



US009410449B2

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

(10) **Patent No.:** **US 9,410,449 B2**  
(45) **Date of Patent:** **\*Aug. 9, 2016**

(54) **DRIVEN STARTER PUMP AND START SEQUENCE**

(71) Applicants: **Timothy James Held**, Akron, OH (US); **Michael Vermeersch**, Hamilton, OH (US); **Tao Xie**, Copley, OH (US)

(72) Inventors: **Timothy James Held**, Akron, OH (US); **Michael Vermeersch**, Hamilton, OH (US); **Tao Xie**, Copley, OH (US)

(73) Assignee: **Echogen Power Systems, LLC**, Akron, OH (US)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 184 days.  
  
This patent is subject to a terminal disclaimer.

(21) Appl. No.: **14/102,677**

(22) Filed: **Dec. 11, 2013**

(65) **Prior Publication Data**

US 2014/0096521 A1 Apr. 10, 2014

**Related U.S. Application Data**

(63) Continuation of application No. 13/205,082, filed on Aug. 8, 2011, now Pat. No. 8,616,001.

(60) Provisional application No. 61/417,789, filed on Nov. 29, 2010.

(51) **Int. Cl.**  
**F01K 13/02** (2006.01)  
**F01K 13/00** (2006.01)  
**F01K 7/32** (2006.01)  
(Continued)

(52) **U.S. Cl.**  
CPC ..... **F01K 13/02** (2013.01); **F01K 23/04** (2013.01); **F01K 25/10** (2013.01); **F01K 25/103** (2013.01); **F22B 35/086** (2013.01)

(58) **Field of Classification Search**  
CPC ..... F01K 13/02; F01K 23/04; F01K 25/10; F01K 25/103; F22B 35/086  
USPC ..... 60/646, 645, 647  
See application file for complete search history.

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

2,575,478 A 11/1951 Wilson  
2,634,375 A 4/1953 Guimbal  
(Continued)

**FOREIGN PATENT DOCUMENTS**

CA 2794150 A1 11/2011  
CN 1165238 A 11/1997  
(Continued)

**OTHER PUBLICATIONS**

PCT/US2010/044681—International Search Report and Written Opinion dated Oct. 7, 2010, 10 pages.  
(Continued)

*Primary Examiner* — Thai Ba Trieu  
*Assistant Examiner* — Deming Wan  
(74) *Attorney, Agent, or Firm* — Edmonds & Nolte, PC

(57) **ABSTRACT**

Aspects of the disclosure generally provide a heat engine system with a working fluid circuit and a method for starting a turbopump disposed in the working fluid circuit. The turbopump has a main pump and may be started and ramped-up using a starter pump arranged in parallel with the main pump of the turbopump. Once the turbopump reaches a self-sustaining speed of operation, a series of valves may be manipulated to deactivate the starter pump and direct additional working fluid to a power turbine for generating electrical power.

**20 Claims, 5 Drawing Sheets**

