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(54) **VARIABLE VALVE TIMING CONTROL DEVICE FOR INTERNAL COMBUSTION ENGINE, AND CONTROL METHOD**

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See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,403,849	B1	7/2008	Watanabe et al.	
2007/0283925	A1*	12/2007	Nagashima	F01L 1/3442 123/406.12
2008/0189022	A1	8/2008	Watanabe et al.	
2009/0210137	A1	8/2009	Kokubo et al.	

FOREIGN PATENT DOCUMENTS

JP	10-318004	12/1998
JP	2004-162706 A	6/2004
JP	2005-233153	9/2005

(Continued)

OTHER PUBLICATIONS

Japanese Office Action dated May 17, 2016 issued in corresponding Japanese Application No. 2013-120036.

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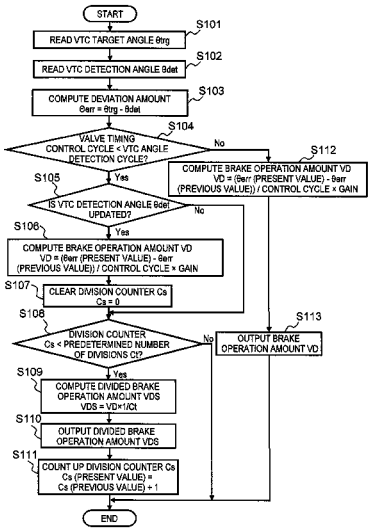
(57) **ABSTRACT**

The present invention relates to variable valve timing control device and control method, which change valve timing of an internal combustion engine. An operation amount for controlling the valve timing is computed, and an operation amount computed at position detection timing of a valve timing control system is divided and output until next position detection timing.

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