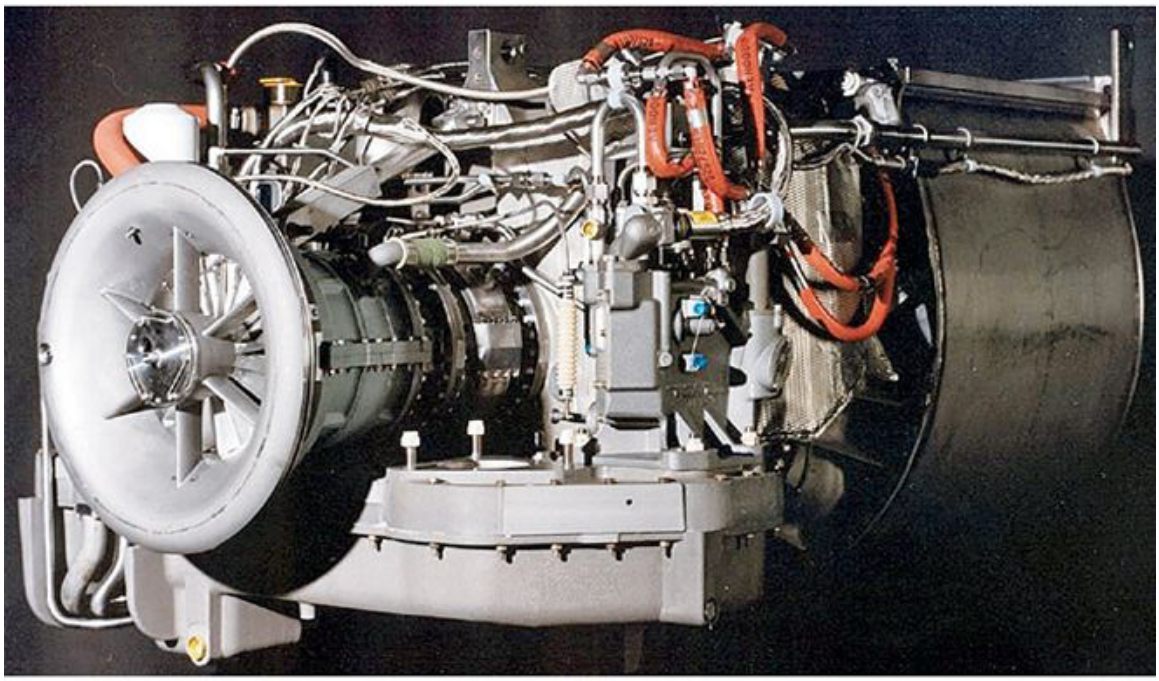


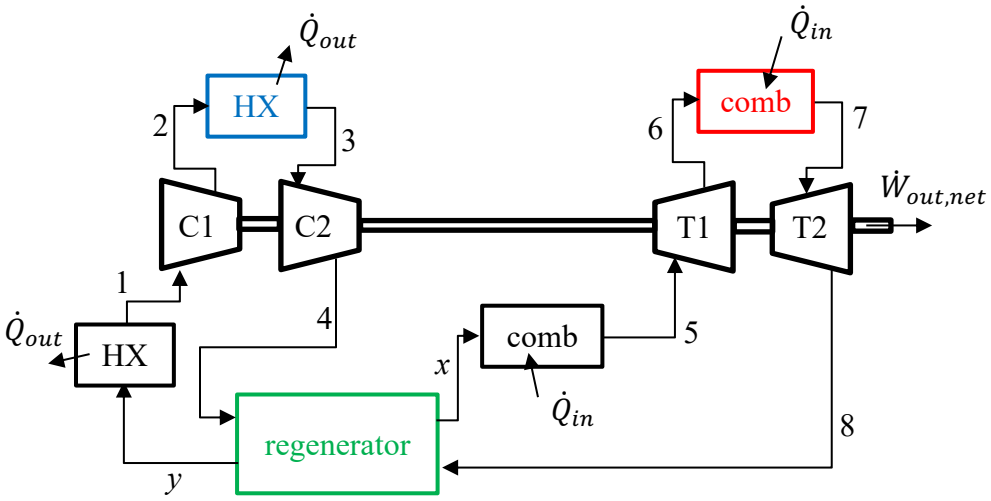
1500 hp turboshaft engine used in the M1 Abrams tank

https://www.youtube.com/watch?v=r8lRxbteAOA (regenerator)
https://www.youtube.com/watch?v=zcWkEKNvqCA (combined cycle)

ME 200 (Thermodynamics I)

Brayton Power Cycle Improvements

Intercooling and Reheating



Recall that from the 1st Law, the 2nd Law, and the *Tds* equations combined together (Lec 32), for a steady state flow with a single inlet-outlet and negligible changes in KE and PE:

$\dot{W}_{out}/\dot{m} = w_{out} = -\int_1^2 vdp$ or $w_{in} = \int_1^2 vdp$

Intercooling between successive compressor stages is used to decrease the specific volume of the working fluid:

- ideal gas law: $v = \frac{RT}{p}$: for p = const, if $T \downarrow$ => $v \downarrow$
- as $v \downarrow$ => $w_{in} \downarrow$

Reheating between successive turbine stages is used to increase the specific volume of the working fluid:

- ideal gas law: $v = \frac{RT}{p}$: for p = const, if $T \uparrow$ => $v \uparrow$
- as $v \uparrow$ => $w_{out} \uparrow$

Regeneration is when the working fluid is preheated in a heat exchanger using combustion gas in order to reduce the amount of heat (and fuel) needed in the combustor.

- From the 1st Law:
  $\dot{Q}_{in} = \dot{m}(h_5 - h_x)$ where $h_x > h_4$ due to heat transfer with the hot combustion gases
- The cycle thermal efficiency increases since $\dot{Q}_{in}$ decreases.
- Regenerator effectiveness: $\eta_{reg} \equiv \frac{h_x - h_4}{h_8 - h_4}$