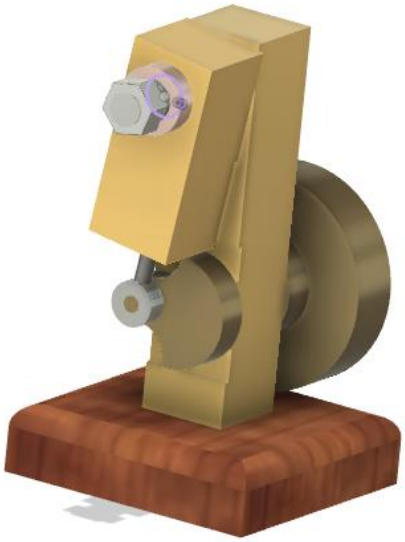
PROJECT – Steam Engine

Advanced Machining



The Purpose....

In this activity you will apply more advanced machining skills and processes into a functional Steam Engine. The Steam Engine is the foundation of the Industrial Age, and from its invention spawned the modern world we know today.

There are many manufacturers of model Steam Engines. They are exceedingly expensive to purchase. Many model Steam Engines become family heirlooms that last for generations. I have one my father-in-law owned as a small boy, *and it still works!!*

This project is very complex, and requires very precise machining, close tolerances and attention to detail. Only high quality production will be successful. You may NOT work in partners.

THIS IS A LEVEL 2 PROJECT. You get less "how to" in this project (I hold your hand less).

The Preparation....

For this activity you will need the following:

- Ruler
- Scriber
- Square
- Bubble level
- Center punch
- Hammer
- Various files
- Various sandpaper

- Demonstrated safe use of the following:
  - Drill press
  - Milling machine
  - Machine lathe
  - Pedestal grinder
  - Oxy-Acetylene torch
  - MIG Welder
  - Foundry

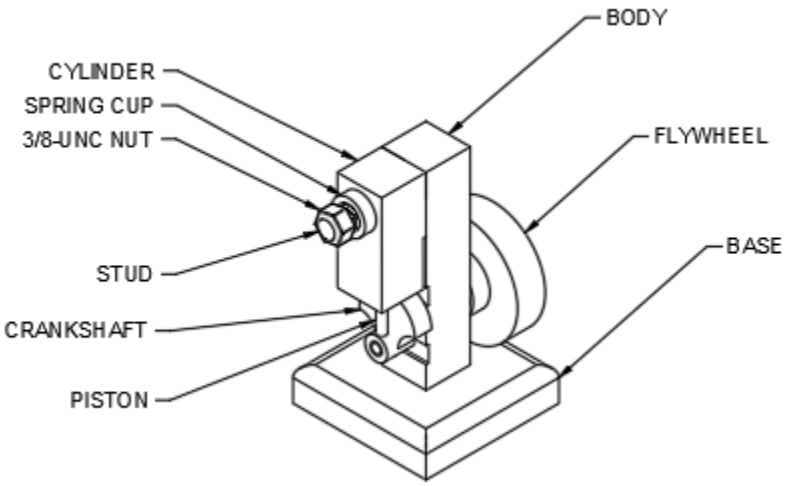
- Understanding of the following:
  - Layout
  - Drilling
  - Countersinking
  - Threading
  - Knurling
  - Milling
  - Facing
  - Casting?

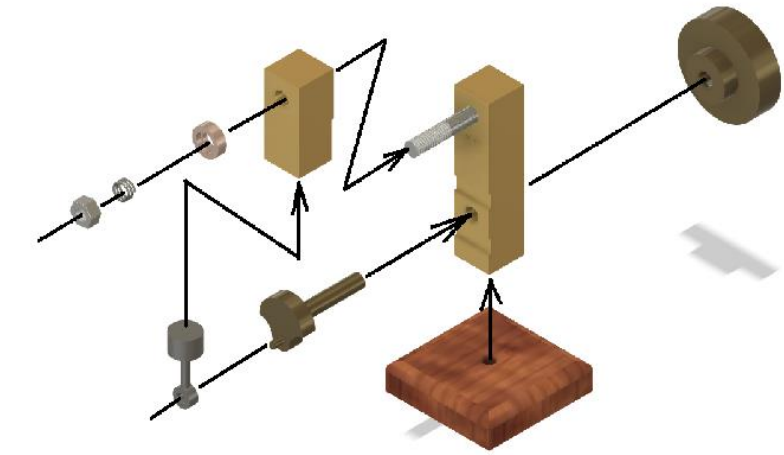
Steam Engine Assembly

The Procedure....

There are five major components to this project:

- Body
  - "Backbone" of the engine
- Cylinder
  - Houses the piston
- Piston
  - Converts steam pressure to rotary motion
- Crankshaft
  - Output of steam engine
- Flywheel
  - Provides momentum to keep running during exhaust





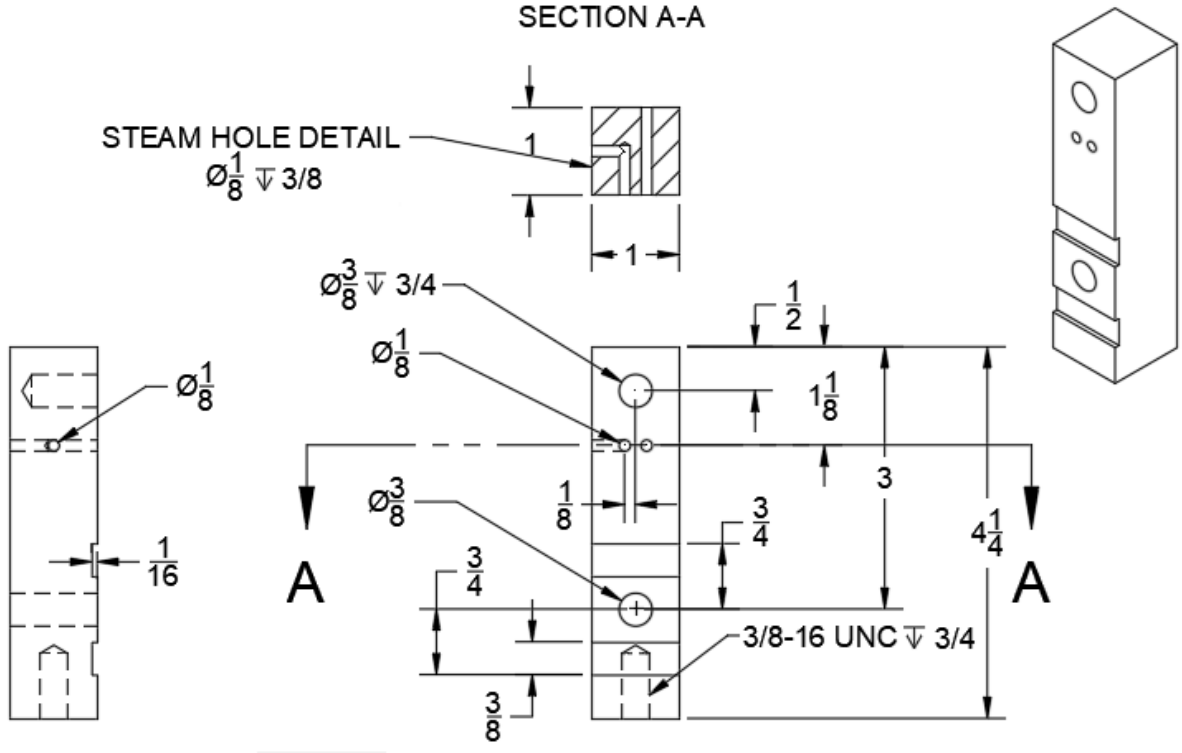
MAKE SURE YOU LETTER-STAMP YOUR INITIALS ON ALL YOUR PARTS

WITH PROJECTS **THIS** COOL, THEFT IS A REALITY

(Oh, and you don't have to make the parts "in order")

Steam Engine Body

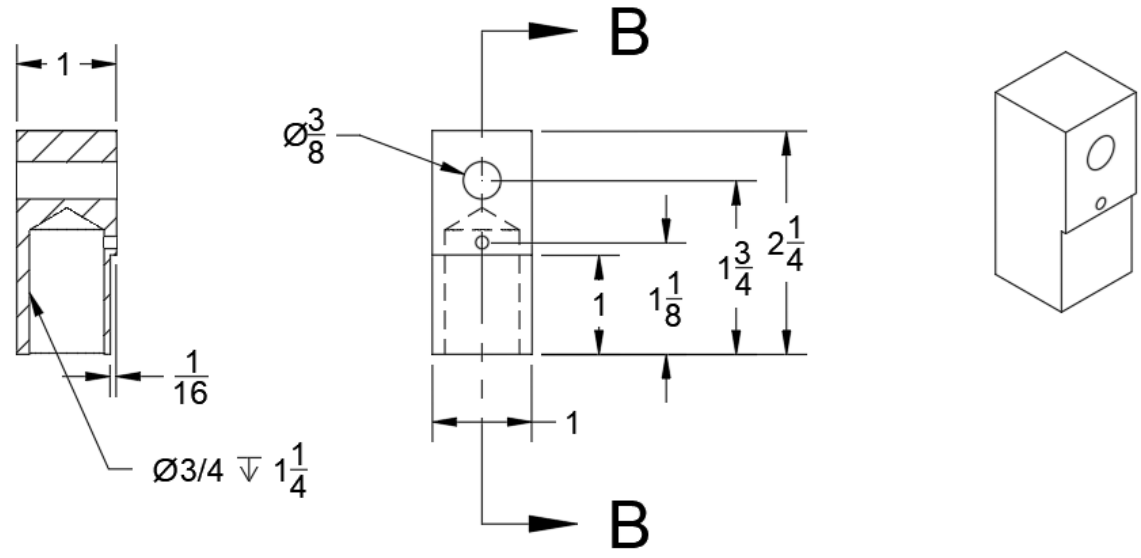
The Backbone of the Engine



- 1/8” hole layout is CRITICAL
- One hole is drilled ALL THE WAY THROUGH
- The other hole is drilled HALF WAY THROUGH, and then met up with ANOTHER HOLE drilled in from the side DO NOT DRILL TOO FAR!!
    - *CAUTION: Drill bits will “grab” and try to break off where they meet inside*
- Slots are milled on the milling machine using a 3/8” cutter – Slots are 3/4” apart from each other (not indicated in drawing)
- What TAP DRILL do you need?

CYLINDER

Houses the Piston

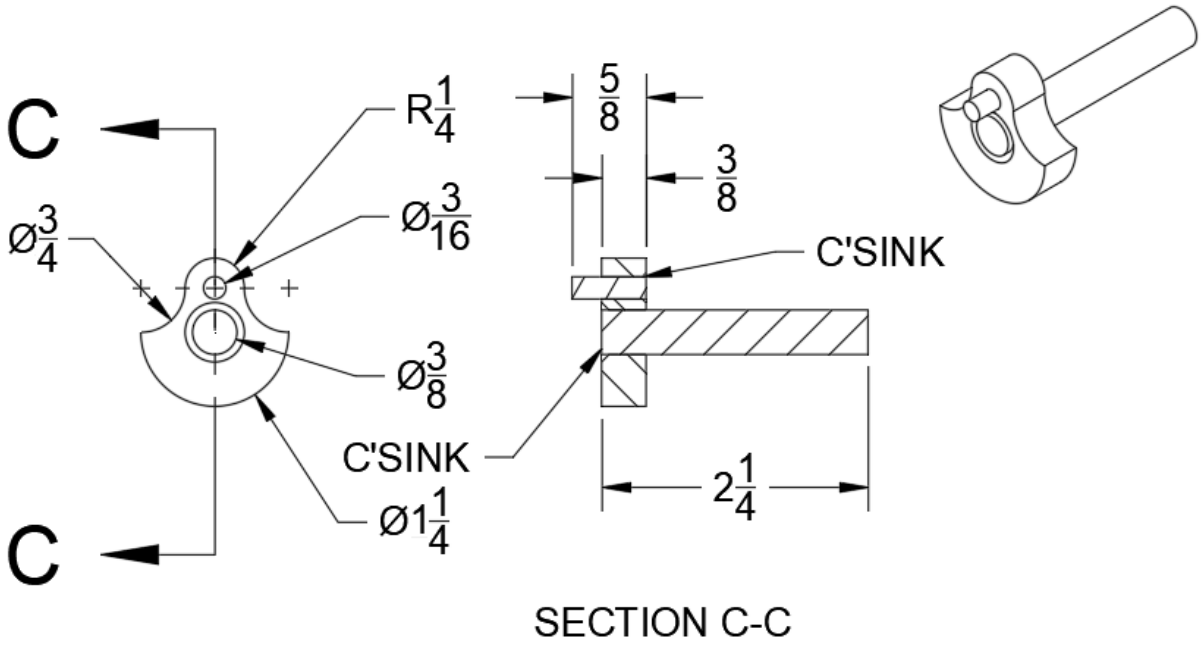


SECTION B-B

- Slot is machined on the milling machine, 1” wide
- Drill 3/4” hole with a LATHE and a **4-JAW CHUCK** (a drill press cannot ensure accuracy)
- NOTE the 3/4” hole drilling depth
- <u>1/8” hole layout is CRITICAL</u>

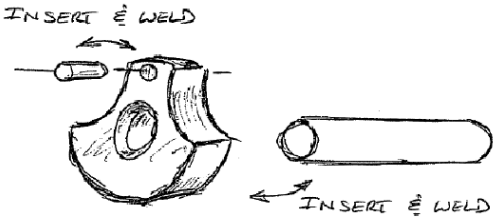
CRANKSHAFT

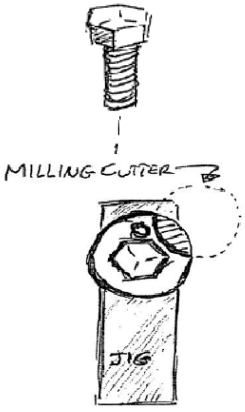
Master of Rotation



SECTION C-C

- Made from THREE pieces – notice the cut away view
- Center to center distance is CRITICAL
    - *I have a jig for this – see me*
- Notches in counterweight can be done on a Milling Machine
    - *I have a jig for this – see me*

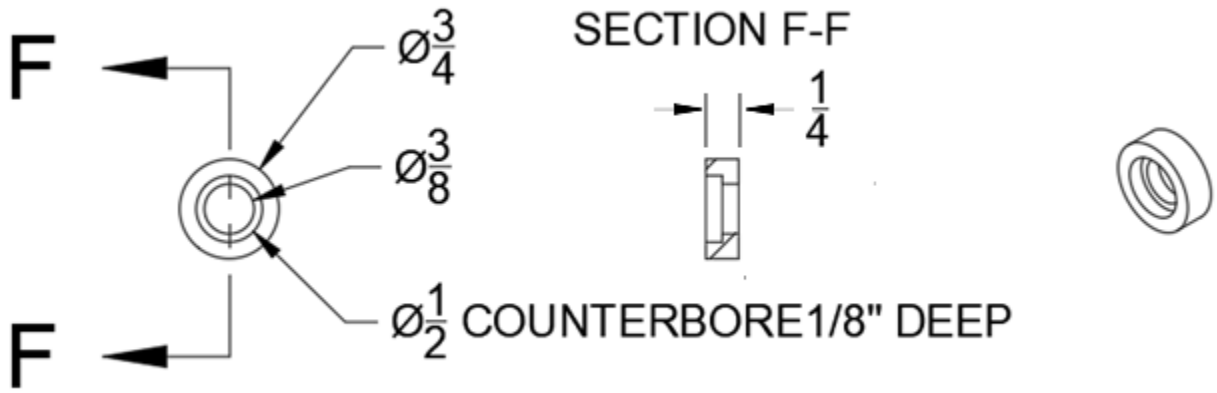




- Crank Pin alignment is CRITICAL (it MUST not be angled)
- Crank journal and rod journal can be brazed (not as strong) or MIG'd (harder to machine)
- Welds must be nice and smooth where Crankshaft contacts the Body.

SPRING CUP

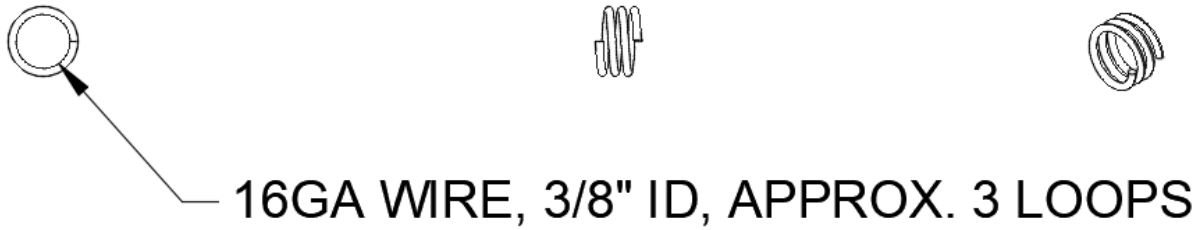
Securing the Tension Spring



- Spring Cup should be made from a longer piece:
    - Face one end
    - Center Drill
    - Drill through 3/8”
    - Counter Drill 1/2" to a depth of 1/8”
    - Cut to length with a hacksaw *(or Parting Tool if you're a gambler)*
        - ***SPRING CUP IS 1/4" THICK***
    - Carefully chuck in the lathe (no wobbling) and face flat

SPRING

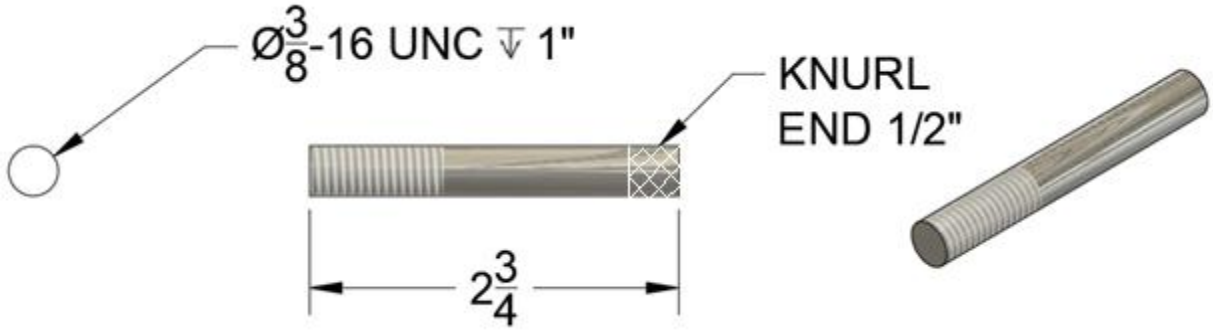
Helps Seal, and is the "Blow Off Valve" *WHEN THINGS GO WRONG*



- Spring is made by winding a short length of 1/16” welding rod around a 3/8” shaft, try to space the coils a bit – careful, if it slips out of your fingers while you’re doing this, it will cut you *(you DID get your Tetanus shot in Grade 9, right?)*
    - You need enough spring to press the cylinder against the body
    - You probably only need 3 or 4 coils
    - The spring also acts as a pressure-relief valve in case something goes excitingly wrong

STUD

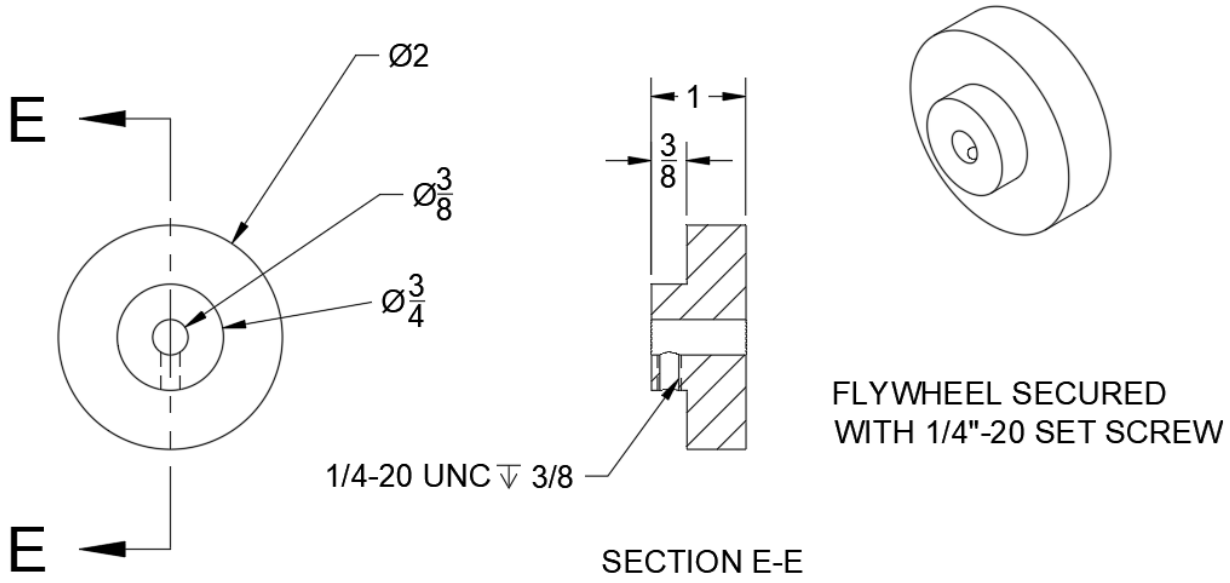
The Magic That Holds It Together



- Stud is made from 3/8" solid round
- Thread one end 3/8-16 UNC
    - *Use the LATHE and a die handle to start the thread BY **HAND** WITH **NO POWER***
- Knurl the other end to make it *larger*
    - *The knurl makes the metal **LARGER**, which becomes a PRESS FIT into the 3/8" hole in the body*

FLYWHEEL

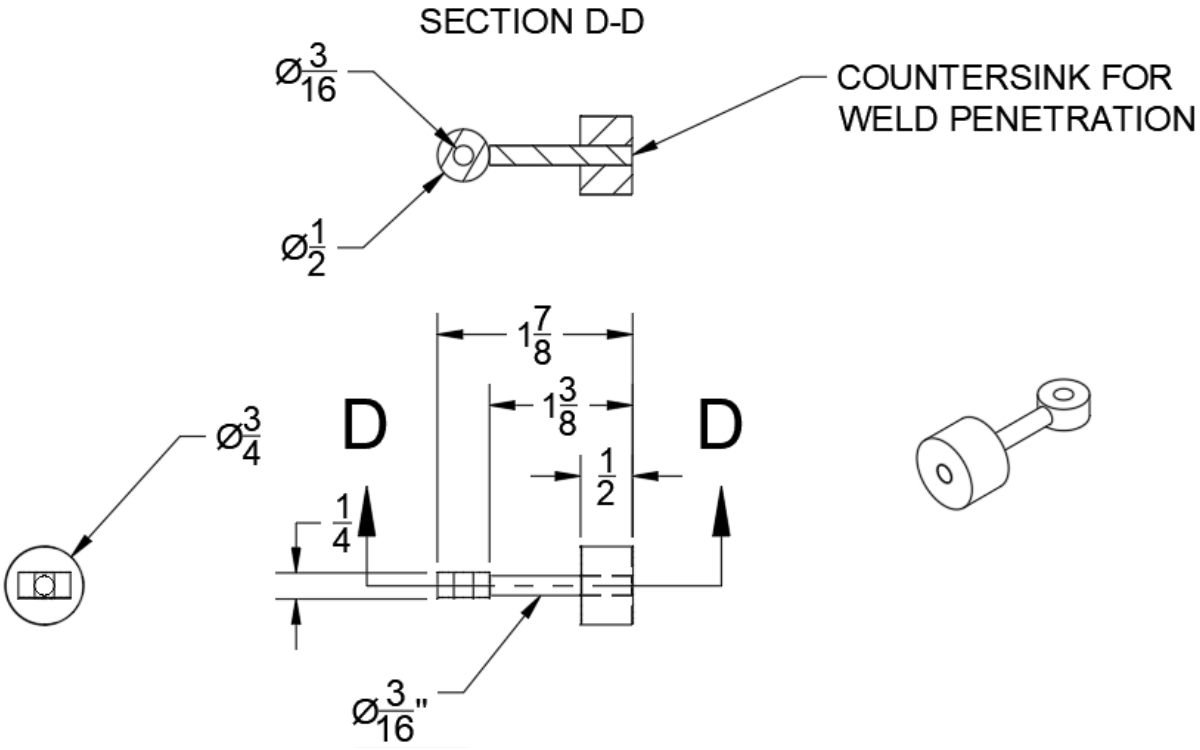
Spinning Mass Provides Momentum

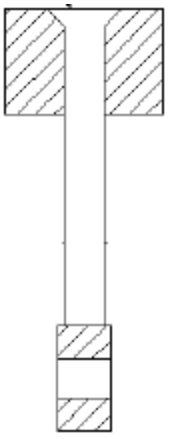


- Flywheel can be made from Aluminum or Steel
    - A heavier flywheel has better momentum and maintains a speed better
    - A lighter flywheel has less momentum and can change speeds faster
- Add some creative design to the flywheel center – don't just make it boring and flat
    - Use the Rotary Table?
    - Use the Dividing Head?
    - Add some Counterbore?
    - _____ ???
- Remove any and all sharp edges
- What **TAP DRILL** do you need??

PISTON & CONNECTING ROD

Harnessing The Power Of Steam

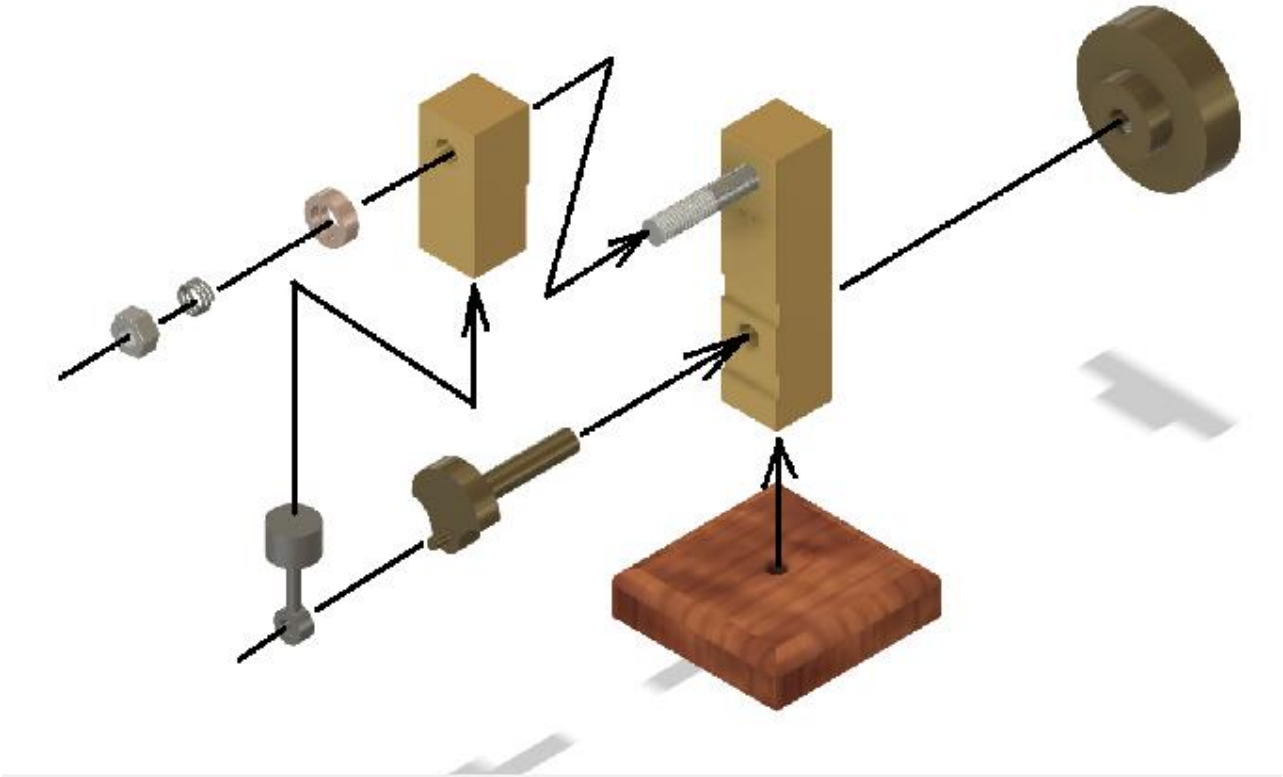




- Piston head to journal center distance is CRITICAL
  - *It should be 1-5/8", but kids struggle to fabricate using that measurement, hence the measurements shown above*
- Piston and rod are made from THREE pieces
  - *Countersink!*
- Piston can be either brazed (not as strong) or MIG'd (not as easy to machine) to the rod
- Rod should be brazed to the bottom end
  - *Better weld control*
  - *Less cleanup for smooth operation*
  - *Prettier*

FINAL ASSEMBLY

BooYeah!



- The Nyloc nut should be tightened so the nylon ring is gripping the threads
- The spring should have at least 1/16” between coils
- Everything should spin freely
- The record with 100psi is 3600rpm! How did yours do?