Engine Group

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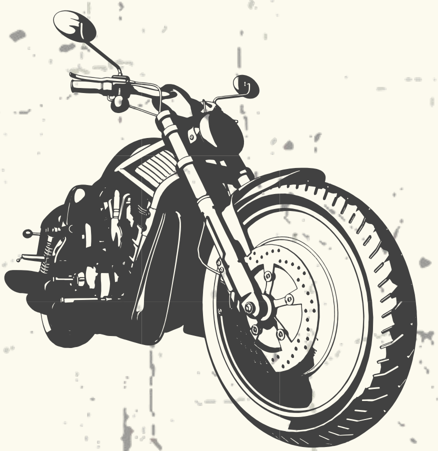
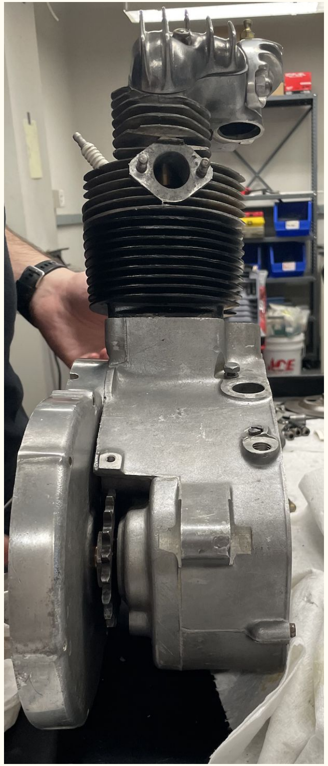


Engine Repair Overview

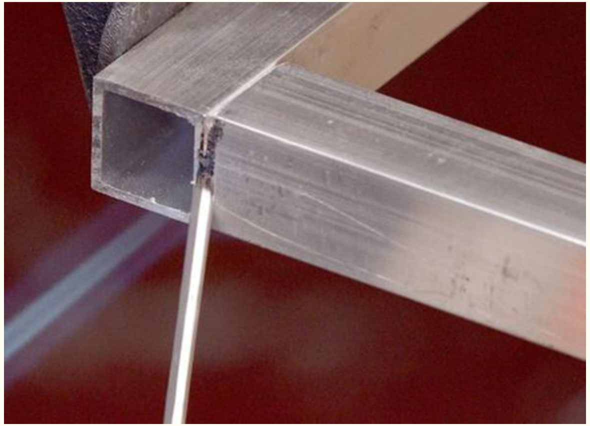
- Cleaning everything: coating in WD-40, parts cleaner & immersion ultrasonic cleaner, sandblasting / spray painting barrel, cleaned bolt threads with a die
- Took apart the head, polished valve seats with lapping compound
- Welding/Brazing to fix cracks in cover
- Replaced crankshaft due to wobbling connecting rod
- Professor Northy honed the barrel, reamed the sleeve bearing
- Roughed up the clutch plates
- Scanned and cut gaskets → created workflow with Photoshop and Inkscape
- Took apart a sample engine to see how it worked
- Began putting it back together
- Tools: Arbor press, Sandblaster, Air blaster, Blowtorch, Vise, Various “home-made” tools (bracket to compress valve springs)



The Repair Process

Brazing & Welding

Brazing → Aluminum brazing is a joining process that joins two parts of aluminum together.



How it works → First you must clean and brush up the material you wish to braze, so that the brazing works to its best ability. Then using a torch, heat up the material to a high temperature. Once at the proper temperature, slightly run your brazing rod across the area you wish to join together. Because the material is hot, the rod will melt, and allow the material to join from the melted materials that are in the rod. Once the materials have cooled, then clean up the flux by brushing your material.

Images of our cracked case before I attempted the brazing.

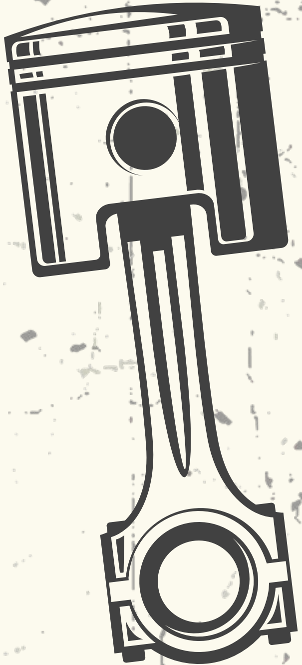
Brazing vs. Welding

The main difference between brazing and welding is that brazing does not melt the base materials. With brazing, you heat up the material to around 800 degrees celsius. While when welding you do not heat the material beforehand, you melt the materials together to fuse them.

What we did → John wanted us to try to use aluminum brazing for one of the cases on the engine that had a crack. I attempted to do so, but had issues with the heat spreading to much across the case, and the brazing rod did not fuse uniformly because of this. Because of this, we did not braze the case, but instead welded it.

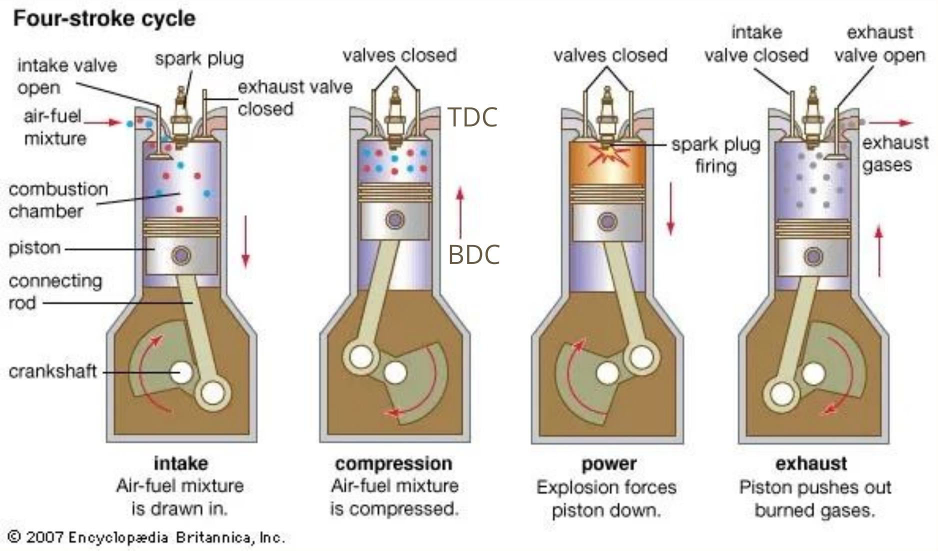
Our attempt with Aluminum Brazing

The Science



How the Engine Works

- 200 cc (the amount of volume moved by the pistons in a single revolution of the engine)
- Compression Ratio of 9:1—medium top & domed
    - 7:1 (flat top) or 10:1 (large top), ~15 hp
- 3 parasitic strokes, 1 power stroke
    - One cylinder → relies on the flywheel's inertia to continue moving during the parasitic strokes
- 14.7:1 is the stoichiometric air to fuel mixture → burning all fuel with no excess air



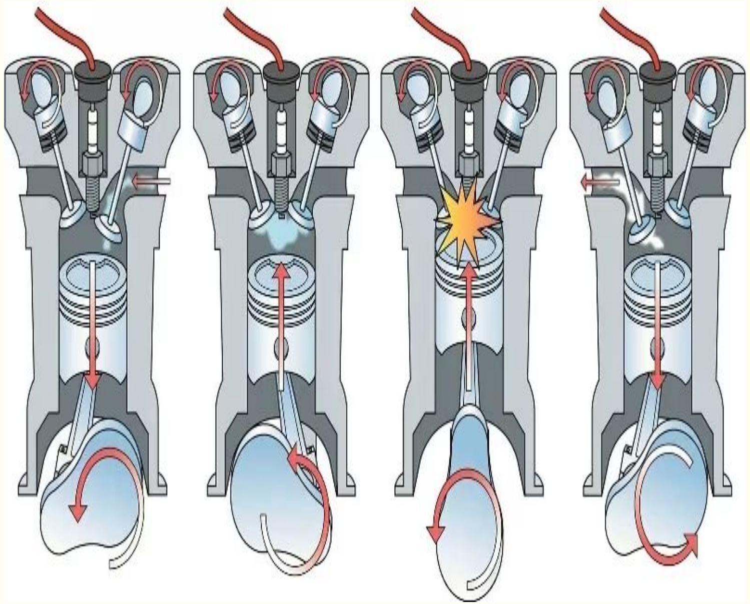
Ideal Gas Law → PV = NRT

1. Intake open, exhaust closed
2. Intake/exhaust closed
3. Spark plug fires (ignition)
4. Exhaust open, gases out

(Suck, Squeeze, Pop, Blow)

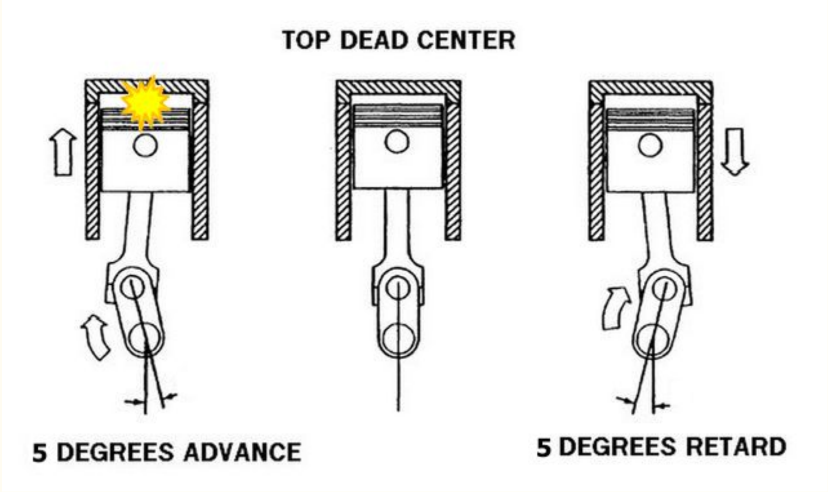
Ignition Timing

- Refers to the precise moment, relative to the position of the piston and the angle of the crankshaft, when a spark is generated in the combustion chamber towards the conclusion of the compression stroke
- If the spark plug fires too soon or too late in the compression stroke, damage occurs to the engine over time
- Steps:
  - Spark plug fires during compression stroke
  - Air/fuel mixture in combustion chamber is ignited
  - Pressure is built in the cylinder as the burning gases expand
  - Just as the piston hits top dead center, pressure is maximized
  - Pressure pushes down on the piston
- After, the exhaust stroke occurs to release old gases, so that this process can occur again
- Factors that influence ignition timing in an engine: condition of spark plugs, engine temperature, intake pressure



Ignition Advancing vs. Ignition Retarding

- Advance: spark plugs fire earlier in the compression stroke, farther from top dead center (TBC)
  - Might be needed to allow time to get everything ignited; air and fuel mixture doesn't burn instantly
  - Benefits include: increasing horsepower of engine, more increased use of air/fuel mixture
- Retard: spark plug fires later in the compression stroke
  - Reduces combustion inside the cylinders after the spark plug fires — a.k.a. engine knocking
  - Can be beneficial to turbocharged engines that run at higher levels of pressure; helps them run more efficiently with the denser air and fuel mixture, and helps them knock less



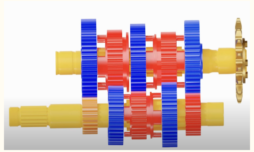
Transmission (Gearbox)

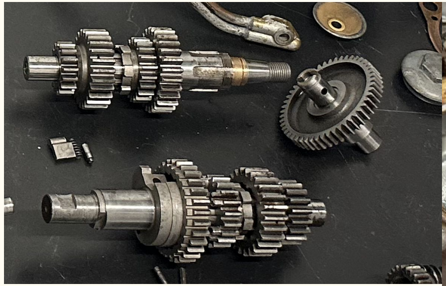
Main parts of constant mesh transmission: series of gearsteps, shafts (shifter, input, output), ratchet mechanism, shifting forks, sliding dog clutches. Controls torque and rpm

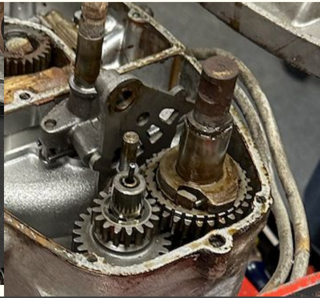
Close Ratio: Smaller than average difference between gear ratios allows engine to remain in narrow ranges of speed
16/29 (low)
25/20 (3rd)
30/25 (2nd)
27/18 (top)

- Vehicles that run on petrol often use high ratios

- Shifter shaft connects to gear lever and ratchet mechanism
- Ratchet mechanism rotates shifting piece at specific angles (not shifting drum)
- Shifting forks and gear dogs attach to shifting piece
- Blue: gears can slide
- Red: Internally splined, can slide, shaft matches angular momentum of gear





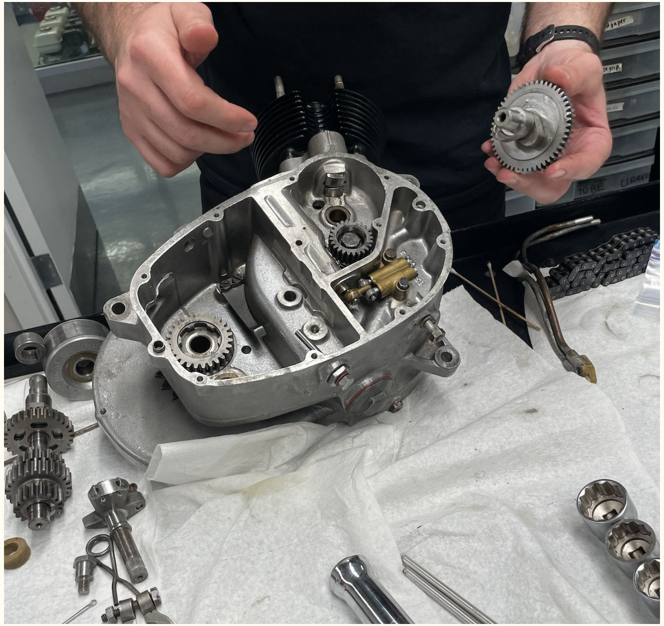


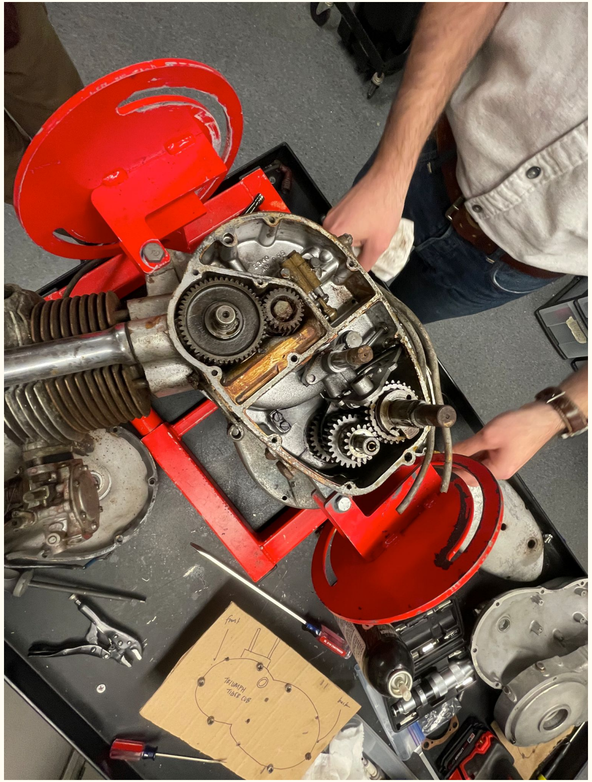
Gears

Lower gears have a lower ratio- more power for each turn of wheel, ideal for acceleration

Higher gears have a higher ratio- less power for each turn of wheel, higher speeds achievable

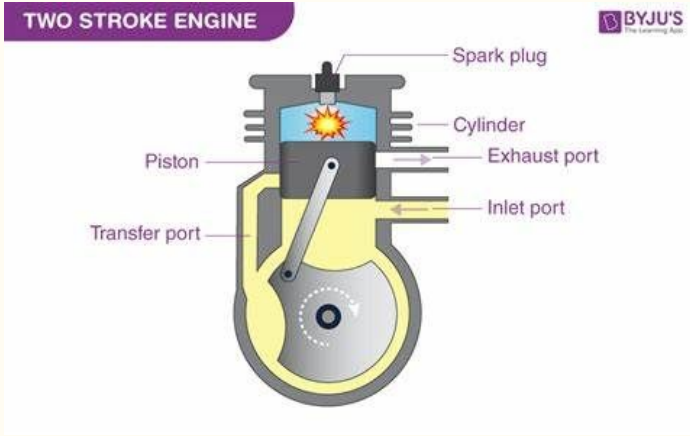
Extra: Comparison of Engines





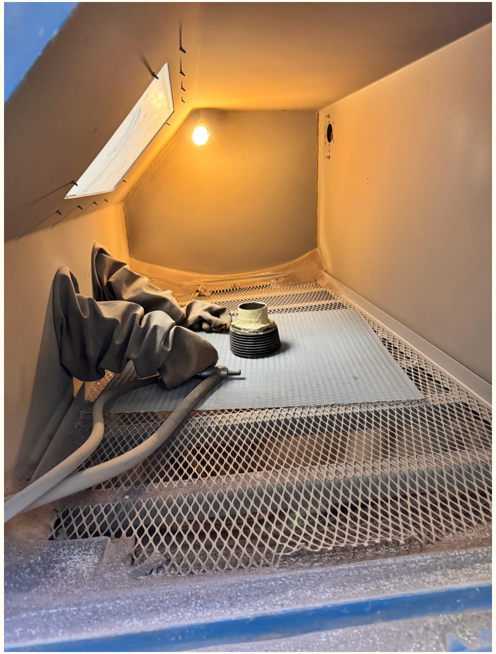
Extra: Two Stroke Engines

- Two stroke engines are lighter, but....
  - They create a lot of smoke (oil for the crank is burned, and it’s dirtier than gas)
  - Spark plugs get a lot of carbon build up
  - Poorer exchange of air (since there is no dedicated exhaust valve) → the piston acts as two valves which leads to lower volumetric efficiency (exhaust valve opens prematurely)



Still used in chainsaws, weedwackers

Extra: Instruments/Videos



Thank you for listening!

Any comments/questions?