Pre Lab 1 - Stirling Lab

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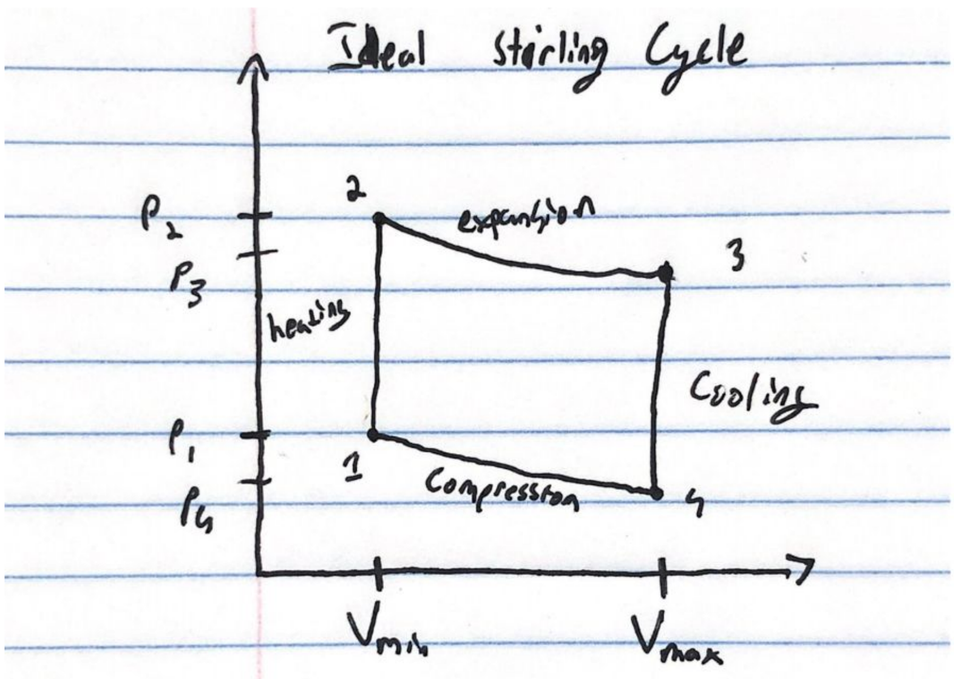
1. **<u>General Theory</u>**
    a. Alpha Stirling engines differ the most from beta and gamma type Stirling engines. Alpha-type Stirling engines have two power pistons, each in their own separate cylinder and connected to the same flywheel. One cylinder is considered hot because it is inside a high temperature heat exchanger. Similarly, the other cylinder is considered cold because it is inside a low temperature heat exchanger. Beta engines, on the other hand, are constructed with only one power piston in addition to a displacer piston. Both the displacer and power piston are located in a single cylinder, containing both a high temperature and low temperature heat exchanger. A displacer piston is loosely fitted so that it does not get pushed around from expanding gases. Instead, it is only used to move the gas between the low temperature and high temperature heat exchangers. Like a beta-type Stirling engine, a gamma type Stirling engine only contains a single power piston along with a displacer. The difference between a beta-type and gamma type Stirling engine is in a gamma-type engine, where the displacer and piston are both located in different cylinders.
    b. The four thermodynamic processes are isothermal expansion, constant volume heat-removal, isothermal compression, constant volume heat addition. The gamma type Stirling engine contains a fixed amount of gas which is sealed off so it cannot escape. During isovolumetric heating, the displacer moves away from the heat exchanger letting most of the gas come in contact with the high-temperature heat exchanger. This will heat the gas and cause it to expand. The power piston moves minimally causing the volume to be at a minimum. During isothermal expansion the gas heats up and expands, the power piston is driven upwards. This causes the flywheel to turn causing the volume to be at a maximum. During isovolumetric cooling, the power piston is fully extended and the displacer begins to move due to the flywheel, pushing the hot gas towards the low-temperature heat exchanger. This cools the gas and causes the gas to contract. During isothermal compression, most of the gas is in contact with the low-temperature heat exchanger so it is cooled and

contracted. This in addition to the flywheel momentum the power piston moves downward and the process starts again.

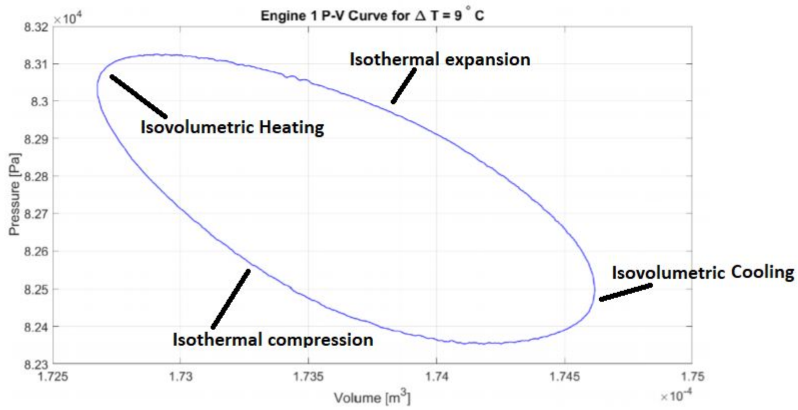
c. Supposing that the process starts at $\theta = 0\,\text{deg}$, when the displacer piston is closest to the heat exchanger, it will begin to move upwards pushing gas towards the hot-heat exchanger causing the gas to heat and expand. At $\theta = 90\,\text{deg},$ the power piston will be at its lowest, and the displacer will continue to push air towards the hot-heat exchanger. At $\theta = 180\,\text{deg},$ the power piston will be moving upwards as the gas heats and expands. At $\theta = 270$, the displacer piston will move the gas towards the low-temperature heat exchanger causing the gas to cool and contract.

2. The Stirling Cycle

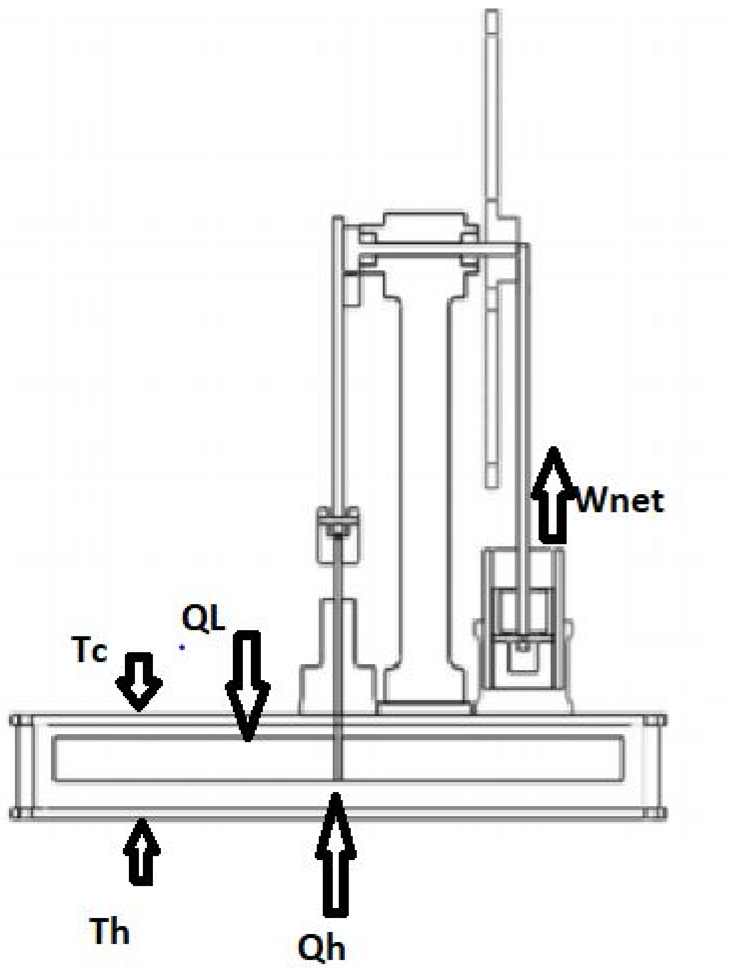


a. Above is a sketch of an ideal Stirling cycle P-V diagram with each of the four processes labeled.

b. The ideal cycle does not look like the real cycle because the change in pressure is not instantaneous.

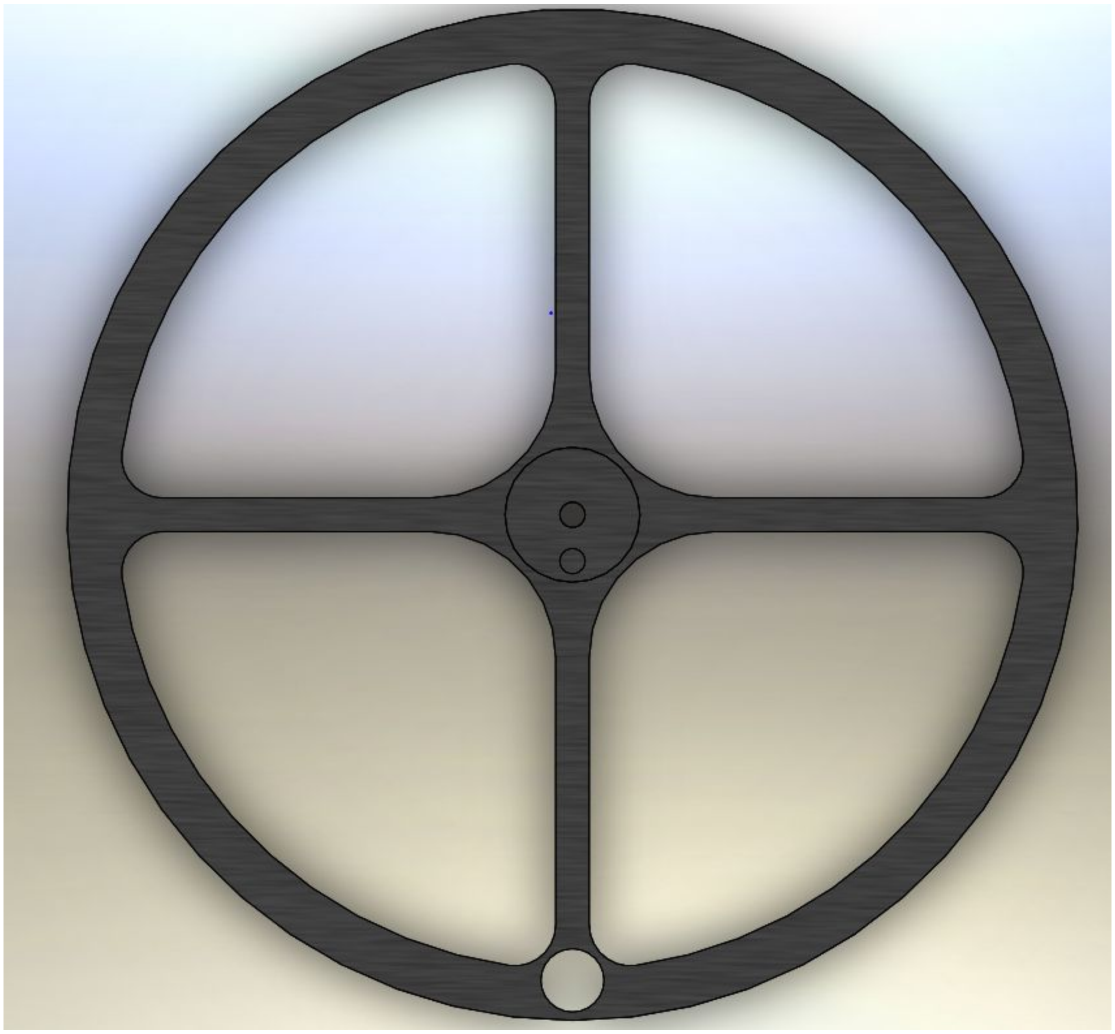


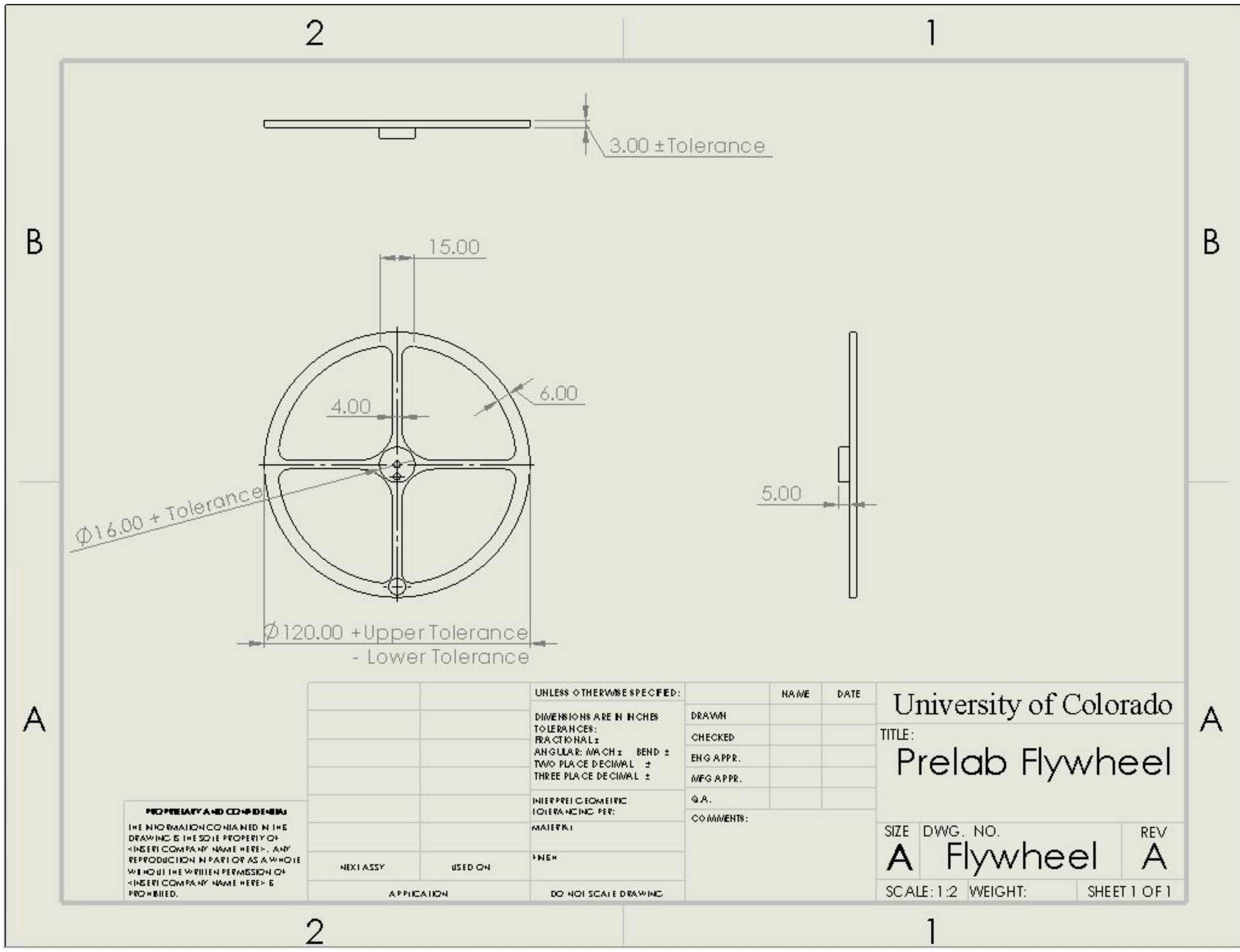
c.



Solid Works

Files are included in submission




2
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15.00
6.00
4.00
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5.00
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- Lower Tolerance
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC
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MATERIAL
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NEXT ASSY
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DO NOT SCALE DRAWING
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