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• **Lee, Su Kyoung**  
**Geumjeong-Gu, Busan 46270 (KR)**

(72) Inventors:  
• **Jung, Kyun Sik**  
**Geumjeong-Gu, Busan 46270 (KR)**  
• **Lee, Su Kyoung**  
**Geumjeong-Gu, Busan 46270 (KR)**

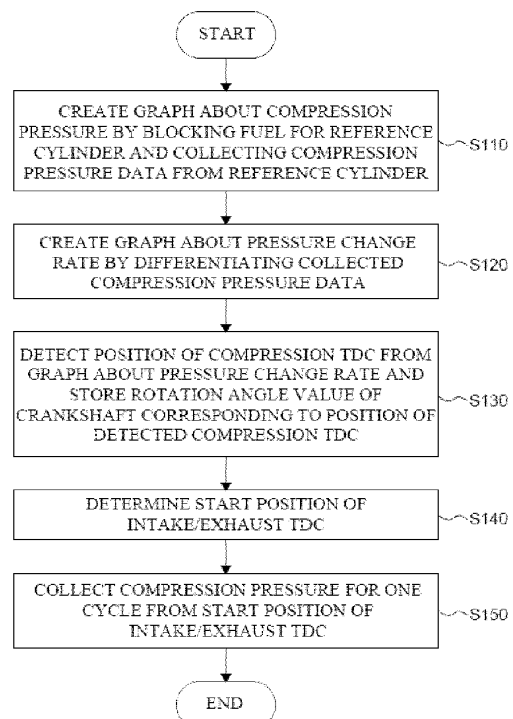
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(74) Representative: **FARAGO Patentanwälte**  
**Thierschstraße 11**  
**80538 München (DE)**

(71) Applicants:  
• **Jung, Kyun Sik**  
**Geumjeong-Gu, Busan 46270 (KR)**

(54) **METHOD FOR COLLECTING 1-CYCLE DATA FOR OUTPUT MEASUREMENT AND COMBUSTION ANALYSIS OF LARGE-SIZED LOW-SPEED 4-STROKE ENGINE**

(57) A method for collecting 1-cycle data for output measurement and combustion analysis of a large-sized low-speed 4-stroke engine according to an embodiment of the present disclosure includes: creating a graph about compression pressure of a predetermined reference cylinder at rotation angles of a crankshaft by blocking fuel for the reference cylinder and collecting compression pressure data from the reference cylinder; creating a graph about pressure change rates of the reference cylinder at rotation angles of the crankshaft by differentiating the compression pressure data collected from the reference cylinder with respect to the rotation angle of the crankshaft; detecting the position of a compression TDC from the graph about the compression change rates of the reference cylinder at the rotation angles of the crankshaft, and storing the rotation angle value of the crankshaft corresponding to the detected position of the compression TDC; determining a start position of an intake/exhaust TDC by adding a rotation angle value of the crankshaft corresponding to 0.5 cycles to the rotation angle value of the crankshaft corresponding to the position of the compression TDC; and collecting compression pressure of the reference cylinder at rotation angles of the crankshaft for one cycle from the start position of the intake/exhaust TDC.



**FIG. 1**



## EUROPEAN SEARCH REPORT

Application Number  
EP 19 17 0459

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2009/178473 A1 (HOSHI SHINYA [JP] ET AL) 16 July 2009 (2009-07-16) * paragraphs [0035], [0036], [0044] - [0052], [0055], [0056], [0061]; claims 1-4; figures 1-5 *	1,2,9	INV. F02D17/02 F02D35/02 F02D41/00
X	WO 2004/048762 A1 (RICARDO CONSULTING ENG [GB] ET AL.) 10 June 2004 (2004-06-10) * page 4, line 15 - page 10, line 25; claims 1-29; figures 1-10 *	1,2,9	
X	US 2008/249677 A1 (KRUGER DUANE D [US]) 9 October 2008 (2008-10-09) * paragraphs [0023], [0024], [0025], [0036], [0038], [0051]; claims 1-5 *	1,2,9	
			TECHNICAL FIELDS SEARCHED (IPC)
			F02D
<p>3 <del>The present search report has been drawn up for all claims</del></p>			
Place of search		Date of completion of the search	Examiner
The Hague		4 September 2019	Boye, Michael
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ..... &amp; : member of the same patent family, corresponding document</p>			

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Application Number

EP 19 17 0459

**CLAIMS INCURRING FEES**

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

**LACK OF UNITY OF INVENTION**

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1, 2, 9

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).



**LACK OF UNITY OF INVENTION**  
**SHEET B**

Application Number

EP 19 17 0459

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1, 2, 9

Motoring the engine, measuring cylinder pressure, differentiating the signal to find the compression TDC and the respective crank angle, collecting compression pressure data for one (4-stroke) cycle when the TDC found is the gas exchange TDC, and adding 0.5 cycles before collecting the compression pressure data when the TDC is the compression TDC.

Putting a TDC of a reference cylinder on a TDC marker of a flywheel and matching the Z-pulse signal of an angle sensor to the TDC of the reference cylinder; and collecting combustion pressure data for one (four-stroke) cycle by taking an A-pulse or B-pulse signal of an angle sensor as a trigger signal.

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2. claims: 3-6, 9

Recognizing a Z-pulse signal of an angle signal sequentially as 0 and 1 for one (4-stroke) cycle, collecting combustion pressure data for one signal and determining TDC at a signal generation point from the collected data, and maintaining or changing signal setting of the angle sensor in accordance with the result of the determination, before collecting the combustion pressure data for one cycle from a setting position.

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3. claims: 7-9

Collecting 1.5 cycles of combustion pressure data by taking a predetermined pulse signal of an angle sensor as a start signal, determining a data collection range corresponding to one cycle by comparing an initially collected combustion pressure datum of the combustion pressure data collected for 1.5 cycles with predetermined reference pressure; and collecting the combustion pressure data from the determined data collection range corresponding to one cycle.

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**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 19 17 0459

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
The members are as contained in the European Patent Office EDP file on  
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04-09-2019

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