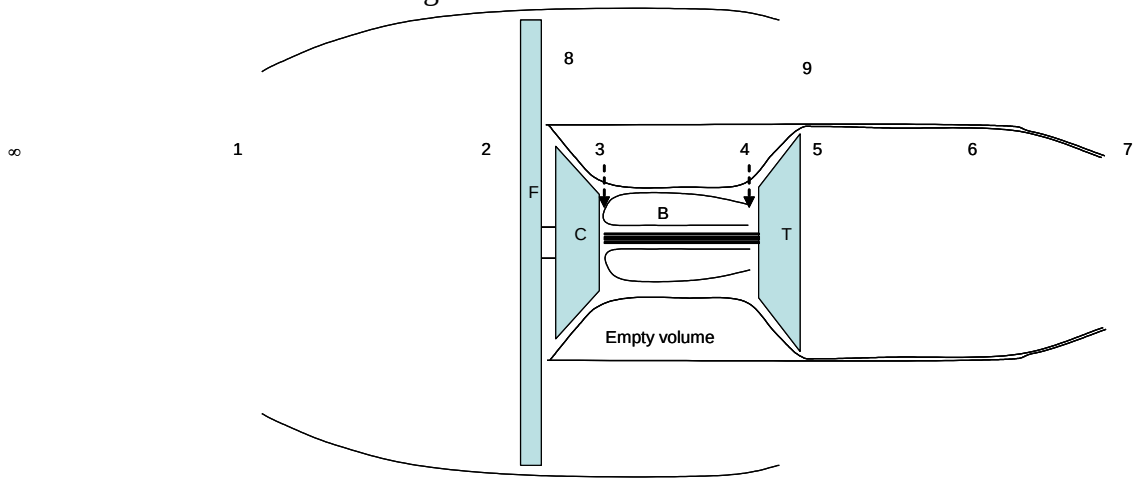
AS5020 Propulsion-- Exercise 2.
Date: Oct 09, 2018

1. A Ramjet engine is designed to work at Mach 2.5 at 12 km altitude (0.2 bar, 220K). The Maximum temperature allowable at combustor exhaust is 3000K. Find the specific thrust and TSFC for this condition. Assume that the inlet, nozzle, and burner operate ideally and there are no frictional/mixing/thermal losses. Assume Cp_{air} = 1010 J/kg/K, calorific value of fuel = 45 MJ/kg.

2. Consider the Turbo Fan engine below: The fan and the compressor are on a single shaft run by a single turbine. The incoming air either goes through the fan and goes to the cold flow nozzle or goes through the combustor and goes through the hot flow nozzle. There is no after burner in this engine.



a. Given below is the data for a turbofan engine. Assume that the nozzles are expanding the flow to ambient pressures. List the To and Po values for each location marked in the figure for compressor pressure ratio of 30 and T_{04} of 1700K for bypass ratios of 0 & 5.
b. Plot the Specific Thrust and TSFC as a function of compressor pressure ratio (values ={5,15, 25, 35}) for two T_{04} values of 1300 K and 1400K for bypass ratios of 0&15.

Data for the engine:
Tamb=220 K, Pamb = 0.22 atm, Flight speed relative to air = 250 m/s, assume that the specific heats are constant (1010 J/kg/K) throughout, Ratio of specific heats =1.4

Diffuser adiabatic efficiency =0.98
Stagnation pressure ratio across the fan = P_{rf} = 1.2, Fan adiabatic efficiency = 0.85, Fan nozzle efficiency = 0.98
Compressor adiabatic efficiency = 0.85, Burner efficiency = 1.00, Stagnation Pressure ratio across burner =1, Turbine adiabatic efficiency = 0.90
Hot flow nozzle efficiency = 0.99, Heat released per kg of **JP4** fuel = 45000 kJ/kg

3. Let us calculate the performance parameters for the Tumansky RD-9 engine in our dept.

a. List the Po & To for each stage of the engine. Also the exit pressure.

b. Calculate the Specific Thrust, TSFC and the propulsive, thermal and overall efficiencies for the engine, with and without afterburner, operating at maximum specific thrust configurations.

Data for Tumansky RD-9 engine: (Turbojet engine with after burner)

T_∞ =220K, P_∞ = 0.25atm, M_∞= 0.85, assume that c_p is constant throughout, and γ =1.4
Compressor pressure ratio = 7.2, T_{04} = 857^{o}C, T_{06} = 927^{o}C, m_dot_air=48 kg/s
η_{diff} =0.97, η_{comp} =0.835, η_b =0.95, η_{turb} =0.865, η_{ab} =0.5, η_n =0.99,
ΔP_{o_burner}=0. $\Delta P_{o\_afterburner}$=0. Heat released per kg of **JP4** fuel = 45 MJ/kg.