, as an accurate atmospheric pressure PA cannot be calculated, or if a determination condition for step S507 is not met and the difference between the intake pressure maximum PMMAX and the intake pressure average PMAV is large enough to exceed the predetermined value δ , as the variation in intake pressures in the internal com-

bustion engine 1 is large, it is determined that the condition of the internal combustion engine is not suitable for calculation of an atmospheric pressure PA, or if a determination condition for step S508 is not met and the difference between the intake pressure average PMAV and the intake pressure minimum PMMIN is large enough to exceed the predetermined value ϵ , as the variation in intake pressures in the internal combustion engine 1 is large, it is determined that the condition of the internal combustion engine 1 is not suitable for calculation of an atmospheric pressure PA, and the routine ends.

[0049] Thus, the atmospheric pressure detector for an internal combustion engine according to the fourth modification comprises the intake pressure sensor 21 functioning as the intake pressure detecting means for detecting intake pressures PMi [mmHg] which are pressures of intake air introduced into the downstream side of the throttle valve 11 disposed in the intake air passage 2 of the internal combustion engine 1, the exhaust stroke detecting means attained by the CPU 31 in the ECU 30 for detecting an exhaust stroke of the internal combustion engine 1, the intake pressure smoothing means attained by the CPU 31 in the ECU 30 for smoothing intake pressures PMi detected by the intake pressure detecting means 21 during the predetermined period of time from the start of the exhaust stroke to the end of the exhaust stroke which were detected by the exhaust stroke detecting means and the atmospheric pressure calculating means attained by the CPU 31 in the ECU 30 for calculating the intake pressure average PMAV smoothed by the intake pressure smoothing means as an atmospheric pressure PA.

[0050] Namely, it is understood that even if there occurs a variation in load in the internal combustion engine 1, the variation in intake pressures PMi is relatively small within the predetermined period of time from the start of the exhaust stroke to the end of the exhaust stroke. As the intake pressures PMi can be obtained in a stable fashion by the samplings during the predetermined period of time including the exhaust stroke and an accurate atmospheric pressure PA can be obtained by using the intake pressure average PMAV which is the smoothed intake pressures PMi, the reliability of the atmospheric pressure detector according to the fourth modification can be increased.

[0051] Note that as the exhaust stroke detecting means attained by the CPU 31 in the ECU 30, to be specific, for example, a predetermined period of time including the exhaust stroke can be specified from the understanding that the exhaust stroke is started after a predetermined period of time has elapsed from the generation of the minimum intake pressure in the intake pressure variation using the engine speed NE of the internal combustion engine 1 as a parameter. Furthermore, for example, in an atmospheric pressure detector for an internal combustion engine in which cam signals are obtained from a cam angle sensor for detecting cam an-

gles [°CA] of a camshaft, not shown, in conjunction with the rotation of the crankshaft 12 of the internal combustion engine 1, as the exhaust stroke detecting means attained by the CPU 31 in the ECU 30, for example, a predetermined period of time including the exhaust stroke can be specified from the understanding that the exhaust stroke is started after a predetermined period of time has elapsed from the generation of a predetermined cam signal using the engine speed NE of the internal combustion engine 1 as a parameter.

[0052] In the above embodiment and the modifications, while intake pressures PMi are sampled by means of the intake pressure sensor 21 when an N signal interruption occurs every 30° [°CA] which is detected by the crank angle sensor 22, the present invention is not limited thereto in carrying out the same, but intake pressures PMi may be designed to be sampled at other crank angle positions. In addition, the plurality of intake pressures PMi which are finally smoothed may be sampled at different crank angle positions.

[0053] Additionally, a preferred amount of fuel can be injected for supply into the internal combustion engine by reflecting the variation in atmospheric pressure PA obtained by the embodiment and the modifications thereto to the intake pressure PM.

[0054] Note that while the present invention has been described in detail heretofore based on the specific embodiment, it will be apparent to those skilled in the art that the present invention may be altered or modified variously without departing from the spirit and scope of the claims of the present invention.

Claims

1. An atmospheric pressure detector for an internal combustion engine comprising;
 - Intake pressure detecting means for detecting intake pressures which are pressures of intake air introduced to a downstream side of a throttle valve disposed in an intake air passage of said internal combustion engine,
 - crank angle detecting means for detecting predetermined crank angle positions of said internal combustion engine, and
 - atmospheric pressure calculating means for smoothing intake pressures detected by said intake pressure detecting means relative to said predetermined crank angle positions detected by said crank angle detecting means according to transition conditions thereof and calculating said intake pressures so smoothed as an atmospheric pressure.
2. An atmospheric pressure detector for an internal combustion engine as set forth in Claim 1, wherein said atmospheric pressure calculating means smoothes said plurality of intake pressures detected relative to said respective predetermined crank

angle positions provided that a difference between the maximum value and the minimum of said intake pressures so detected falls within a predetermined value.

3. An atmospheric pressure detector for an internal combustion engine as set forth in Claim 1, wherein said atmospheric pressure calculating means smoothes said plurality of intake pressures detected relative to said respective predetermined crank angle positions from an expansion stroke to an exhaust stroke of said internal combustion engine provided that a difference between the maximum and the minimum of said intake pressures so detected falls within a predetermined value. 5 10 15
4. An atmospheric pressure detector for an internal combustion engine as set forth in Claim 1, wherein said atmospheric pressure calculating means smoothes said plurality of intake pressures detected relative to said respective predetermined crank angle positions from an induction stroke to an exhaust stroke of said internal combustion engine provided that a difference between the maximum and the minimum of said intake pressures so detected falls within a predetermined value. 20 25
5. An atmospheric pressure detector for an internal combustion engine comprising;
 - Intake pressure detecting means for detecting intake pressures which are pressures of intake air introduced to a downstream side of a throttle valve disposed in an intake air passage of said internal combustion engine, 30
 - intake pressure smoothing means for smoothing intake pressures detected by said intake pressure detecting means provided that a variation in said intake pressures so detected falls within a predetermined value, and 35
 - atmospheric pressure calculating means for calculating said intake pressures smoothed by said intake pressure smoothing means as an atmospheric pressure. 40
6. An atmospheric pressure detector for an internal combustion engine as set forth in Claim 5, wherein said intake pressure smoothing means smoothes intake pressures detected by said intake pressure detecting means provided that a difference between the average of said intake pressures and the peak of said intake pressures falls within a predetermined value. 45 50
7. An atmospheric pressure detector for an internal combustion engine comprising; 55
 - Intake pressure detecting means for detecting intake pressures which are pressures of intake air introduced to a downstream side of a throttle valve

disposed in an intake air passage of said internal combustion engine,

exhaust stroke detecting means for detecting an exhaust stroke of said internal combustion engine,

intake pressure smoothing means for smoothing intake pressures detected by said intake pressure detecting means within a predetermined period of time including at least an exhaust stroke detected by said exhaust stroke detecting means, and

atmospheric pressure calculating means for calculating said intake pressures smoothed by said intake pressure smoothing means as an atmospheric pressure.

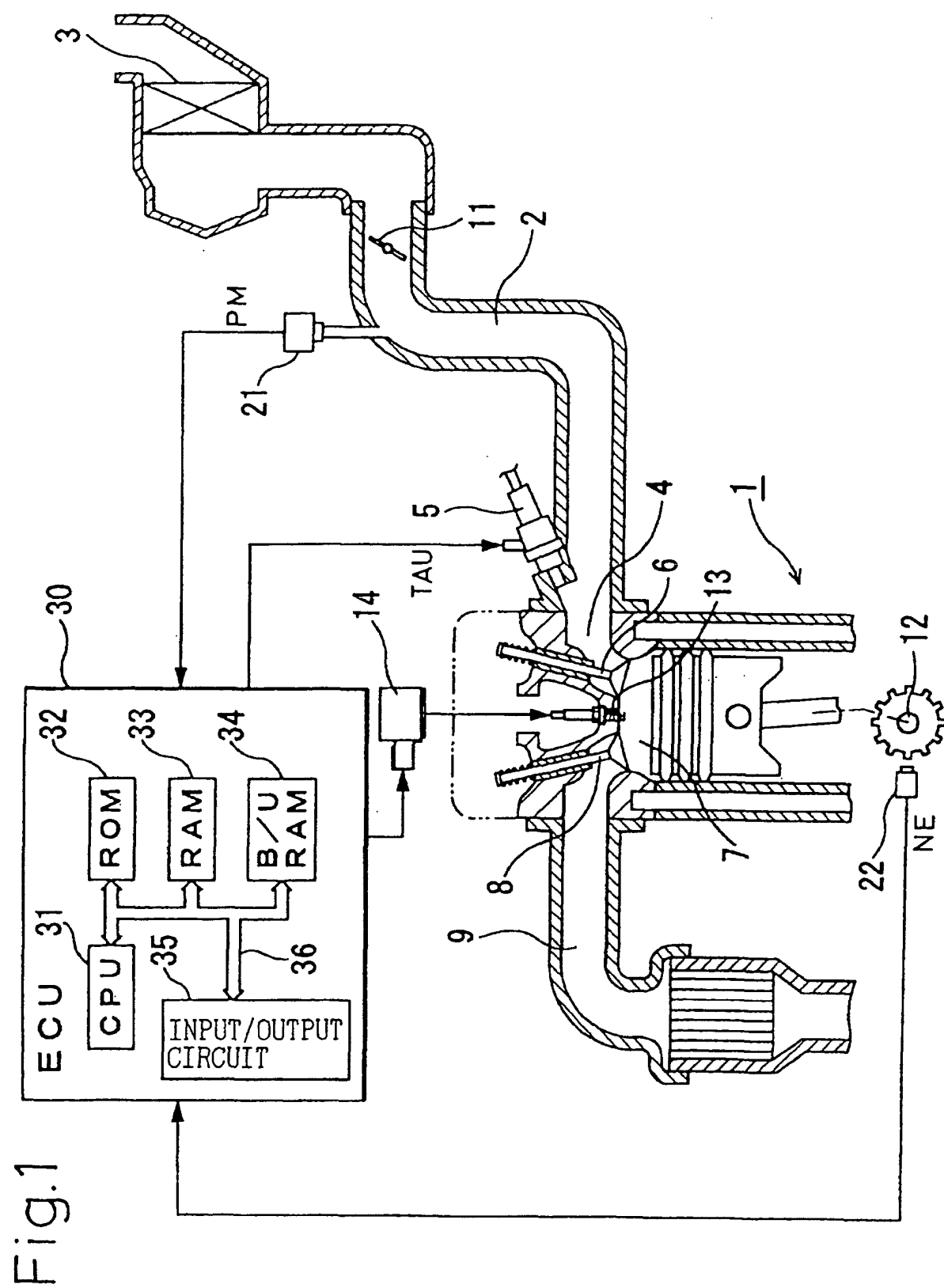
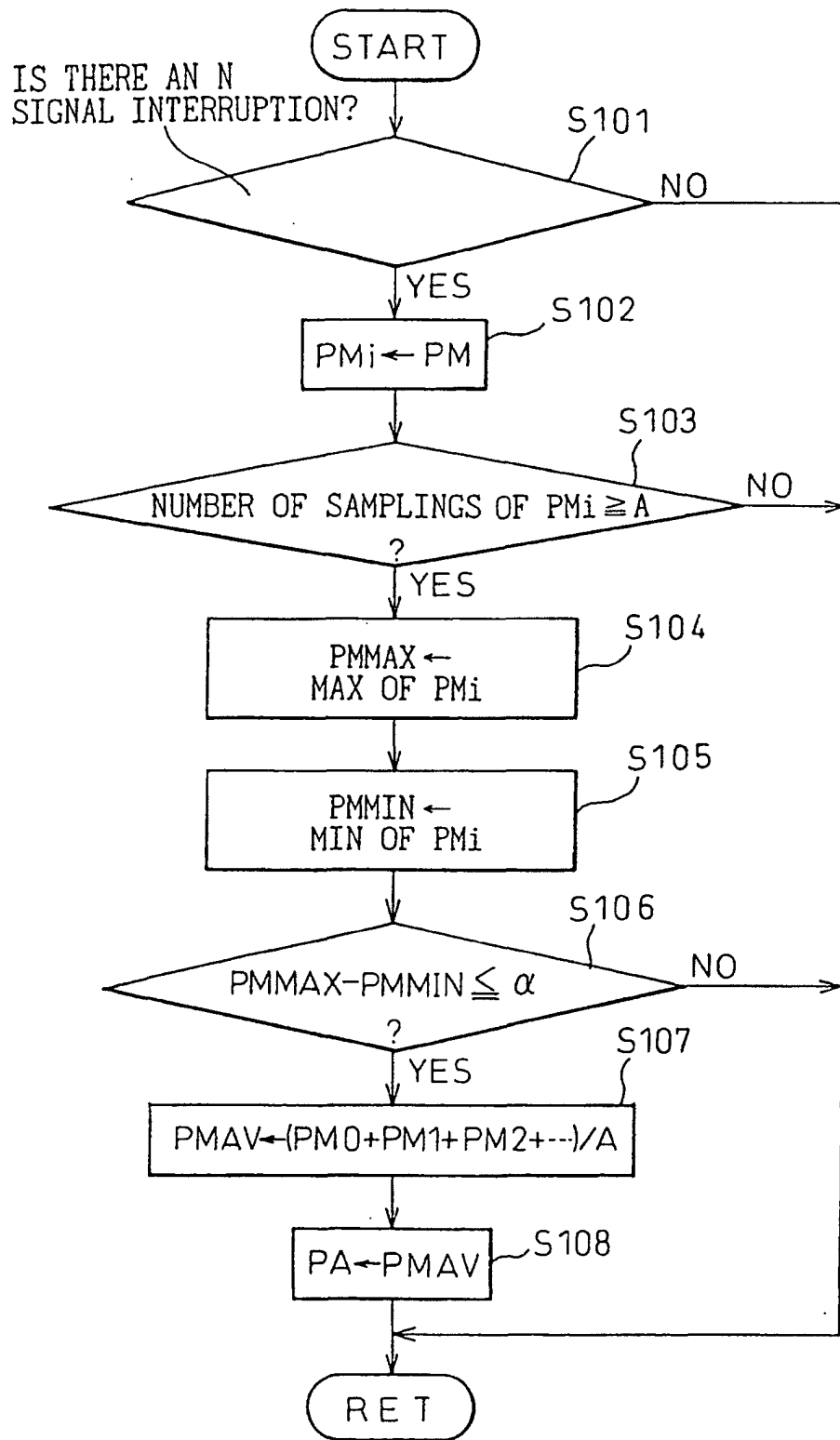


Fig.2



3
0
1
1

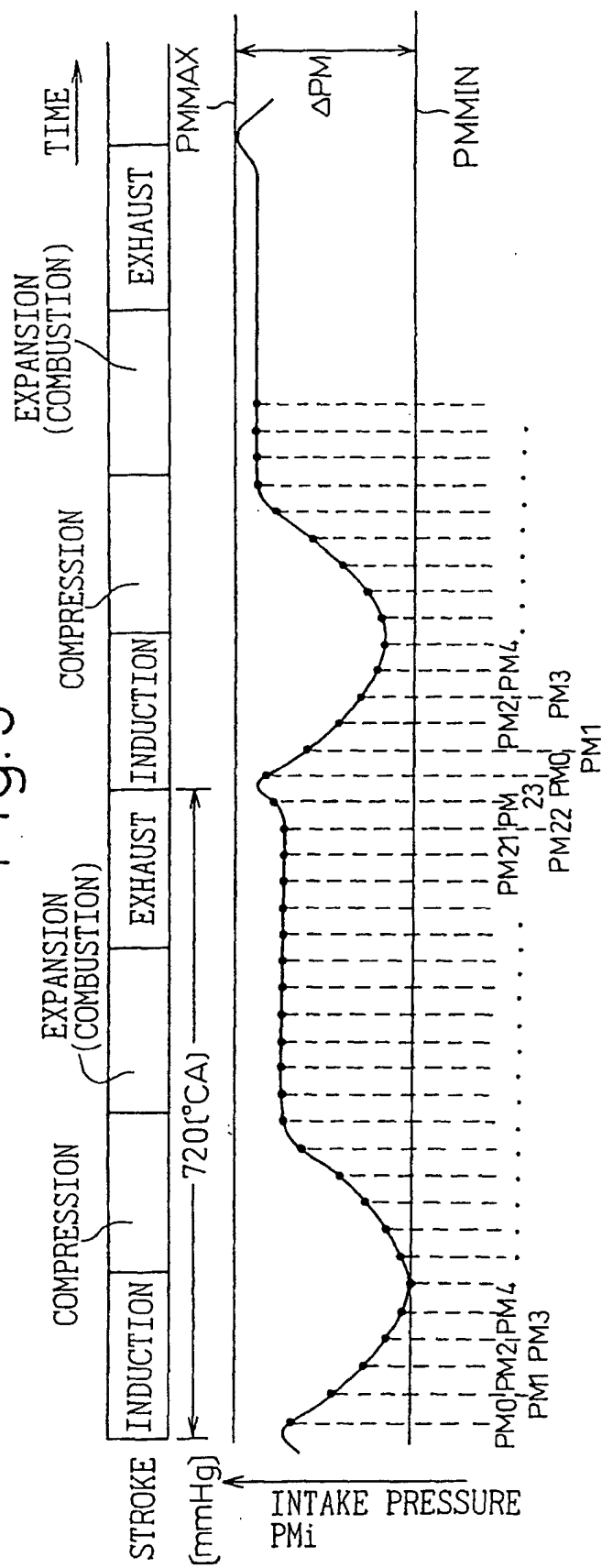


Fig.4

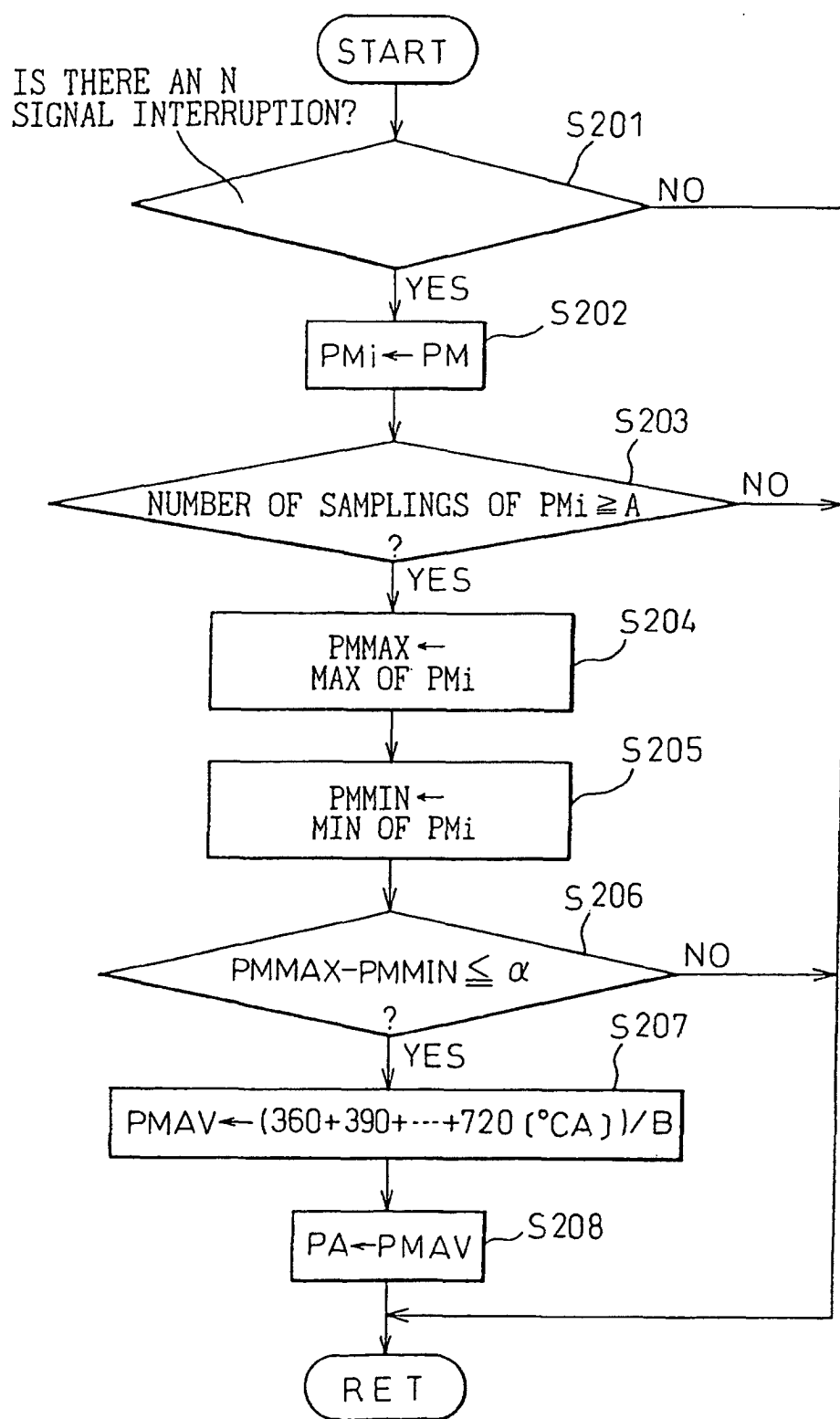


Fig.5

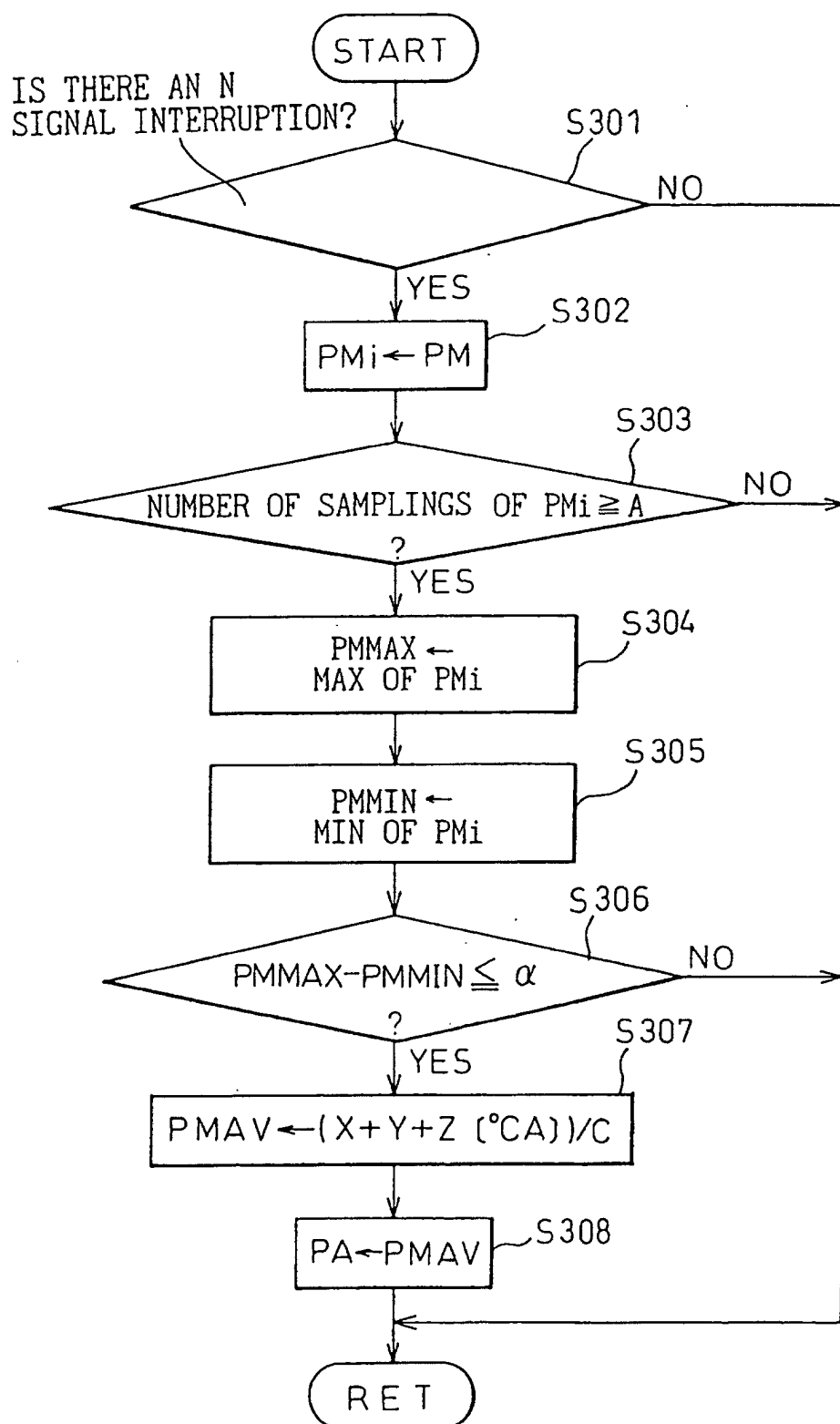


Fig.6

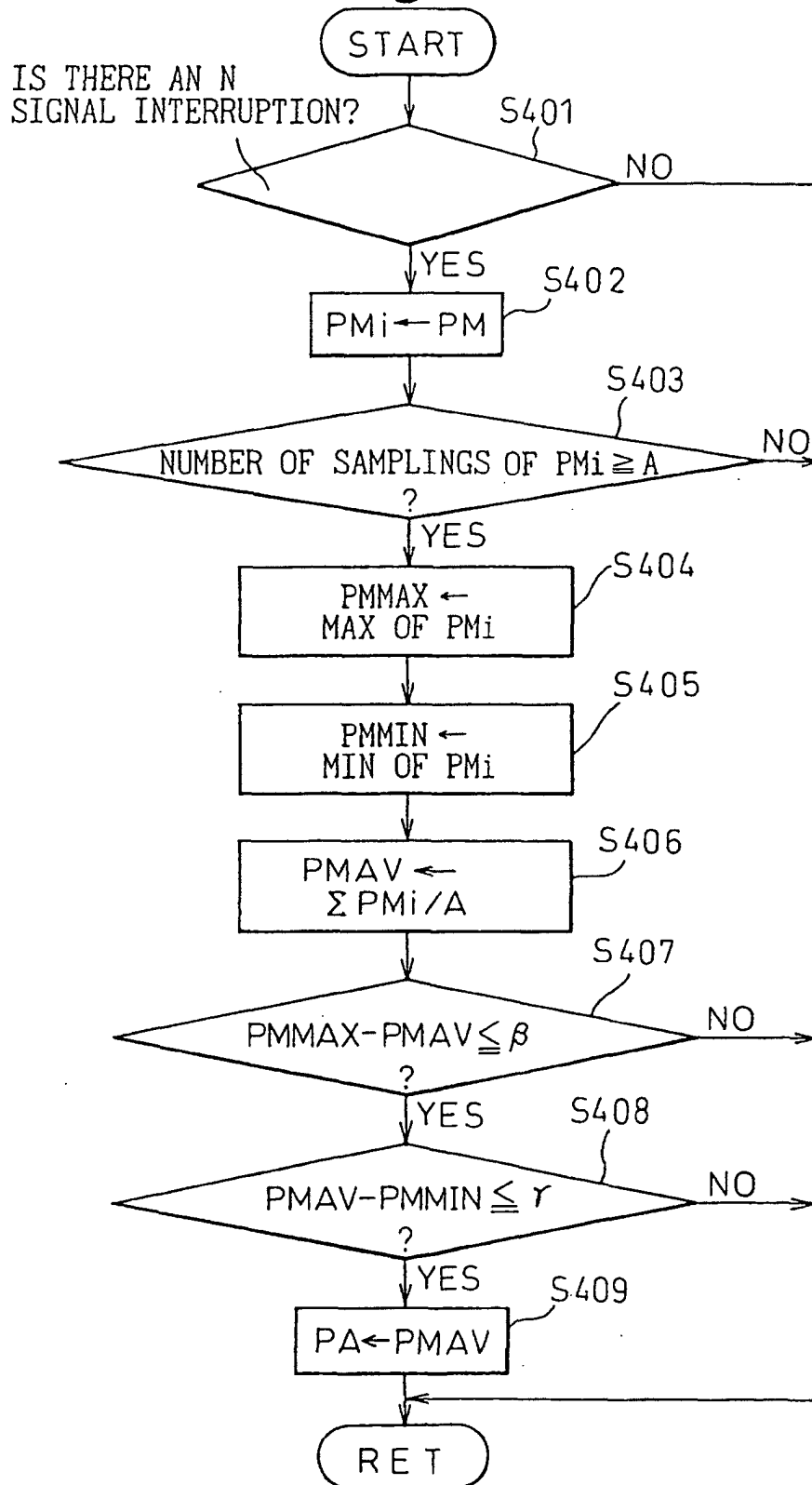
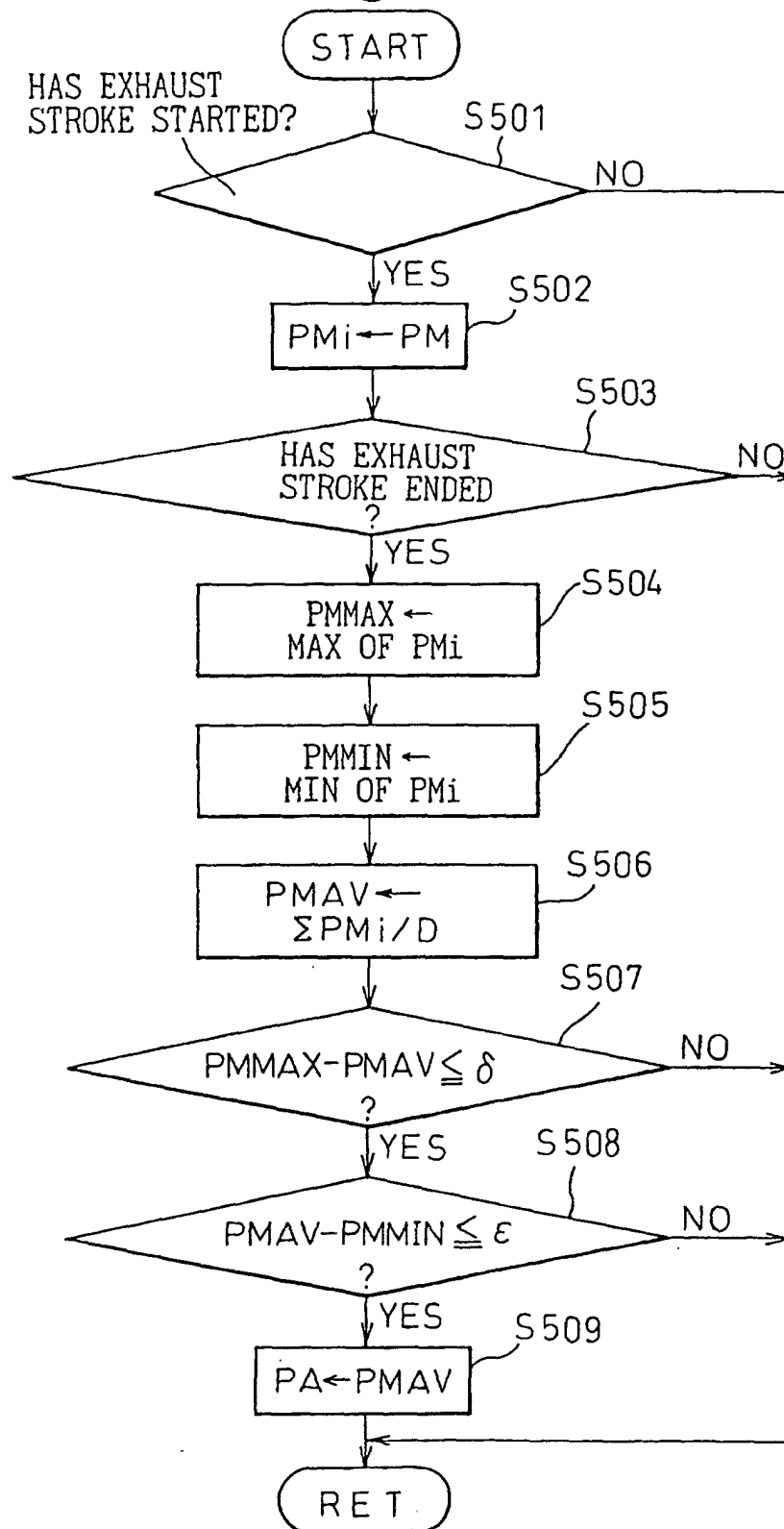


Fig. 7



(Description of Reference Numerals)

1... internal combustion engine

11... throttle valve

21... intake pressure sensor

22... crank angle sensor

30... ECU (electronic control unit)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP02/10340

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl⁷ F02D45/00

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)

Int.Cl⁷ 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	1996-2002
Kokai Jitsuyo Shinan Koho	1971-2002	Toroku Jitsuyo Shinan Koho	1994-2002

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.
X Y	JP 61-185646 A (Nippondenso Co., Ltd.), 19 August, 1986 (19.08.86), Full text; all drawings (Family: none)	1, 5, 7 2-4, 6
Y	JP 1-280662 A (Mitsubishi Electric Corp.), 10 November, 1989 (10.11.89), Full text; all drawings (Family: none)	2-4, 6

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

* Special categories of cited documents:

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"&"

document member of the same patent family

Date of the actual completion of the international search
16 December, 2002 (16.12.02)Date of mailing of the international search report
24 December, 2002 (24.12.02)Name and mailing address of the ISA/
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