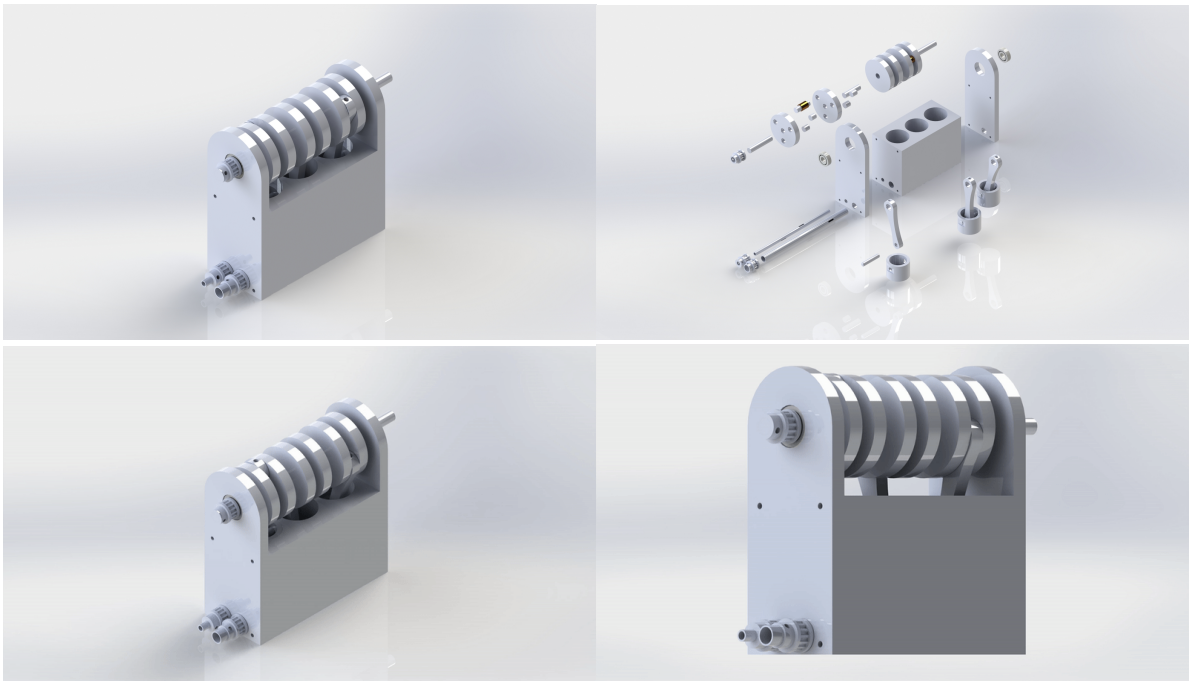
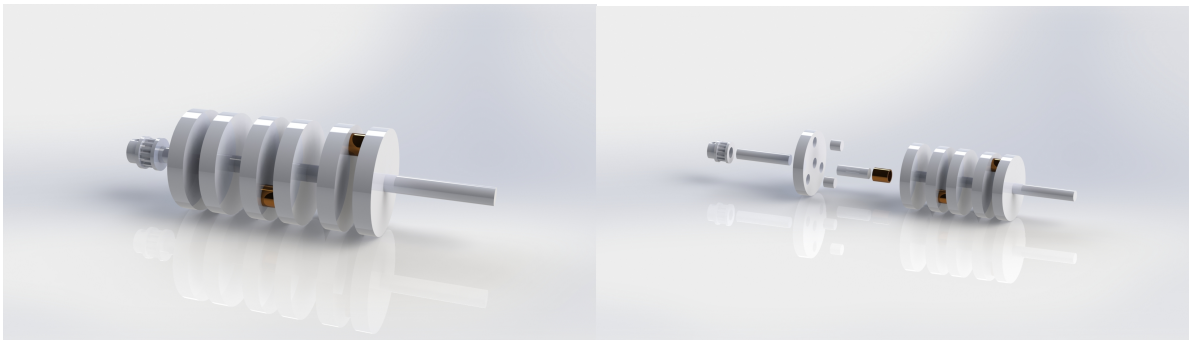
Greensteam Design Report: 3 Cylinder Inline Engine

Tae Rugh, Summer 2020



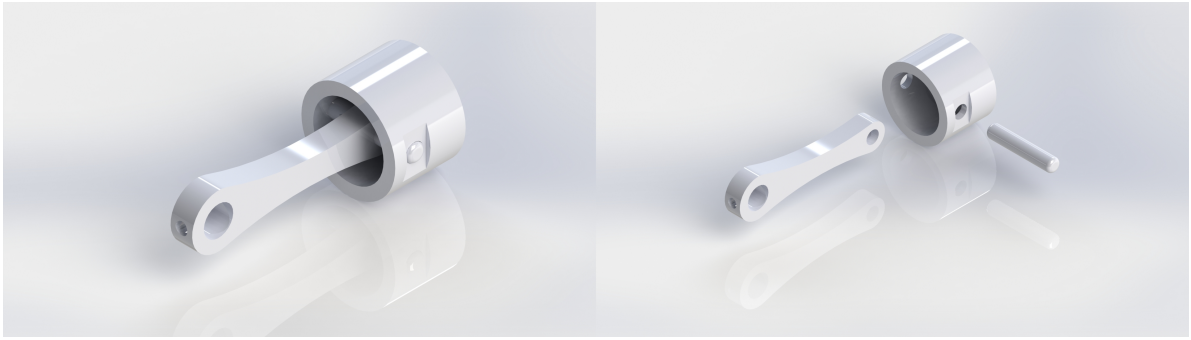
This engine has 3 inline cylinders bored out of a single block. The 3 corresponding pistons are attached to the crankshaft with equal spacing of 120°. Due to this layout no flywheel is required. A drawback, however, is that a traditional crankshaft must be used, which is more difficult to manufacture than an overhung crank (which has been favored in many of our other designs). There are 2 rotating hollow pipes that run below the head of the cylinders, parallel to the crankshaft, and act as the inlet and exhaust valves. These pipes are linked to the crankshaft via a timing belt. The inlet tube is fed a constant supply of steam from one side and sealed on the other, while the exhaust tube is open on both sides to atmospheric pressure. Both pipes each have 3 slotted cuts that open into the cylinders for a period which determines timing for inlet, expansion, exhaust, and compression. The benefit of this valve system is that the 2 pipes essentially replace the need for 6 valves, reducing the number of moving parts while maintaining perfect control over valve timing. The drawback is that there are concerns with sealing between the pipes and their bores which could result in leakage between cylinders. Additionally, thermal expansion of the pipes must be taken into account when determining clearance so as to prevent the pipes from seizing in the cylinder block.

Part Breakdown

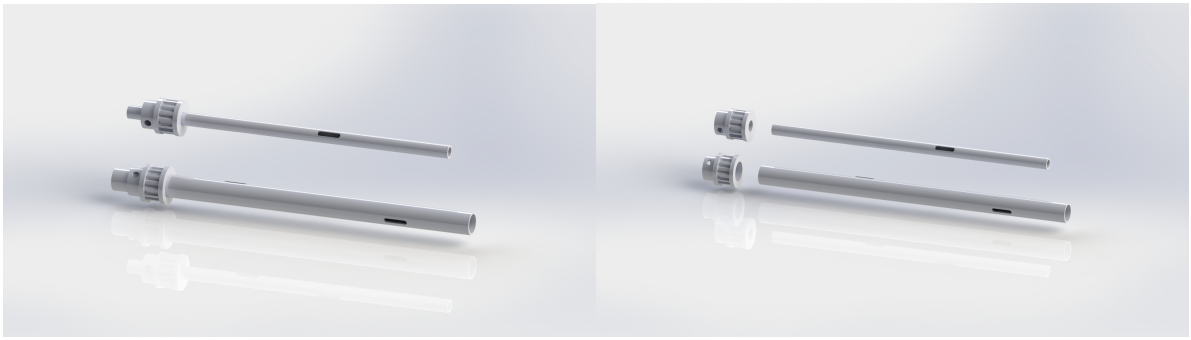


The crankshaft requires precision manufacturing in order to be correctly aligned and rotate smoothly. To achieve this in a frugal and simple manner, the following manufacturing process will be used. First, a center hole of the same diameter as the crankshaft will be drilled through a large round bar. Additionally, 3 surrounding holes will be drilled at 120° from each other, a half stroke distance from the center, and of a diameter to fit the crank pins. This bar will then be sliced up to become the 6 crank disks shown in the image above. The shaft, crank pins, and crank bushings will then be inserted and fixed in the disks at correct spacing, and the unwanted shaft material will be cut out.

The cylinder block has 3 bores for the 3 pistons and 2 holes below the cylinder heads that run parallel to the crankshaft and house the inlet and exhaust pipe valves. There are bearing plates on each side, press-fit with ball bearings, which support the crankshaft.



The piston consists of the piston head, piston pin, and piston rod. The pin is press-fit to the rod, but given clearance through the head. The pin stays in place by slight contact with the cylinder wall on each side. In this way, the rod is free to rotate along the axis of the pin, but held in place otherwise.



The valve pipes have slotted cuts that line up with each cylinder manifold and are radially spaced 120° between each other. Since they are hollow, the pulleys are attached on the ends with 2 set screws. The pulleys hold a belt which connects between the two valve pipes and the crankshaft.

Files

- Master CAD
- Renders