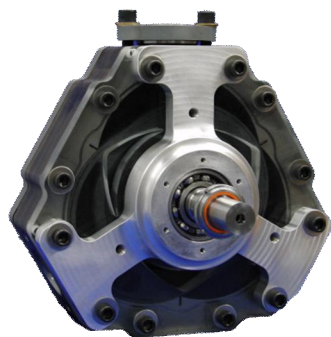


Advanced
Thermodynamic Cycle

+

=



Rotary Engine
Embodiment

Expected Benefits

Compact and Lightweight

- . >5x smaller, >2x lighter than comparably powered engines
- . High power density potential of up to 2 HP/Lb (3.3kW/kg)

Quiet

- . No poppet valves
- . Exhaust turbulence minimized by over-expansion

High-efficiency

- . 75% theoretical thermal cycle efficiency of HEHC, LPI ϕ patented cycle
- . 57% expected realized peak brake efficiency
- . 50% expected realized partial load brake efficiency

Low-vibration

- . Only two primary moving parts, optimally balanced

Multi-fuel Capable

- . Including diesel, gasoline, natural gas, JP-8

Scalable

- . From 1 kW to over 1000 kW; Prototypes from 2 to 60 kW

Low Temperature Exhaust

- . Due to overexpansion

Low Cost

- . Few moving parts and materials



X-mini Engine (Alpha Prototype, 2kW)



X1 Engine (Alpha Prototype, 55kW)

Current Stage

- . Proof of concept prototypes (DOD TRL 3-4)
- . Demonstrated net indicated efficiency approaching that of piston diesel engine
- . Have run on diesel, JP8 and gasoline

Engineering work required to reach “beta stage”

- . Demonstrate full efficiency and power density potential
- . Achieve long durability
- . Design for low cost manufacturing

Able to do 1-5 kW Engine

- . Currently working on 2kW gasoline prototype, X-mini (see photo on left)

Trade-offs

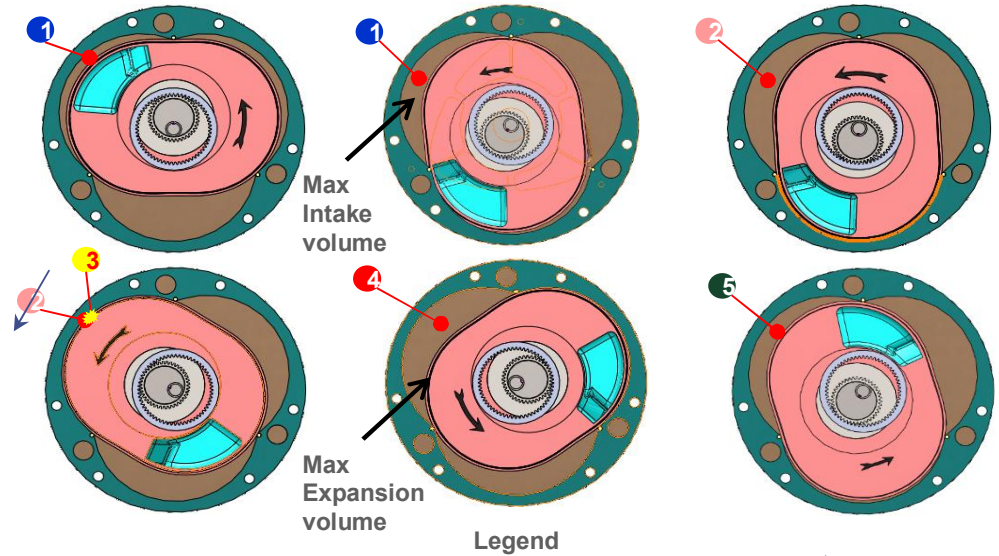
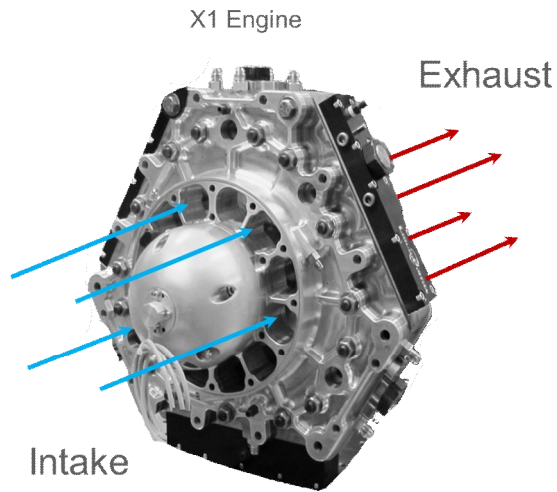
- . Efficiency vs size vs cost

Well suited for residential use

- . Low noise, low vibration

Manufacturing capability

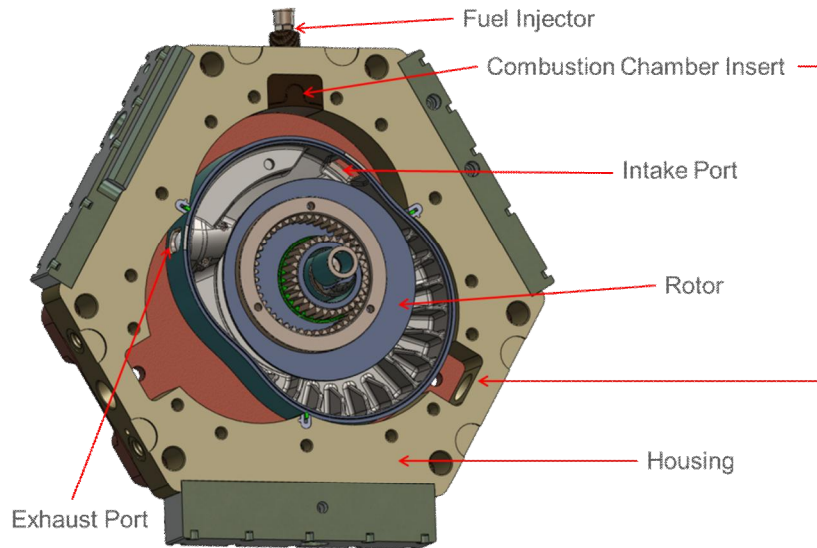
- . Business model: licensing technology to engine manufacturers



1 Intake
 2 Compression
 3 Combustion
 4 Expansion
 5 Exhaust
 6 Process Just Ended

NOTE: expansion volume is larger than Intake volume (compare center two figures)

Four-stroke Operation with only upper left chamber annotated for clarity. All chambers actually operate on different strokes simultaneously creating 3 power strokes per revolution.



For video animation, see:
<http://liquidpiston.com/technology/how-it-works/>