Aalto University
School of Engineering

MEC-E1003
Machine Design Project

Sept. 8, 2023

Prof. Sven Bossuyt

Schedule: Overview and milestones

Week	Deadline	Description
Week 35-36	Sept 8	Project team formation and pre-questionnaire
Week 37	Sept 15	Design brief for group project
Week 37-39	Sept 27-29	Stirling engine starter project (individual work)
Week 40	Oct 6	Initial concept for group project
Week 43	Oct 27	Concept pitch + peer review & 1st evaluation questionnaire
Week 46	Nov 17	Status report & 2nd evaluation questionnaire
Week 47		Status report peer review
Week 48	Nov 29	Information poster
Week 48	Dec 1	Gala: Prototype demonstration & Demonstration gala reflections
Week 50	Dec 15	Final report & Final evaluation questionnaire

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Projects from previous years

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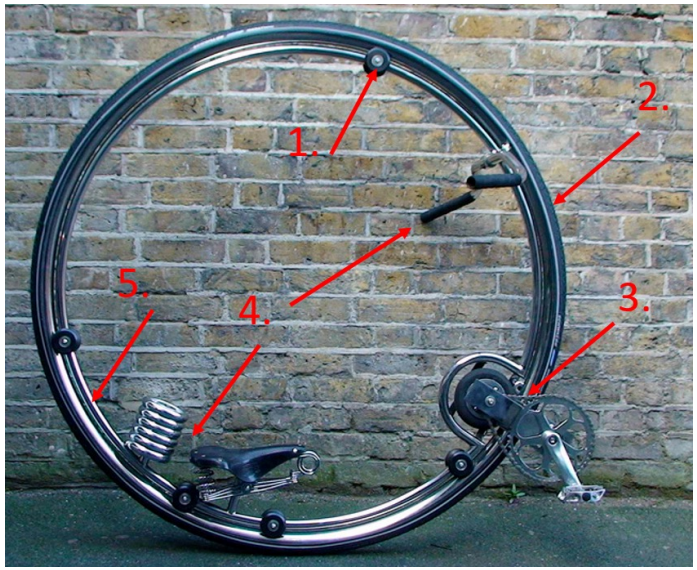

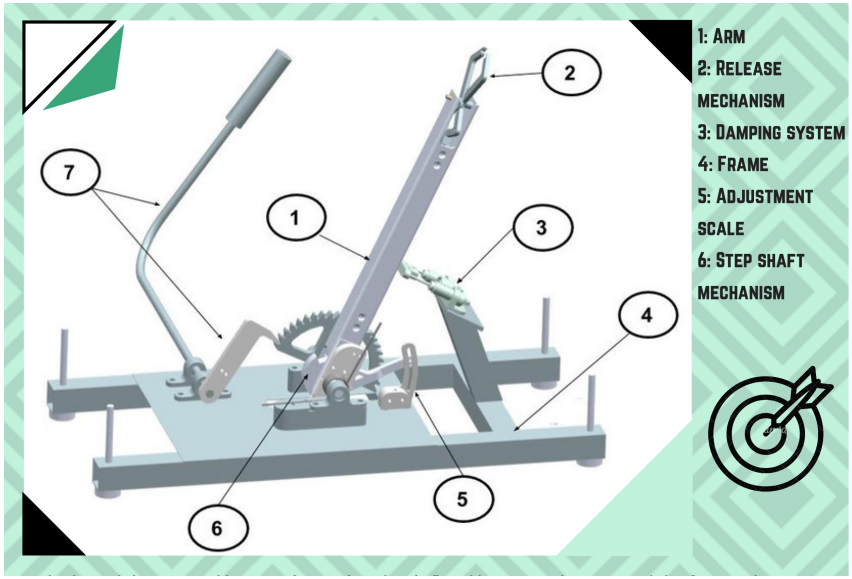

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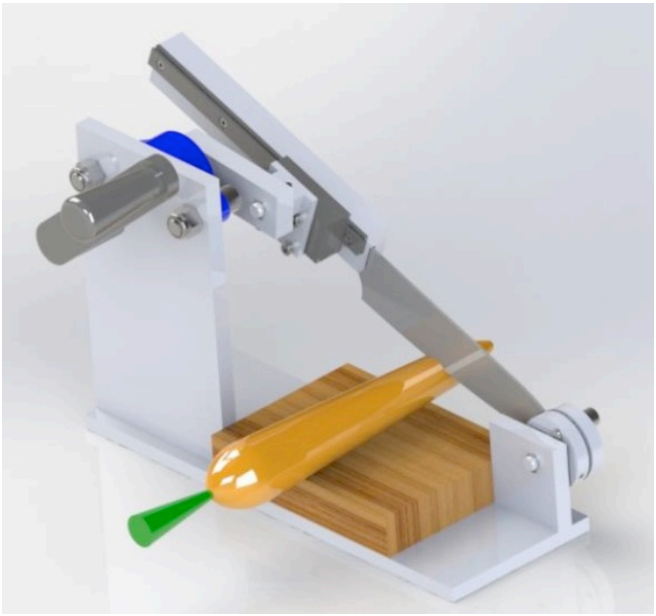

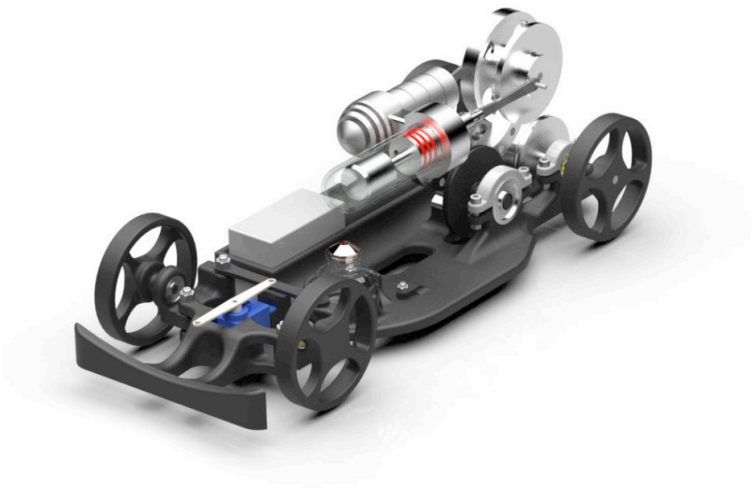

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Stirling Engine Starter Project

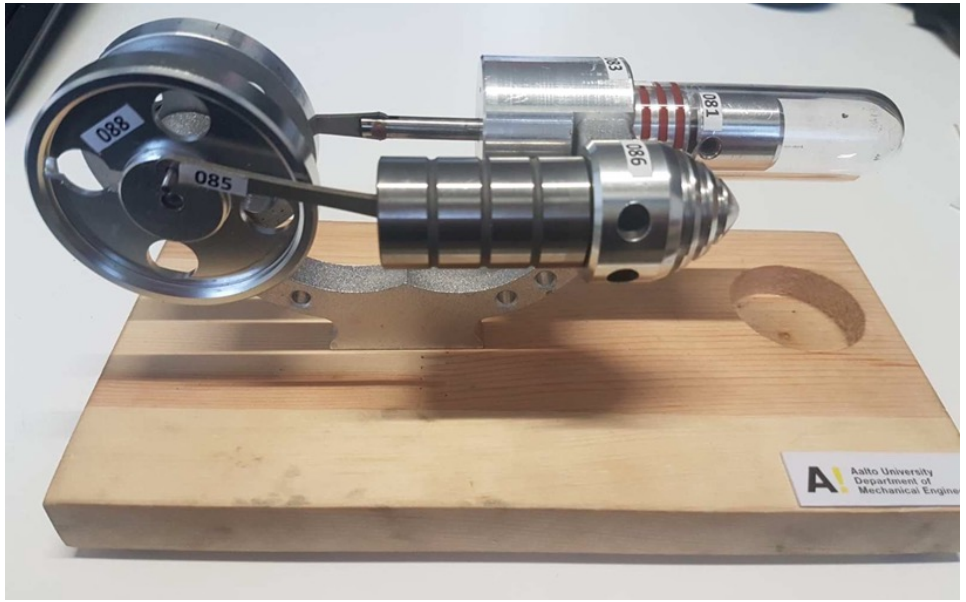
What is this starter project about?

- This project will provide a introduction to mechanical fabrication: specified parts for ***machining***, ***assembly***, ***inspection***, and ***compliance***. *These are all skills you will need to be successful at designing machines.*
- This is a ***hands-on experience*** project. It is purposefully given *now*, before you have learned any theory on cutting, machining, measurement, or fabrication.
- It provides a practical background before you study the theory.

Miniature Stirling Engine

First three weeks

- You will inspect parts, assemble, and test a working miniature Stirling engine built of machined parts.
- The more precisely you fabricate parts and assemble the engine, the faster it will go

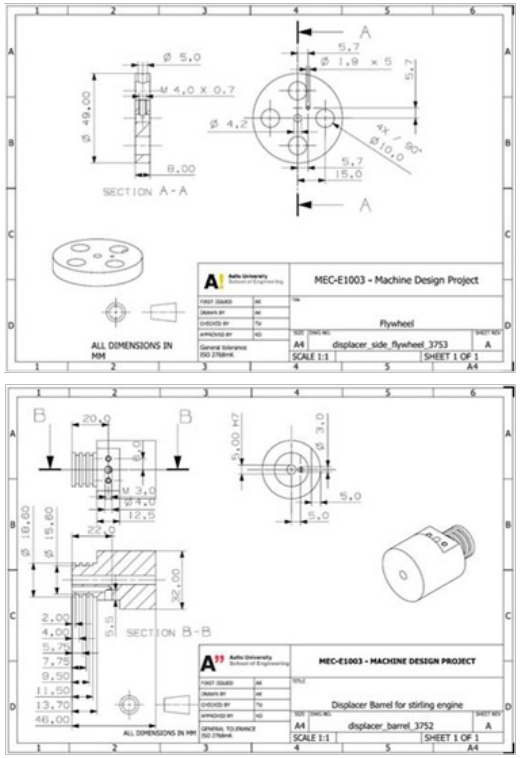


Miniature Stirling Engine

kit of parts

Miniature Stirling Engine

part drawings which were used as a basis for machining the parts



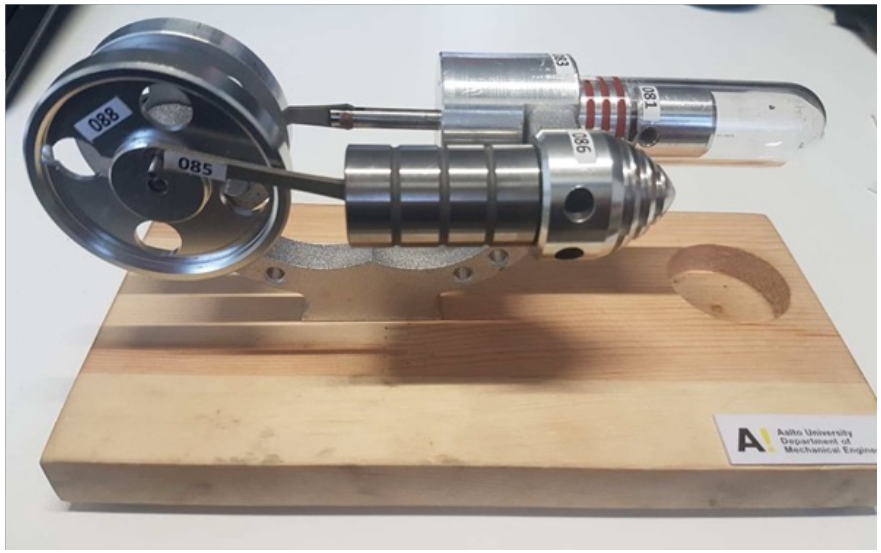
35mm and 50mm aluminum rod stock

Miniature Stirling Engine

individually inspect all of the parts

Miniature Stirling Engine

"customer acceptance" test for acceptable speed performance



Starter project learning outcomes

This starter project is to provide a hands-on experience for the basis of future courses.

After completing the starter-project the successful student will be more comfortable designing machined parts and assemblies

- Understand machine tool capabilities
- Understand dimensions and tolerances and design documentation
- Understand tolerances and measurement inspection
- Understand design verification and validation
- Understand engineering estimation in design

Starter project grading

- **In-class activities (2% each)**
- **HW 1: Engine project work (20%)**
  - Individual inspection measurement assignment
- **HW 2: Engine Engineering Analysis (2%)**
  - Engine redesign improvement homework assignment
- **Performance quality (2%)**
  - Engine test speed

Course workload

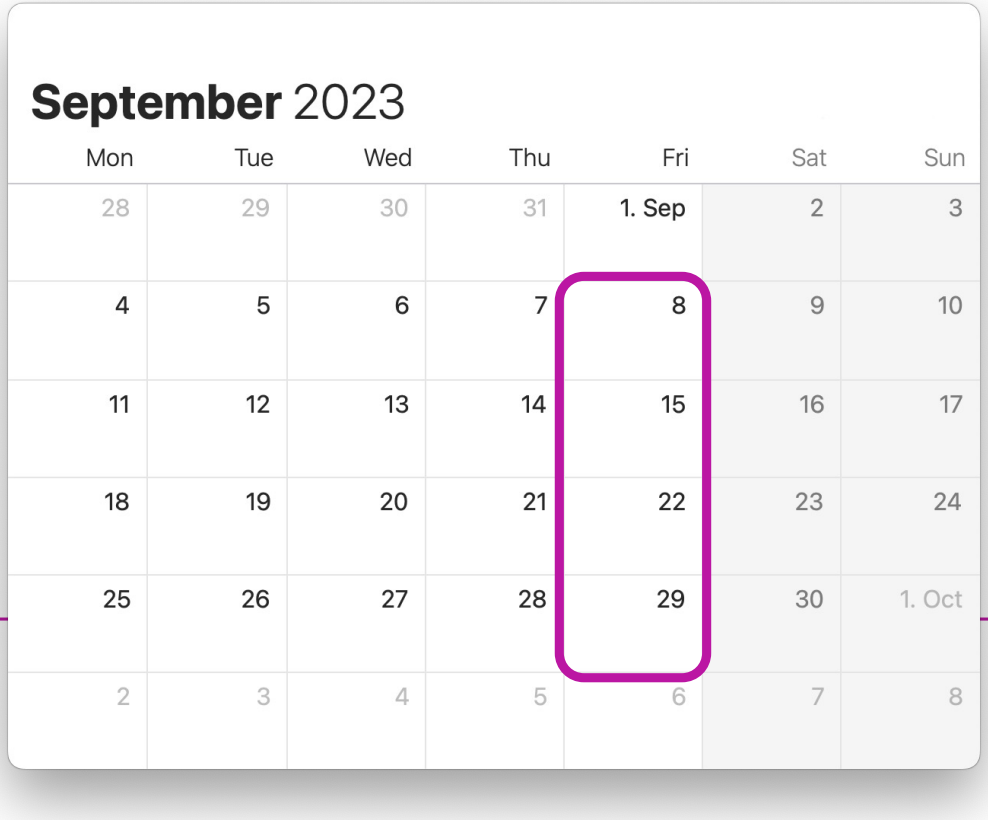
- **5 credit course: 135 hours**

- **This starter project: 5 hours**
  - Measurements: 2 hours
  - Assembly: 1 hour
  - Test and disassembly: 1 hour
  - Homework 2: 1 hour

- **Earning grade 5: you need to do good work, not many hours**

Pedagogy and attendance

- This starter project includes in-class discussions with *hands-on* activities. *Active participation* is essential to your learning and therefore *attendance* is *strongly recommended*.



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Final Project

What is the final project about?

- This project will provide an opportunity to *explore mechanical design in practice*: you will develop a ***concept*** you choose with your ***team***, develop ***specifications*** and produce ***design documentation***, and gradually refine these while producing a ***prototype*** for demonstration at the course gala on December 1.

- This is a ***hands-on experience*** project. It is purposefully given *now*, before you have learned any theory on machine design, material selection, quality control, and production methods.
- It provides a practical background before you study the theory.

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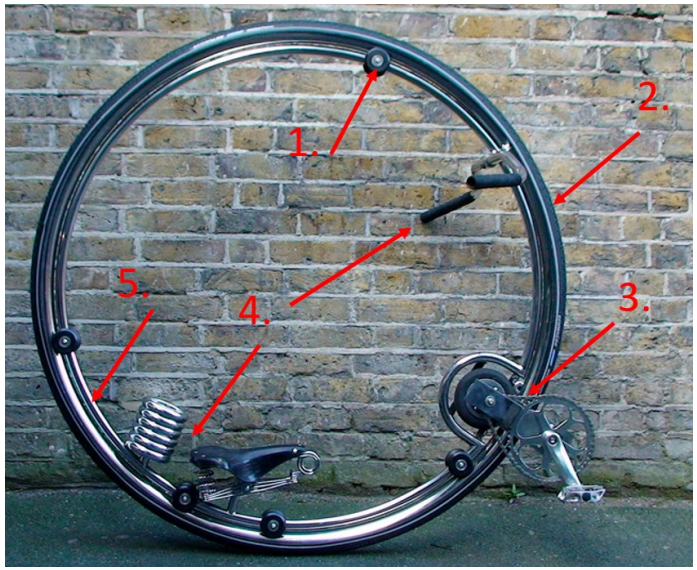

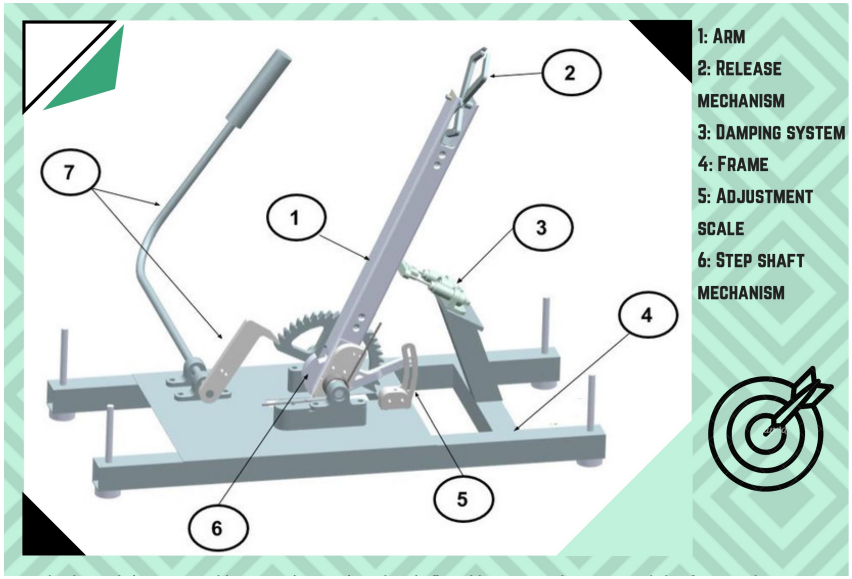

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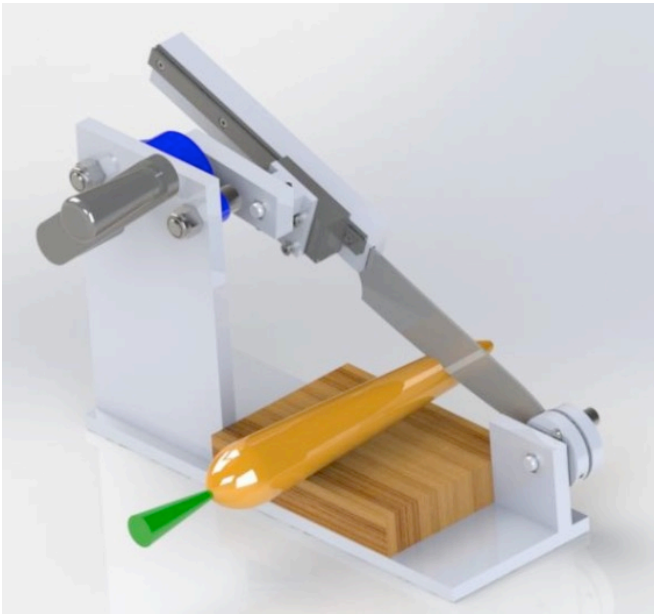
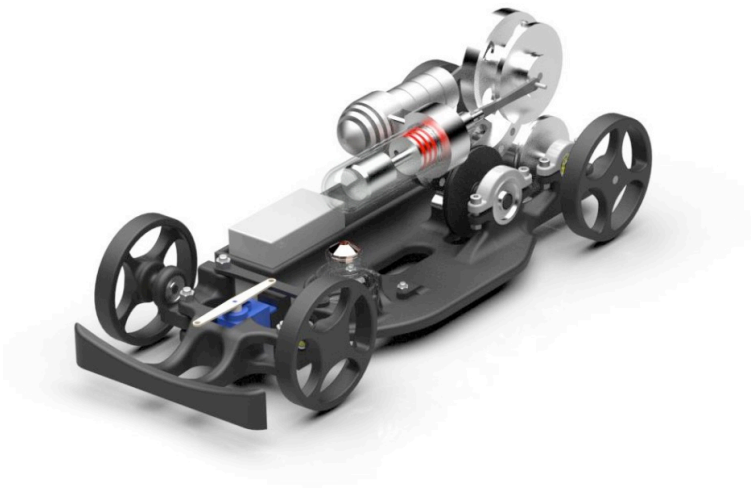




Final outcomes and grading

30% Stirling engine starter project

60% Final project

- Prototype demonstration & reporting
- Report should include
  - *Final design documentation,*
  - *Manufacturing and testing reports,*
  - *Conclusions about course and demo, constructive self-evaluation by including scope for improvement*
- One grade for the whole report and gala presentation
  - *Individual grades modified according to contribution to team effort*

10% Individual reflection and peer feedback

Contribution to team effort

Mutual assessment within each team

- With the help of three evaluation questionnaires
- Includes self-assessment
- May be overruled in teams where it doesn't work well

Multiplicative combination of four factors

- Timeliness
- Participation/effort
- Quality
- Communication

Criteria for assessment of the contribution to the team effort

Criterion	Characteristics lowering the grade	Grade 3 (good)	Characteristics improving the grade
Timeliness	Work is often not ready on time	Work is usually completed on time, according to the common plan agreed	Work is always completed before the agreed deadline
Participation	Avoiding duties	Participation in the group work, attending meetings, contributing to discussions, taking their part of duties	Taking responsibility for their own duties and readily available to help others
Quality	Deliverables and tasks are incomplete, not working, or poorly documented	Deliverables and tasks are completed in a way that meets expectation	Deliverables are working reliably and are well documented
Communication	Not communicating as planned, difficulty in reaching-out via selected channels	Active communication whenever necessary via planned channels	Proactive, taking initiative in team communication

Team formation

5 or 6 students per team

- common interests
- complementary skillset
- diverse backgrounds

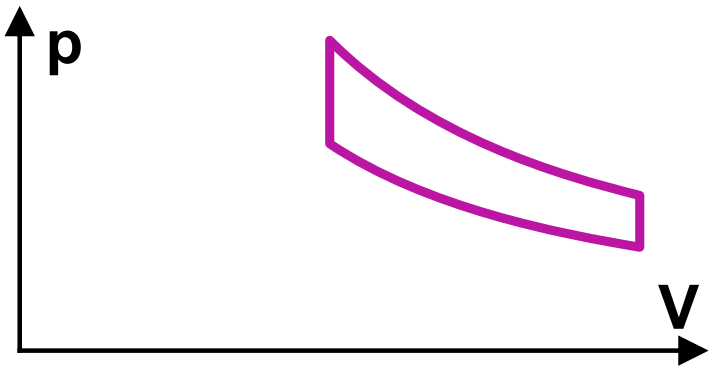
MyCourses "group choice"

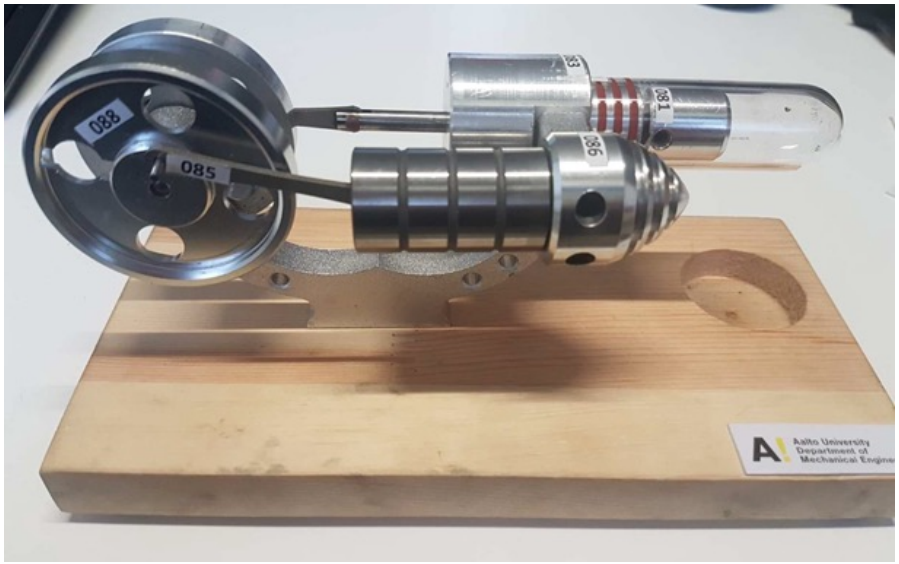
- Talk to the people in the group before joining.
  - *in person, or online in the general discussion forum*
- You get some time now to sort yourselves into teams, and can modify your choice until 10 AM on Monday.
- After that time, we will make any adjustments needed to balance the group sizes and resolve any issues.

https://mycourses.aalto.fi/mod/choicegroup/view.php?id=1079546

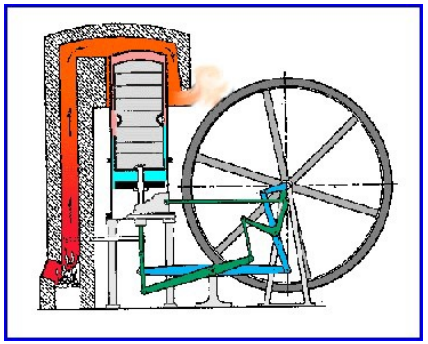
Stirling engine

- A Stirling engine operates not through internal combustion, but rather from simple heat transfer.
- It can approach Carnot thermodynamic efficiency.





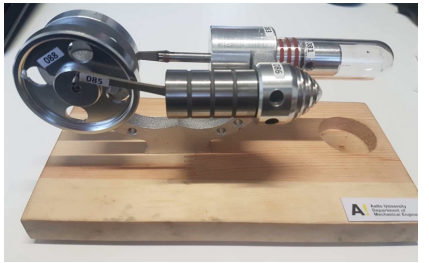
Alternative Stirling engines



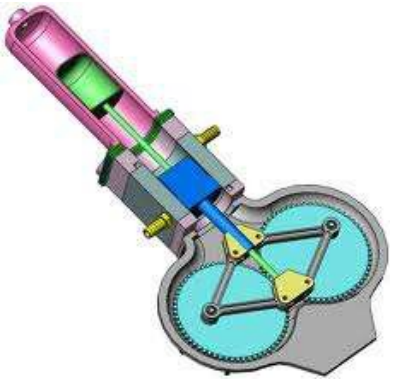
Robert Stirling's original

Dean Kamen's house

Siemens CHP design

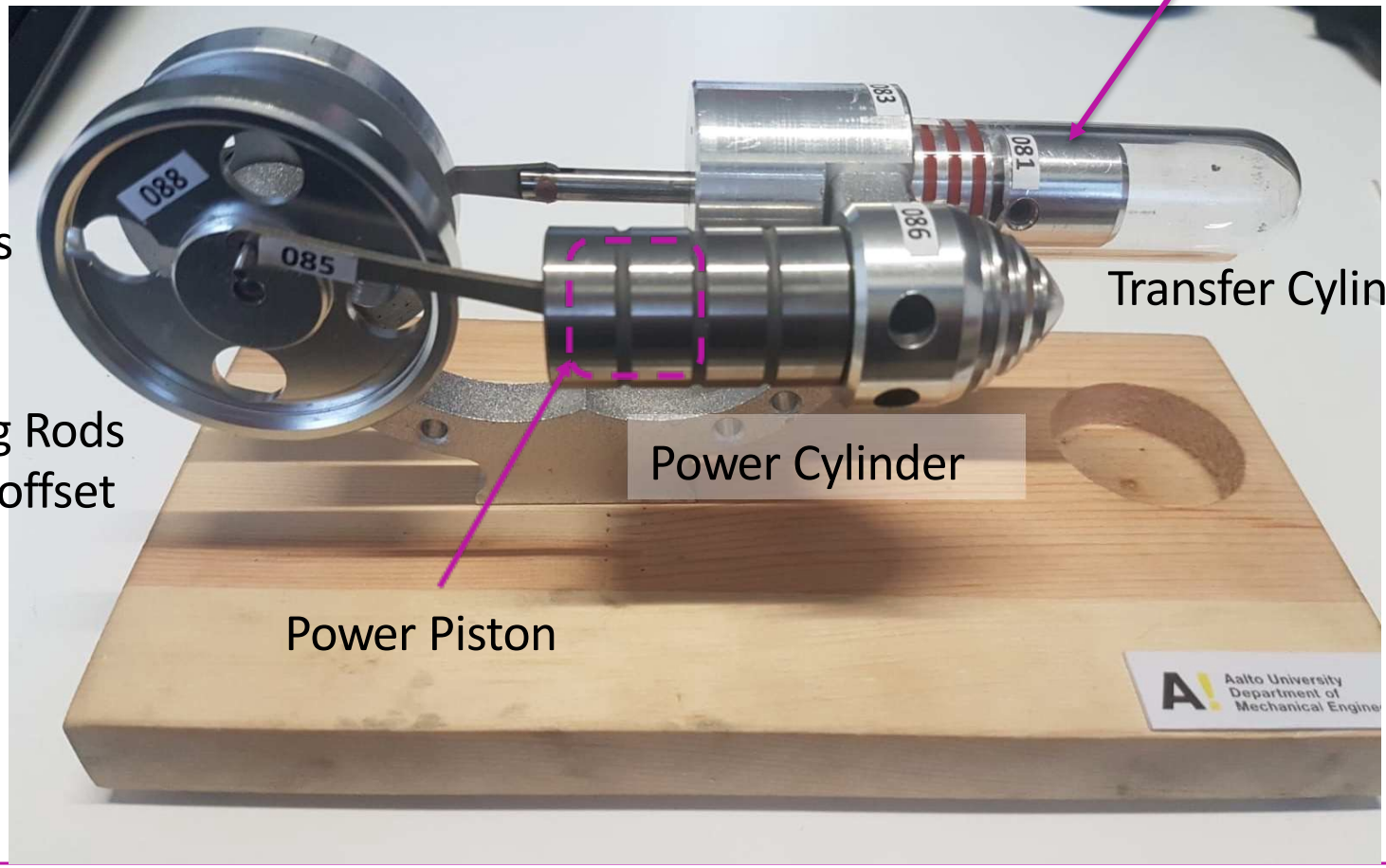


miniature engine kit



NASA designs for space

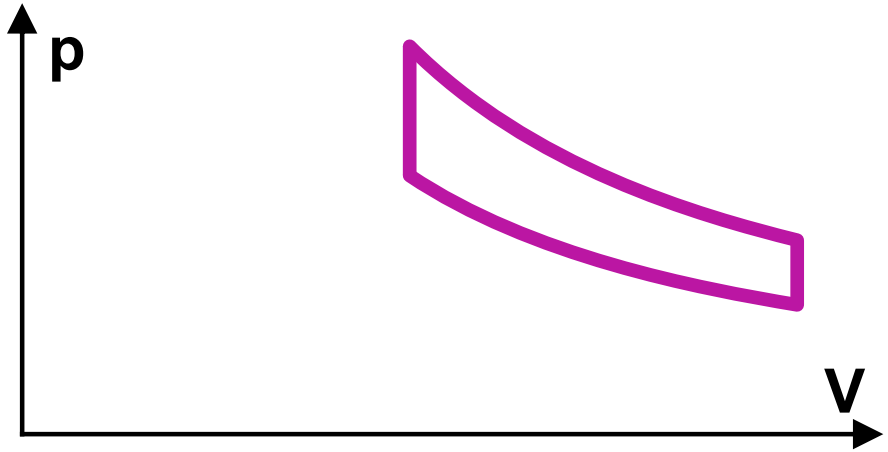
Parts of a Stirling engine



Stirling engine operation

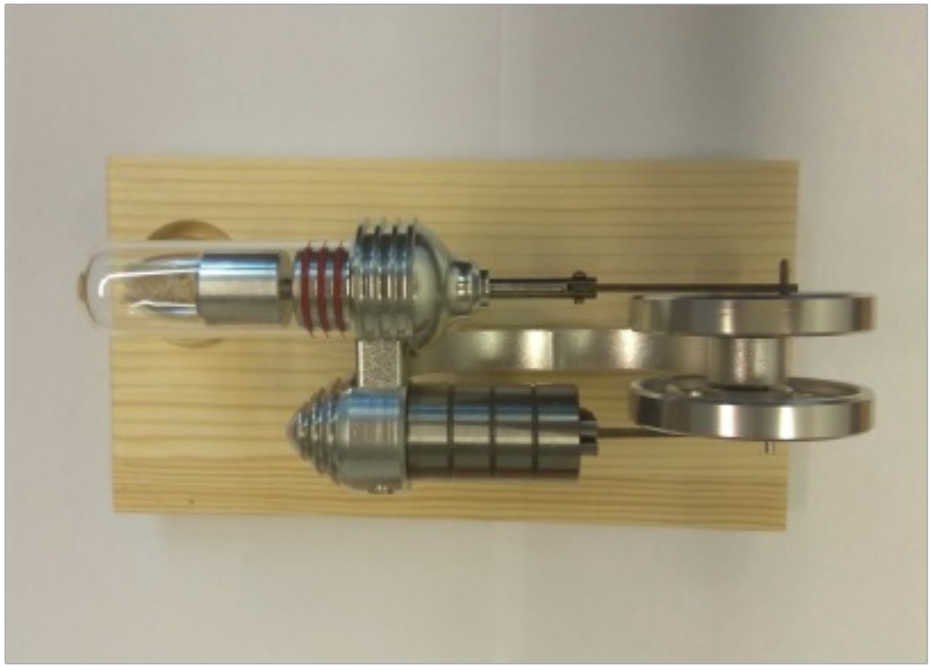
Watch it spin.

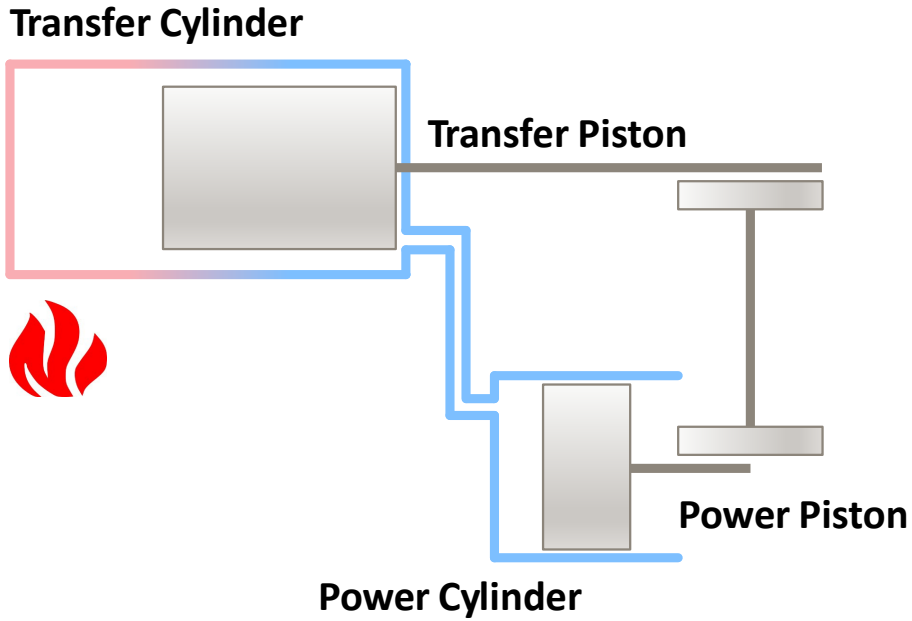
What makes it go?



Power cycle of a Stirling engine

What makes it turn?

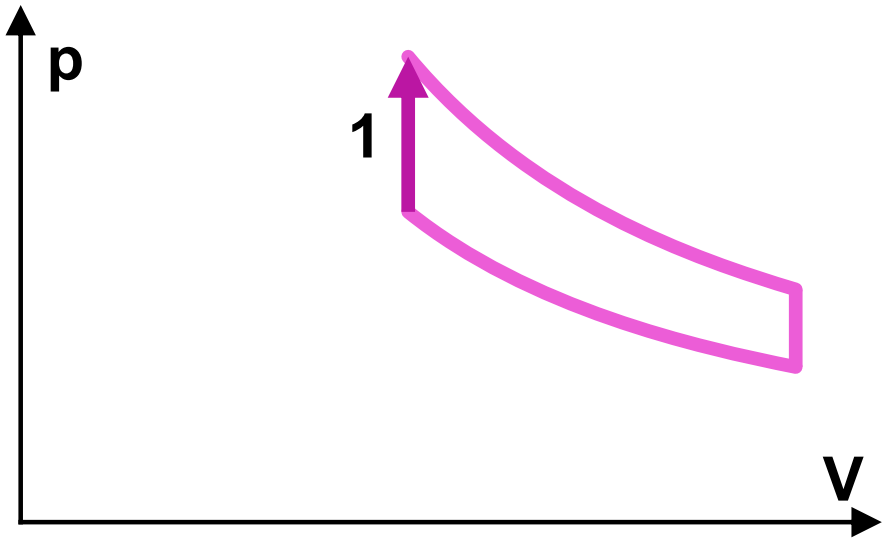


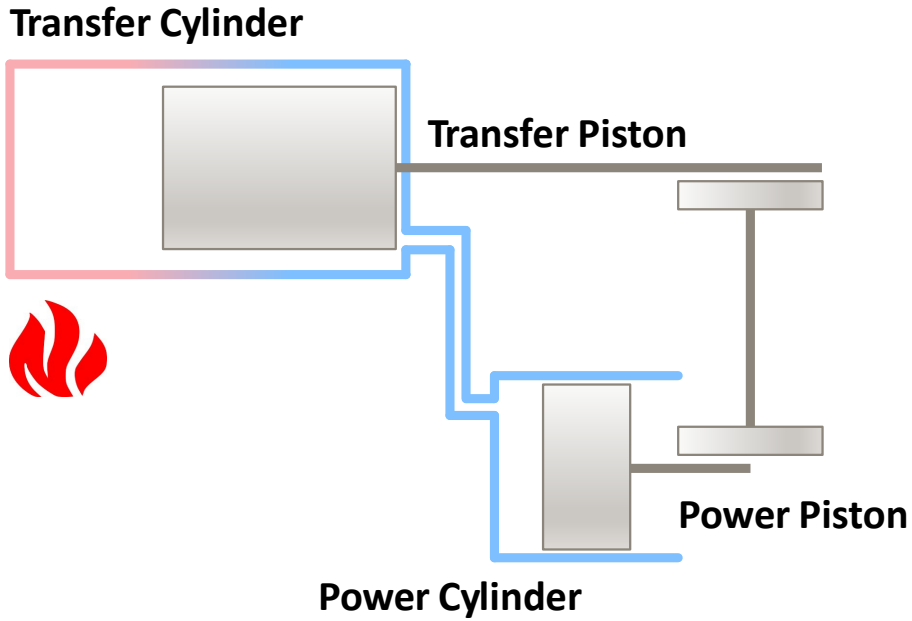


Power cycle of a Stirling engine

phase 1: heating

pressure increases

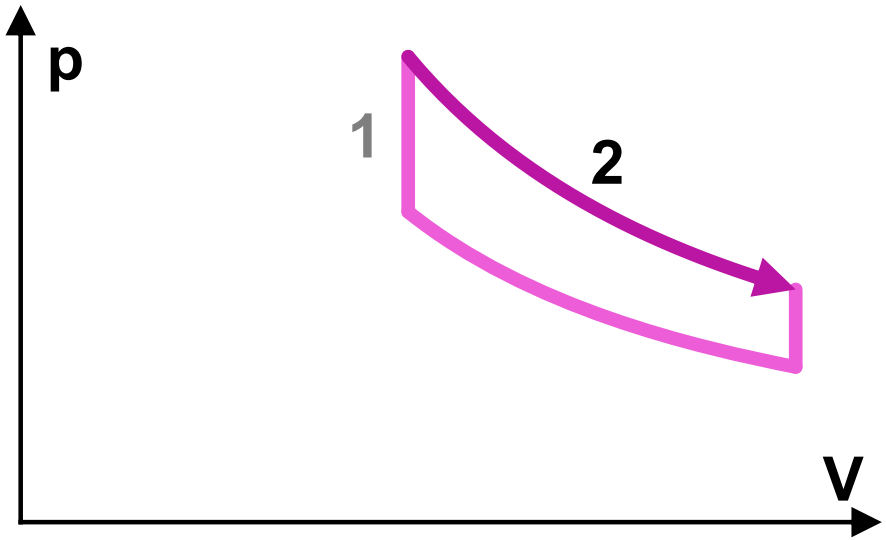


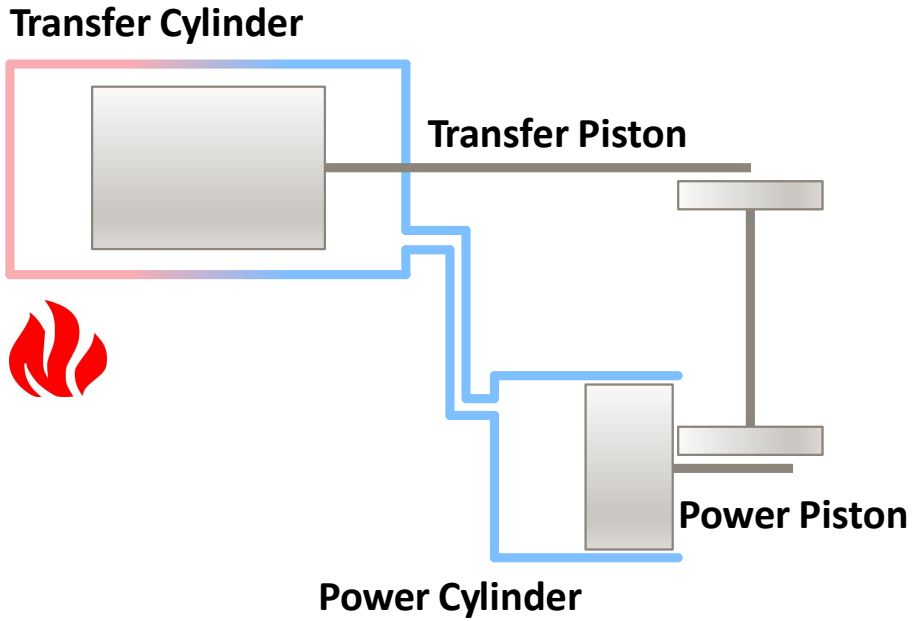


Power cycle of a Stirling engine

phase 2: expansion

pressure drives volume increase

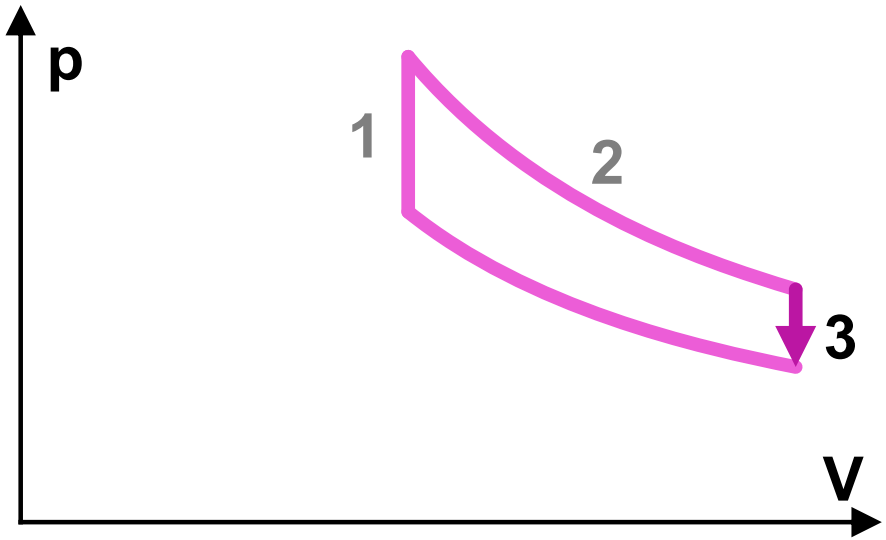


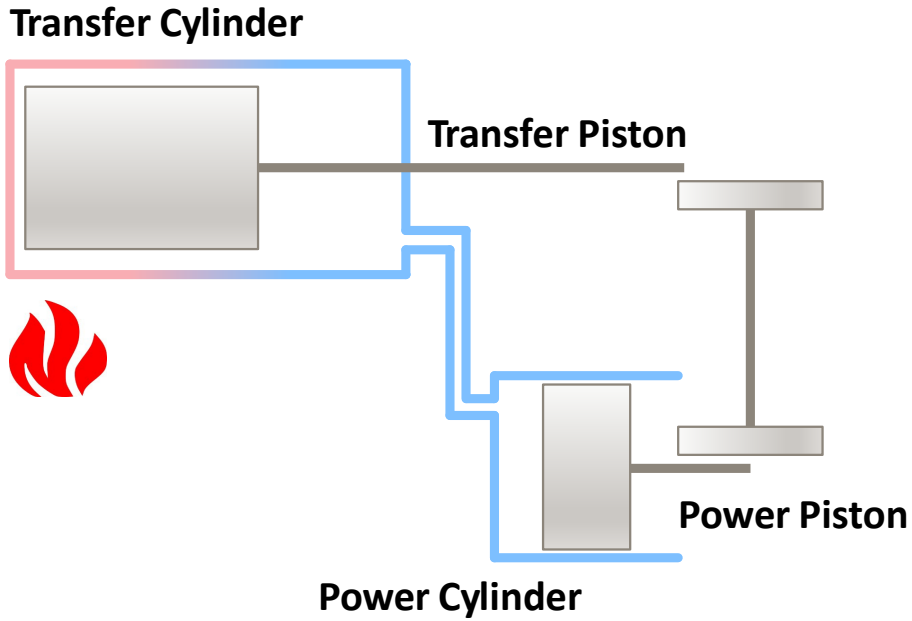


Power cycle of a Stirling engine

phase 3: cooling

pressure decreases

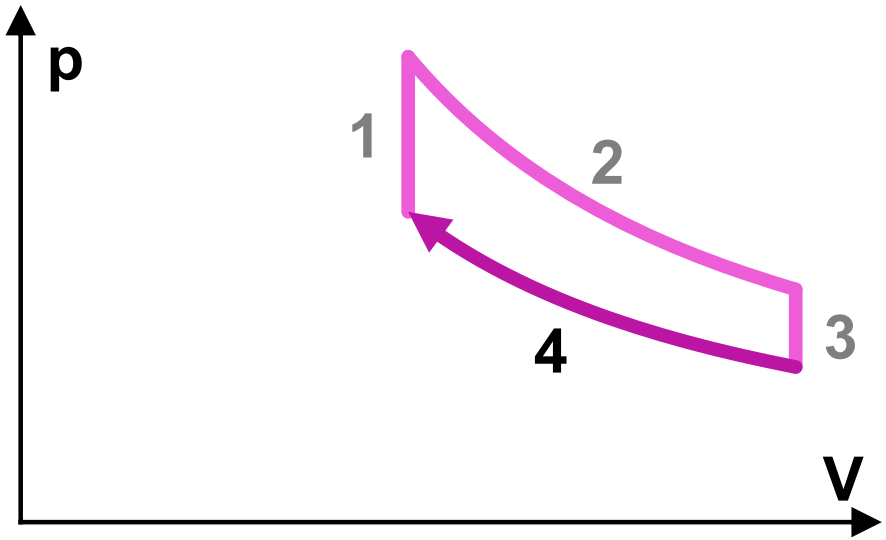


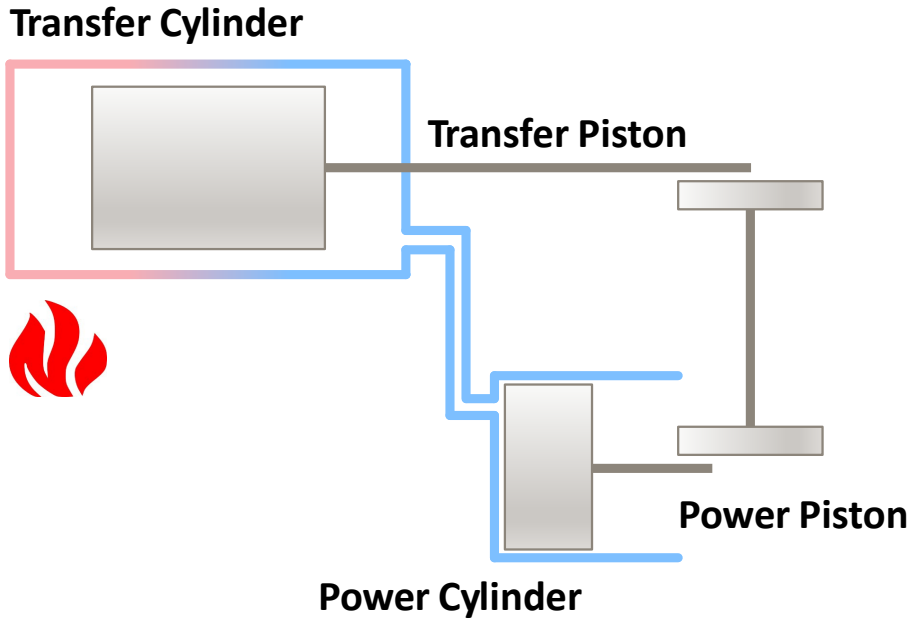


Power cycle of a Stirling engine

phase 4: contraction

underpressure drives volume decrease





Power cycle of a Stirling engine

The result is motion from heat!