Precision Eng.
Yr2 24-25

Stirling Engine – Beta Configuration

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Aim of the Project

The Aim of the project is to design, assemble and test a Beta Stirling Engine. The Power piston must not exceed 40mm of a stroke and we must test the capabilities in terms of torque and rpm.

Background

A Stirling engine operates on the principle of converting heat energy into mechanical work through cyclic compression and expansion of air or other gases at different temperatures. Heating phase: the working gas is heated by external source on the hot side causing the gas to expand.

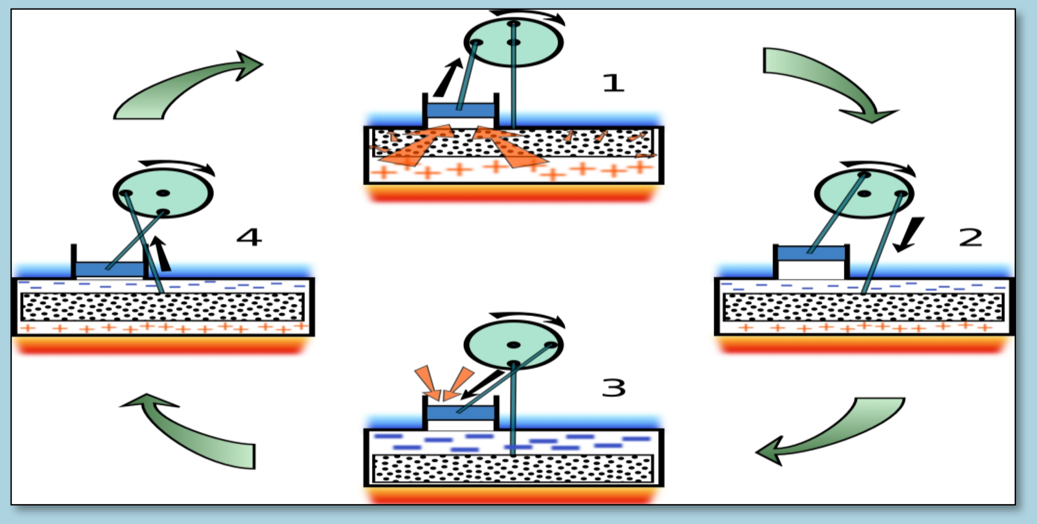


Figure 1: Stirling Engine process

Cooling phase: The gas is then transferred to the cold side, where it cools down and the gas contracts.
This expansion and contraction of gas push a piston which is connected to a mechanical system.

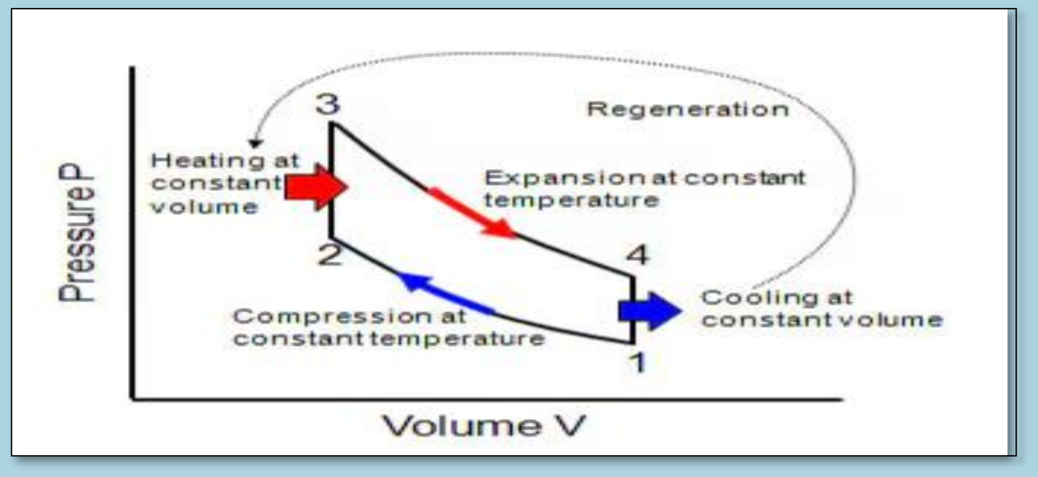


Figure 2: Four phase cycle

Initial Design

Extensive research was done on the three configurations with a design on each, to decide on which concept design we want. The team came to an agreement with the beta configuration due to the amount of power produced and ease to manufacture.

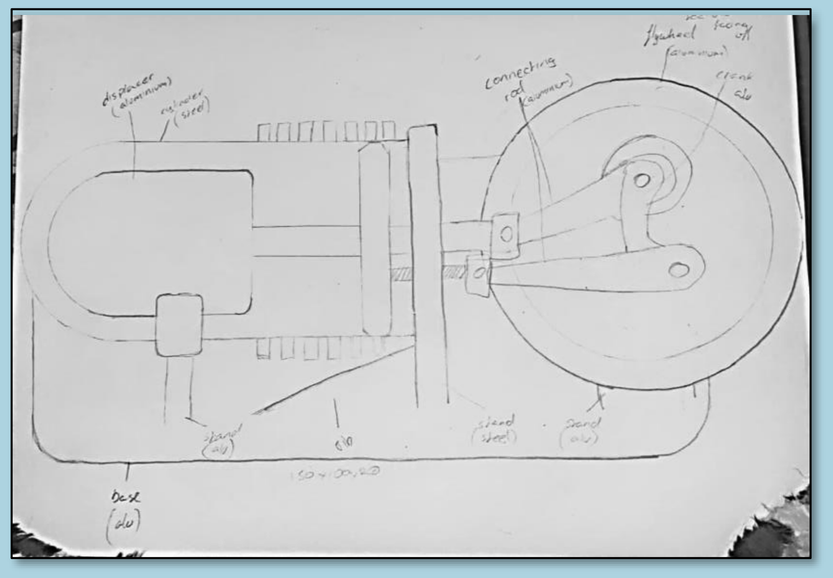


Figure 3: Beta Concept Design

The concept design below has main components of one long cylinder, a displacer and power piston, a rib, 2 stands, flywheel and a shaft. The design was ineffective, and features had to be changed

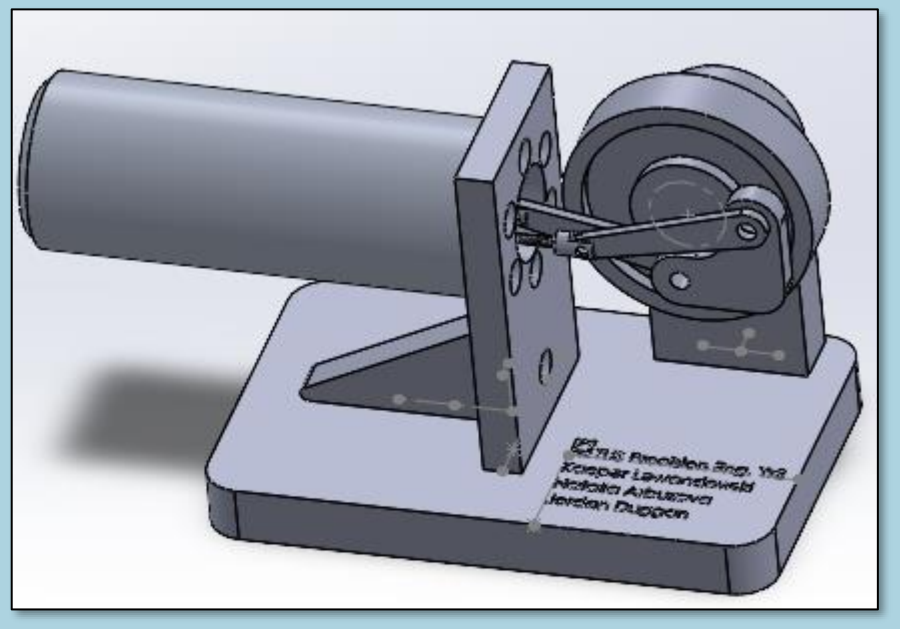


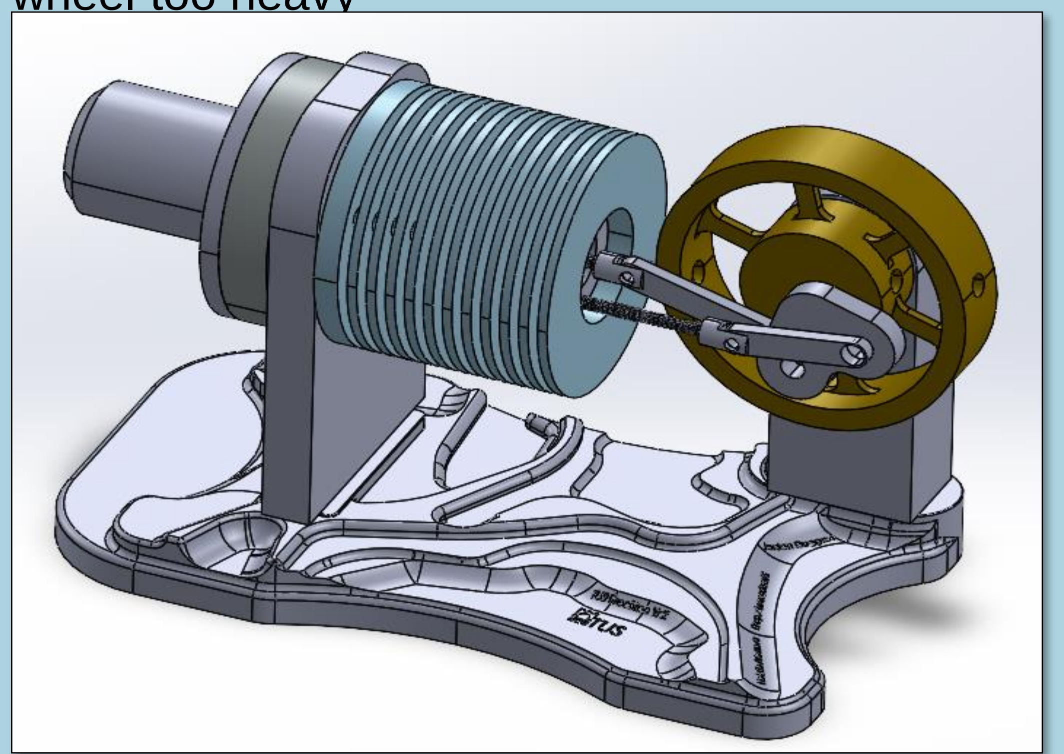
Figure 4: CAD model of design

Final Design

After running simulations and solving problems we produced the following final design.

Some of the changes made to the initial design include reducing the length of linkages. The original length of linkages didn't allow for the fly wheel to fully rotate.

The fly wheel was redesigned so it would run more efficiently the previous design made the fly wheel too heavy



Materials

- **Aluminium** Parts that didn't need specific properties or needed to be as light as possible were designed to be made from aluminium as it was the lightest metal we had available.
- **Brass** The flywheel is one of the parts designed to be brass. This was decided due to the extra weight brass would provide and it would eliminate the need for a brass sleeve if the flywheel was made from aluminium. The power piston was made from brass as it would be easier to machine than aluminium as the power piston had the most crucial tolerances compared to any other part.
- **PTFE** The thermal break was designed to be made from PTFE as this would allow for less heat transfer from the hot chamber to the cold chamber.

Manufacturing

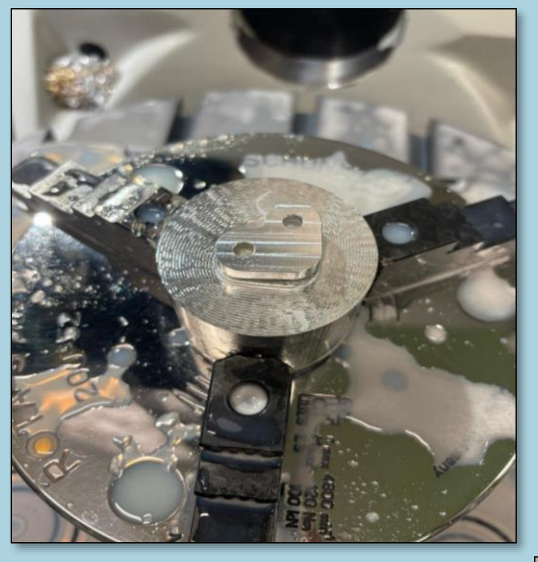


Figure 6: CNC Machined Crank

Due to the complex shape of our crankshaft, it was CNC machined as manually making it would be too time consuming.

The cylinder parts featured a PCD of holes needed for fasteners. This forced multiple parts to be made using a manual lathe and milling machine.

Figure 7: Machining of Hot Chamber

Figure 8: 3D Printed Linkages

The linkages designed for the engine was extremely small and difficult to manufacture. So, they were 3D printed to save time.

Conclusion

The team successfully designed, manufactured and assembled a Stirling Engine following the guidelines given in accordance with strict deadlines. Unfortunately, the engine does not run possibly due to errors in manufacturing. However, the team still sees this project as a success as the engine was still able to be assembled. The team found time constraints and team communication as the biggest challenges in this project. Time management was a big issue as last-minute changes and submissions were often throughout the project .