



US009410454B2

(12) **United States Patent**  
**Kobayashi et al.**

(10) **Patent No.:** **US 9,410,454 B2**  
(45) **Date of Patent:** **Aug. 9, 2016**

(54) **VALVE OPENING/CLOSING TIMING CONTROL DEVICE**

USPC ..... 123/90.17  
See application file for complete search history.

(71) Applicant: **AISIN SEIKI KABUSHIKI KAISHA,**  
Kariya-shi, Aichi (JP)

(56) **References Cited**

(72) Inventors: **Masaki Kobayashi,** Okazaki (JP);  
**Yoshiaki Yamakawa,** Toyota (JP)

U.S. PATENT DOCUMENTS

(73) Assignee: **AISIN SEIKI KABUSHIKI KAISHA,**  
Kariya-Shi, Aichi (JP)

2010/0175651 A1 7/2010 Takenaka  
2010/0313835 A1\* 12/2010 Yamaguchi ..... F01L 1/3442  
123/90.15  
2012/0186547 A1 7/2012 Fujiyoshi et al.

(\* ) Notice: Subject to any disclaimer, the term of this  
patent is extended or adjusted under 35  
U.S.C. 154(b) by 0 days.

FOREIGN PATENT DOCUMENTS

(21) Appl. No.: **14/772,450**

JP 2010-163942 A 7/2010  
JP 2010-249031 A 11/2010

(22) PCT Filed: **Dec. 25, 2014**

(Continued)

(86) PCT No.: **PCT/JP2014/084218**

OTHER PUBLICATIONS

§ 371 (c)(1),

(2) Date: **Sep. 3, 2015**

International Search Report (PCT/ISA/210) mailed on Mar. 24, 2015,  
by the Japanese Patent Office as the International Searching Author-  
ity for International Application No. PCT/JP2014/084218.

(87) PCT Pub. No.: **WO2015/141096**

(Continued)

PCT Pub. Date: **Sep. 24, 2015**

(65) **Prior Publication Data**

US 2016/0108769 A1 Apr. 21, 2016

(30) **Foreign Application Priority Data**

Mar. 19, 2014 (JP) ..... 2014-056929

(51) **Int. Cl.**

**F01L 1/34** (2006.01)

**F01L 1/344** (2006.01)

(52) **U.S. Cl.**

CPC ..... **F01L 1/344** (2013.01); **F01L 1/3442**  
(2013.01); **F01L 2001/3443** (2013.01); **F01L**  
**2001/34433** (2013.01); **F01L 2001/34463**  
(2013.01); **F01L 2001/34466** (2013.01); **F01L**  
**2001/34473** (2013.01); **F01L 2001/34476**  
(2013.01); **F01L 2001/34479** (2013.01); **F01L**  
**2001/34483** (2013.01); **F01L 2250/04**  
(2013.01); **F01L 2800/03** (2013.01)

(58) **Field of Classification Search**

CPC .... **F01L 1/344**; **F01L 1/3442**; **F01L 2250/04**;  
**F01L 2001/34483**; **F01L 2001/34476**; **F01L**  
**2001/34433**; **F01L 2001/34479**; **F01L**  
**2001/34473**; **F01L 2001/34466**; **F01L**  
**2001/34463**; **F01L 2800/03**; **F01L 2001/3443**

*Primary Examiner* — Zelalem Eshete

(74) *Attorney, Agent, or Firm* — Buchanan Ingersoll &  
Rooney PC

(57)

**ABSTRACT**

A valve opening/closing timing control device includes an advancing chamber and a retarding chamber between driving and driven rotating bodies, an intermediate locking mechanism performing switching between a locked state and an unlocked state, an advancing channel connected to the advancing chamber, a retarding channel connected to the retarding chamber, and at least one electromagnetic valve supplying/discharging working fluid to/from the advancing chamber, retarding chamber, and intermediate lock mechanism due to an electricity supply amount being changed. When working fluid is discharged from the intermediate lock mechanism, and working fluid is supplied to the advancing chamber and is discharged from the retarding chamber, the maximum working fluid flow amount through the advancing and retarding channels is greater than the maximum working fluid flow amount through the advancing and retarding channels when the electromagnetic valve is controlled such that the working fluid is supplied to the intermediate lock mechanism.

**3 Claims, 12 Drawing Sheets**

