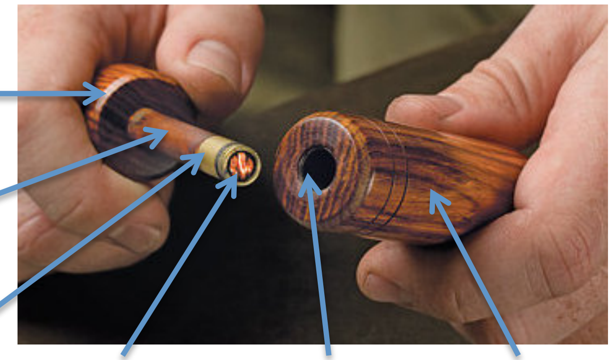
Simple Example: Fire Piston

Importance: Operates on the same principal as a diesel engine (the type of engine I am simulating)

The primitive Fire Piston is a traditional fire starting tool used by the South-East Asian Islanders. It rapidly compresses air molecules inside its cylinder, making them hot enough to cause combustion (autoignition temperature). With a single push, tinder placed in the end of the shaft ignites.



Conservation of Energy: $$\frac{du}{dt} = -P\frac{dv}{dt}$$

u is the energy per mass with units of joule per kilogram

v is the specific volume with units of m^3 per kilogram

P is the pressure with units of pascal (same as Joule per m^3)

As the volume decreases energy increases, using specific heat, c_v , we can bring temperature into the equation.

$$\frac{du}{dt} = c_v\frac{dT}{dt}$$

$$c_v\frac{dT}{dt} = -P\frac{dv}{dt}$$

The pressure, P , is increasing as we compress the piston, therefore we need an additional equation to model the system.

Ideal Gas Law: $$Pv = \frac{R_u}{W}T$$

T is the temperature with units of Kelvin

W is the molecular weight with units of kilogram per mole

R_u is the universal gas constant with units of joule per mole kelvin

Using chain rule: $$v\frac{dP}{dt} + P\frac{dv}{dt} = \frac{R_u}{W}\frac{dT}{dt}$$

Note: In a reacting mixture, the average molecular weight is not constant. Molecules can break apart or combine.