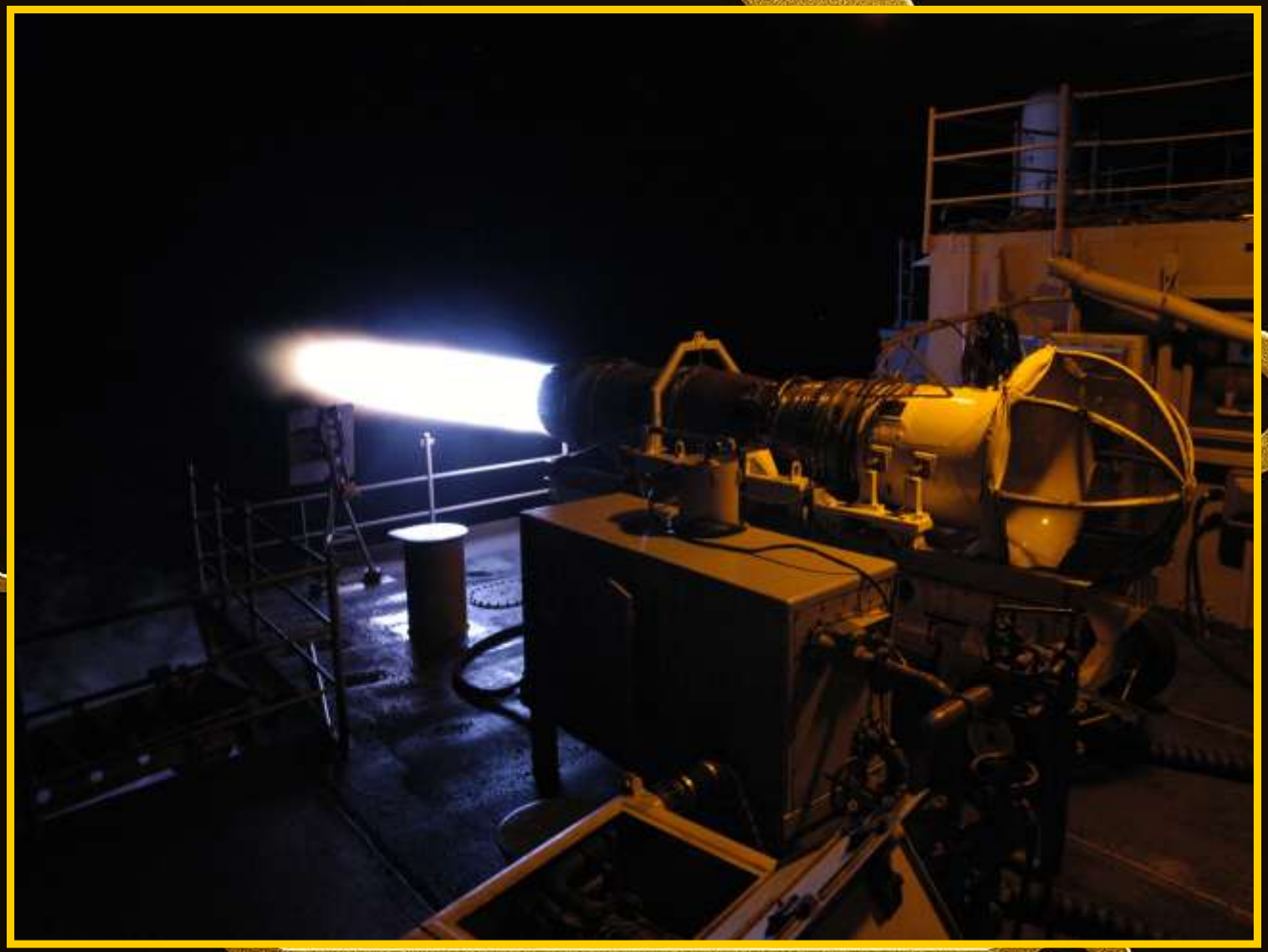
NAVAL GAS TURBINE ENGINES



Enabling Objectives

Name the major components of a gas turbine engine and explain their function in accordance with NAVEDTRA 14008.

Understand the effects of bleed air on gas turbine engine power and efficiency in accordance with NAVEDTRA 14008.

Describe the 2 shaft classifications of Marine Gas Turbine Engines in accordance with NAVEDTRA 14114.

State the four types of Aviation Gas Turbine Engines and their applications in accordance with NAVEDTRA 14008.

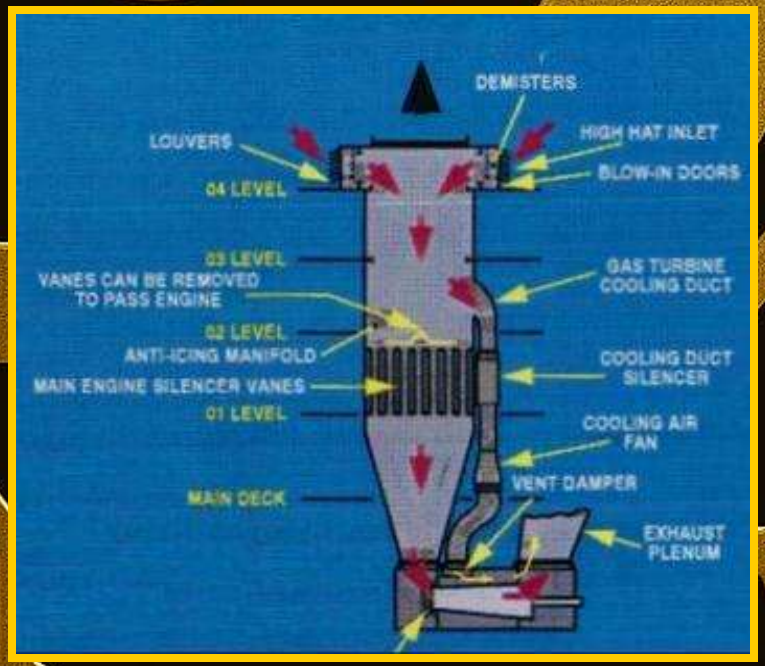
State the Advantage and Disadvantage of using a Gas Turbine over a Diesel or Steam Engine in accordance with NAVEDTRA 14114.

Gas Turbine Operation

Suck Squeeze Bang Blow

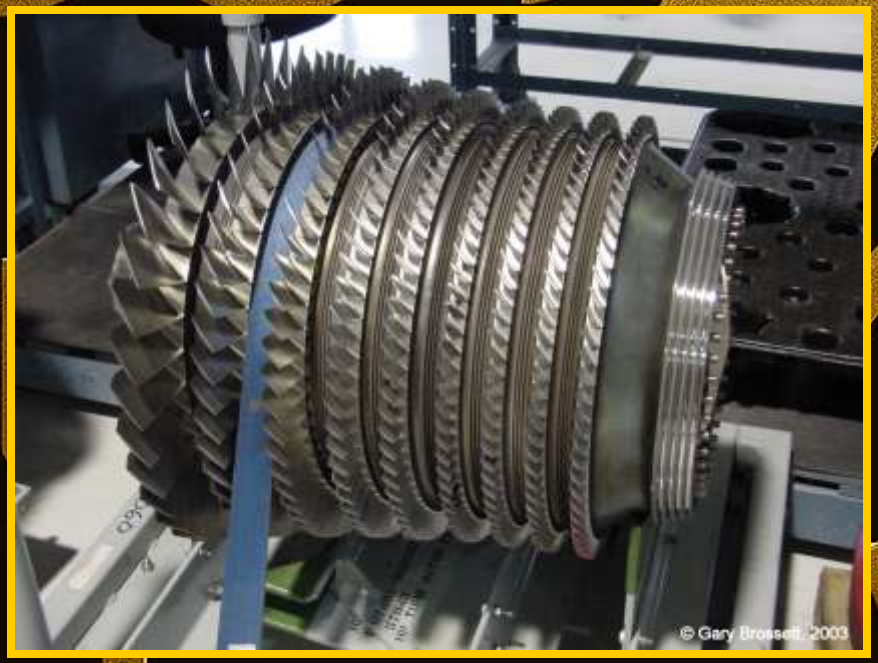
Intake

- Directs incoming air to the compressor with minimal loss of energy.
- Slows airflow to subsonic speeds during supersonic flight by use of ramps or creating a shock wave.



Compressor

- Supplies air in enough quantity to satisfy the requirements of the combustion section.
- A secondary function is to supply compressor bleed air for various purposes in the engine, aircraft and ship.

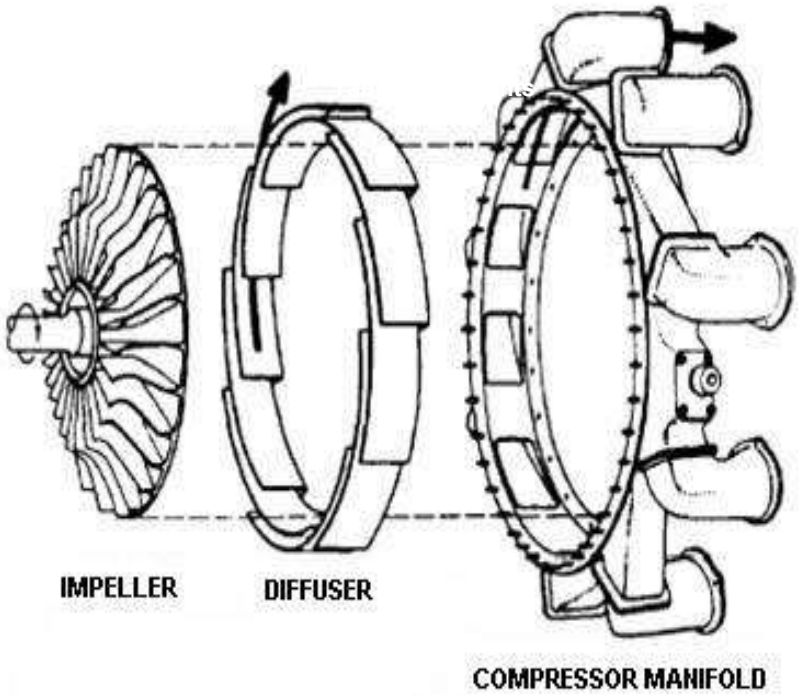


Compressor Bleed Air

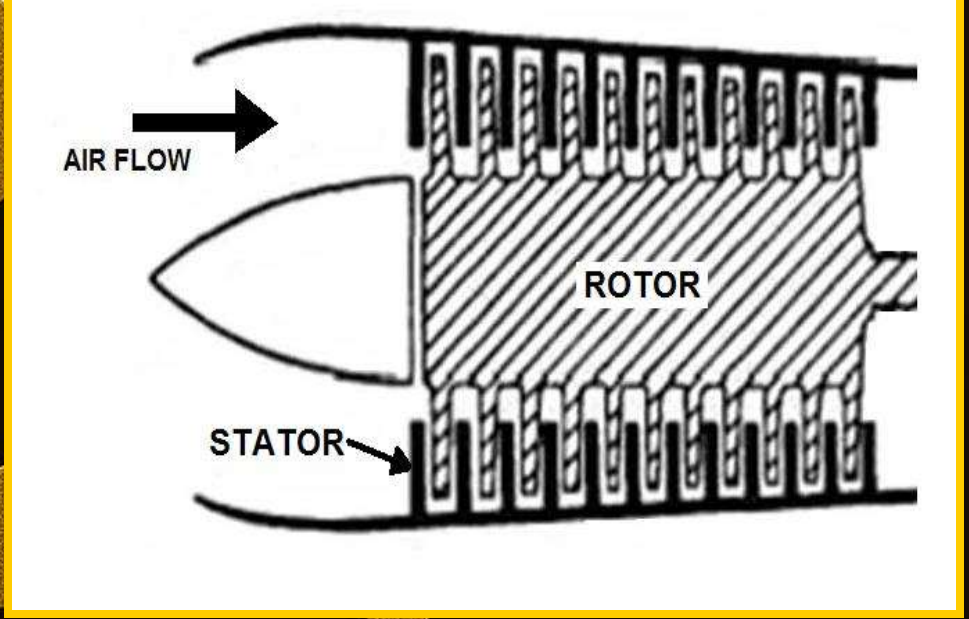
- Bleed air is tapped off from different stages of the compressor and used for cabin pressurization, engine starting, oil pressurization, anti-icing, de-icing, etc….

- As more air is bled off the compressor, Exhaust Gas Temperature (EGT) and/or Turbine Inlet Temperature (TIT) increase causing engine efficiency and power to decrease.

Compressor Classification



Centrifugal Flow



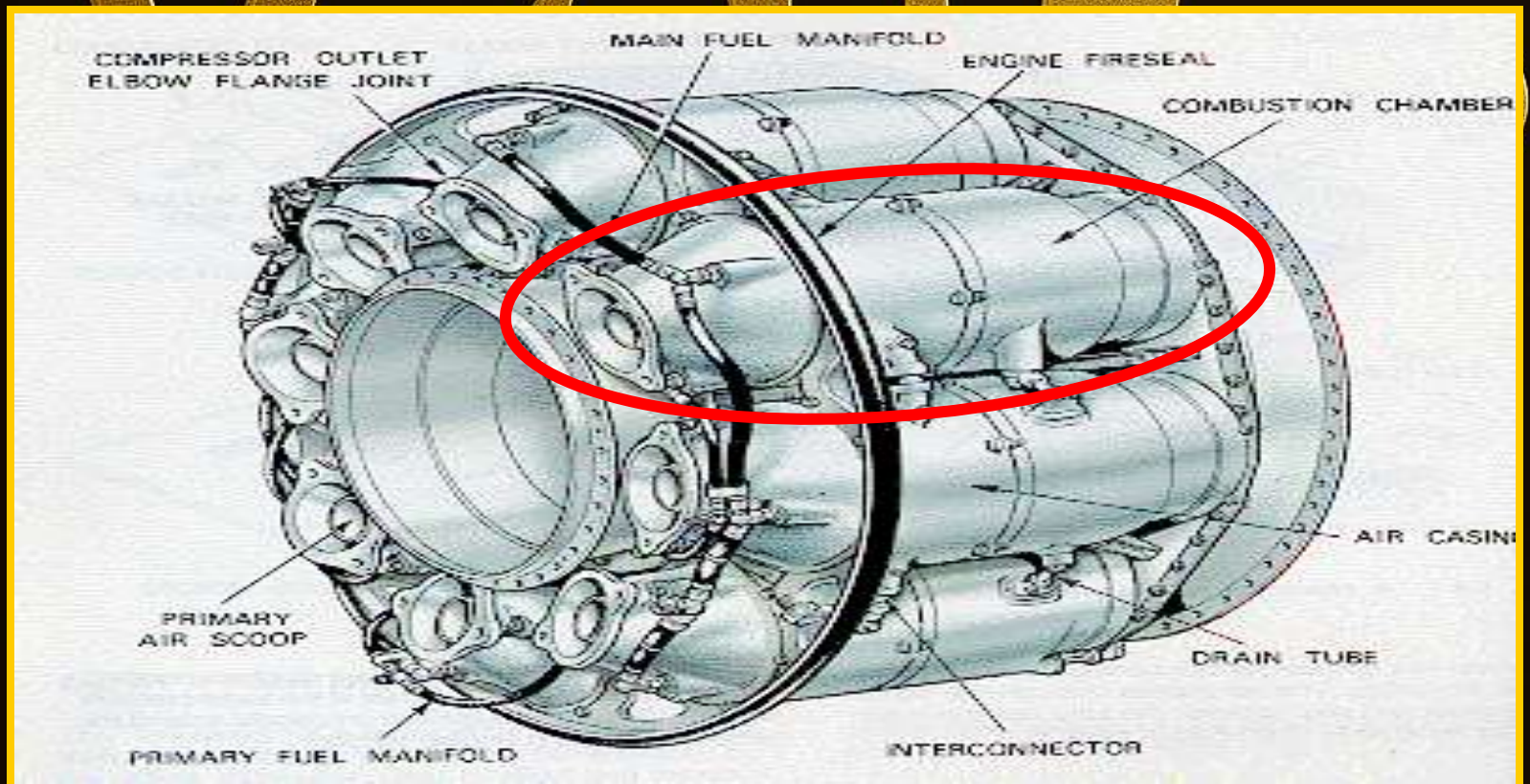
Axial Flow

Combustion Section

- Where the fuel-air mixture is burned.
- 25% of the air mixes with the fuel for combustion. The remaining 75% serves as cooling and flame control.

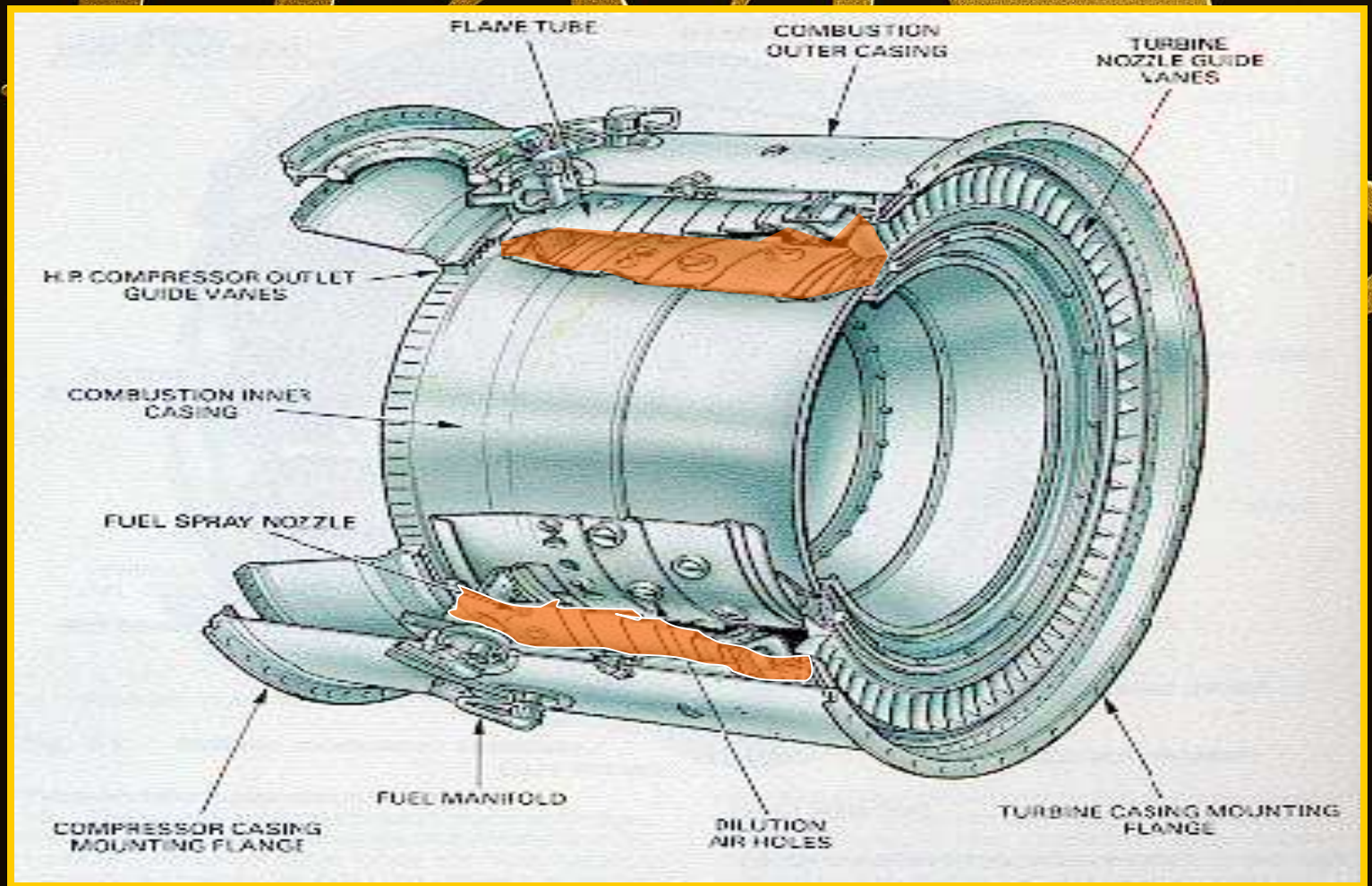
Can Type – Combustion Chamber

Individual liners and cases mounted around the axis of the engine.



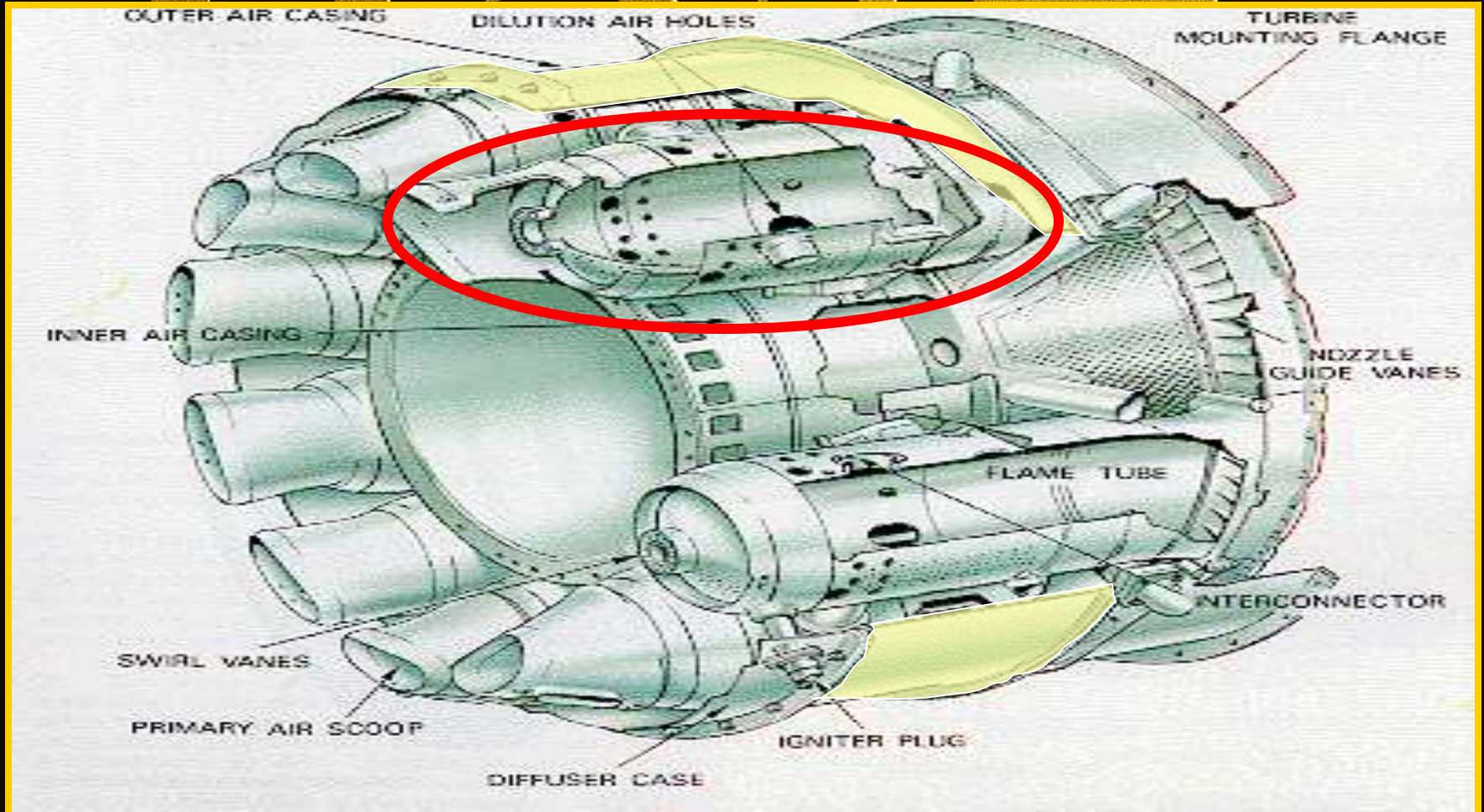
Annular Type – Combustion Chamber

An undivided circular shroud extending all the way around the outside of the turbine shaft housing.



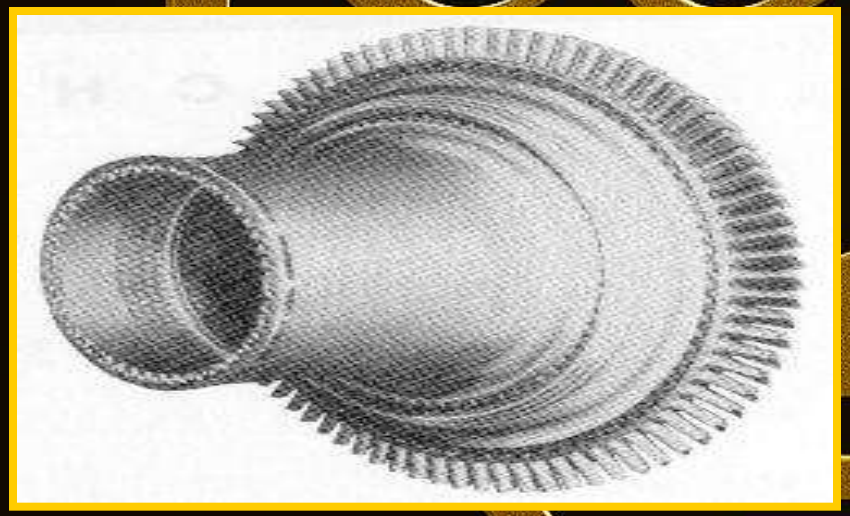
Can Annular Type – Combustion Chamber

Individual cans are placed inside an annular case.

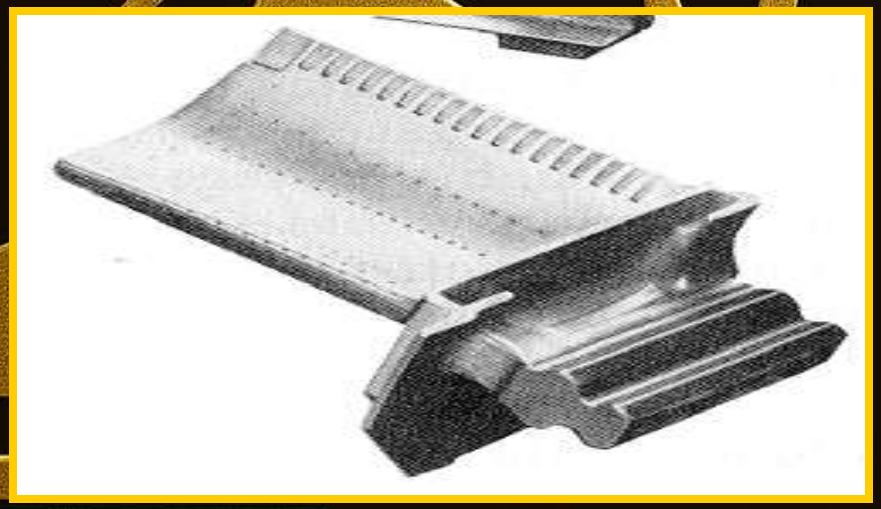


Turbine Section

- Transform a portion of the kinetic energy of the exhaust gases into mechanical energy to drive the compressor and necessary accessories.



Turbine Wheel



Turbine Blade

Exhaust Section

- Directs the flow of hot gases rearward in such a manner as to prevent turbulence, while causing a high final or exit velocity to the gases.

Afterburner

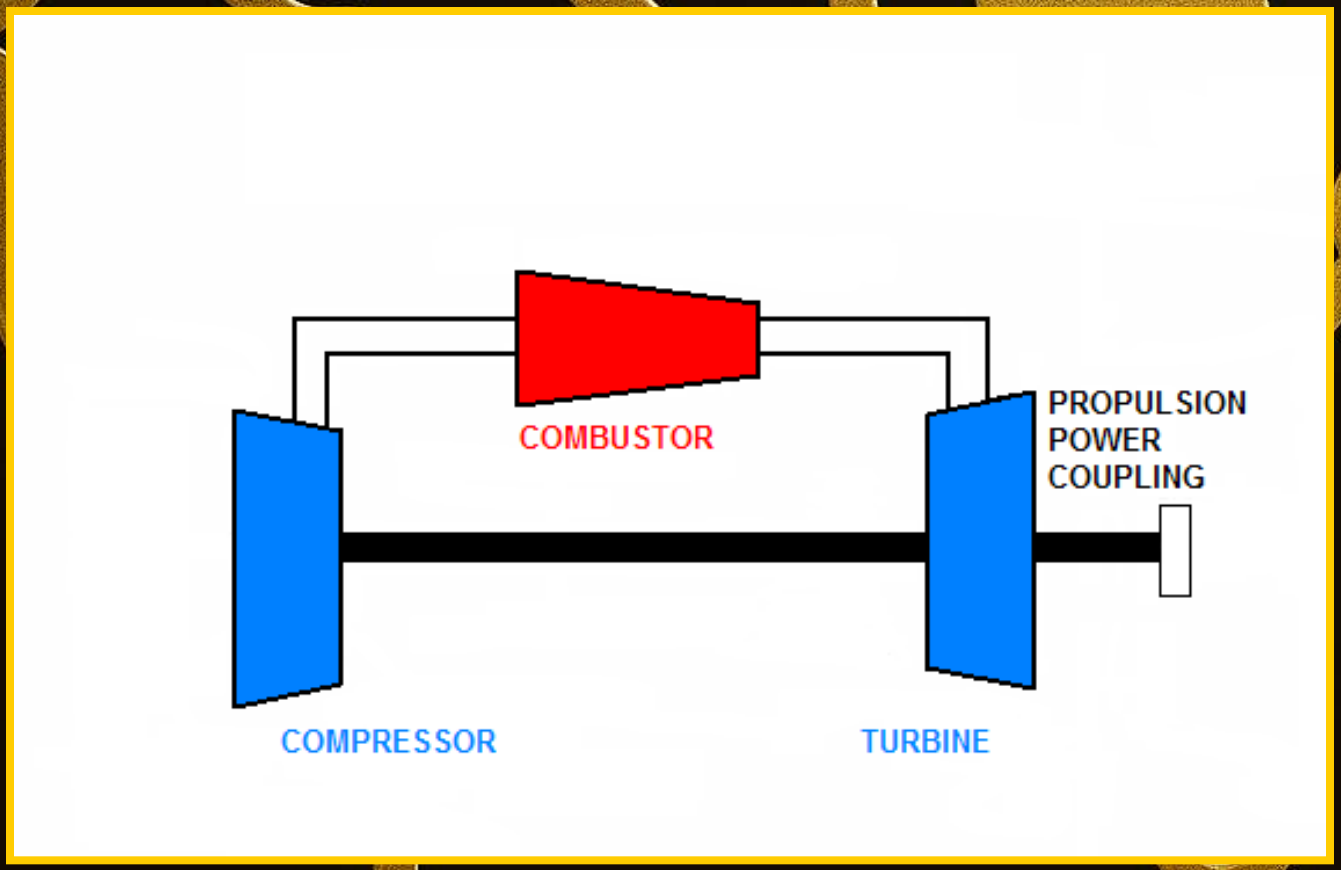
- The afterburner increases the normal thrust rating of a gas turbine engine.
- Additional fuel is mixed with unburned air that was previously used for engine cooling.

Gas Turbine Shaft Classification

- Single Shaft
- Split Shaft

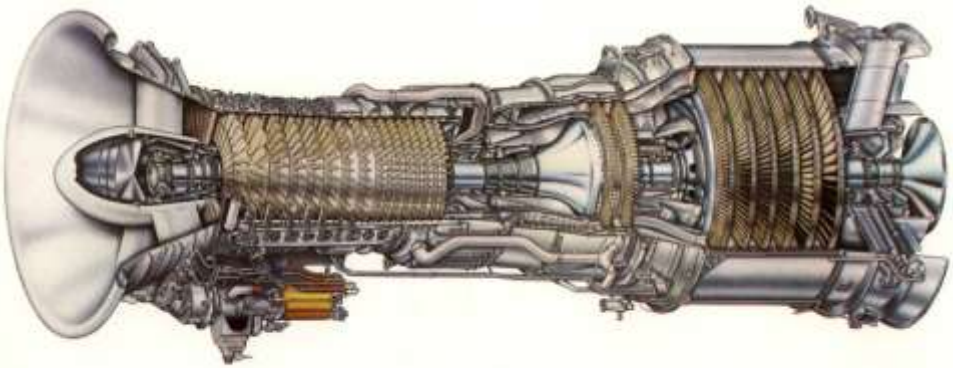
Single Shaft

Output shaft is connected directly to the same turbine rotor that drives the compressor.

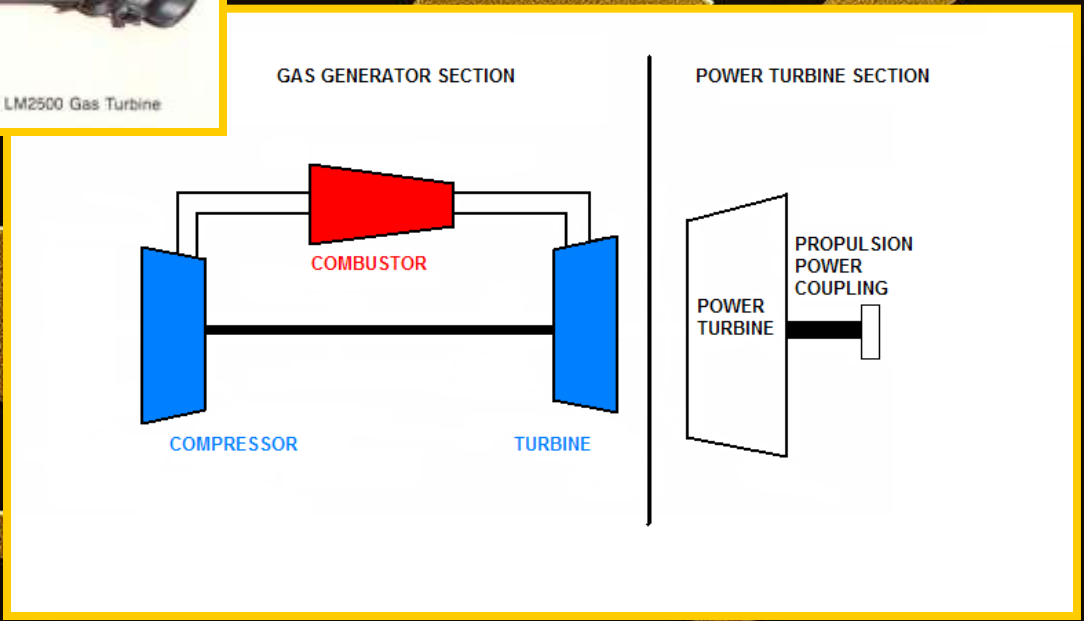


Split Shaft

No mechanical connection exists between the Gas Generator Turbine and the Power Turbine.



General Electric LM2500 Gas Turbine



Aviation Gas Turbine Classification

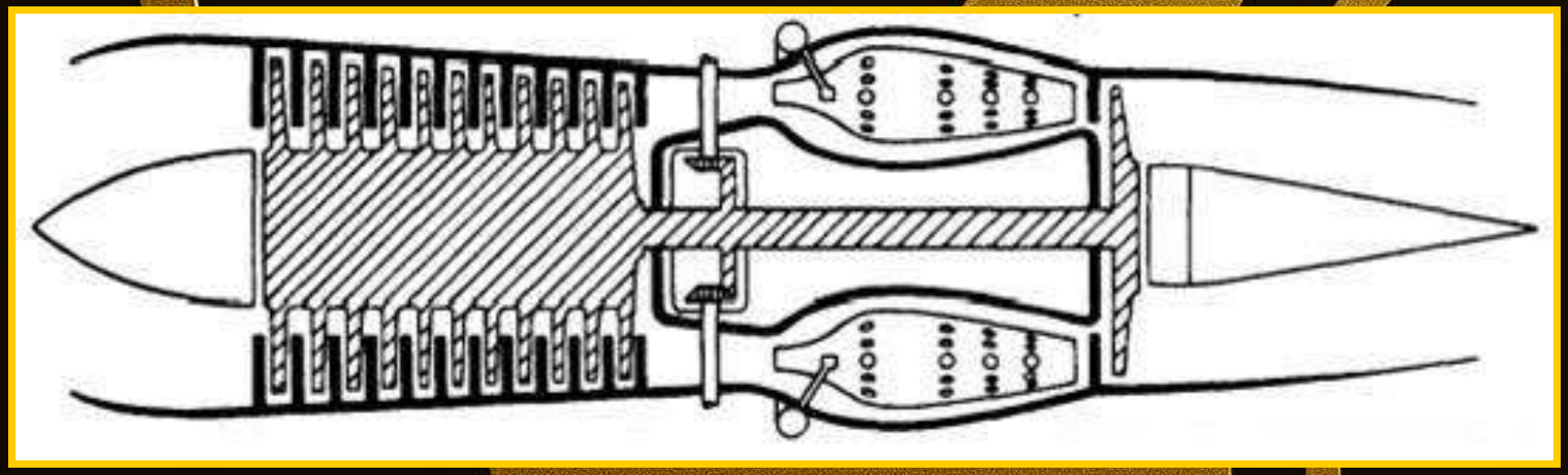
- Turbo jet
- Turbo prop
- Turbo shaft
- Turbo fan

Turbojet

Turbojet

Basis for all other gas turbine engines.

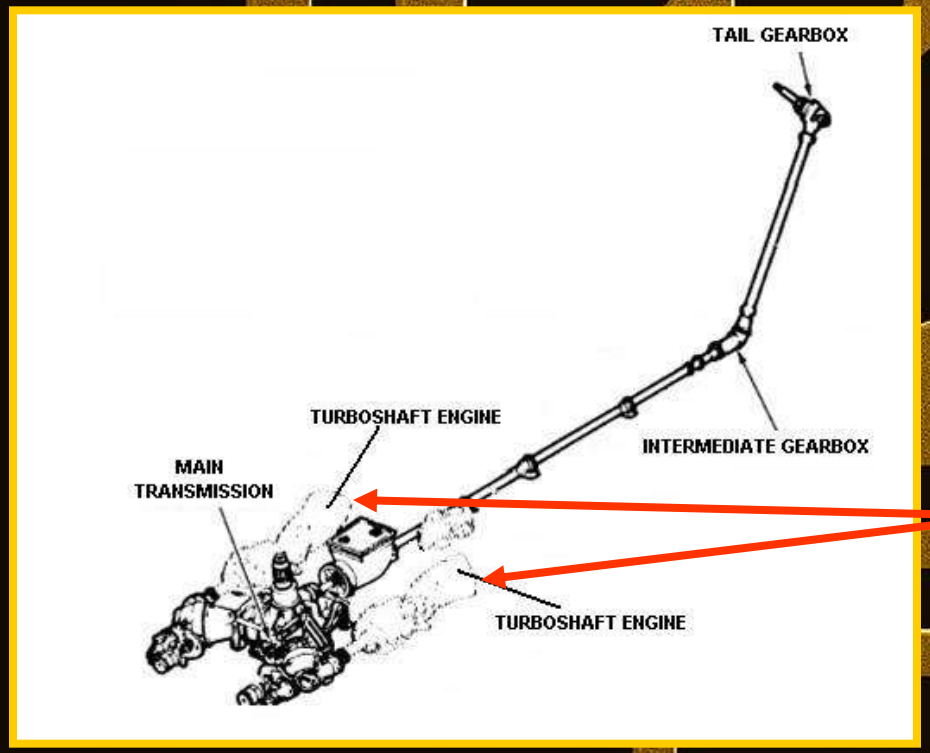
The exhaust product produces thrust which propels the aircraft.

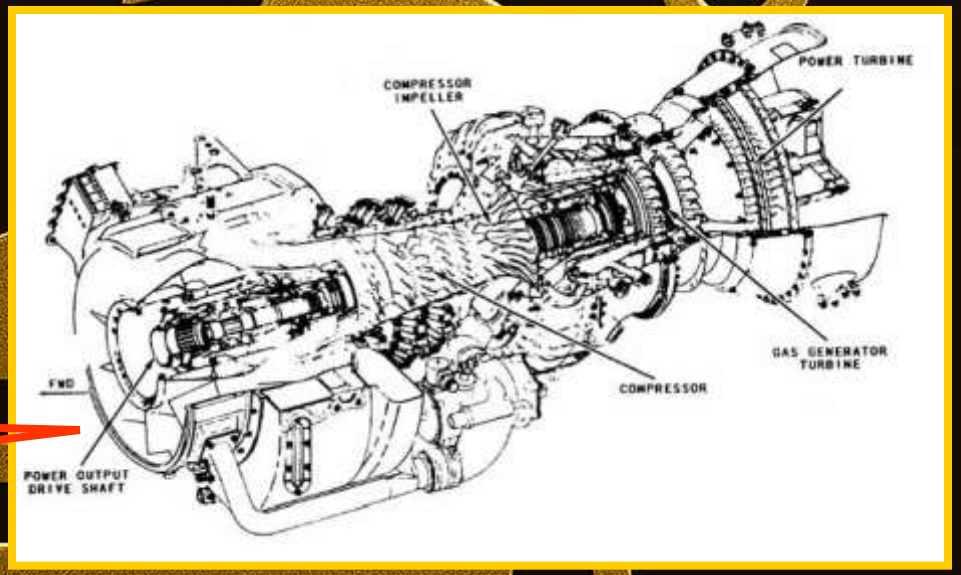


Turbo Shaft

Turbo Shaft

Exhaust gases drive the Gas Generator Turbine and Power Turbine. The power turbine drives the rotor blades, through drive shafts and gearboxes.

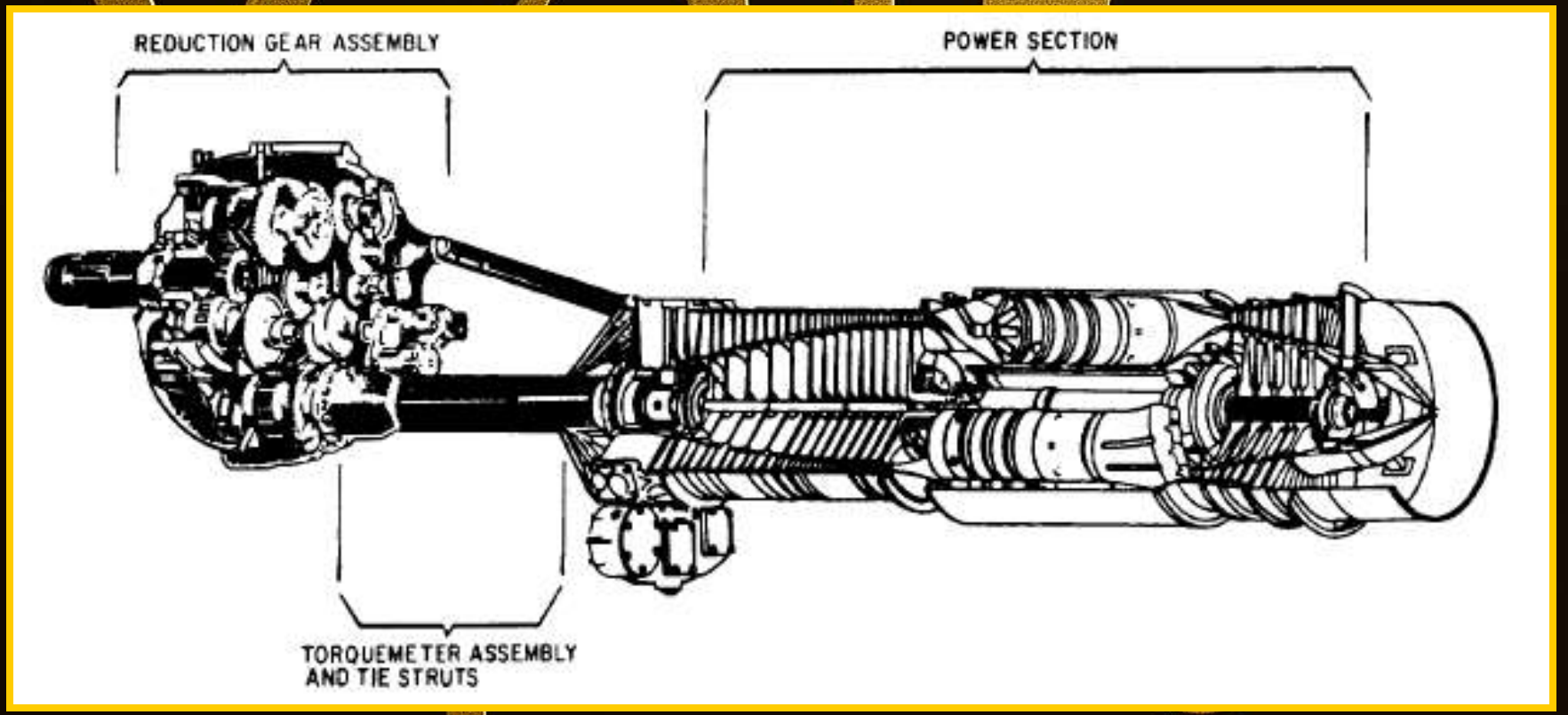




Turboprop

Turboprop

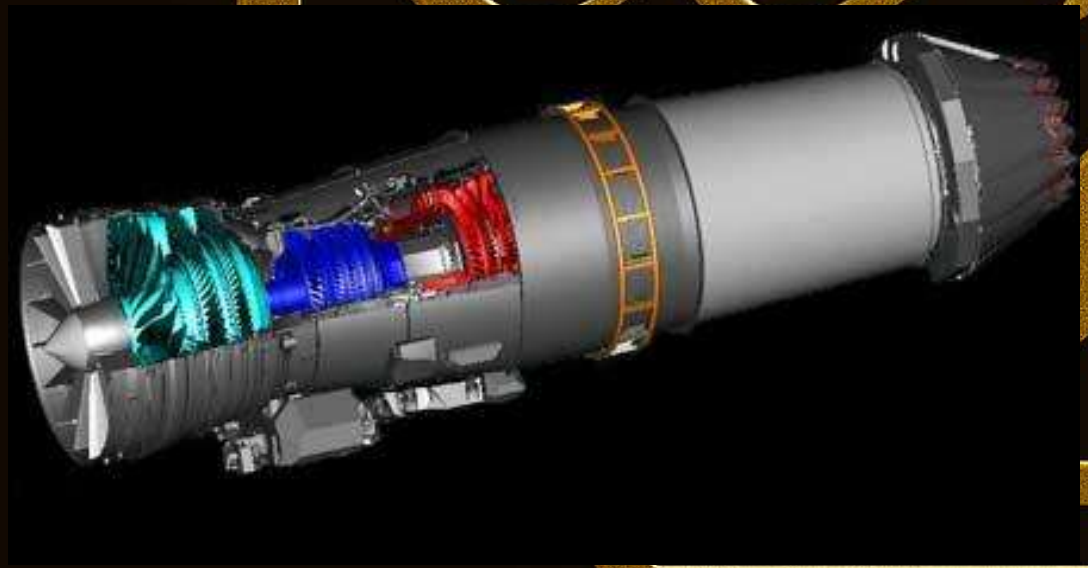
The turbine sends increased power forward to a reduction gearbox. A propeller mounted on the gearbox provides thrust.

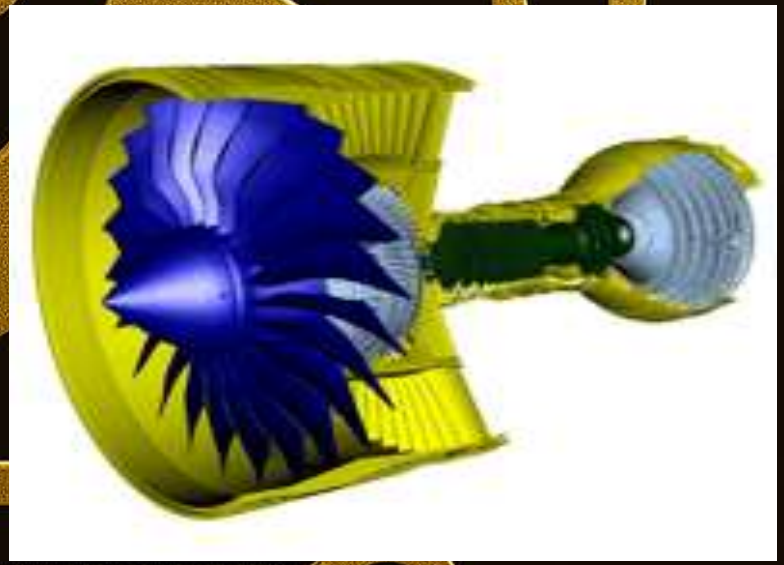


Turbofan

Turbofan

Similar to a turboprop, Except a duct-enclosed, fan replaces the gearbox and prop. The fan is either part of the compressor or mounted as a separate set of fan blades.





Advantages over Diesel and Steam

- High power to weight ratio
- Vibration Free Operation
- Lack of low frequency operation make it hard for submarines to detect
- Cost effective reliability

Disadvantages over Diesel and Steam

- High stress leads to engine failure
- Large air ducting takes up space
- High Heat Signature
- Depot level Maintenance