



US010210677B2

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

(10) **Patent No.:** **US 10,210,677 B2**

(45) **Date of Patent:** **Feb. 19, 2019**

(54) **SYSTEMS AND METHODS OF DETERMINING CAUSES OF PERFORMANCE DEFICIENCIES OF VEHICLES**

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,434,512 B1 8/2002 Discenzo  
9,691,025 B2\* 6/2017 Kirsch ..... G06N 5/022  
(Continued)

(71) Applicant: **Freeport-McMoRan Inc.**, Phoenix, AZ (US)

(72) Inventors: **Mary Amelia Walker**, Phoenix, AZ (US); **Robert Catron**, Phoenix, AZ (US); **D. Bradley Brown**, Phoenix, AZ (US)

(73) Assignee: **Freeport-McMoRan Inc.**, Phoenix, AZ (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.

(21) Appl. No.: **15/426,755**

(22) Filed: **Feb. 7, 2017**

(65) **Prior Publication Data**

US 2017/0236341 A1 Aug. 17, 2017

**Related U.S. Application Data**

(60) Provisional application No. 62/294,023, filed on Feb. 11, 2016.

(51) **Int. Cl.**  
**G07C 5/08** (2006.01)  
**G07C 5/00** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **G07C 5/0808** (2013.01); **G07C 5/0825** (2013.01); **G07C 5/008** (2013.01)

(58) **Field of Classification Search**  
CPC ..... **G07C 5/0808**; **G07C 5/006**; **G07C 5/12**;  
**G07C 5/0841**; **G07C 5/0816**

See application file for complete search history.

OTHER PUBLICATIONS

PCT International Search Report and Written Opinion, dated Apr. 17, 2017, corresponding to PCT Application No. PCT/US2017/016966, 14 pages.

*Primary Examiner* — Jelani A Smith

*Assistant Examiner* — Mathew Franklin Gordon

(74) *Attorney, Agent, or Firm* — Fennemore Craig, P.C.

(57) **ABSTRACT**

A method of determining a cause of a performance deficiency of a vehicle may include: Determining whether the vehicle is operating in a defined load condition; comparing an actual vehicle performance parameter with a predetermined baseline performance parameter for the defined load condition; comparing a plurality of key indicator values of the vehicle with a predetermined specification for each of the plurality of key indicator values; concluding that the performance deficiency is the result of a mechanical condition of the vehicle when at least one of the key indicator values is outside of the predetermined specification for a corresponding key indicator value and when the actual vehicle performance parameter is outside of the predetermined baseline performance parameter; and concluding that the performance deficiency is the result of an operational condition when none of the key indicator values is outside of the predetermined specification for the corresponding key indicator value and when the actual vehicle performance parameter is outside of the predetermined baseline performance parameter.

**20 Claims, 7 Drawing Sheets**

