VANDERBILT UNIVERSITY

CTTC Center for Technology Transfer & Commercialization

High Inertance Liquid Piston Engine-Compressor

Summary

Inventors at Vanderbilt University have developed a high inertance engine-compressor for use with pneumatically actuated devices, especially those with periods of inactivity between periods of pneumatic use. It utilizes a flexible diaphragm in combination with a liquid piston to achieve high inertance and other operational features such as high efficiency, low noise and low temperature operation.

Addressed Need

- There are significant energetic limitations in the development of compact, lightweight, untethered power supplies such as power tools and human-scale robots. For example, the Honda P3 humanoid robot is only operational for 20-25 minutes due to limited power sources.
- State of the art batteries are too heavy for the amount of energy they store and electric motors are too heavy for the mechanical power they can deliver
- Energy density of batteries is relatively low and the power density of electrical motors is not very high
- Particularly on small scales, surface effects such as friction, leaking, quenching and heat loss are primarily responsible for the loss of mechanical power generation and thus efficiency of these machines.
- Traditional free piston engines have fast cycle rates limiting their usefulness, applications and control.

Technology Description

The invention is comprised of a free piston compressor with a liquid piston trapped by two elastic diaphragms. A high pressure mix of fuel and compressed air is injected causing the diaphragms and fluid to expand; however the fluid provides substantial inertial resistance to the injection. Upon combustion the piston is set into rapid motion and the cycle is eventually completed after a series of pressure changes and air pumping. This power generation system is intended for mobile or portable devices that require a portable long lasting energy source. Such devices include free-piston machines as well as other high impulse machines (eg: absorbing recoil in guns or jackhammers).

Unique Properties and Competitive Advantages

- Lightweight and portable long lasting energy source that does not need to be in a state of “idle” that consumes energy without delivering useful work.
- Combined power supply and actuation system that is capable of delivering human-scale mechanical work in a human-scale self-contained package for a useful duration of time.
- Slower operational speed for same piston mass, correcting many of the limitations due to high cycle rates
- Lighter weight free-piston for same operational speed
- Reduction of velocity dependent sliding piston friction
- Capability of a balanced engine with only one piston
- Slower dynamics allow for fire-on-demand capabilities, or a no-idle operation
- Reduction in size and speed of intake, exhaust and other flow valves
- Self-sufficient in the generation of compressed air for long periods of time
- Solves problems of: limited power supply, inability to operate after lengthy non-operational periods, bulky starter systems, vibration and temperature issues association with small-scale engines

Intellectual Property Status

- US patent issued 8,297,237; 10/30/2012.
- For lab information: Barth Lab
- Click names below for inventor bios

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