

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

(10) **Patent No.:** **US 10,247,142 B1**  
(45) **Date of Patent:** **Apr. 2, 2019**

(54) **TECHNIQUES FOR TRACKING EXHAUST GAS CONSTITUENTS THROUGH A LOW PRESSURE EXHAUST GAS RECIRCULATION SYSTEM OF A TURBOCHARGED GASOLINE ENGINE**

(58) **Field of Classification Search**  
CPC ..... F02M 26/06; F02M 26/19; F02M 26/23; F02M 35/024; F02B 37/18; F02D 41/1454  
See application file for complete search history.

(71) Applicants: **Shu Wang**, Rochester Hills, MI (US);  
**Ethan Bayer**, Lake Orion, MI (US);  
**William P Attard**, Brighton, MI (US);  
**Tyler Tutton**, Royal Oak, MI (US)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2008/0040085	A1*	2/2008	Wang	.....	F02D 23/02 703/7
2009/0112445	A1*	4/2009	Wills	.....	F02D 41/14 701/108
2011/0088674	A1*	4/2011	Shutty	.....	F02D 41/0007 123/568.21
2014/0163841	A1*	6/2014	Sane	.....	F02D 41/0087 701/104
2014/0372009	A1*	12/2014	Song	.....	F02D 41/0052 701/108
2016/0146130	A1*	5/2016	Haskara	.....	F02D 41/005 701/108

(72) Inventors: **Shu Wang**, Rochester Hills, MI (US);  
**Ethan Bayer**, Lake Orion, MI (US);  
**William P Attard**, Brighton, MI (US);  
**Tyler Tutton**, Royal Oak, MI (US)

(73) Assignee: **FCA US LLC**, Auburn Hills, MI (US)

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

(Continued)

*Primary Examiner* — Thomas Moulis

(74) *Attorney, Agent, or Firm* — Ralph E. Smith

(21) Appl. No.: **15/800,430**

(57) **ABSTRACT**

(22) Filed: **Nov. 1, 2017**

Systems and methods for a turbocharged gasoline engine utilize an exhaust gas concentration sensor disposed upstream from an exhaust gas recirculation pickup point of a low pressure EGR (LPEGR) system of the engine and a controller configured to receive a measured air/fuel ratio of the exhaust gas from the sensor, determine an air/fuel ratio of the exhaust gas at the EGR pickup point, determine an air/fuel ratio of the exhaust gas at an inlet and outlet of an EGR cooler, determine first/second sets of exhaust gas fractions and fuel fractions upstream/downstream from an EGR port that is upstream from a compressor in an induction system of the engine, and control at least one of a wastegate valve, a throttle valve, a fuel injector, and a spark plug based on the sets of second exhaust gas fractions and fuel fractions to prevent misfires of the engine.

(51) **Int. Cl.**  
**F02M 26/00** (2016.01)  
**F02M 26/06** (2016.01)  
**F02B 37/18** (2006.01)  
**F02M 26/23** (2016.01)  
**F02M 35/024** (2006.01)  
**F02M 26/19** (2016.01)  
**F02D 41/14** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **F02M 26/06** (2016.02); **F02B 37/18** (2013.01); **F02D 41/1454** (2013.01); **F02M 26/19** (2016.02); **F02M 26/23** (2016.02); **F02M 35/024** (2013.01)

**20 Claims, 17 Drawing Sheets**

