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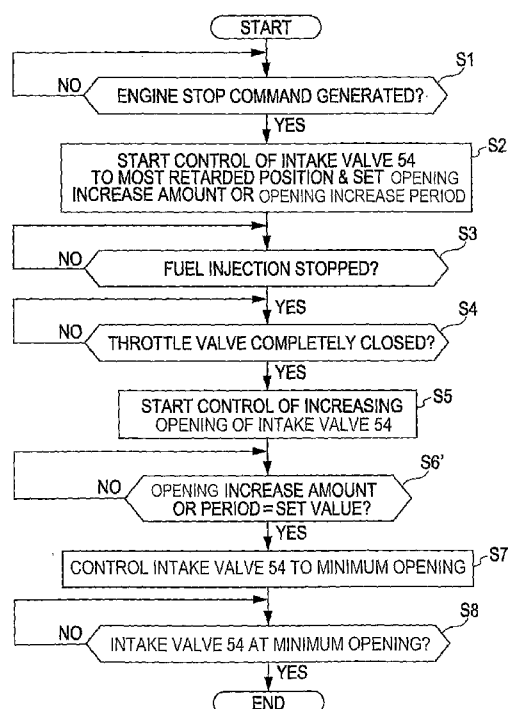
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[Continued on next page]

(54) Title: VALVE CONTROL APPARATUS FOR INTERNAL COMBUSTION ENGINE

FIG. 7



(57) Abstract: A valve control apparatus is provided for an internal combustion engine. The apparatus includes a variable phase angle mechanism (10) configured to continuously change a valve opening phase angle of a valve (54), a variable valve mechanism (20) configured to continuously change at least one of a valve opening duration and a valve lift of the valve, and a controller (61) configured to control the variable phase angle mechanism and the variable valve mechanism. The variable phase angle mechanism is configured to set the valve opening phase angle at a retarded phase angle in a startup operation as compared with a normal phase angle in a normal operation. After an engine stop command is generated, the controller controls the variable valve mechanism such that an integrated valve opening value is increased to be larger than an idle state integrated valve opening value in an idle state.



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- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))
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AMENDED CLAIMS
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WHAT IS CLAIMED IS:

1. A valve control apparatus for an internal combustion engine, the apparatus comprising:
 - a variable phase angle mechanism configured to continuously change a valve opening phase angle of a valve, the variable phase angle mechanism being configured to set the valve opening phase angle at a retarded phase angle in a startup operation as compared with a normal phase angle in a normal operation;
 - a variable valve mechanism configured to continuously change at least one of a valve opening duration and a valve lift of the valve; and
 - a controller configured to control the variable phase angle mechanism and the variable valve mechanism;wherein after an engine stop command is generated and fuel injection is stopped, the controller controls the variable valve mechanism such that an integrated valve opening value is increased to be larger than an idle state integrated valve opening value in an idle state.
2. The valve control apparatus according to claim 1, wherein the controller starts controlling the variable valve mechanism such that the integrated valve opening value is increased to be larger than the idle state integrated valve opening value only after the engine stop command is generated and after an engine stop operation is completed.
3. The valve control apparatus according to claim 1, wherein the controller controls the variable valve mechanism such that after the integrated valve opening value is increased to be larger than the idle state integrated valve opening value, the integrated valve opening value is then decreased.
4. The valve control apparatus according to claim 1, the apparatus further comprising:
 - a sensor configured to detect or estimate an engine speed;

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wherein the controller controls the variable valve mechanism such that the integrated valve opening value is increased to be larger than the idle state integrated valve opening value for a predetermined period; and

wherein at least one of the predetermined period and the integrated valve opening value is set according to the engine speed at the time the engine stop command is generated such that when the engine speed at the time the engine stop command is generated is higher, at least one of the predetermine period and the integrated valve opening value is set to be lower.

5. The valve control apparatus according to claim 1,

wherein the controller controls the variable valve mechanism such that the integrated valve opening value is increased to be larger than the idle state integrated valve opening value for a predetermined period; and

wherein at least one of the predetermined period and the integrated valve opening value is set according to a phase angle difference between a valve opening center phase angle when the engine stop command is generated and the valve opening center phase angle to be set in the startup operation such that when the phase angle difference is larger, at least one of the predetermined period and the integrated valve opening value is set to be higher.

6. The valve control apparatus according to claim 1, the apparatus further comprising:
a sensor configured to detect or estimate an engine temperature;

wherein the controller controls the variable valve mechanism such that the integrated valve opening value is increased to be larger than the idle state integrated valve opening value for a predetermined period; and

wherein at least one of the predetermined period is increased and the integrated valve opening value is set according to a temperature of the engine such that when the engine temperature is lower, at least one of the predetermined period and the integrated valve opening value is set to be higher.

7. The valve control apparatus according to claim 1,

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wherein the controller controls fuel injection to the engine and delays stopping of fuel injection for a predetermined period after the engine stop command is generated.

8. The valve control apparatus according to claim 7, the apparatus further comprising:
a sensor configured to detect or estimate an engine operating parameter of the engine;

wherein the controller sets the predetermined period according to the engine operating parameter;

wherein when the engine operating parameter is an engine speed or an engine temperature when the engine stop command is generated, the predetermined period is set inversely with respect to the engine operating parameter such that as the engine operating parameter is lower, the predetermined period is longer; and

wherein when the engine operating parameter is a phase angle difference between a valve opening center phase angle when the engine stop command is generated and a valve opening center phase angle to be set in the startup operation, the predetermined period is set directly with respect to the engine operating parameter such that as the engine operating parameter is higher, the predetermined period is longer.

9. The valve control apparatus according to claim 1, wherein the variable phase angle mechanism is hydraulically driven, and wherein the variable valve mechanism is electrically driven.

10. A valve control apparatus for an internal combustion engine, the apparatus comprising:

a variable phase angle mechanism configured to continuously change a valve opening phase angle of a valve, the variable phase angle mechanism being configured to set the valve opening phase angle at a retarded phase angle in a startup operation as compared with a normal phase angle in a normal operation;

a variable valve mechanism configured to continuously change at least one of a valve opening duration and a valve lift of the valve; and

a controller configured to control the variable phase angle mechanism and the variable valve mechanism;

wherein during a predetermined period after an engine stop command is generated and fuel injection is stopped, and prior to stopping of operation of the engine, the controller controls the variable valve mechanism such that an integrated valve opening value is increased to be larger than a startup operation integrated valve opening value for a startup operation, and then controls the variable valve mechanism such that the integrated valve opening value is restored to the startup operation integrated valve opening value.

11. A valve control apparatus for an internal combustion engine, the apparatus comprising:

a variable phase angle mechanism configured to continuously change a valve opening phase angle of a valve, the variable phase angle mechanism being configured to set the valve opening phase angle at a retarded phase angle in a startup operation as compared with a normal phase angle in a normal operation;

a variable valve mechanism configured to continuously change at least one of a valve opening duration and a valve lift of the valve; and

a controller configured to control the variable phase angle mechanism and the variable valve mechanism,

wherein during a predetermined period after an engine stop command is generated and fuel injection is stopped, and prior to stopping of operation of the engine, the controller controls the variable valve mechanism such that at least one of the valve opening duration and the valve lift of the valve is increased to be larger than a respective valve opening and valve lift of the valve in an idle state, and then controls the variable valve mechanism for the startup operation.

12. The valve control apparatus according to claim 11,

wherein one of the valve opening duration and the valve lift of the valve is held fixed while the other of the valve opening duration and the valve lift of the valve is controlled by the controller during the predetermined period after an engine stop command is generated and prior to stopping of operation of the engine.

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13. A method for controlling a valve in an internal combustion engine, the method comprising:

determining an idle state integrated valve opening value by integrating the area under a curve plotting a valve lift of the valve on the vertical axis and a valve opening duration of the valve on the horizontal axis when the engine is operating in an idle state; and

after an engine stop command is generated and fuel injection is stopped, determining a current integrated valve opening value by integrating the area under a curve plotting a valve lift of the valve on the vertical axis and a valve opening duration of the valve on the horizontal axis, and controlling at least one of the valve lift and the valve opening duration of the valve such that the current integrated value is increased to be larger than the idle state integrated valve opening value.

14. The method according to claim 13, wherein the step of controlling at least one of the valve lift and the valve opening duration starts only after the engine stop command is generated and after an engine stop operation is completed.

15. The method according to claim 13, further comprising:

after the step of controlling the at least one of the valve lift and the valve opening duration of the valve such that the current integrated value is increased to be larger than the idle state integrated valve opening value, controlling the at least one of the valve lift and the valve opening duration of the valve such that the current integrated value is decreased.

16. The method according to claim 13, further comprising:

detecting or estimating an engine speed;
maintaining the integrated valve opening value to be larger than the idle state integrated valve opening value for a predetermined period; and
setting at least one of the predetermined period and the integrated valve opening value according to the engine speed at the time the engine stop command is generated such that when the engine speed at the time the engine stop command is generated is higher, at

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least one of the predetermine period and the integrated valve opening value is set to be lower.

17. The method according to claim 13, further comprising:

determining a phase angle difference between a valve opening center phase angle to be set in a startup operation and a valve opening center phase angle when the engine stop command is generated;

maintaining the integrated valve opening value to be larger than the idle state integrated valve opening value for a predetermined period; and

setting at least one of the predetermined period and the integrated valve opening value according to the phase angle difference such that when the phase angle difference is larger, at least one of the predetermined period and the integrated valve opening value is set to be higher.

18. The method according to claim 13, further comprising:

detecting or estimating an engine temperature;

maintaining the integrated valve opening value to be larger than the idle state integrated valve opening value for a predetermined period; and

setting at least one of the predetermined period and the integrated valve opening value according to a temperature of the engine such that when the engine temperature is lower, at least one of the predetermined period and the integrated valve opening value is set to be higher.

19. The method according to claim 13, further comprising:

after the engine stop command is generated, delaying stopping of fuel injection to the engine for a predetermined period;

detecting or estimating an engine operating parameter of the engine; and

setting the predetermined period according to the engine operating parameter;

wherein when the engine operating parameter is an engine speed or an engine temperature when the engine stop command is generated, the predetermined period is set

inversely with respect to the engine operating parameter such that as the engine operating parameter is lower, the predetermined period is longer; and

wherein when the engine operating parameter is a phase angle difference between a valve opening center phase angle when the engine stop command is generated and a valve opening center phase angle to be set in the startup operation, the predetermined period is set directly with respect to the engine operating parameter such that as the engine operating parameter is higher, the predetermined period is longer.

20. A valve control apparatus for an internal combustion engine, the apparatus comprising:

variable phase angle means configured to continuously change a valve opening phase angle of a valve, the variable phase angle means being configured to set the valve opening phase angle at a retarded phase angle in a startup operation as compared with a normal phase angle in a normal operation;

variable valve means configured to continuously change at least one of a valve opening duration and a valve lift of the valve; and

control means configured to control the variable phase angle means and the variable valve means;

wherein after an engine stop command is generated and fuel injection is stopped, the variable valve means changes at least one of the valve opening duration and the valve lift of the valve to increase an integrated valve opening value to be increased to be larger than an idle state integrated valve opening value in an idle state.

STATEMENT UNDER PCT ARTICLE 19(1)

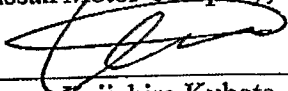
Sir:

Claims 1, 10, 11, 13 and 20 are amended to recite "after an engine stop command is generated and fuel injection is stopped." Applicant submits that the amendment does not go beyond the disclosure of the international application as filed.

Applicant submits that JP2006-266200 cited in the International Search Report dated September 15, 2009 discloses a variable valve duration mechanism in which the control section changes the valve duration to a valve duration suitable for starting the engine. However JP2006-266200 changes the valve duration only during a no misfire condition of the engine, and the change process of the valve duration is suspended when the engine is in a misfire condition. Thus, JP2006-266200 does not disclose that a variable valve mechanism is changed while fuel injection is stopped.

Respectfully submitted,

Nissan Motor Company, Ltd.


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Date:

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