Jet Aircraft Propulsion

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Lect-1

JET AIRCRAFT PROPULSION

a NPTEL-II Video Course for Aerospace Engineering Students

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Brief outline of the syllabus

- Introduction to Aircraft Jet Propulsion (BR)
- Jet Engine Cycles : Thermodynamic Analysis of real cycles; (AMP)
- Compressors and Turbines; (AMP & BR)
- Combustion Systems (BR)
- Intakes and Propelling Nozzles (AMP)
- Aircraft Engine Installed Performance, Sizing & Matching (BR)
- Ramjets, Scramjets & Pulsejets (AMP & BR)

More details are available in the NPTEL Website

Course Pre-requisites

Introduction to Aerospace Propulsion,

or

A course in **Engineering Thermodynamics**

Additionally : A course in **Fluid Mechanics** would be helpful

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Text / References

1) Kroes Michael J; Wild Thomas W; *Aircraft Powerplants;* 2010 (7 Ed), Tata-Mcgraw-Hill
2) Hill Philip, Peterson Carl, *Mechanics and Thermodynamics of Propulsion*, 1992, Addison Wesly,.
3) Mattingly J D , *Elements of Propulsion – Gas Turbines and Rockets,* 2006, AIAA Education series
4) El-Sayed Ahmed, *Aircraft Propulsion and gas Turbine Engines* , 2008, Taylor and Francis ,CRC press
5) Saravanamuttoo, H.I.H., Rogers G.F.C., Cohen H.; *Gas Turbine Theory,* 2001, Pearson
6) Roy Bhaskar, *Aircraft Propulsion,* 2008, Elsevier (India),

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The Lecture schedules

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Lect No.	Topic
Lect-1	Intro & Development of Jet Aircraft Propulsion (BR & AMP)
Lect-2	How the Aircraft Jet Engines make Thrust (BR)
Lect-3	Jet Engine Basic Performance Parameters (BR)
Lect-4	Turbojet, Reheat Turbojet and Multi-spool Engines (BR)
Lect-5	Turbofan, Turbo-prop and Turboshaft engines (BR)
Lect-6	Ideal and Real Jules - Brayton cycles (AMP)
Lect-7	Jet engine Cycles for Aircraft propulsion (AMP)
Lect-8	Cycle components and component performances (AMP)
Lect-9	Tute-1 (AMP)
Lect-10	Analysis of aircraft jet engine real cycles (AMP)
Lect-11	Tute-2 (AMP)
Lect-12	Thermodynamics of Compressors (BR)
Lect-13	Thermodynamics of Turbines (BR)

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Lect-14	Axial Compressors : Two dimensional analytical model (AMP)
Lect-15	Cascade analysis; Loss and Blade performance estimation (AMP)
Lect-16	Free Vortex theory; Single and Multi-stage characteristics; (AMP)
Lect-17	Tutes – 3 (AMP)
Lect-18	Elements of centrifugal compressor (AMP)
Lect-19	Centrifugal Compressor Characteristics : Surging, Choking (AMP)
Lect-20	Axial flow turbines; Turbine Blade 2-D (cascade) analysis (BR)
Lect-21	Multi-staging of Axial Turbine; Turbine Cooling Technology (BR)
Lect-22	Radial Turbine Aerodynamics & Thermodynamics; Losses and efficiency (BR)
Lect-23	Tutes – 4 (BR)

Lect-24	Types of combustion chambers: mechanism & parameters (BR)
Lect-25	Pr. Loss, Combustion efficiency; Combustion intensity (BR)
Lect-26	Practical combustion system ; Stability, Fuel injection (BR)
Lect-27	Intakes for Powerplant: Transport/ Military Aircraft (AMP)
Lect-28	Subsonic, Transonic, Supersonic Intake Designs (AMP)
Lect-29	Nozzle : fixed and variable geometry nozzles (AMP)
Lect-30	C-D nozzle and their uses (AMP)
Lect-31	Tute-5 (AMP)

Lect-32	Engine Off Design Operations (BR)
Lect-33	Aircraft Engine component matching: Dimensional analysis (BR)
Lect-34	Engine component matching and Sizing (BR)
Lect-35	Installed Performance of Engine (BR)
Lect-36	Tute-6 (BR)

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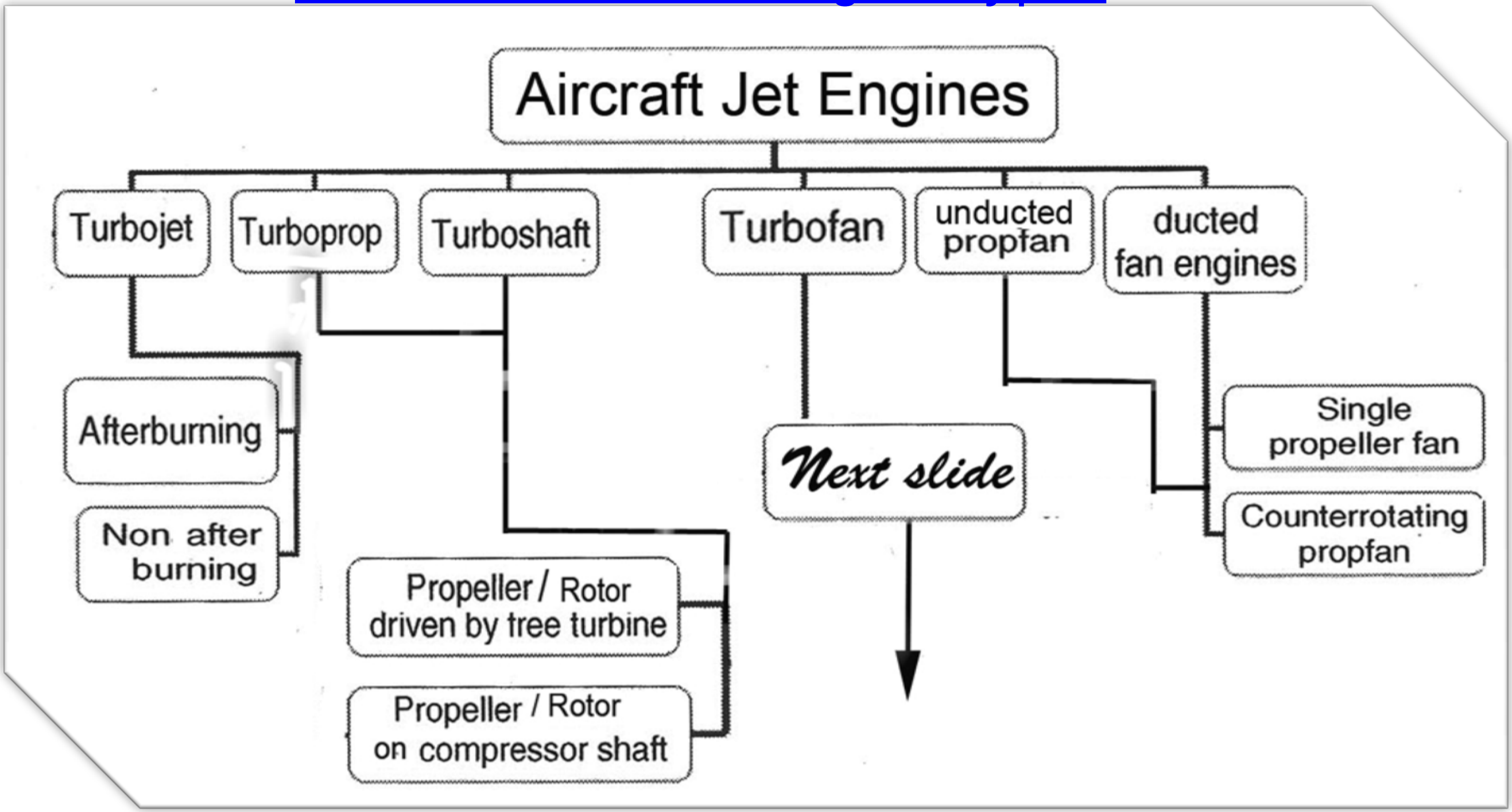
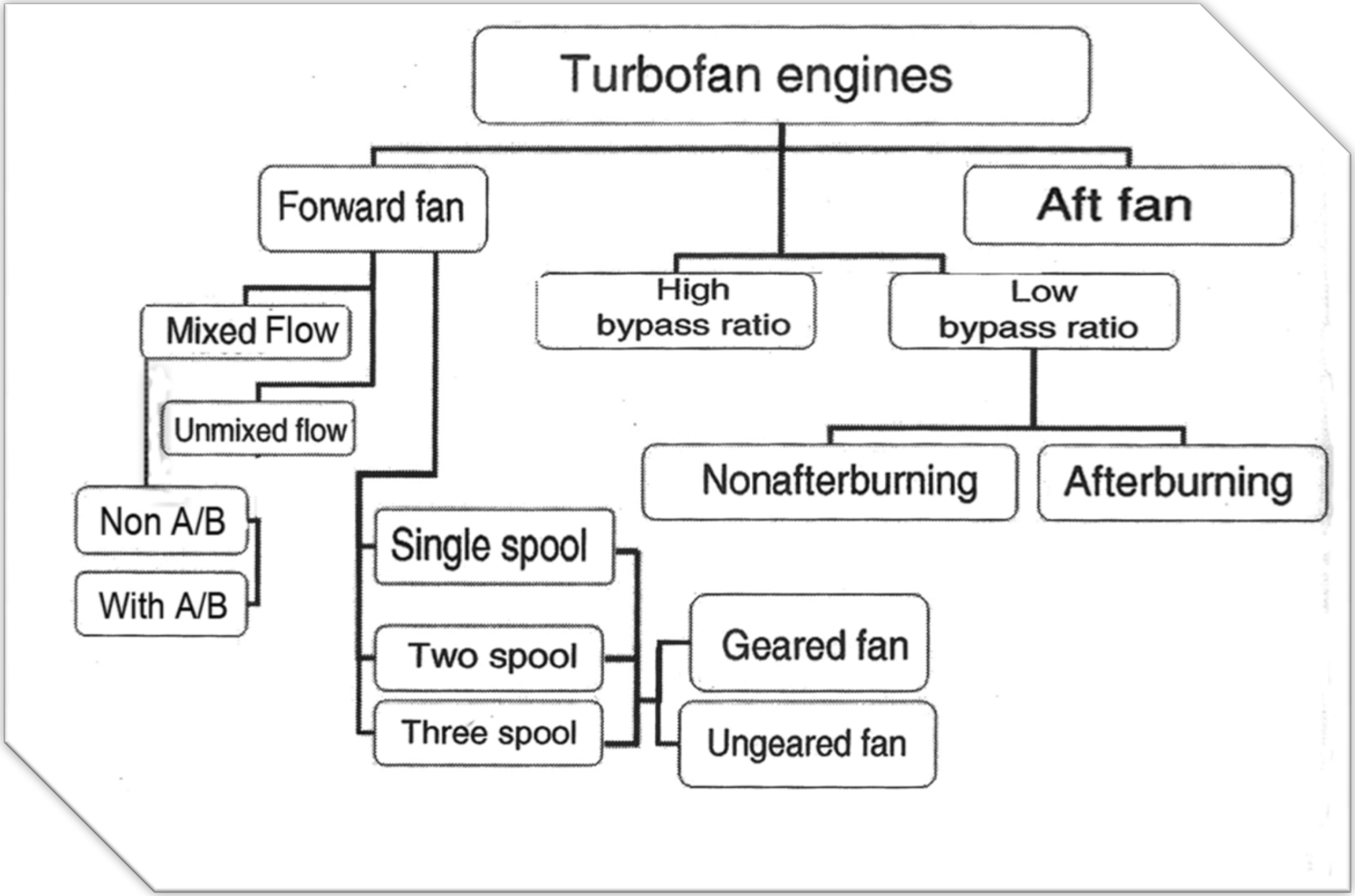
Lect-37	Use of Ramjets and Pulsejets in Aircraft propulsion (BR)
Lect-38	Thermodynamic Cycle & Performance Parameters of Ramjet Engines (AMP)
Lect-39	Flow in Diffusers, Combustors and Nozzles (AMP)
Lect-40	Design/Performance of Ramjet-Scramjet Engines (BR)
Lect-41	Tute – 7 (BR)
Lect-42	Future of Aircraft Propulsion (BR & AMP)

Basic Aircraft Jet Engine types



Aircraft Turbofan Engines



Development of Aircraft Jet Engines

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- Sir Isaac Newton in the 18th century was the first to theorize that a rearward-directed acceleration could propel a machine forward at a great speed. This theory was based on his own third law of motion.
- As the hot air blasts backwards through the jet nozzle the aeroplane moves forward.

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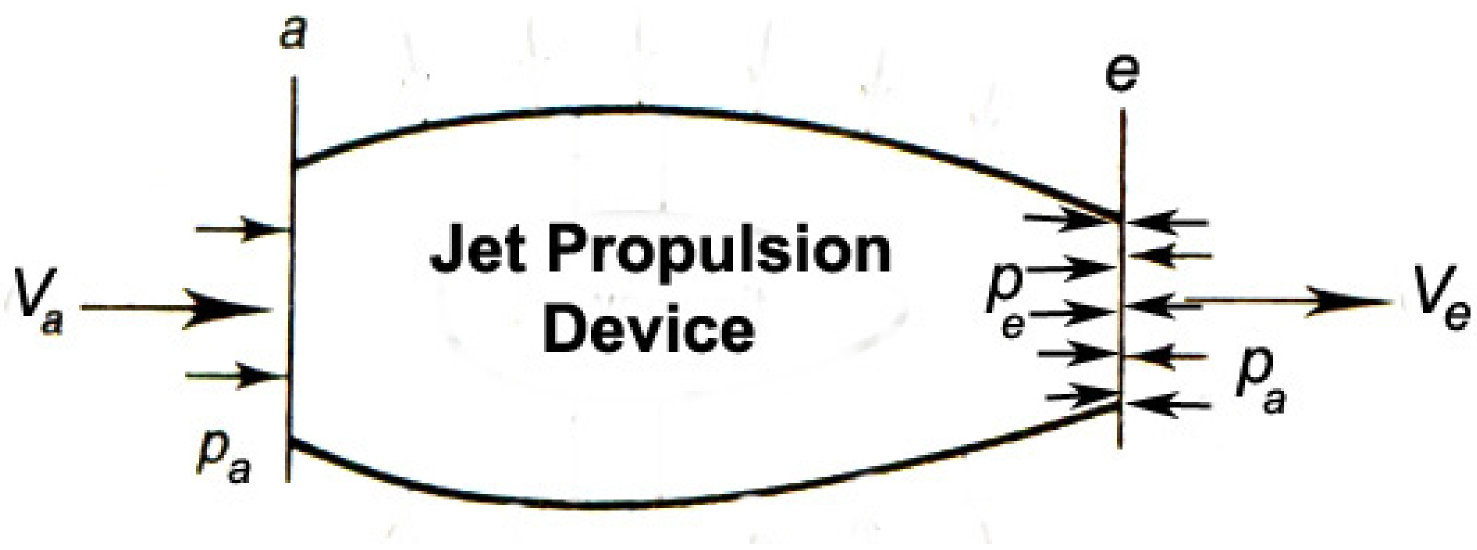
- In 1920’s a high powered committee in USA, working under NACA, produced a report that stated that a jet engine was not a feasible proposition. So very little work was done in USA on jet engine development till world war II.
- Frank Whittle patented his jet engine in England 1930. He later developed it in USA.
- Dr Hans Von Ohain patented his jet engine in Germany in 1936. It flew in 1939. He also late worked in USA

How Jet Propulsion works



- The key to a practical jet engine was the gas turbine, used to extract energy from the engine itself to drive the compressor.
- The gas turbine was not an idea developed in the 1930s: the patent for a stationary turbine was granted to John Barber in England in 1791.
- The first gas turbine to successfully run was built in 1903 by Norwegian engineer Ægidius Elling. Limitations in design and practical engineering and metallurgy prevented such engines reaching manufacture.

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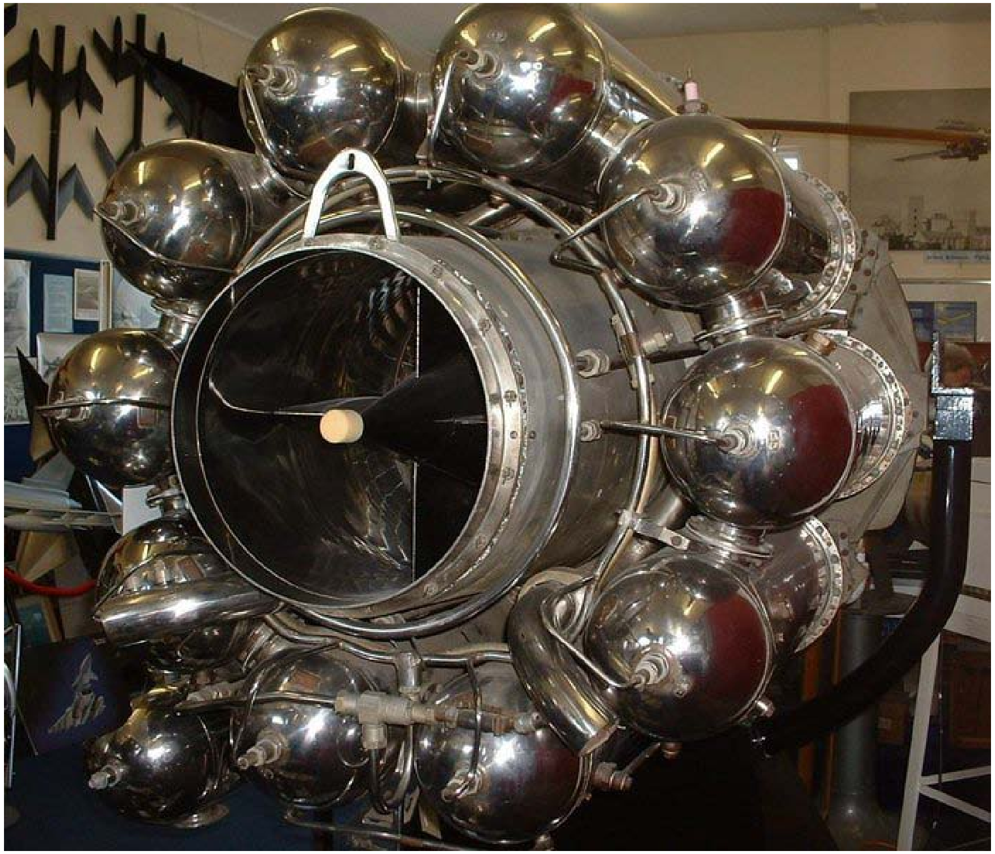
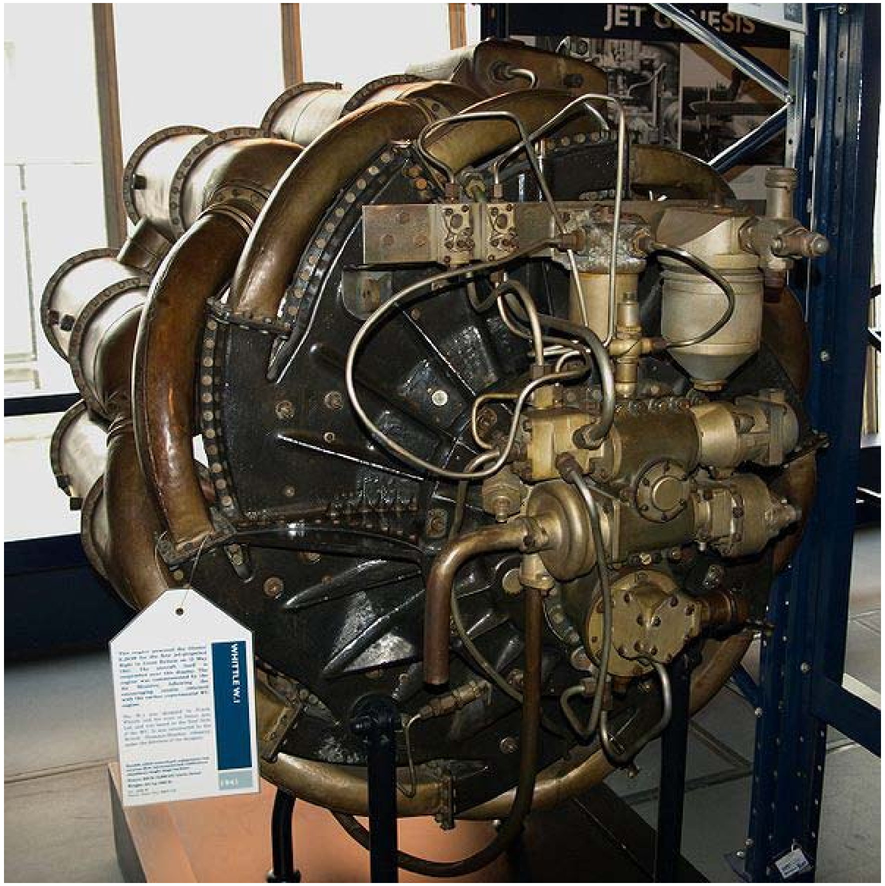
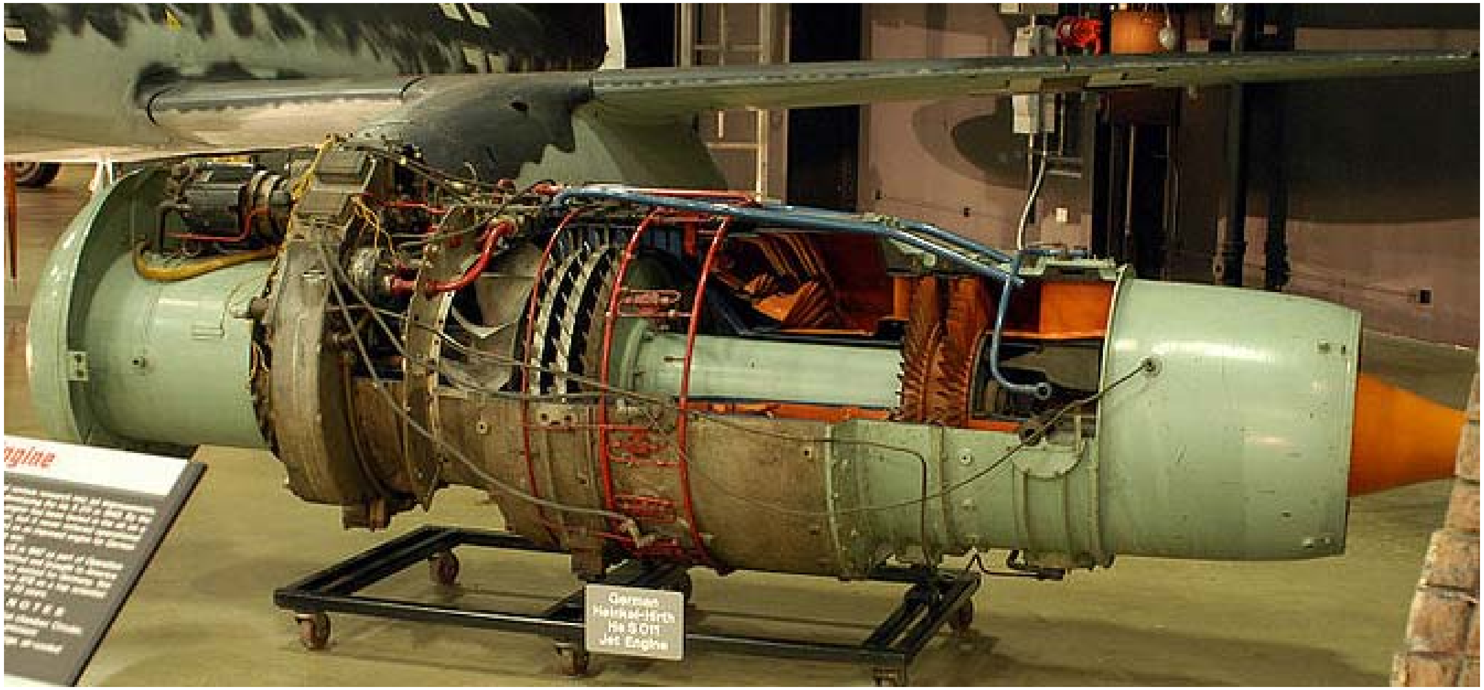
Whittle's jet engine that flew





Heinkel Engine by Von Ohain that flew



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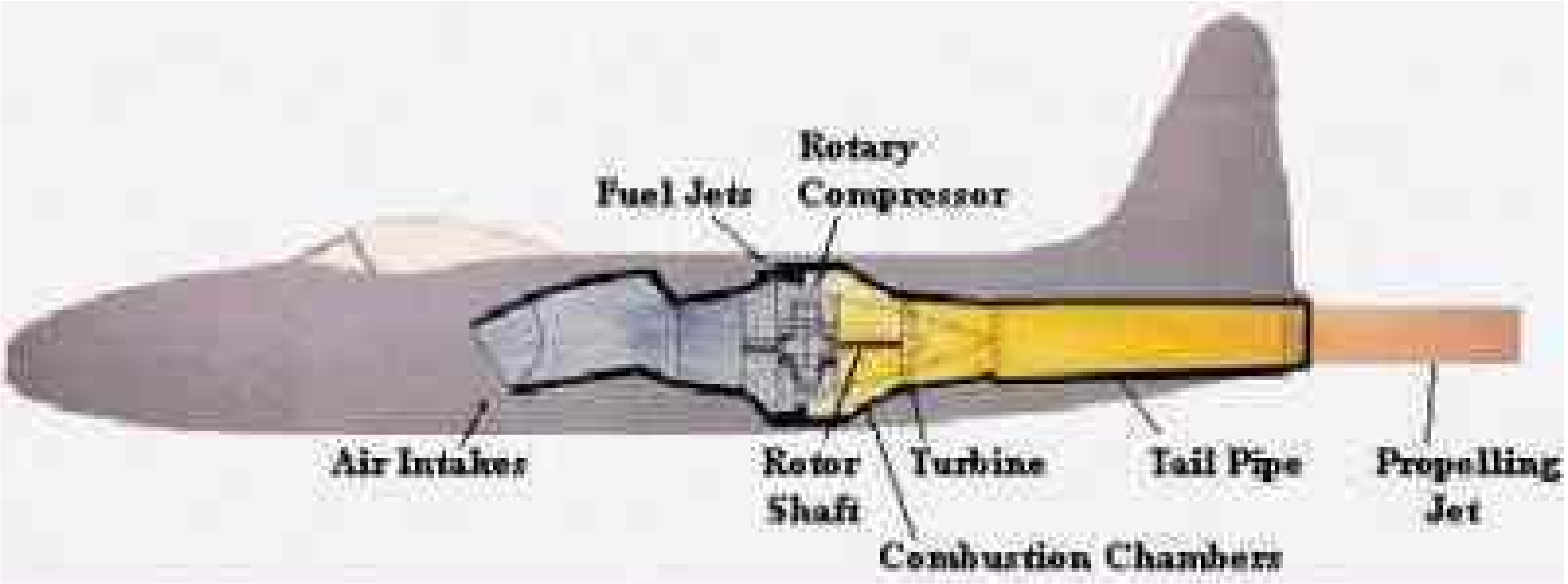
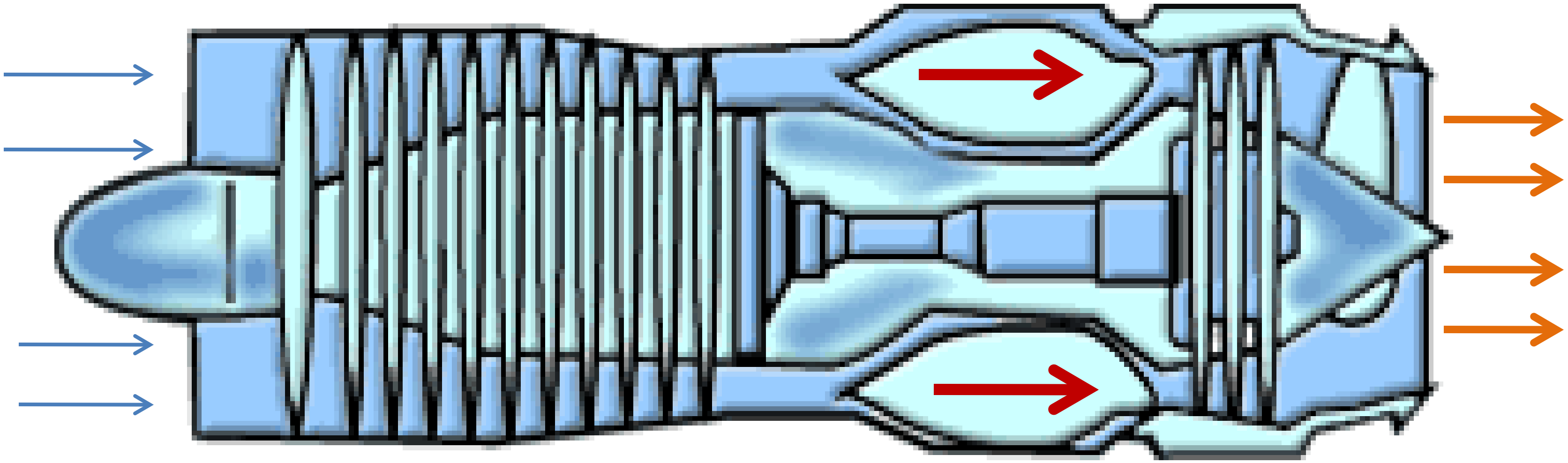

Rotary Compressor
Fuel Jets
Air Intakes
Rotor Shaft
Turbine
Tail Pipe
Propelling Jet
Combustion Chambers

A typical Gas Turbine based jet engine



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A modern aircraft jet engine