Drive Mechanism Design for the Improvement of Stirling Cycle Heat Engines

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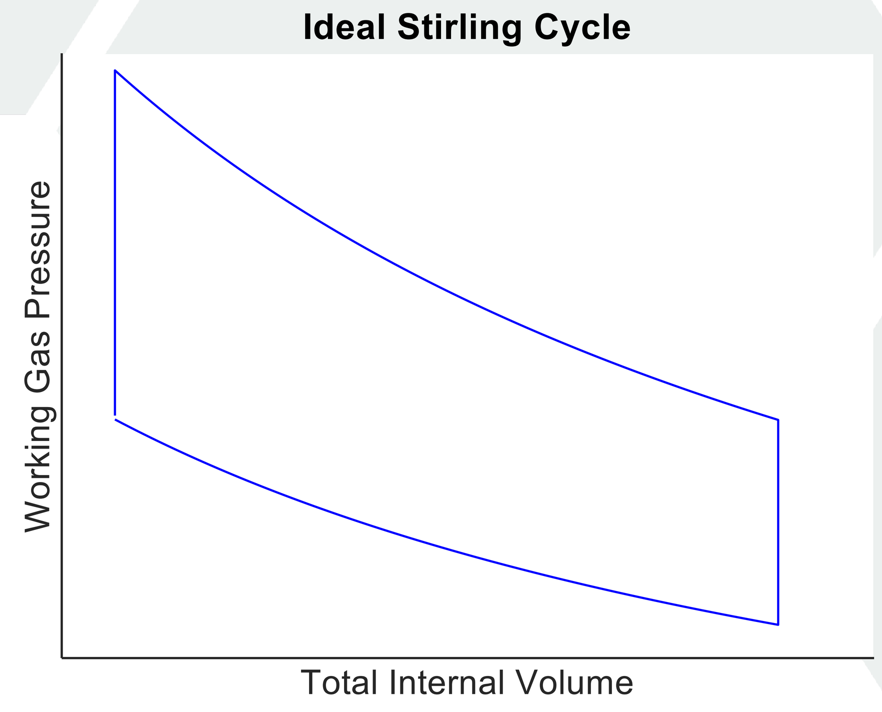
BACKGROUND

The ideal Stirling engine cycle involves discrete heating, expanding, cooling and compressing of the gaseous working fluid. This would provide the maximum possible power for an engine configuration. This cycle however is not physically possible.

Practical engines use pistons and cylinders as the moving boundaries of the system. Slider-crank mechanisms link the piston to the output shaft and constrain the pistons to simple harmonic motion. This motion leads to overlaps in the cycle processes that decrease indicated power and efficiency.



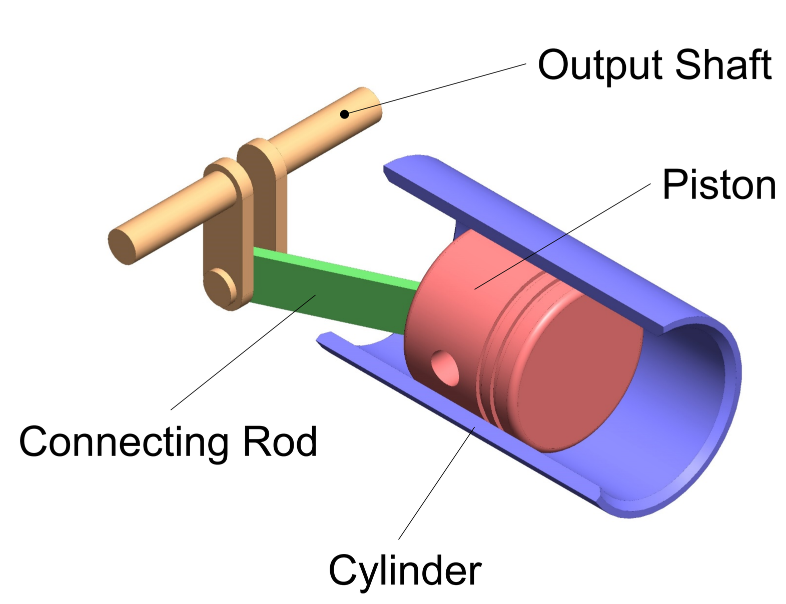
AIMS AND OBJECTIVES

- Address the inherent inefficiency of converting thermal potential into mechanical work by explore non-traditional engine mechanisms.
- Identify potential drive mechanisms that better replicate the ideal thermodynamic cycle.
- Develop models to characterize the mechanism motion, kinematics and dynamics.
- Experimentally test mechanisms and compare with thermodynamic models

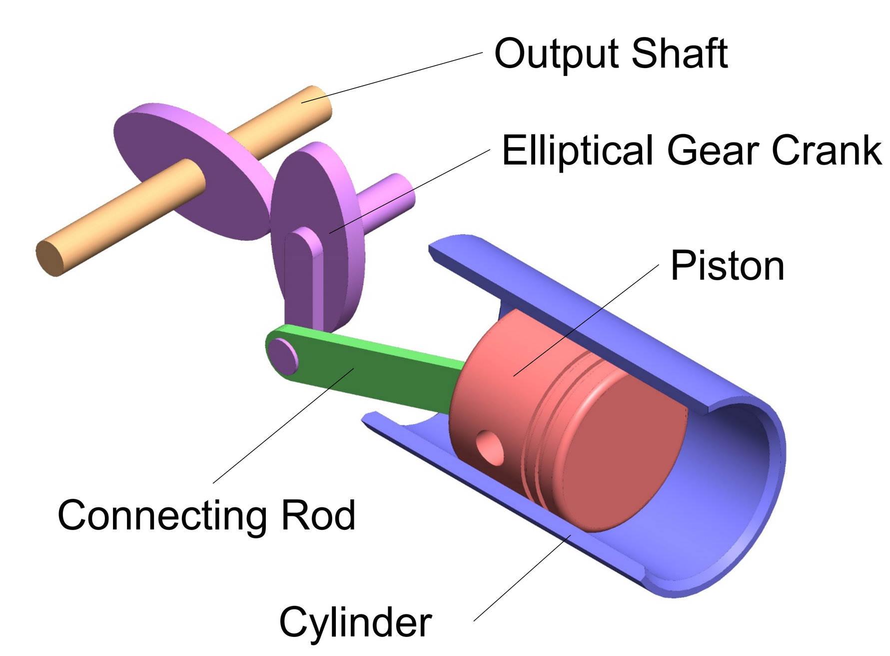
PROPOSED DEVELOPMENTS

Mechanical devices are being investigated that can achieve desired piston kinematics with minimal additional mechanical complexity. Proposed devices include non-circular gearing, cam profile drive shafts, and other mechanical linkages. Preliminarily investigation shows better cycle discretization and lower forced work.

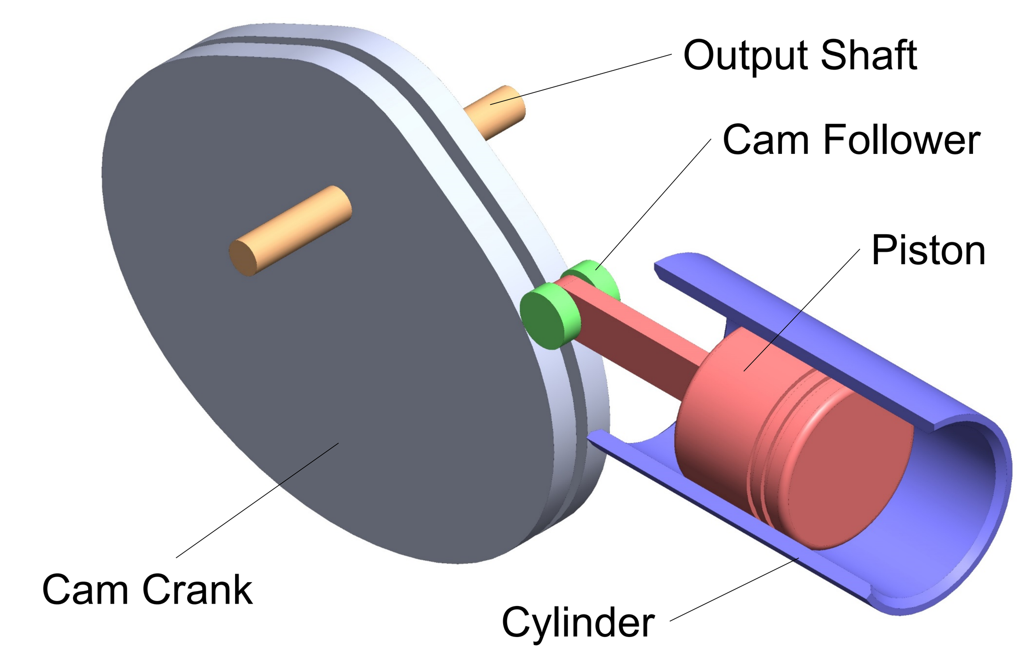
Conventional Slider-Crank

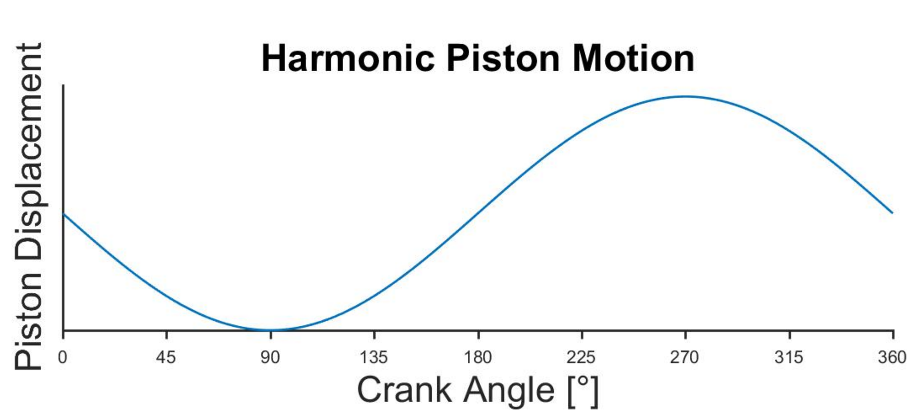


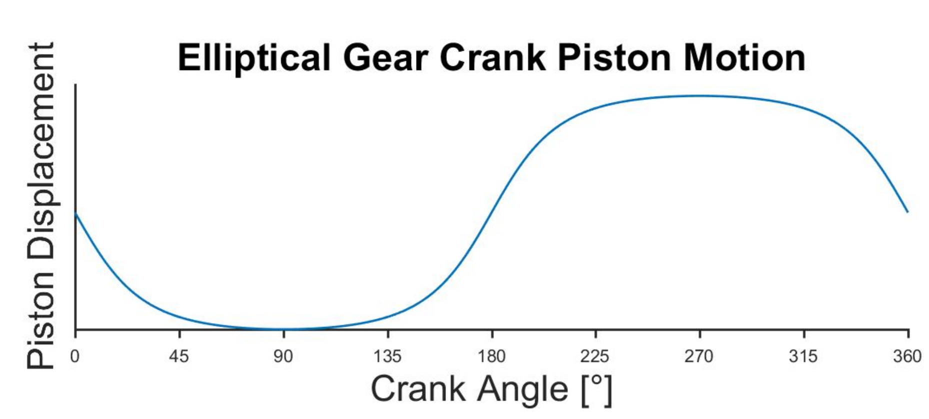
Elliptical Gear Crank

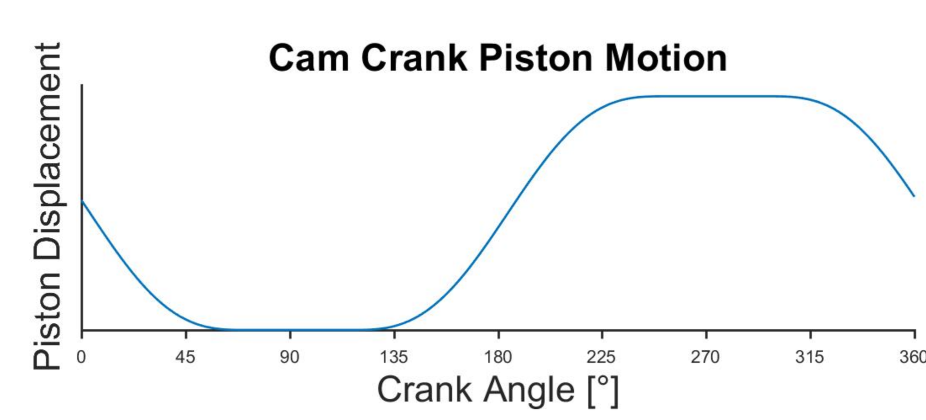


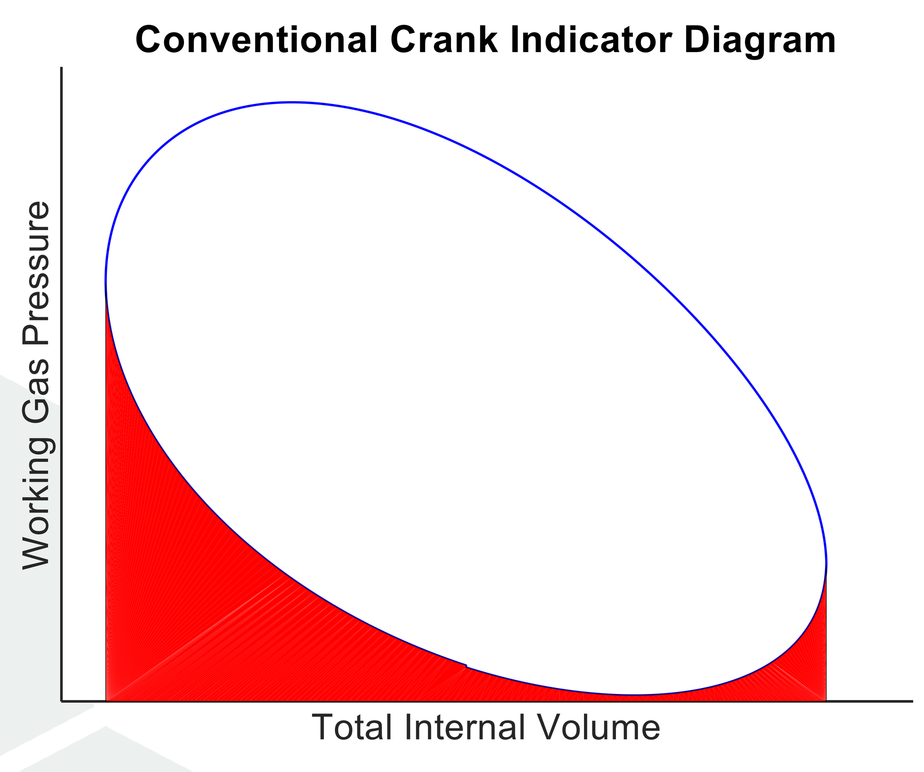
Cam Crank

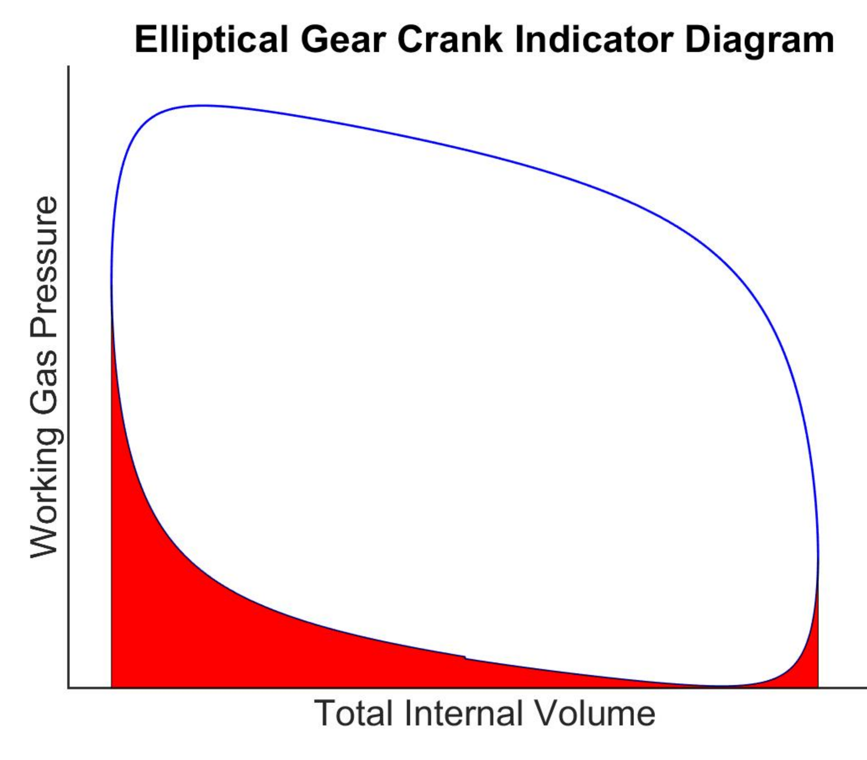


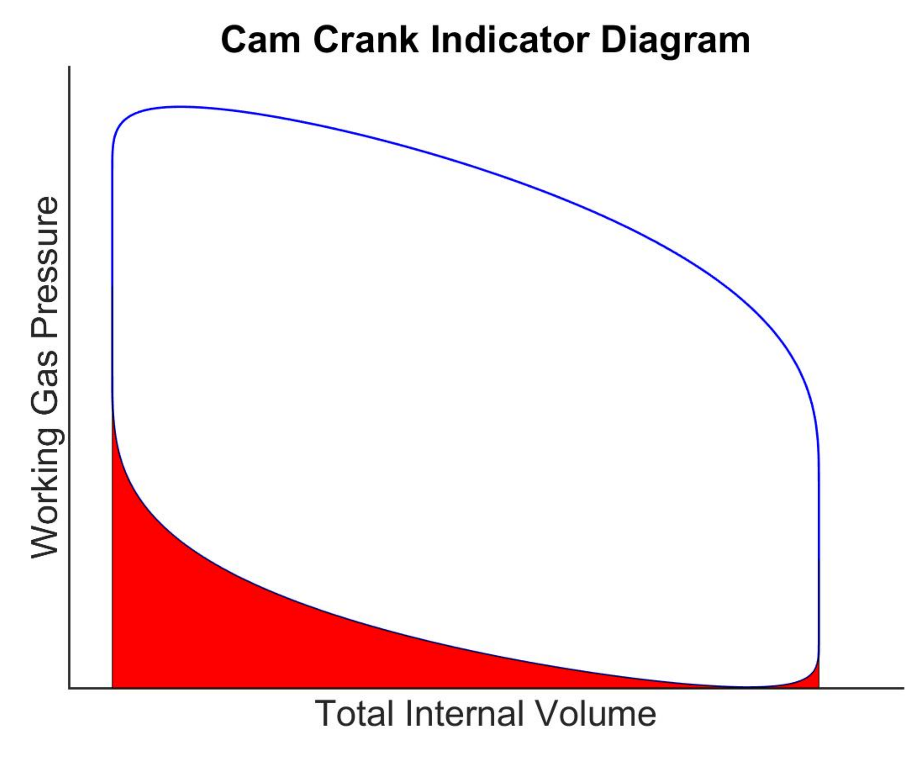












FUTURE DIRECTIONS

- Explore the effect of the drive mechanism on mechanical effectiveness, system forced work, heat transfer, and gas dynamics
- Develop semi-empirical models to predict heat transfer for different mechanism configurations

PARTNERS

- Alberta Innovates
- Terrapin Geothermics Inc.

FES PROJECT OVERVIEW

This Future Energy Systems (FES) project is part of the Geothermal Theme, entitled **Optimizing Geothermal Energy Production and Utilization Technology** (FES T05_P03) With the vast amount of energy available in geothermal reservoirs identified throughout Alberta, a new technology is need to access and convert this low grade heat into a useful form. This means converting available fluid temperatures, typically <100 ℃ into electricity or space heating. This project focuses primarily on the development of proof-of-concept and viability studies of ultra-low maximum temperature (ULT_{max}) Stirling engines, their design and the development of predictive models for system scale up and development.

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CANADA FIRST RESEARCH EXCELLENCE FUND

This research has been undertaken thanks in part to funding from the Canada First Research Excellence Fund.