Aircraft engines - introduction

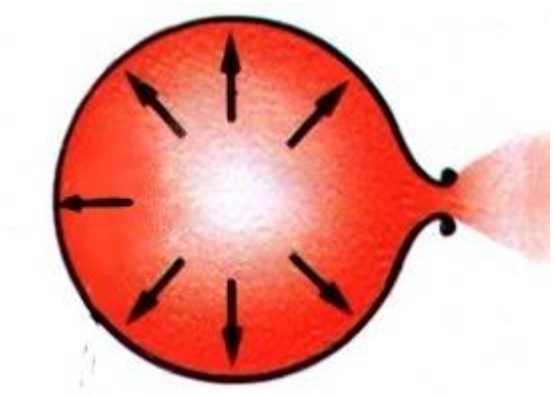
http://jakubowskirobert.sd.prz.edu.pl

Robert JAKUBOWSKI

Literature

- Pasquale M. Sforza: Theory of Aerospace Propulsion
- Ahmed F. El-Sayed: **Aircraft Propulsion and Gas Turbine Engines**

Thrust



Pressure difference cause, gas outflow the balloon. The action of gas flow cause reaction of balloon. Process could be described by **II** & **III Newton Laws**

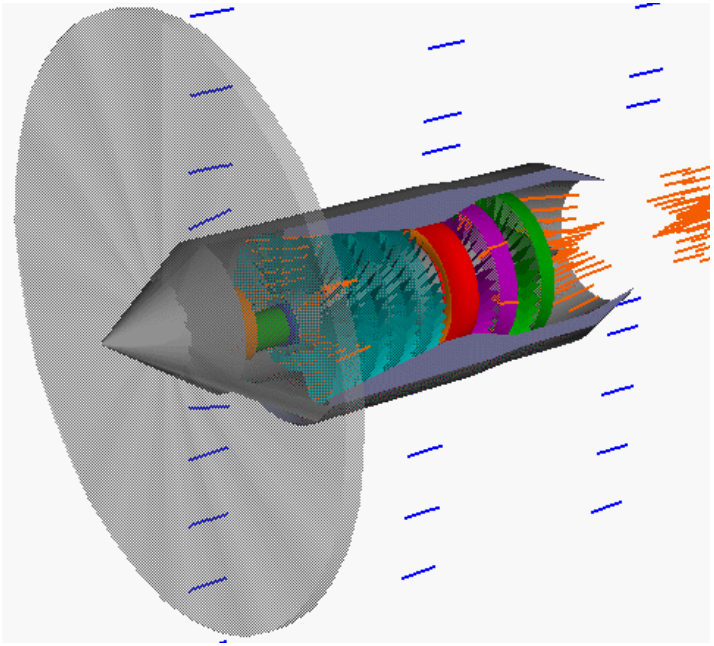
$$T = F = \dot{m} \cdot c$$

$\dot{m}$ – mas flow of gas

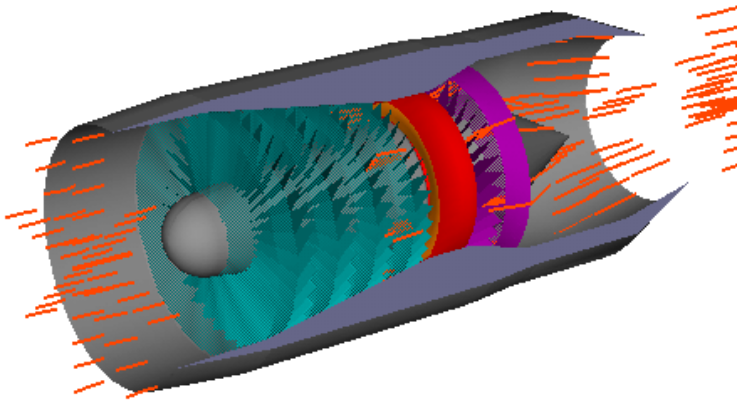
c – gas speed

Thrust

How we can produce the thrust?

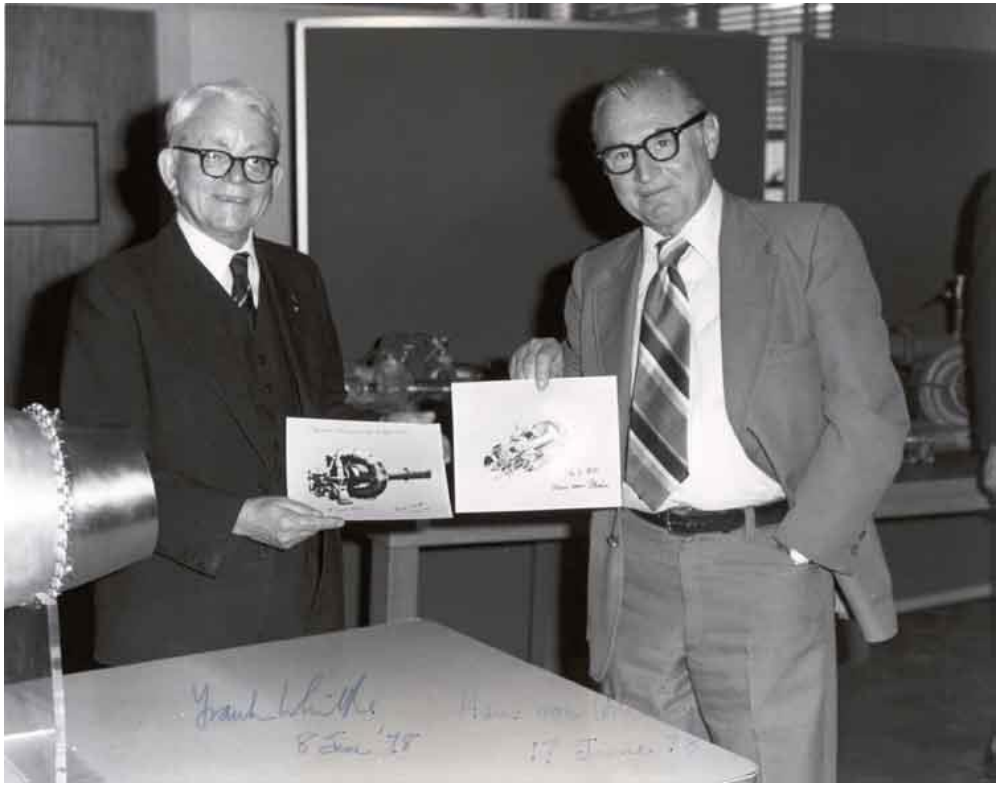


Low gas speed after the propeller
Large mass of gas



High speed of outlet gas
Small mass of gas

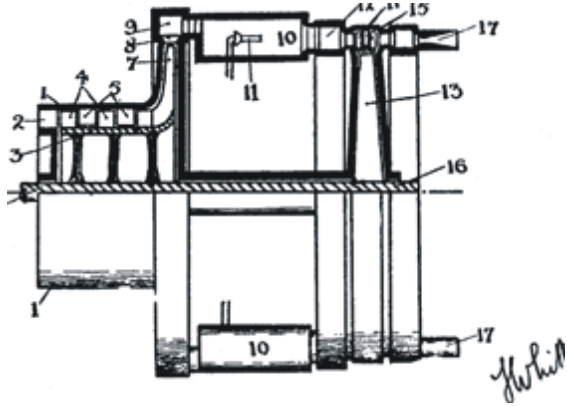
Begining of turbojet propulsion

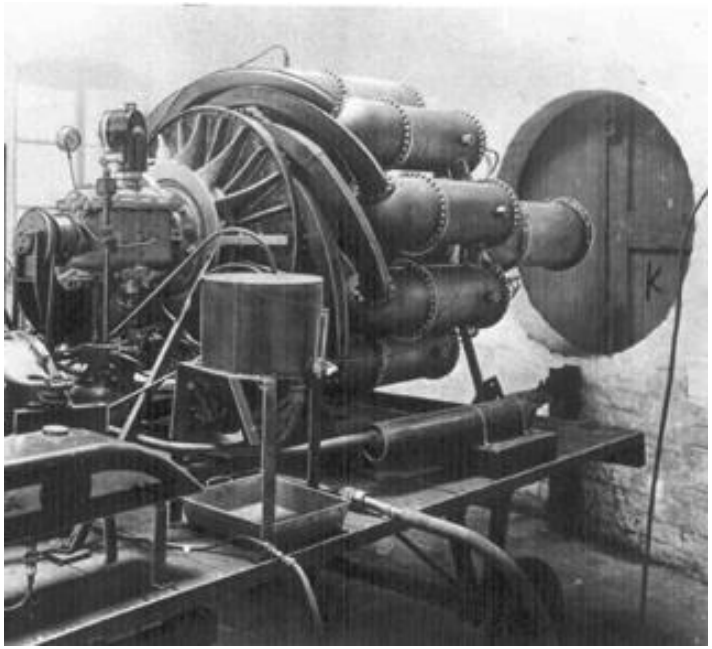


Sir Frank WHITTLE
1907 - 1996

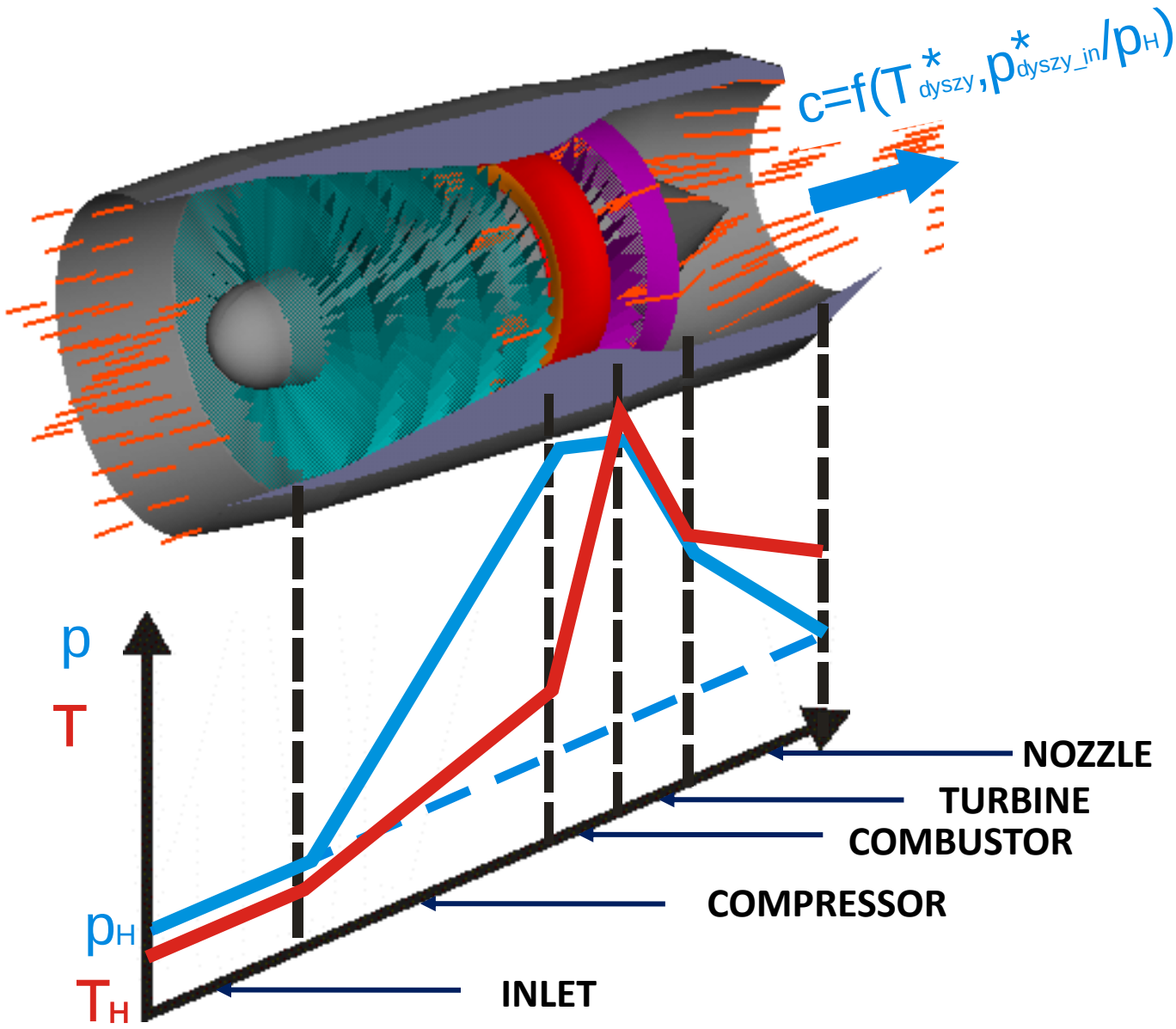
Dr Hans Joachim
PABST von OHAIN
1911 - 1998

1. Axial compressor casing
2. Intake
3. Compressor body
4. Compressor blades
5. Stator blades
7. Centrifugal compressor
8. Compressor outlet
9. Elbow
10. Combustion chambers
11. Fuel injector
13. Turbine disk
14. Turbine blades
15. Stator blades
16. Shaft
17. Divergent nozzle ring.

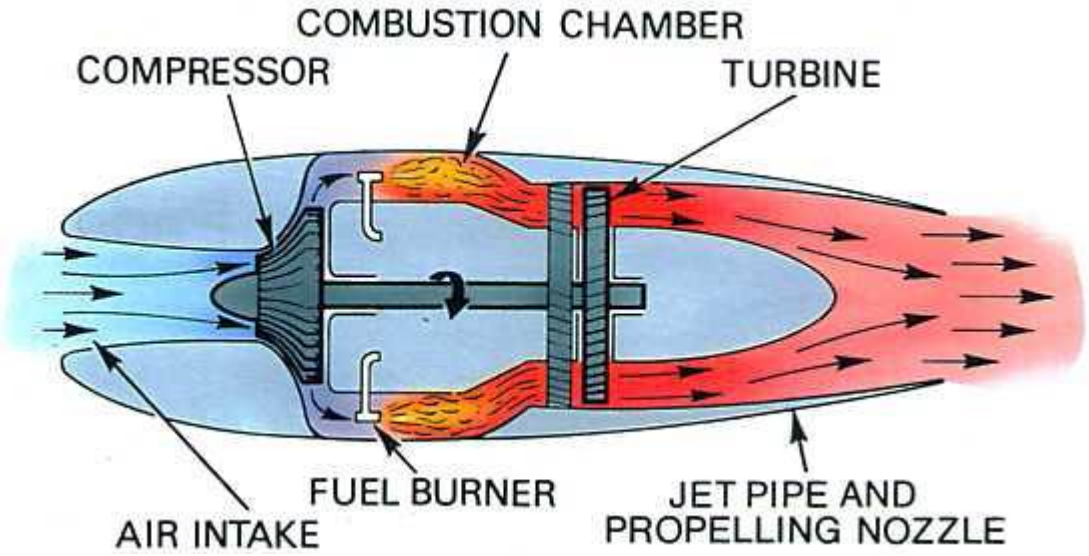


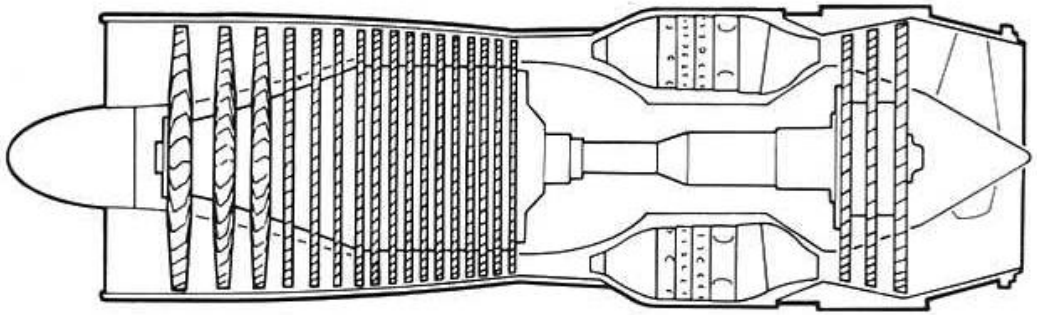


TURBOJET ENGINE



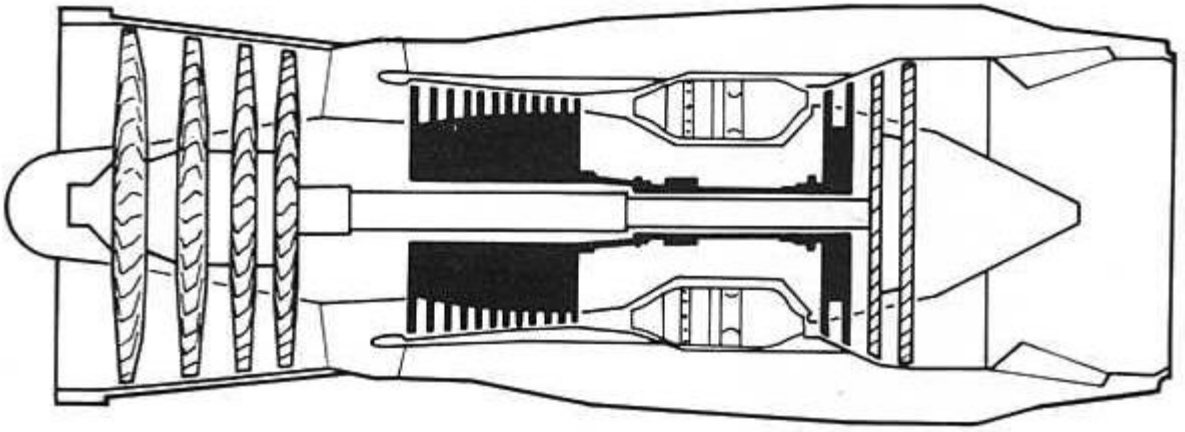
SINGLE SPOOL TURBOJET ENGINE



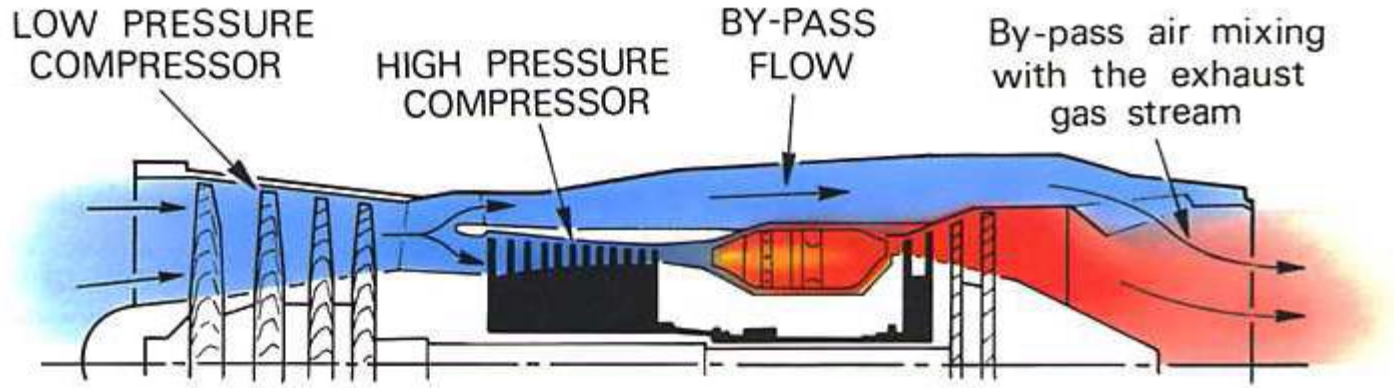


SINGLE-SPOOL AXIAL FLOW TURBO-JET

TWIN SPOOL BYPASS ENGINE

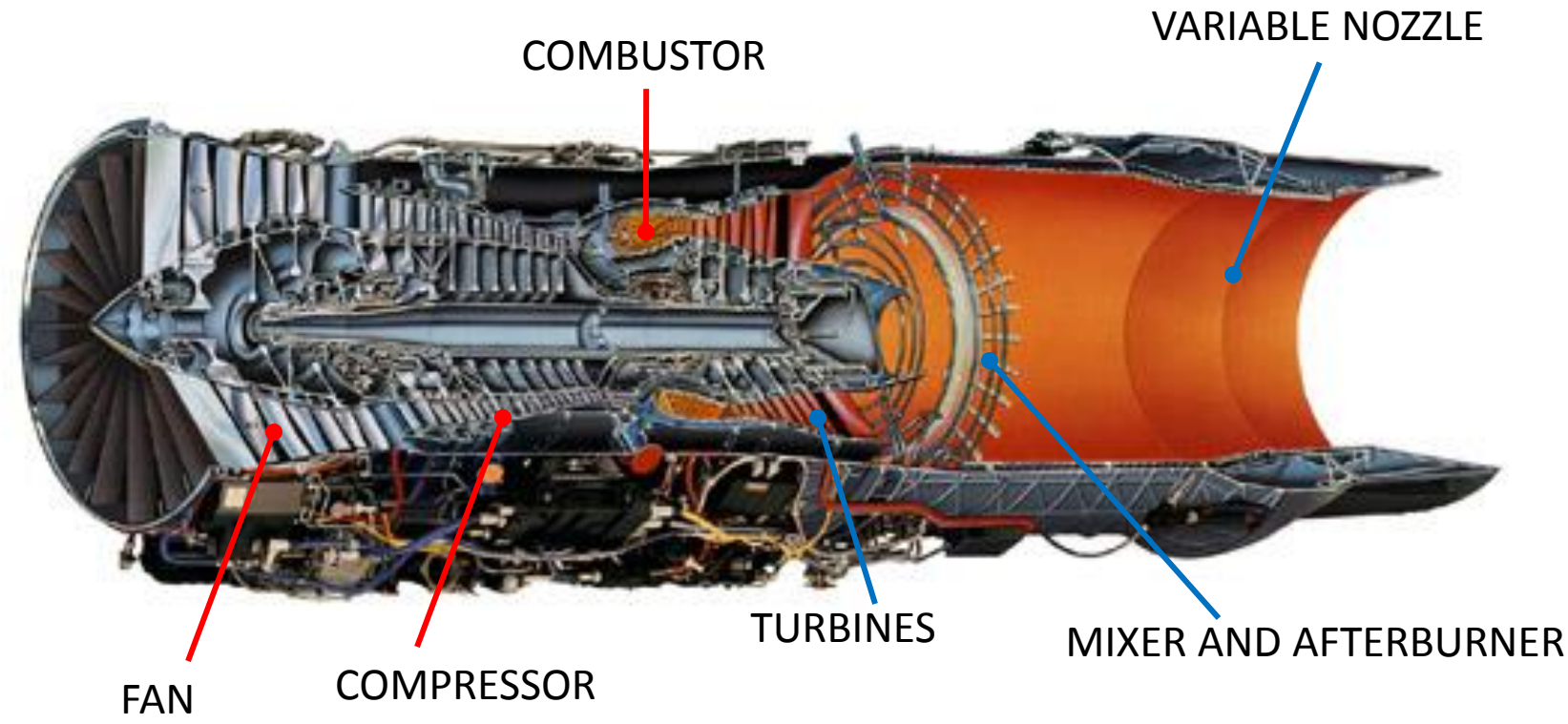


TWIN-SPOOL BY-PASS TURBO-JET



TWIN-SPOOL AXIAL FLOW BY-PASS TURBO JET ENGINE(low by-pass ratio)

BY-PASS ENGINE WITH MIXER



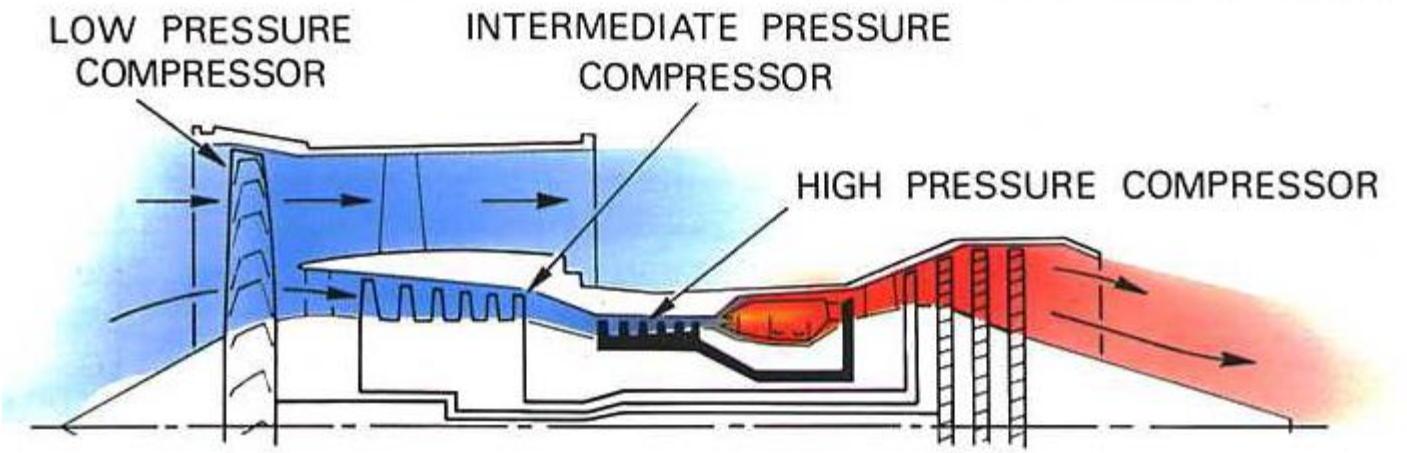
F100 PW 229

Military airplane propulsion aplication
F-16

F-100-PW229

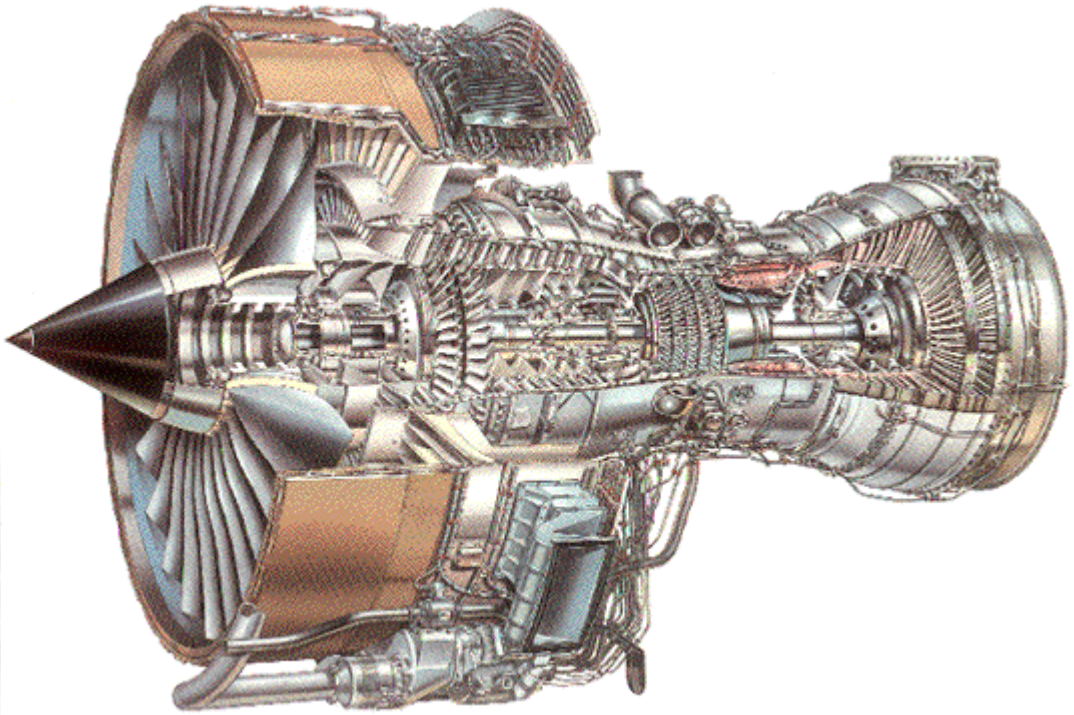
Thrust=130/80 kN, airplane mass 17000 kg
SFC=2.05/0.74 kg/daNh,
Engine mass =1400 kg,
π=23,
T_3=1775 [K]

TURBOFAN ENGINE



TRIPLE-SPOOL AXIAL FLOW FRONT FAN TURBO JET ENGINE (high by-pass ratio)

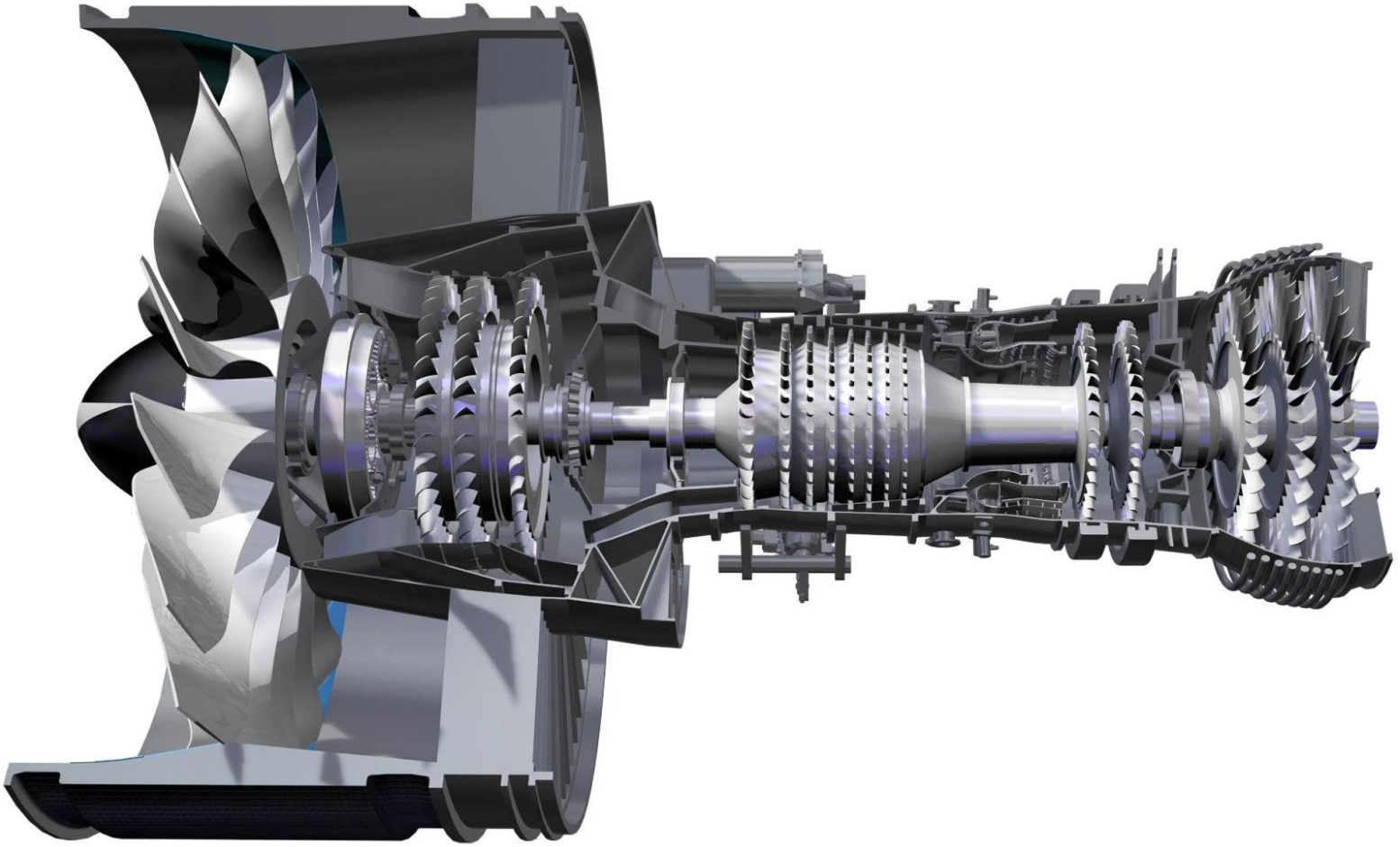
Engine aplication



B-747-300 (340 Ton)
K=240 kN,
π=30
μ=4.3

RB-211-534E

GTF (Geared turbofan)



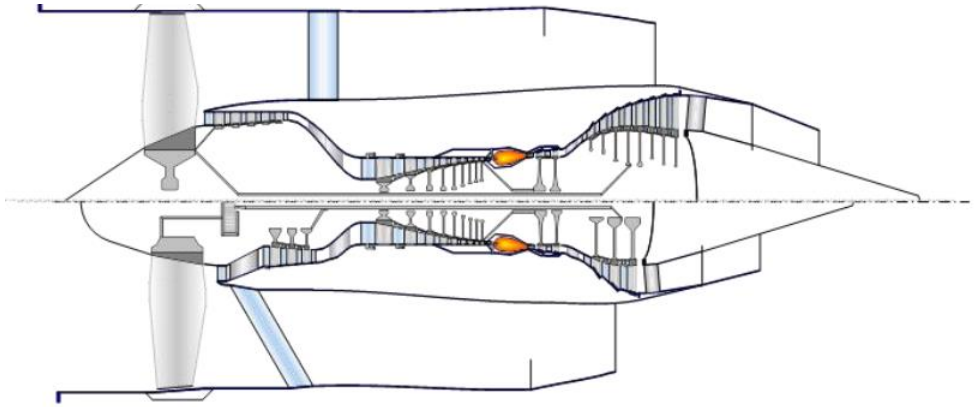
GTF vs TF

Parameter	IAE V2527-A5	CFM56-5B4	PW1127G
Aircraft	Airbus A320-232	Airbus A320-214	Airbus A320NEO
Thrust	26,600 lbs (118.3kN)	27,000 lbs (120.1kN)	27,000lbs (120.1kN)
Bypass Ratio	4.8 : 1	5.7 : 1	12 : 1
Architecture (Stage Count)	1-4-10-2-5	1-4-9-1-4	1-G-3-8-2-3
Fan Diameter	63.5 inches (1613 mm)	68.3 inches (1735 mm)	81 inches (2057 mm)
Overall Length	3201 mm	2600 mm	3800mm (estimated)*
High Pressure Spool RPM (N2)	14,950	15,183	18,000 – 20,000 (estimated)*
Low Pressure Spool RPM (N1)	5,650	5200	10,500 (estimated)*
Fan RPM	5,650	5200	3,500 (estimated)*
Overall Pressure Ratio	27.2	32.6	Unknown**
Engine Weight	2400 kg	2500 kg	Unknown**

Estimated by The Flying Engineer, for informative purposes only. Do not rely or quote estimated data. *,This field shall be updated when official data is available.*

TF

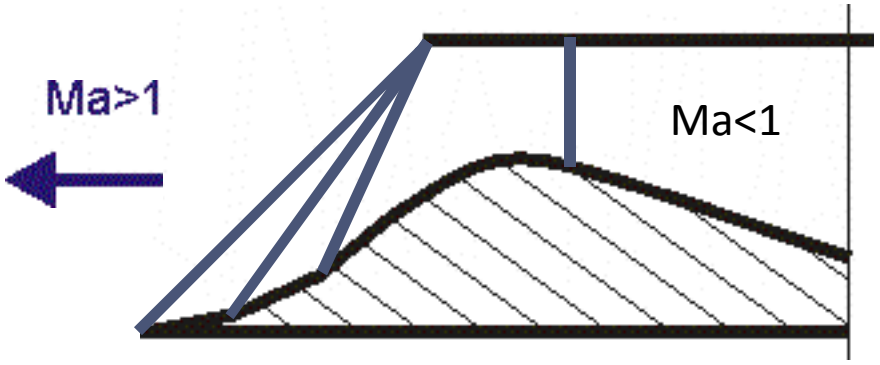
GTF



https://theflyingengineer.com/flightdeck/pw1100g-gtf/

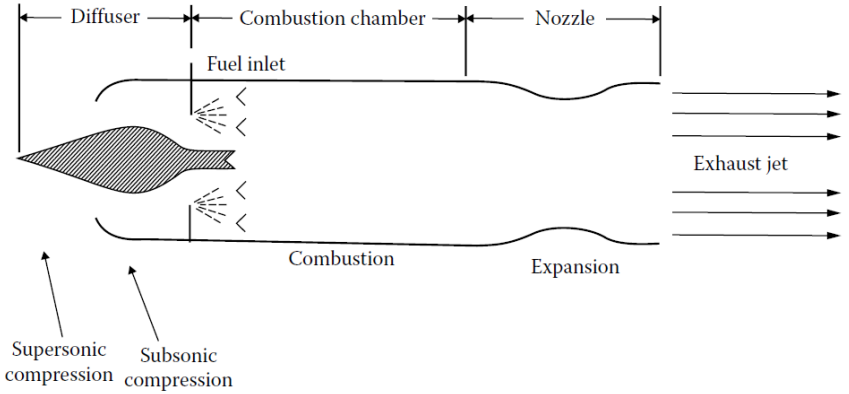
Engine for supersonic flight Ramjet

Inlet of supersonic engine



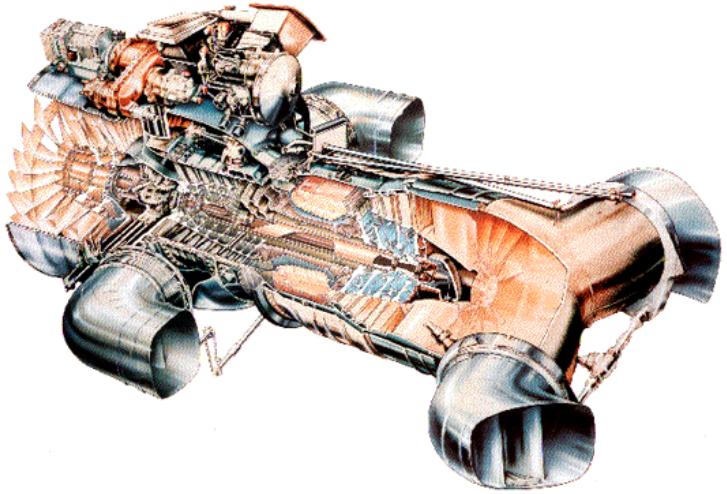
Flight speed Ma	Ram compression (ideal)
1	1,89
1,5	3,67
2	7,82
2,5	17,09
3	36,73

X-43A – M=6.83 (27.03.2004)



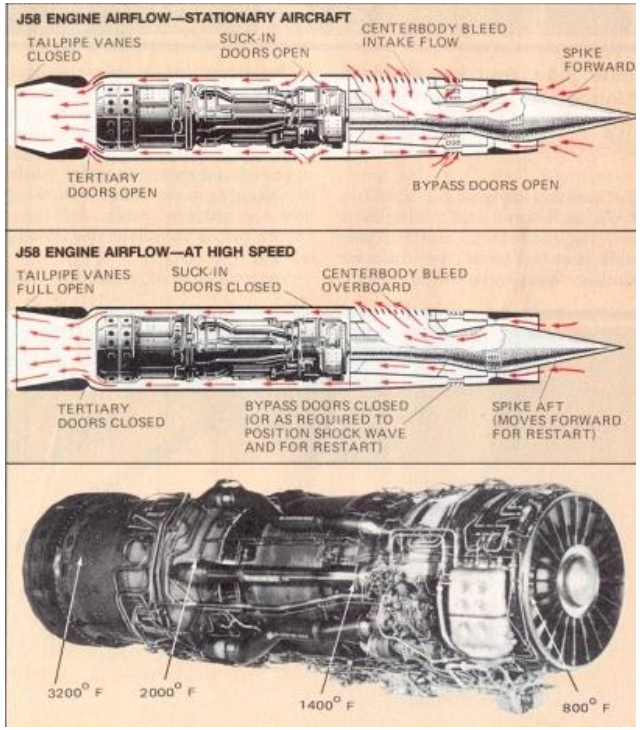
ENGINES FOR AIRCRAFT OF VERTICAL TAKE OFF AND LENDING

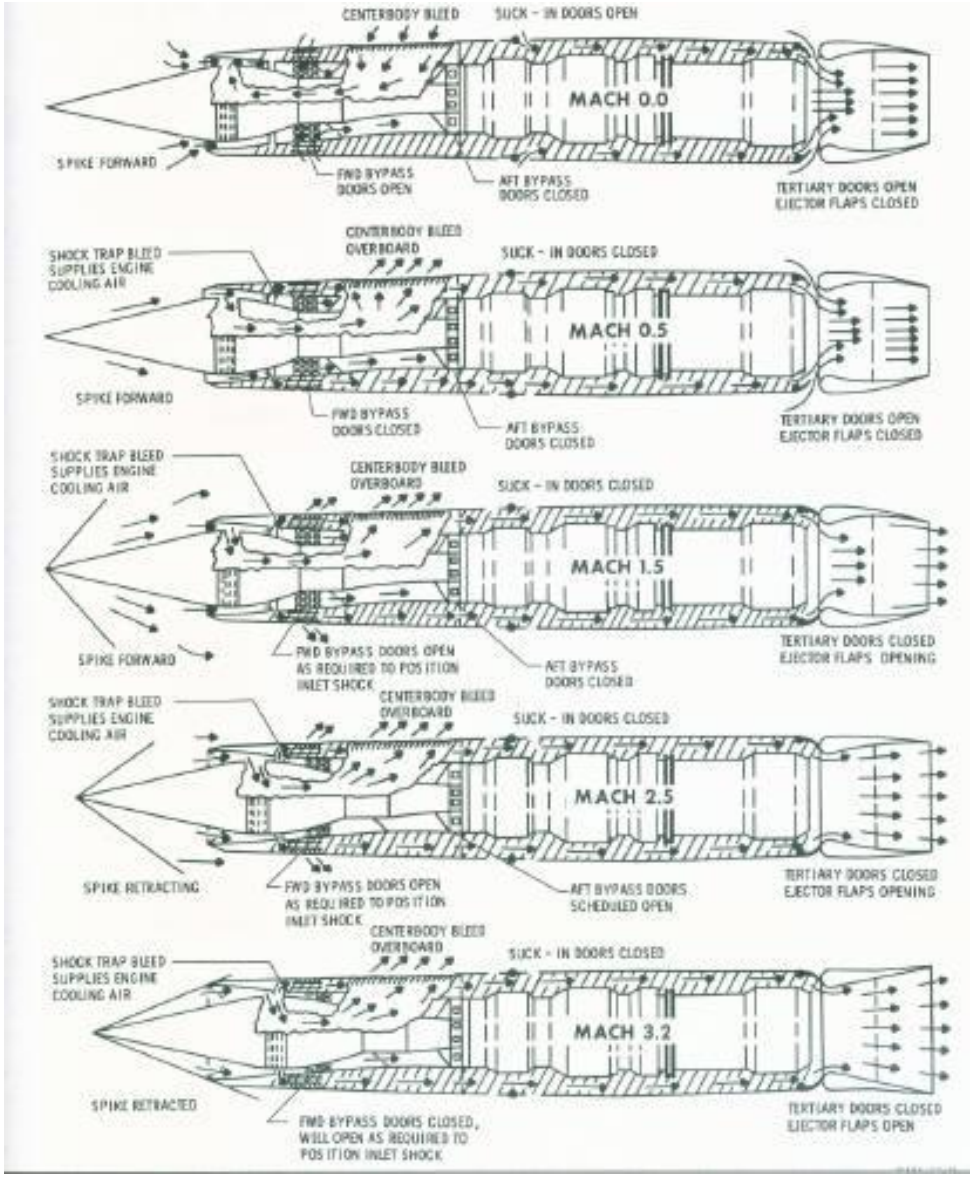
Joint Strike Fighter (JSF)



Harier

VARIABLE CYCLE ENGINE (VCE)





AIRCTAFT WITH TURBOPROP ENGINES

Propfan engines

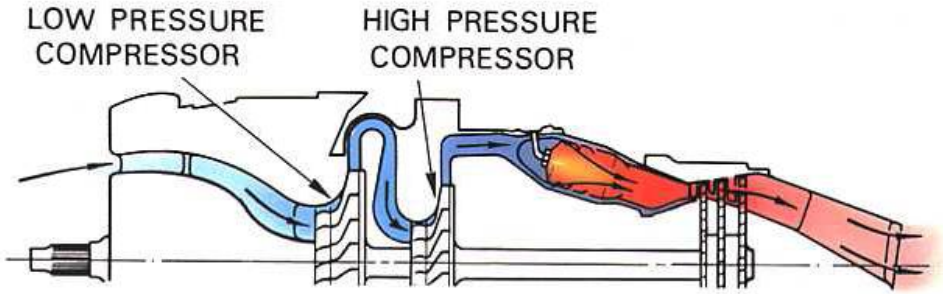
30% decreasing of SFC

Helicopters

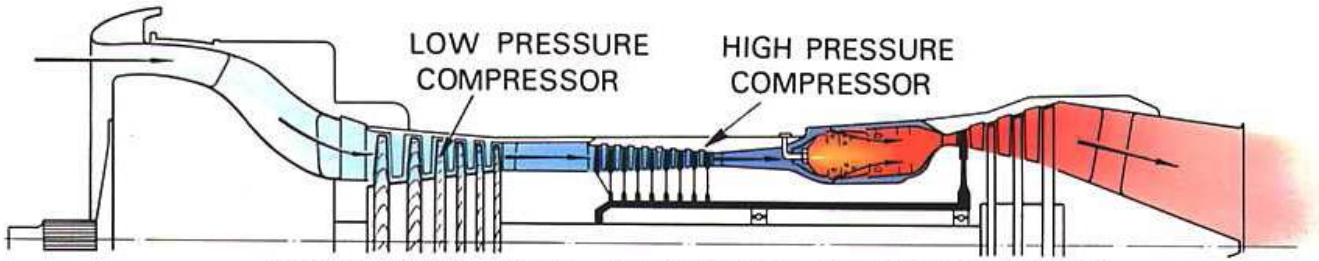
Two engines PZL – 10W , take off power 900 kW,

Helicopter **PZL W-3A Sokół** – max speed 260 km/h, flight altitude 6000 m

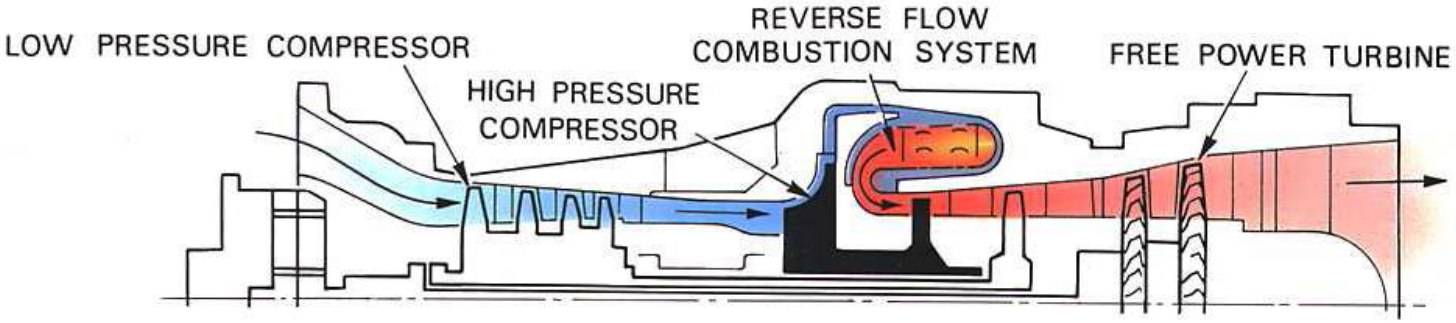
Examles of turboprop and turboshaft engines



TWO-STAGE CENTRIFUGAL FLOW TURBO-PROPELLER ENGINE

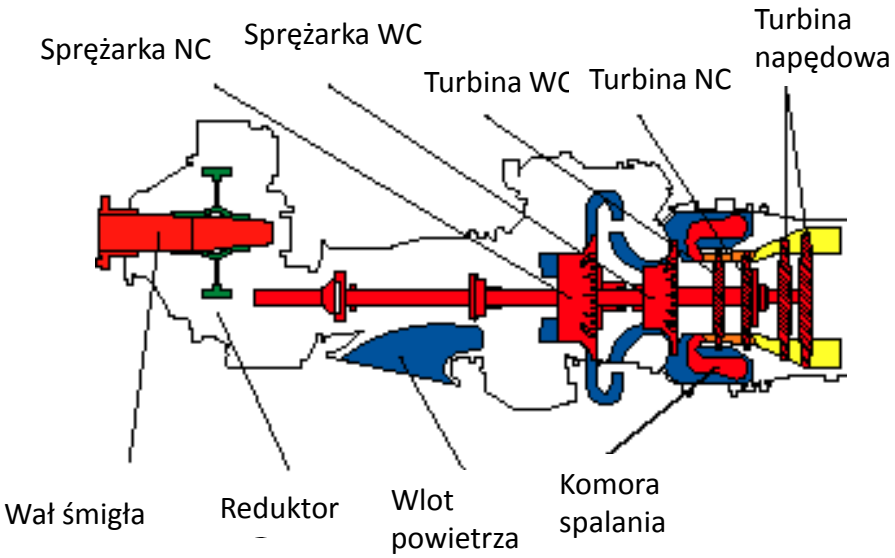


TWIN-SPOOL AXIAL FLOW TURBO-PROPELLER ENGINE

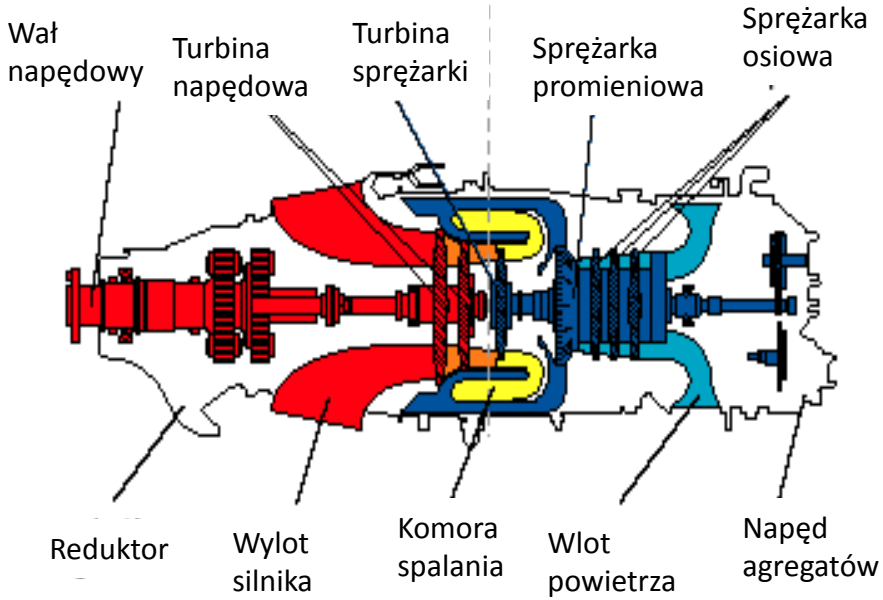


TWIN-SPOOL TURBO-SHAFT ENGINE (with free power turbine)

Examles of turboprop and turboshaft engines

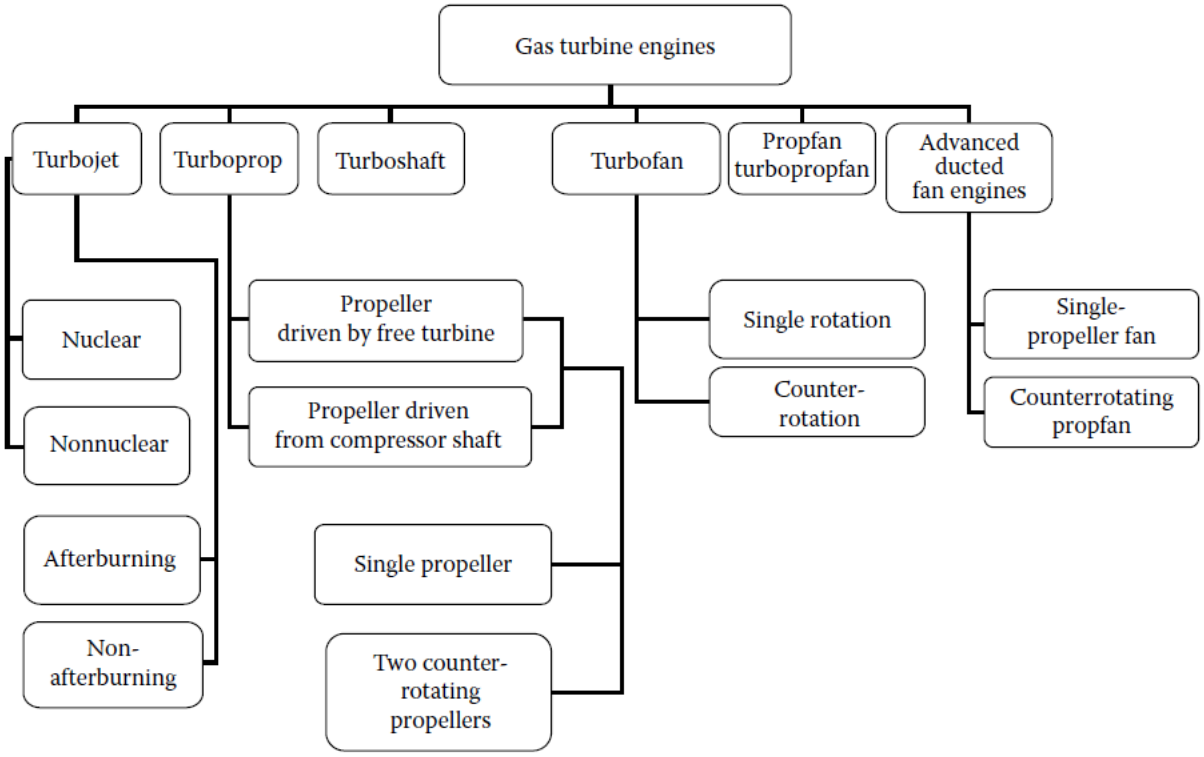


Turbinowy silnik śmigłowy PW 100



Turbinowy silnik śmigłowcowy PT 6A

Gas turbine clasification



Literature

“The Aircraft Gas Turbine Engine and its Operation”, United Technologies - Pratt & Whitney.

“The Jet Engine”, Rolls Royce Publications

Ahmed F. El-Sayed: **Aircraft Propulsion and Gas Turbine Engines,**