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The Director

of the United States Patent and Trademark Office has received an application for a patent for a new and useful invention. The title and description of the invention are enclosed. The requirements of law have been complied with, and it has been determined that a patent on the invention shall be granted under the law.

Therefore, this United States

Patent

grants to the person(s) having title to this patent the right to exclude others from making, using, offering for sale, or selling the invention throughout the United States of America or importing the invention into the United States of America, and if the invention is a process, of the right to exclude others from using, offering for sale or selling throughout the United States of America, products made by that process, for the term set forth in 35 U.S.C. 154(a)(2) or (c)(1), subject to the payment of maintenance fees as provided by 35 U.S.C. 41(b). See the Maintenance Fee Notice on the inside of the cover.

Katherine Kelly Vidal

DIRECTOR OF THE UNITED STATES PATENT AND TRADEMARK OFFICE





US011560784B2

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

(10) **Patent No.:** **US 11,560,784 B2**  
(45) **Date of Patent:** **Jan. 24, 2023**

(54) **AUTOMATED BEAM PUMP DIAGNOSTICS USING SURFACE DYNACARD**

(71) Applicant: **Noven, Inc.**, Houston, TX (US)

(72) Inventors: **Mahmut Sengul**, Houston, TX (US); **Mario Ruscev**, Houston, TX (US); **Juan Felipe Arjona**, Houston, TX (US); **Vyacheslav Nadovoretskiy**, Houston, TX (US); **Hanna Broadus**, Houston, TX (US)

(73) Assignee: **NOVEN, INC.**, Houston, TX (US)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 231 days.

(21) Appl. No.: **16/898,019**

(22) Filed: **Jun. 10, 2020**

(65) **Prior Publication Data**

US 2020/0392833 A1 Dec. 17, 2020

**Related U.S. Application Data**

(60) Provisional application No. 62/859,997, filed on Jun. 11, 2019, provisional application No. 62/860,012, filed on Jun. 11, 2019.

(51) **Int. Cl.**  
**E21B 47/009** (2012.01)  
**G06N 20/00** (2019.01)  
**F04B 51/00** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **E21B 47/009** (2020.05); **G06N 20/00** (2019.01); **F04B 51/00** (2013.01)

(58) **Field of Classification Search**  
CPC ..... **E21B 47/009**; **G06N 20/00**; **F04B 51/00**  
See application file for complete search history.

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*Primary Examiner* — Charles G Freay

(74) *Attorney, Agent, or Firm* — MH2 Technology Law Group LLP

(57)

**ABSTRACT**

A method for detecting operational issues in a beam pump unit includes receiving sensor data representing a position of and a load on the beam pump unit, using a sensor coupled to the beam pump unit, generating a surface dynacard based on the sensor data, predicting a source of inefficiency in the beam pump unit based at least in part on the surface dynacard using a machine learning algorithm, and identifying one or more corrective actions to take to address the source of inefficiency.

**20 Claims, 13 Drawing Sheets**

