اقتصاديات وصيانة محطات القدرة

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Maintenance

A formal definition of maintenance is “that function of manufacturing management that is concerned with day to day problem of keeping the physical plant in good operating condition”

Types of Maintenance

1-Corrective or Breakdown Maintenance.
2-Scheduled Maintenance.
3-Preventive Maintenance.
4-Predictive Maintenance.

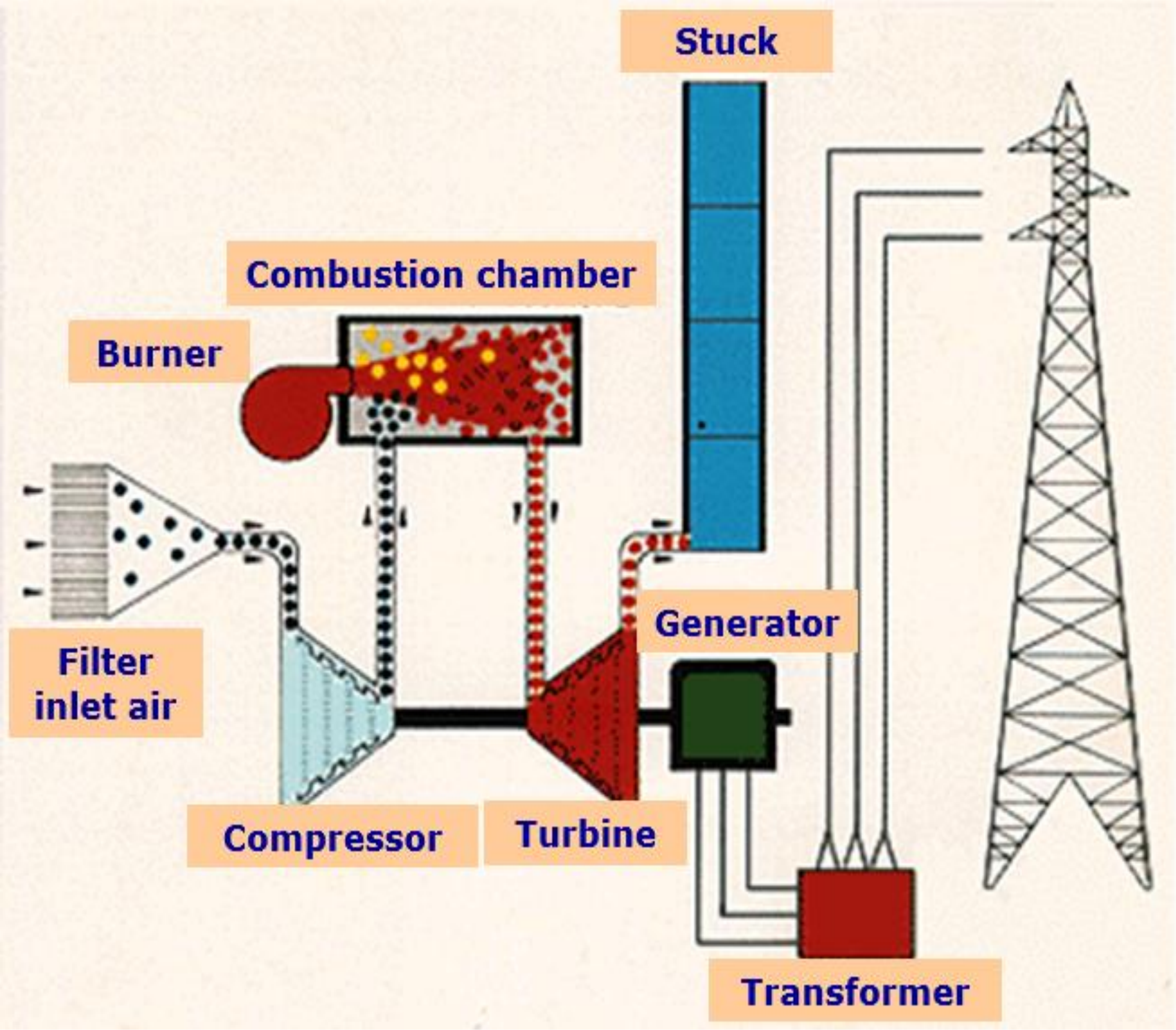
Procedures of PM (Plant Maintenance)

- Who should do PM?
- Where to start PM?
- What to Inspect in PM?
- What to Inspect for?
- How often to inspect-frequency?
- When to inspect-schedules?
- Maintaining PM Records.
- Storage of spare parts.
- Control and evaluation of PM.

Advantages of Maintenance

1-Reduced breakdowns and connected downtimes.
2- Greater safety for workers.
3- Fewer Large-scale and repetitive repairs.
4- Low Maintenance and repair costs.
5- Lower unit cost of Manufacture.
6- Better Product quality and fewer products rejects.
7- Increased equipment life.

Gas Turbine power station



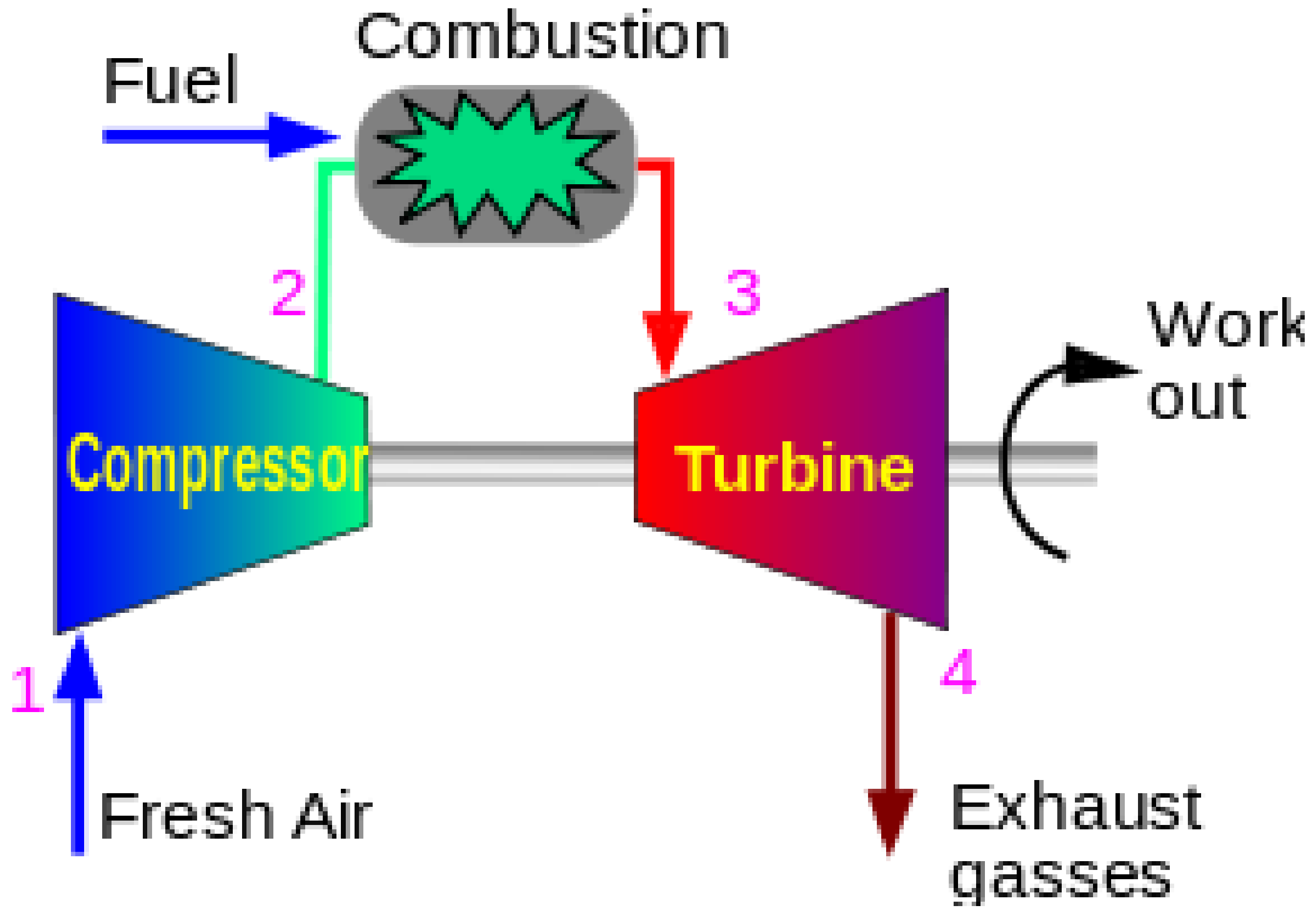
Thermodynamics principles of gas turbine

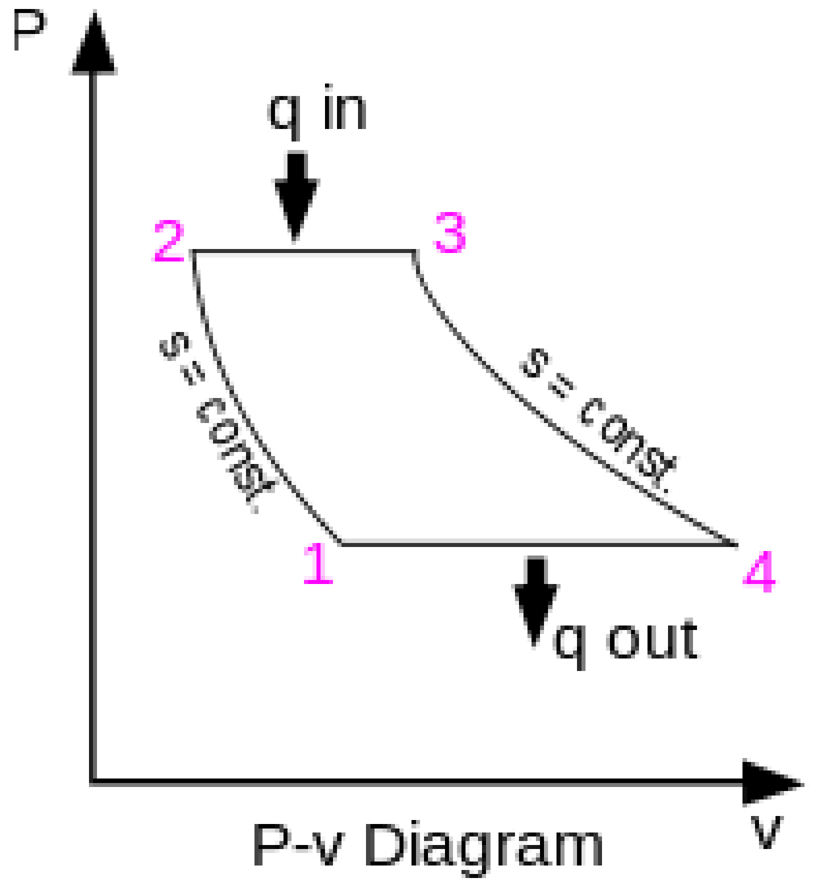
Brayton cycle:

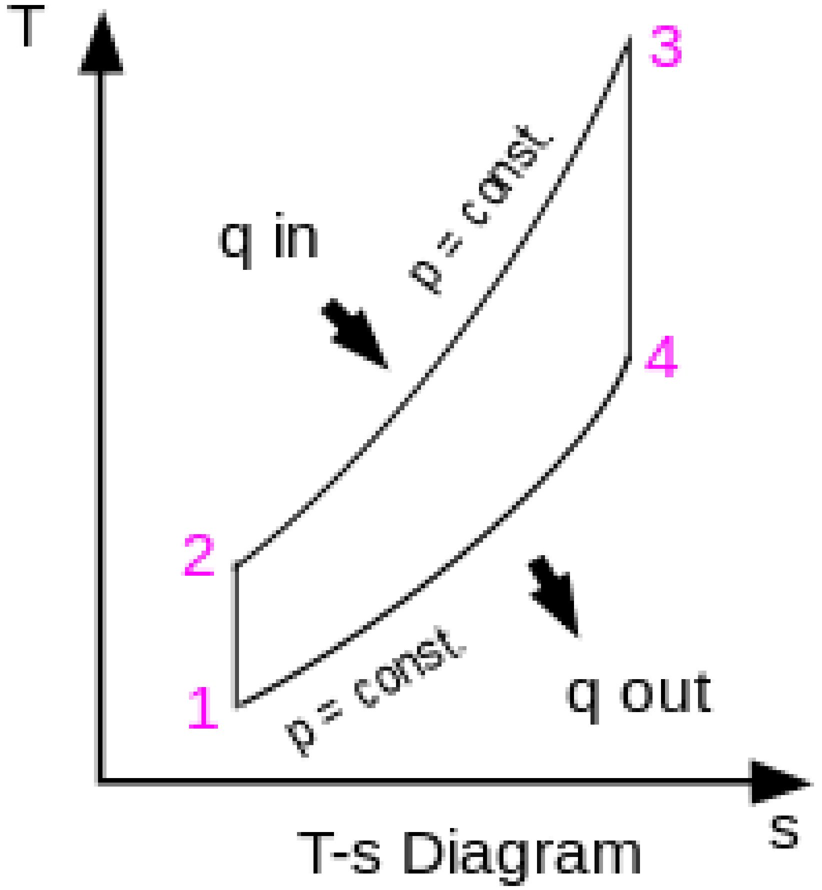
1. isentropic process – ambient air is drawn into the compressor, where it is pressurized.
2. isobaric process – the compressed air then runs through a combustion chamber, where fuel is burned, heating that air—a constant-pressure process, since the chamber is open to flow in and out.
3. isentropic process – the heated, pressurized air then gives up its energy, expanding through a turbine (or series of turbines). Some of the work extracted by the turbine is used to drive the compressor.
4. isobaric process – heat rejection (in the atmosphere).

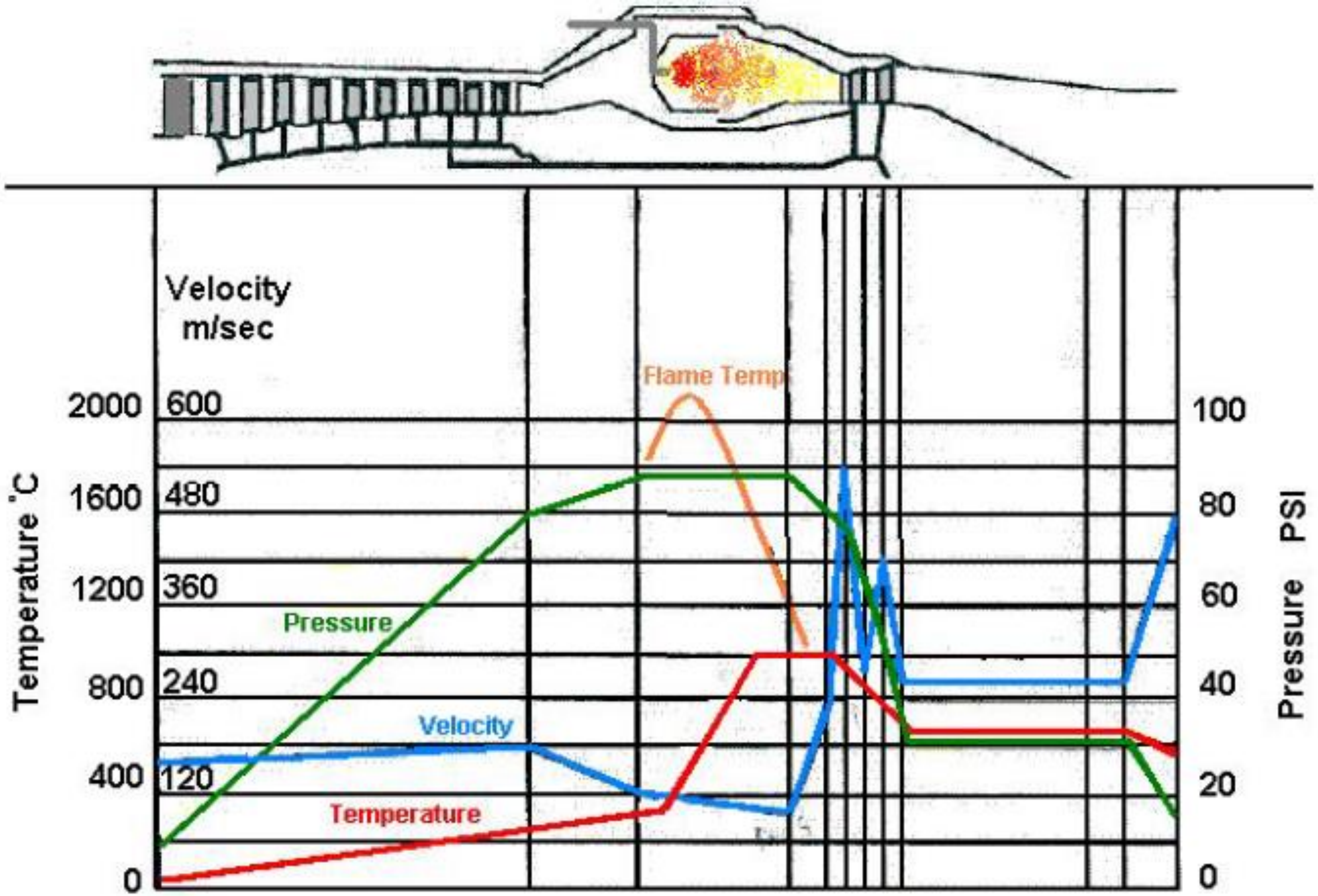
Actual Brayton cycle:

1-adiabatic process – compression
2- isobaric process – heat addition
3-adiabatic process – expansion
4-isobaric process – heat rejection





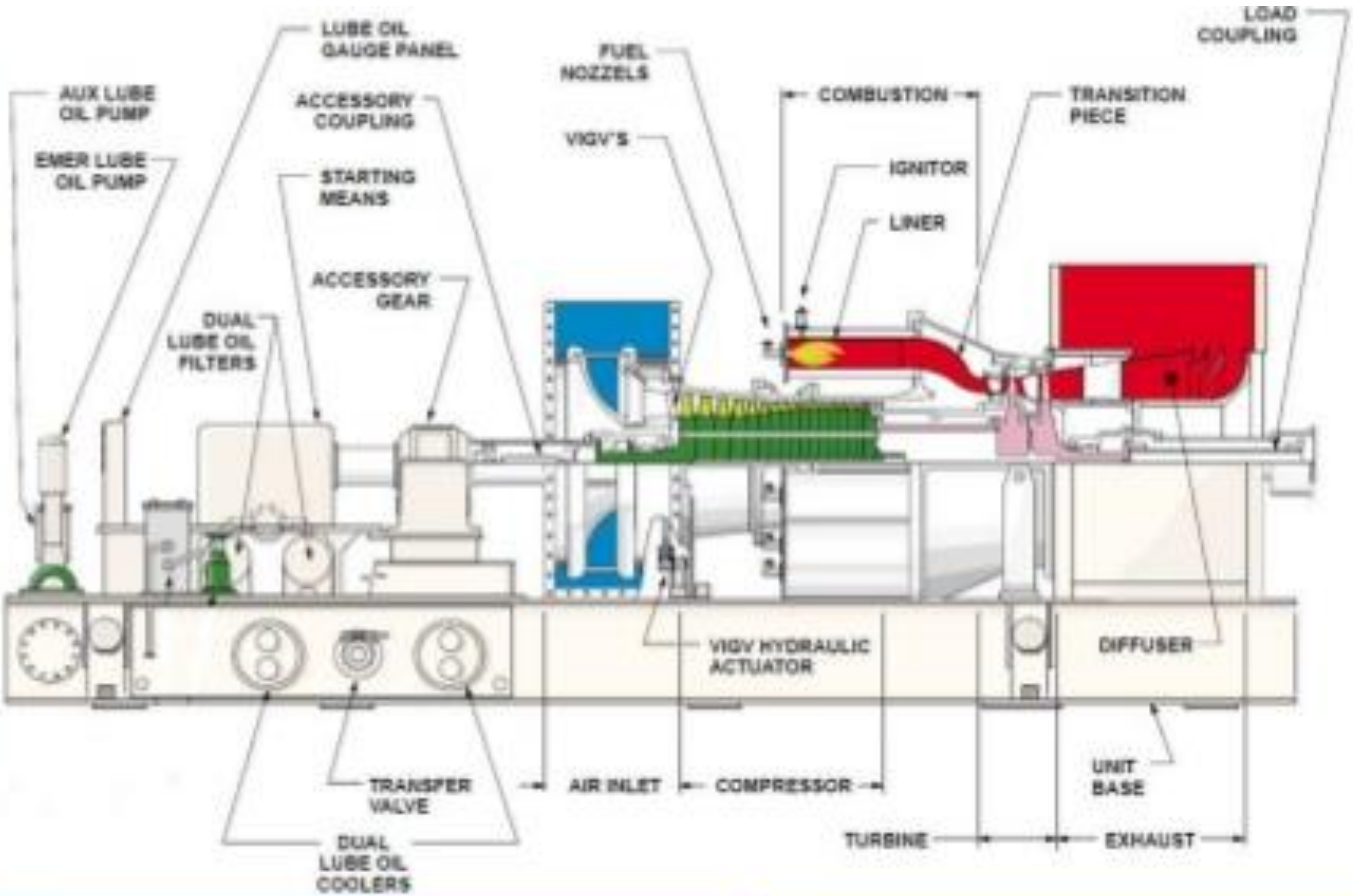




Velocity
m/sec
Flame Temp
Pressure
Velocity
Temperature
Temperature °C
2000
1600
1200
800
400
0
600
480
360
240
120
100
80
60
40
20
0
Pressure PSI

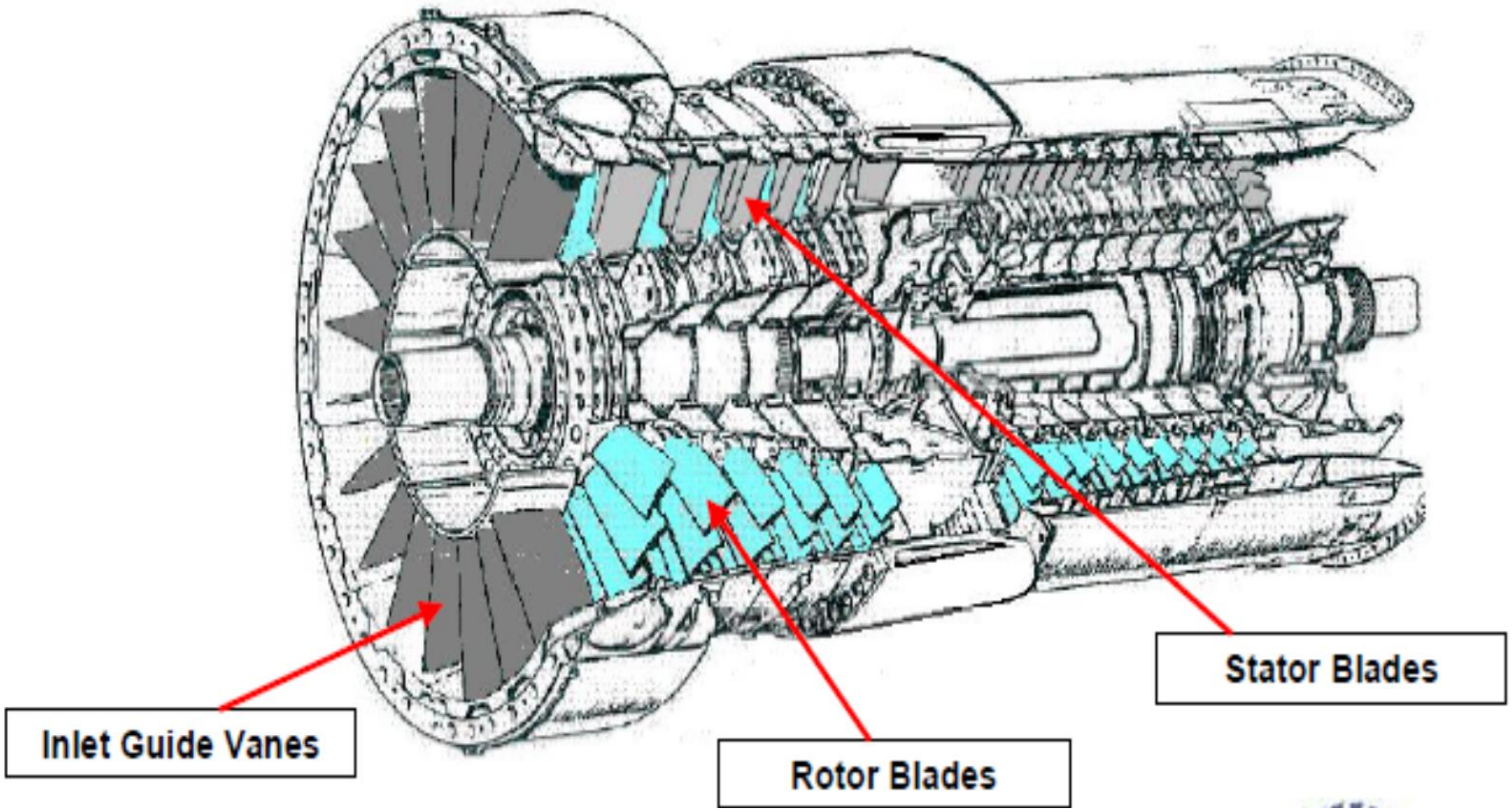
Gas Turbine Sections

- Accessory Section
- Air Inlet Section
- Compressor Section
- Combustion Section
- Turbine Section
- Exhaust Section

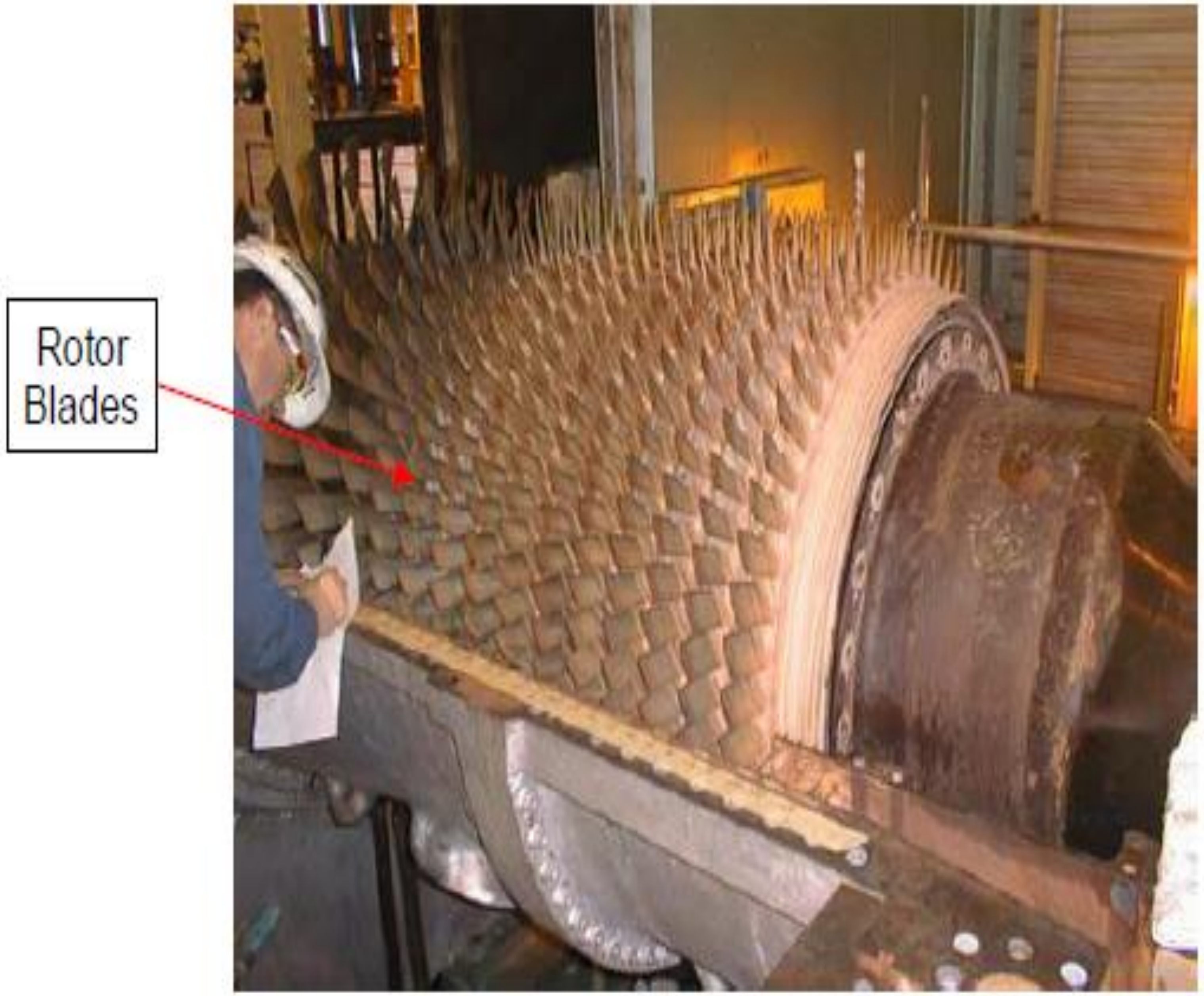


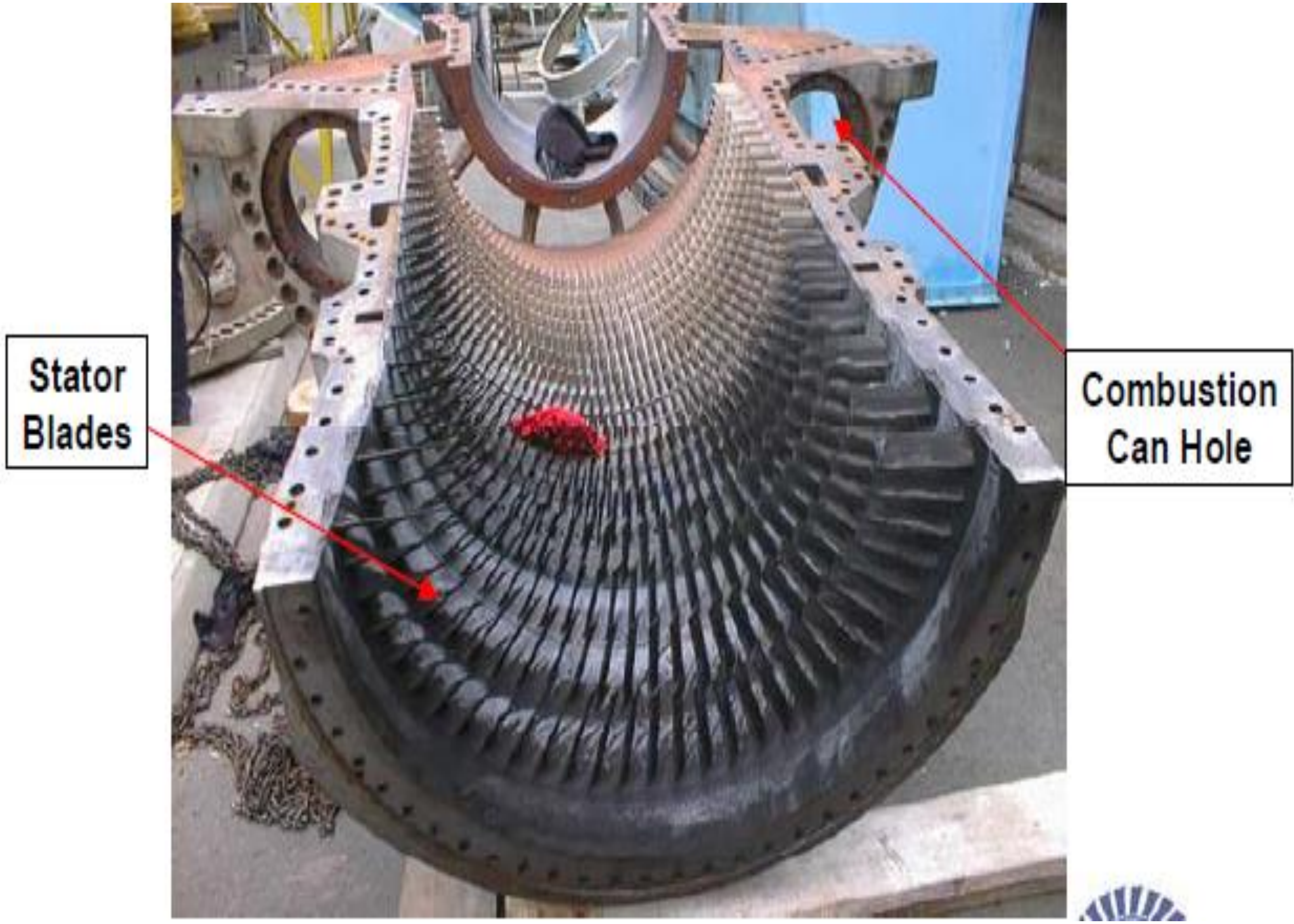
Axial Compressor

- **Airflow is in the direction of the compressor axis.**
- **This type of compressor gradually increases the air pressure over a number of stages.**
- **Each stage consists of a row of Stator Blades and a row of Rotor Blades.**



Axial Compressor





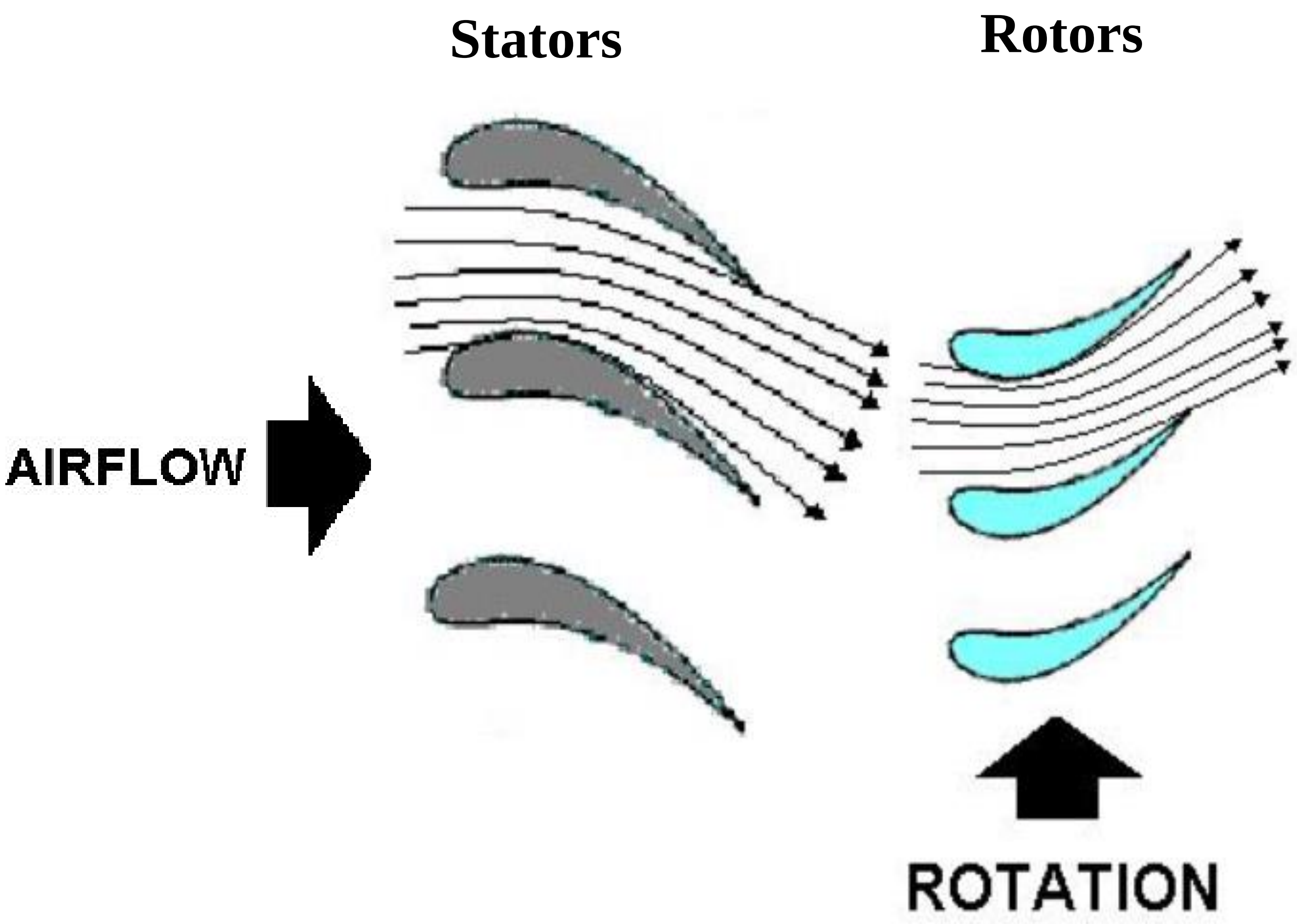
Compressor Blading

• **Inlet Guide Vanes straighten the airflow onto the first stage Rotor Blades.**

• **Due to the rotation, the Rotor Blades *increase air velocity*, and due to the blades forming a Divergent passage, *pressure and temperature are increased*.**

• **The Stator Blades then direct the air onto the next Rotor stage.**

• **Due to the Stator Blades forming a Divergent passage, *pressure and temperature are increased*, where *velocity remains approximately the same*.**



Inlet Guide Vanes (IGV)

- Used to control air flow into compressor
- Older machines had two position IGV's :- fully open, fully closed
- New machines have modulating IGV's :- open partially on startup and fully on load at a constant value of exhaust temperature

Made from GTD450 Alloy

Compressor Bleed Valves

- Compressor Bleed valves prevent rotating stall during startup
- Open during startup
- Closed by compressor discharge pressure at 95% Speed

Compressor Bleed Valves

Compressor Materials

- ❑Different stages of the compressor use different materials
- ❑STG 1&2 Compressor blades and vanes usually GTD450 alloy
- ❑STG 3-7 Compressor blades and vanes are 403 + Cb with NiCd coating
- ❑STG 8-17 Compressor blades and vanes are 403 + Cb

Compressor Performance

- ❑A drop in pressure ratio across the compressor will result in a loss of output
- ❑Drop in pressure ratio can be due to
- • Dirty/Fouled Compressor
- • Incorrectly calibrated IGV’s
- • Incorrectly operating IGV’s
- • Filtration system malfunction or blockage

Compressor Washing

- ❑Used to improve compressor performance
- ❑Abrasive Cleaning using organic compounds (rice and nutshells) :- no longer advised for newer machines
- ❑Liquid Cleaning using potable water and detergents
- • Liquids can be manually applied through hose or applied through fixed nozzles

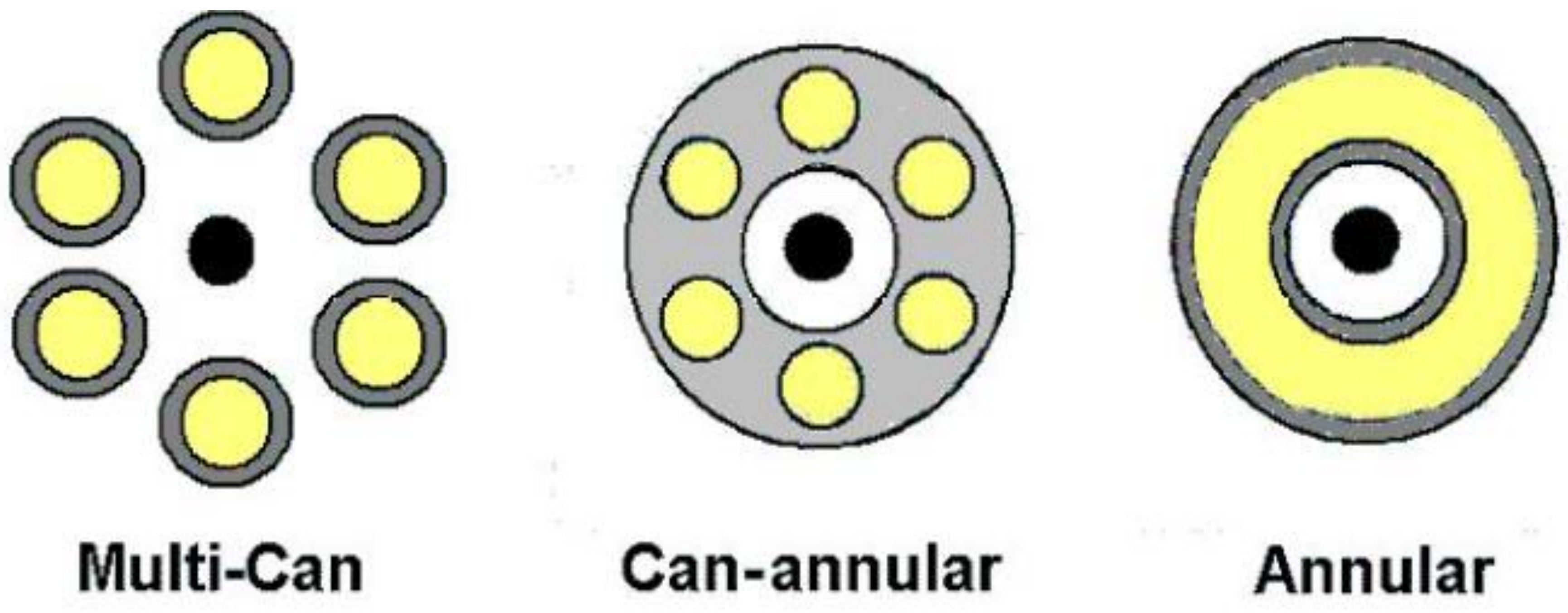
Combustion Section

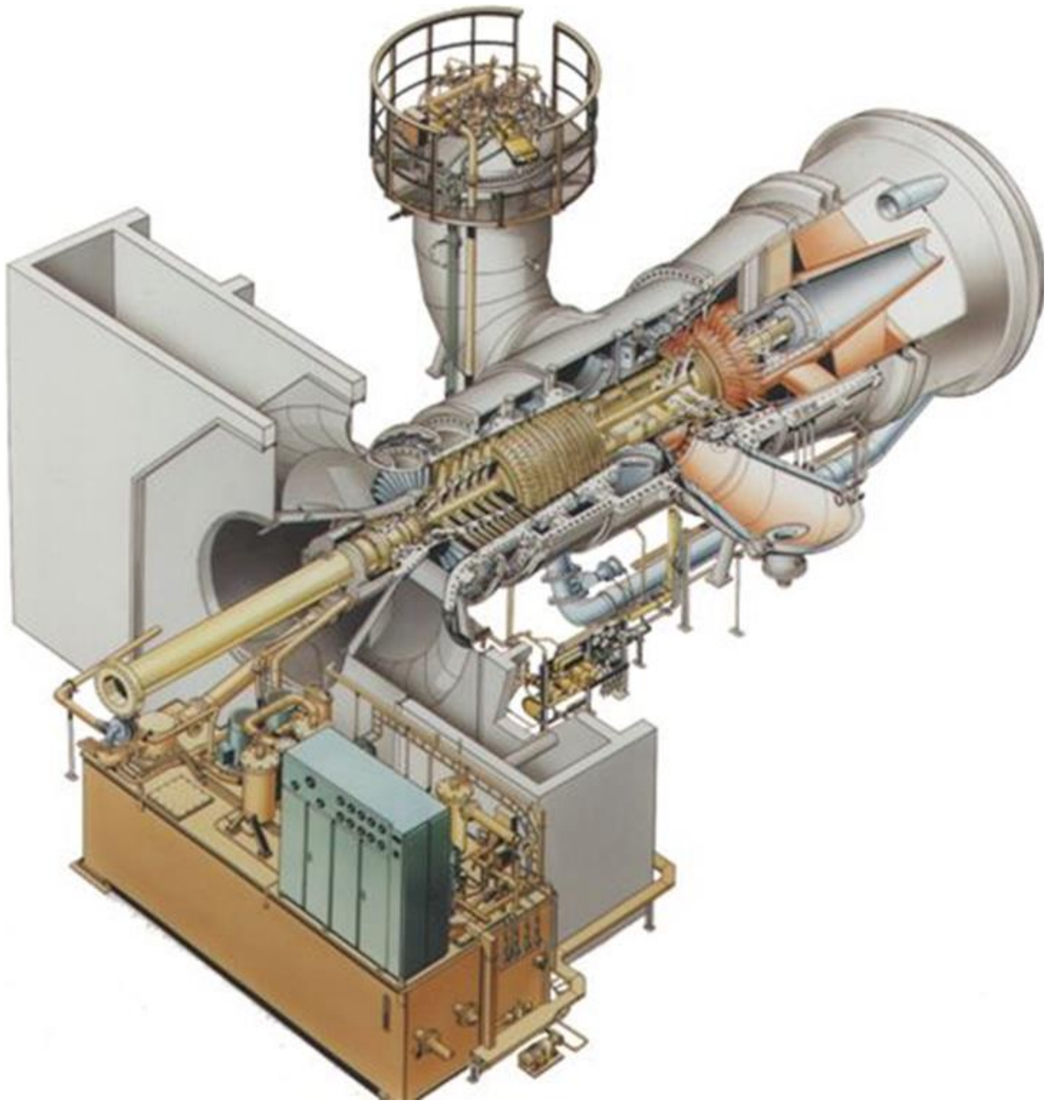
- **The purpose of the combustion section is to expand and accelerate the compressed gas rearwards to drive the Turbine section.**
- **It does this by *burning a fuel/air mix*, which *accelerates the gas*, and *increases the temperature* with little or *no pressure rise*.**

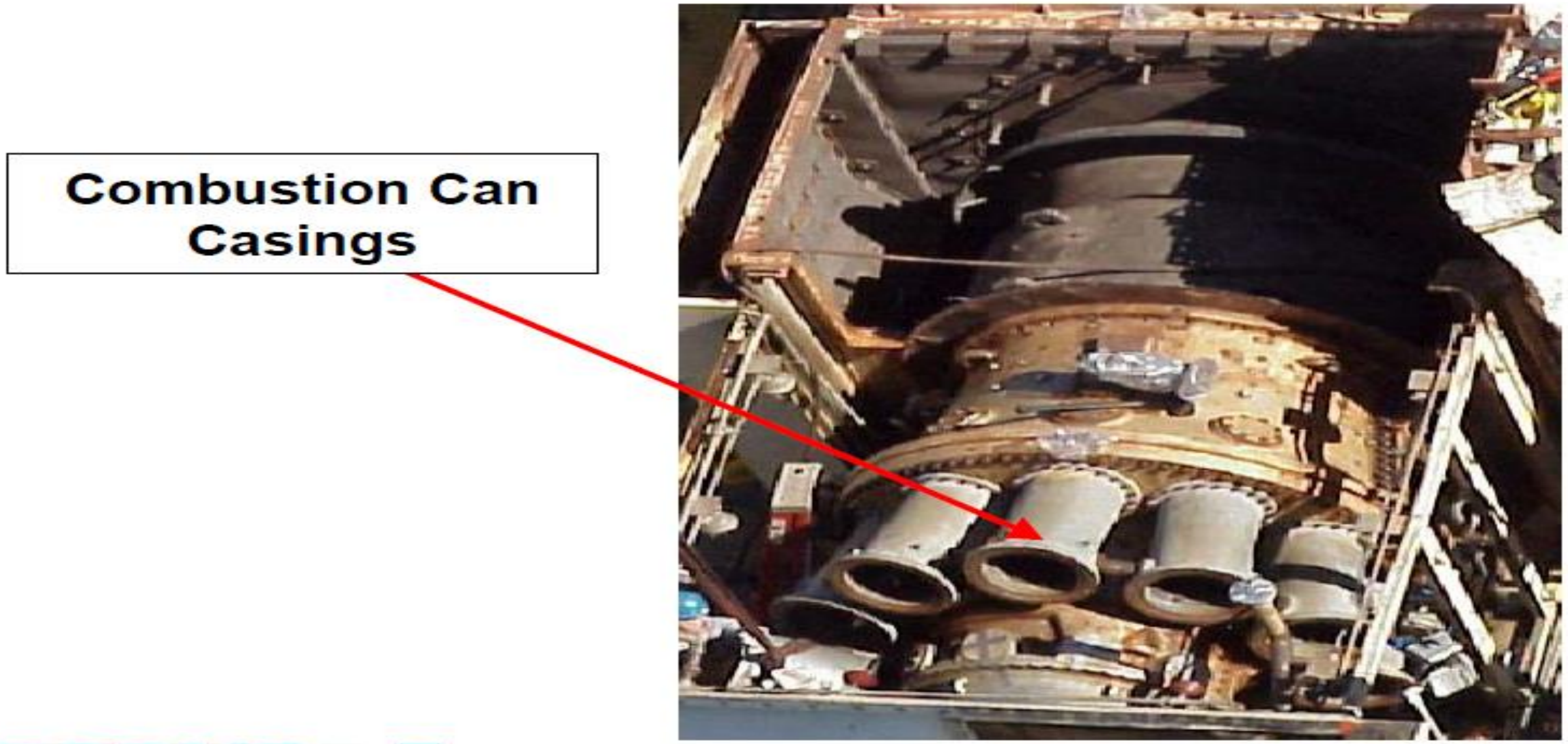
Combustion Components

- ❑ **Combustion Chamber or Can**
- ❑ **Combustion Liner**
- ❑ **Fuel Nozzle**
- ❑ **Crossfire Tube**
- ❑ **Ignition Source**
- ❑ **Flame Detector**
- ❑ **Transition Piece**

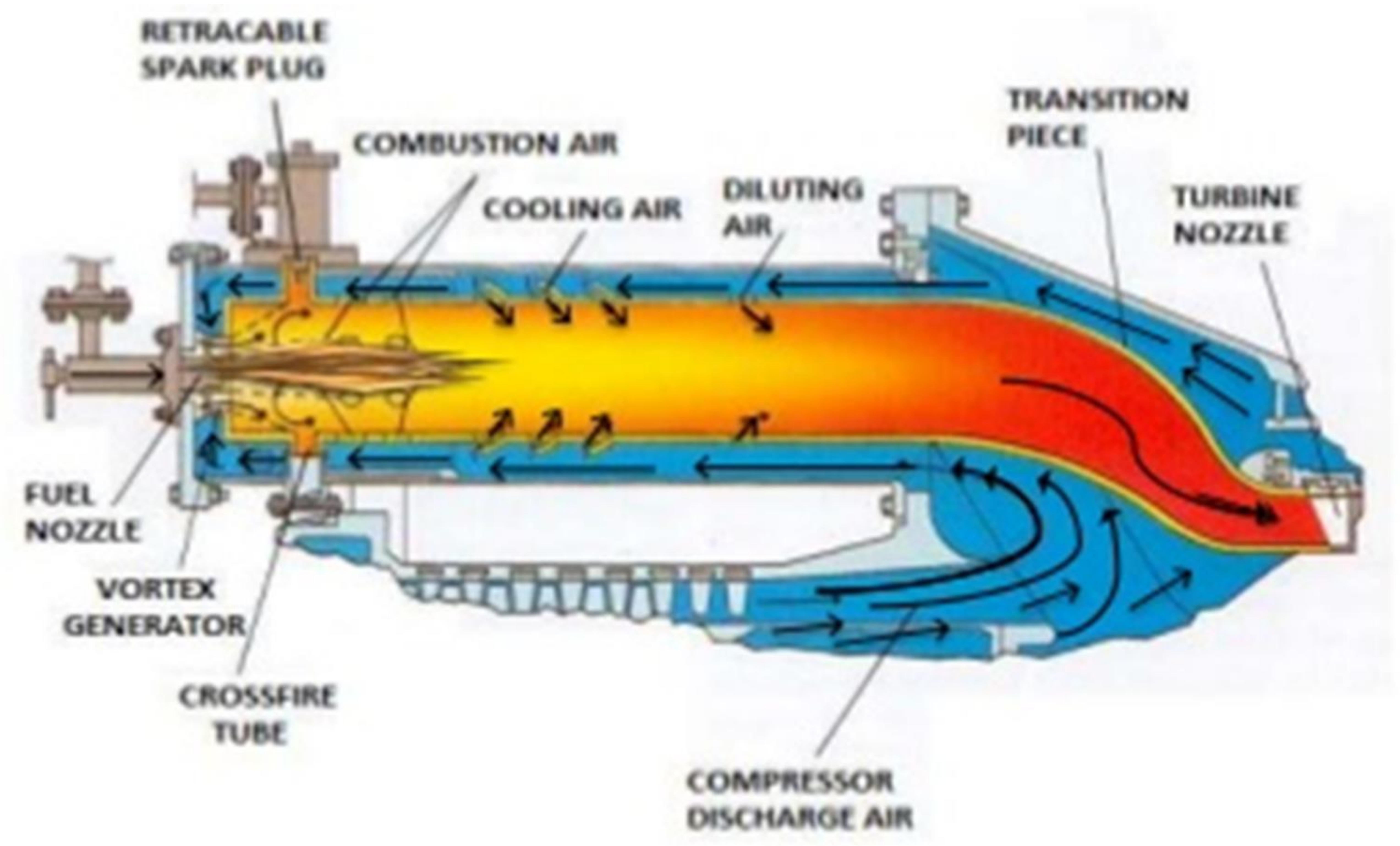
Combustion System Arrangement







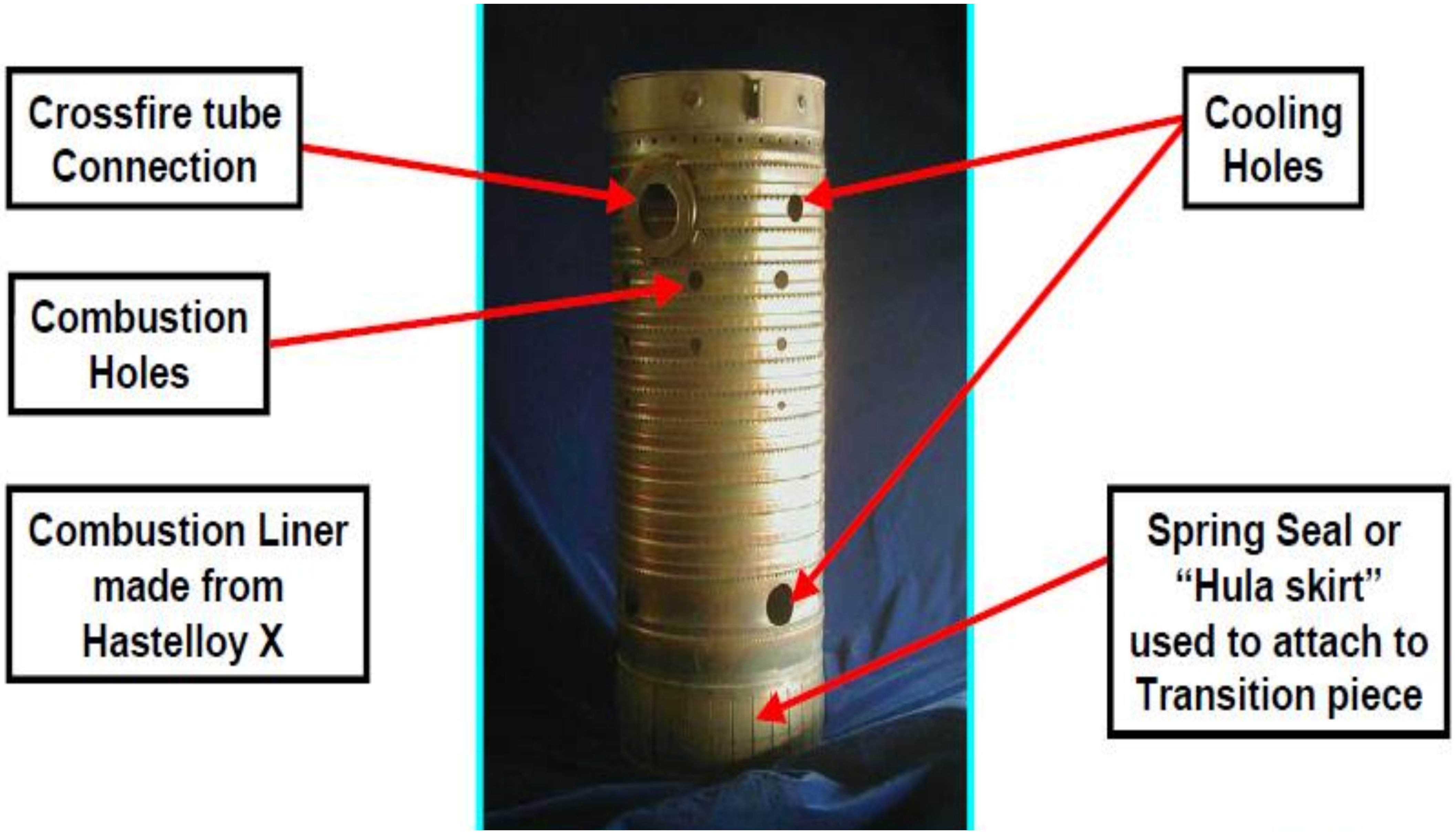
Reverse Flow Combustion



Frame 6 GE Combustion Liner

Hastelloy X Material

- ❑ **Alloy resistant to high temperatures.**
- ❑ **Easy to shape**
- ❑ **Alloy made from following materials**
- **49% Nickel**
- **22% Chromium**
- **18% Iron**
- **9% Molybedenum**
- **Small amounts Tungsten and Cobalt**



Fuel Systems

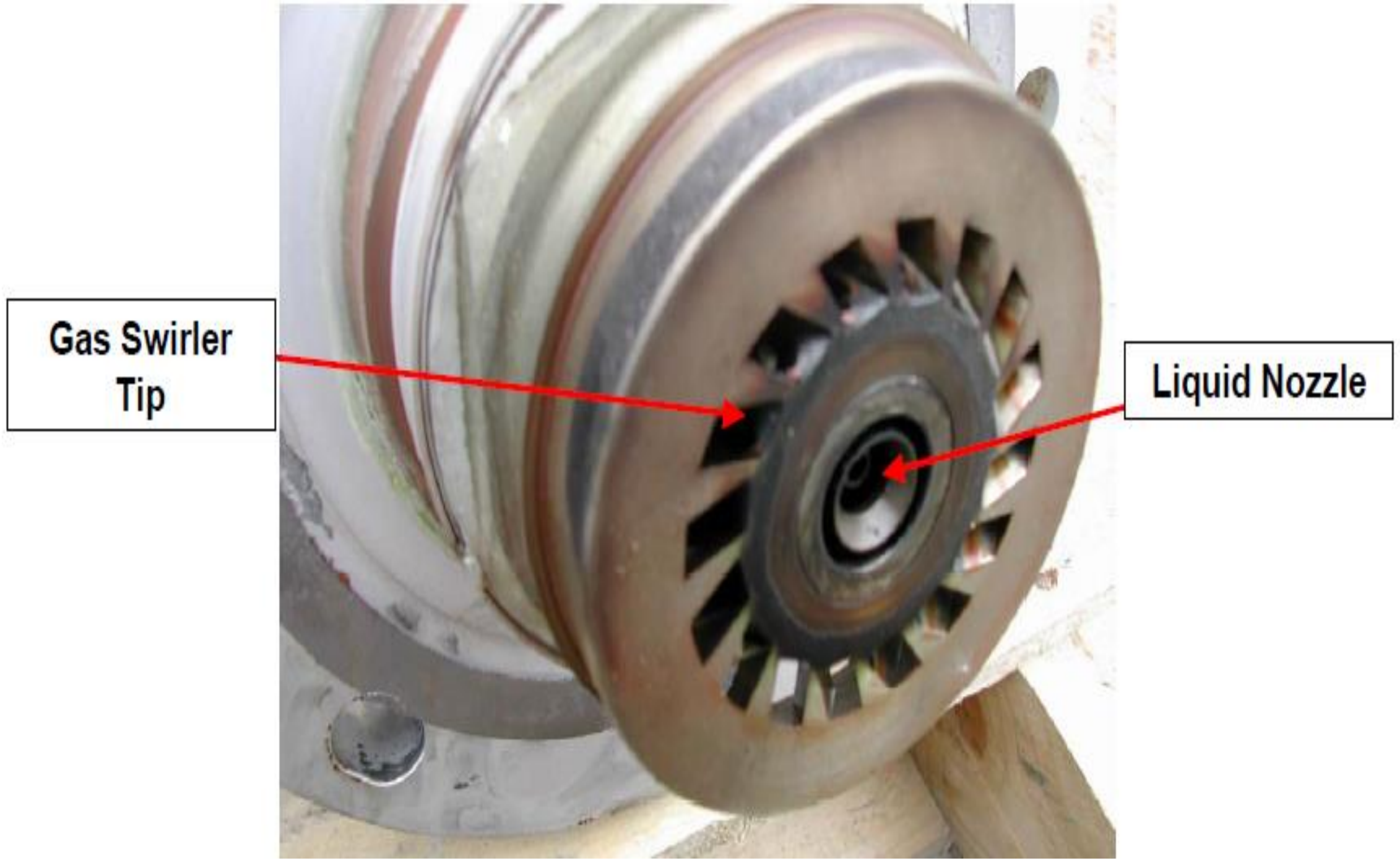
Gas Turbines are designed for fuel flexibility.
Therefore they can burn the following fuels and fuel combinations:-

- **Gas Fuel**
- **Liquid Fuel**
- **Residual Fuel Oil**
- **Heavy Crude**

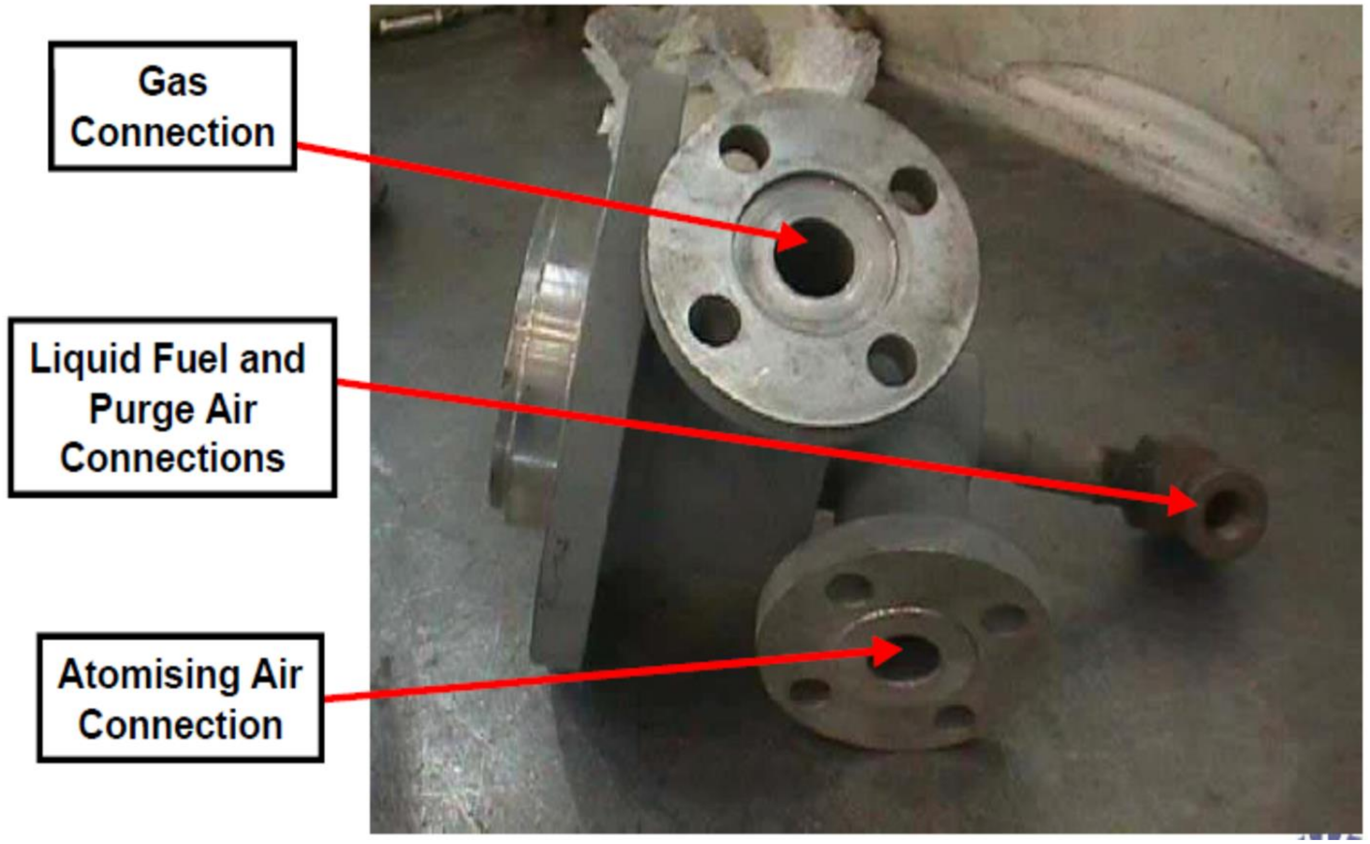
Fuel Nozzle Types

Gas Fuel Nozzle
Liquid Fuel Nozzle
Dual Fuel Nozzle
Swirler Tip Fuel Nozzle

Fuel Nozzle



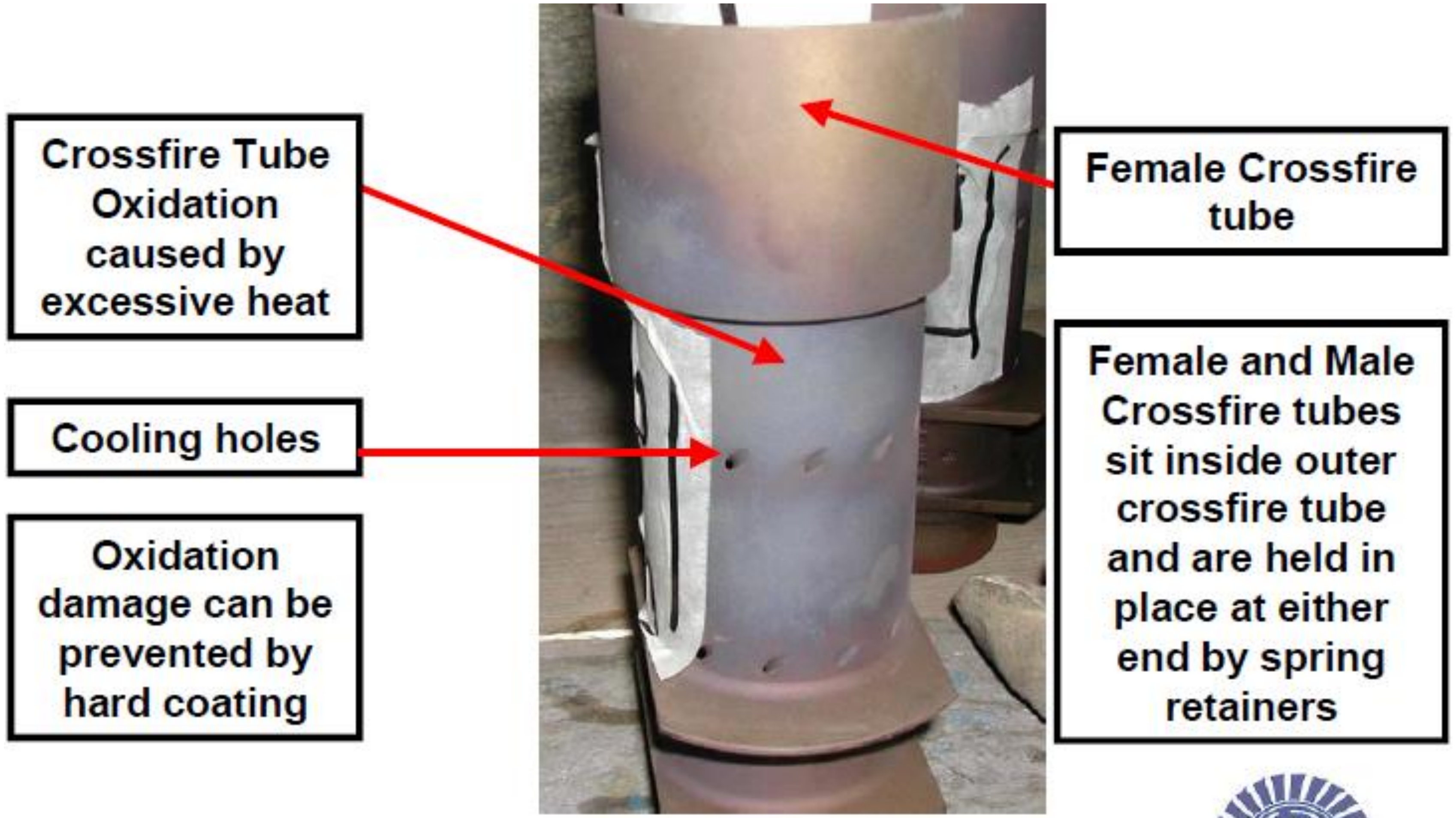
Dual Fuel Nozzle Connections



Cross Fire Tubes

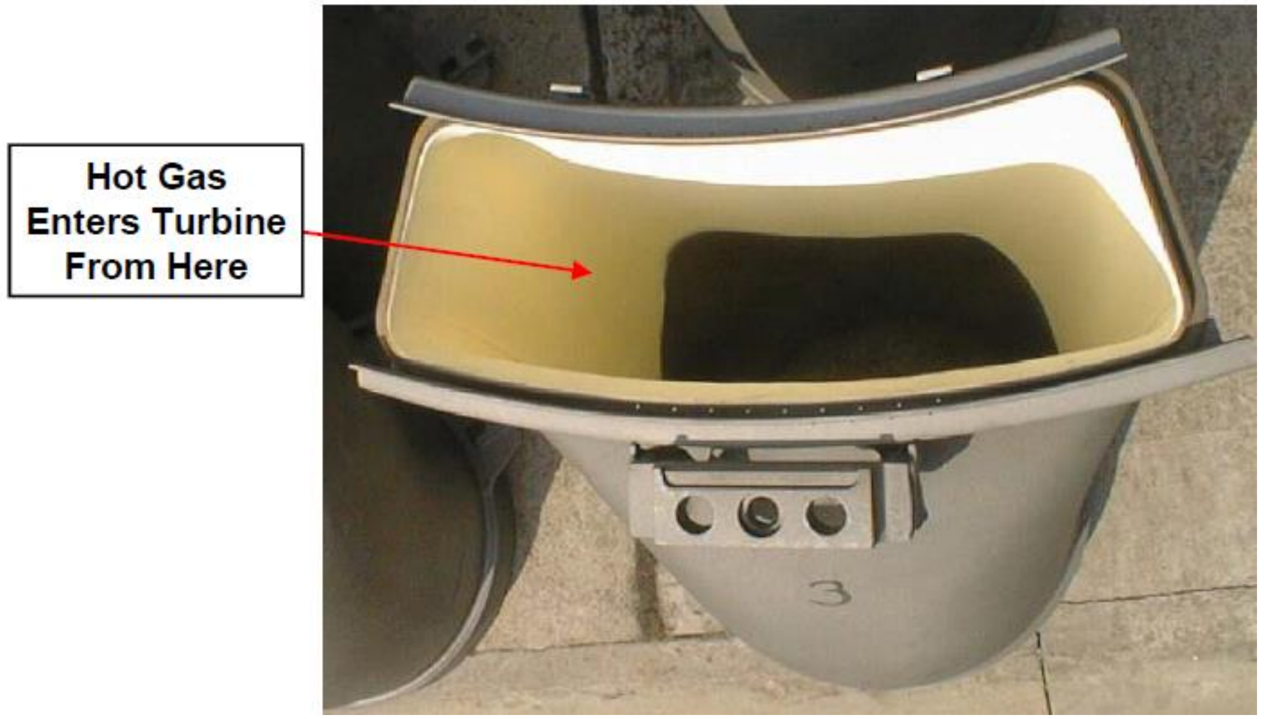
- Used to conduct hot gas (flame) from one Combustion chamber to the next
- Made from 304 Alloy
- Can be welded and machine repaired
- Can be Hard coated

Crossfire Tube Oxidation



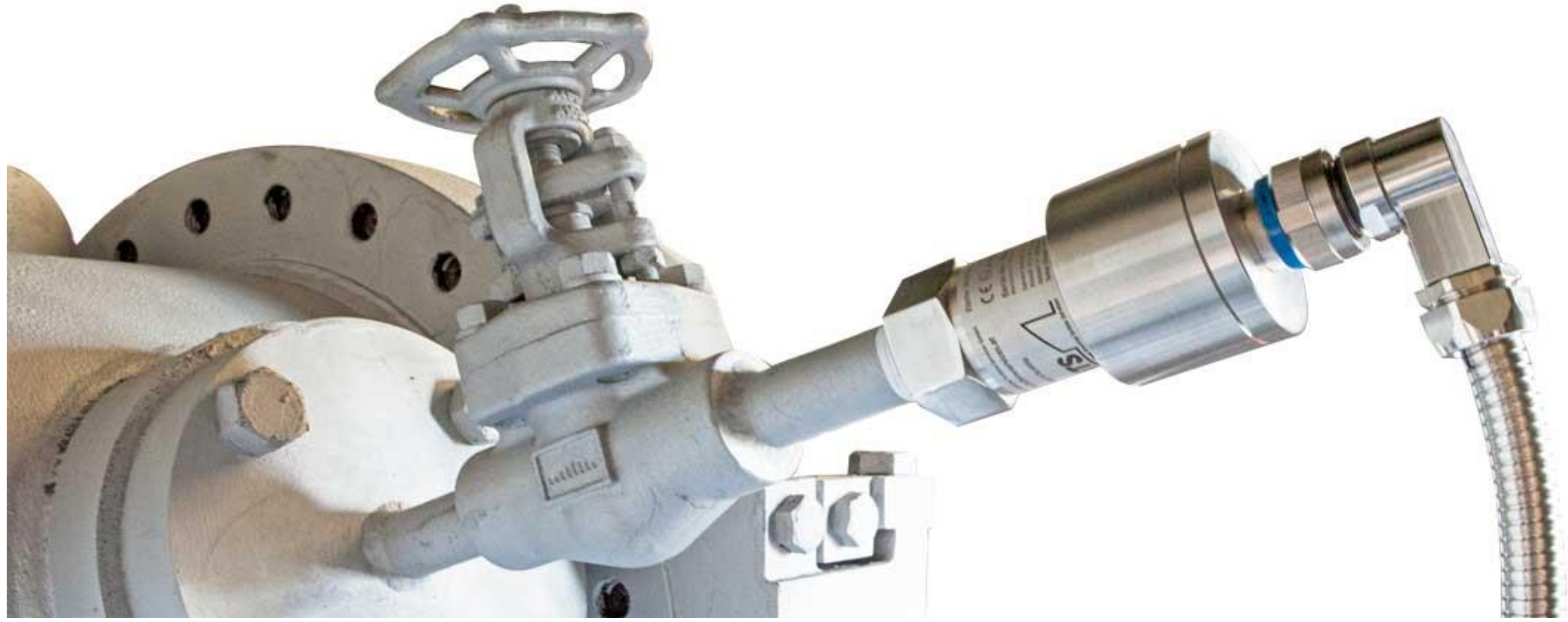
Transition Piece/1st Stage Nozzle

Transition Piece



Spark Plugs

Flame Detector



Additional Combustion Components

Flow Sleeves

• **Sit inside Combustion Chamber. Used to channel cooling air around combustion liner**

Floating Seals

• **Used to provide seal between transition piece and first stage nozzle**

Support Clamp (Bullhorn Bracket)

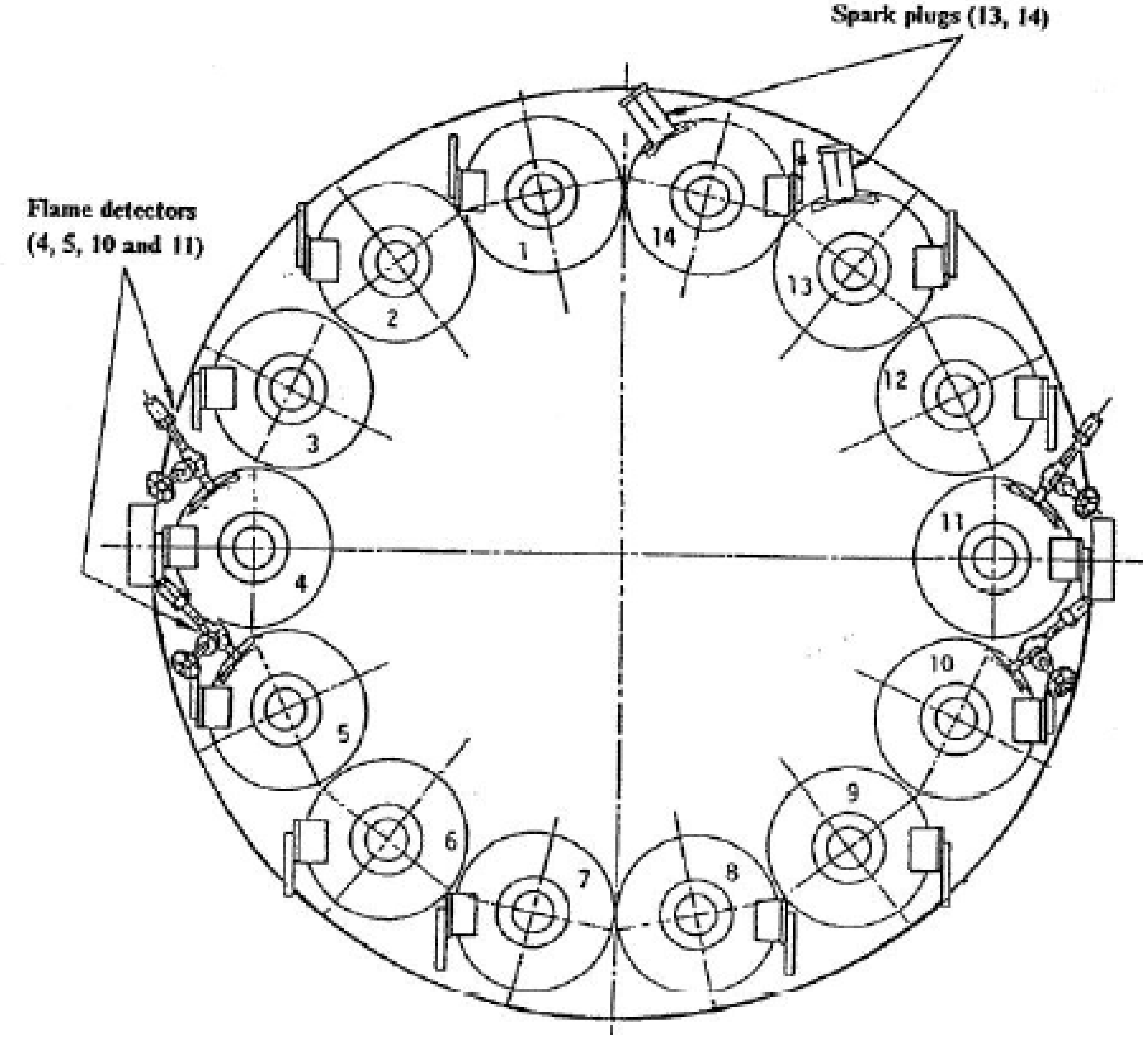
• **Used to support Transition piece at Forward end**

Retractable Spark Plugs

• **Provide ignition spark. Retract due to pressur build up in combustion liner**

Flame Detector

• **Provide frequency signal to control system. Frequency is relative to flame intensity.**



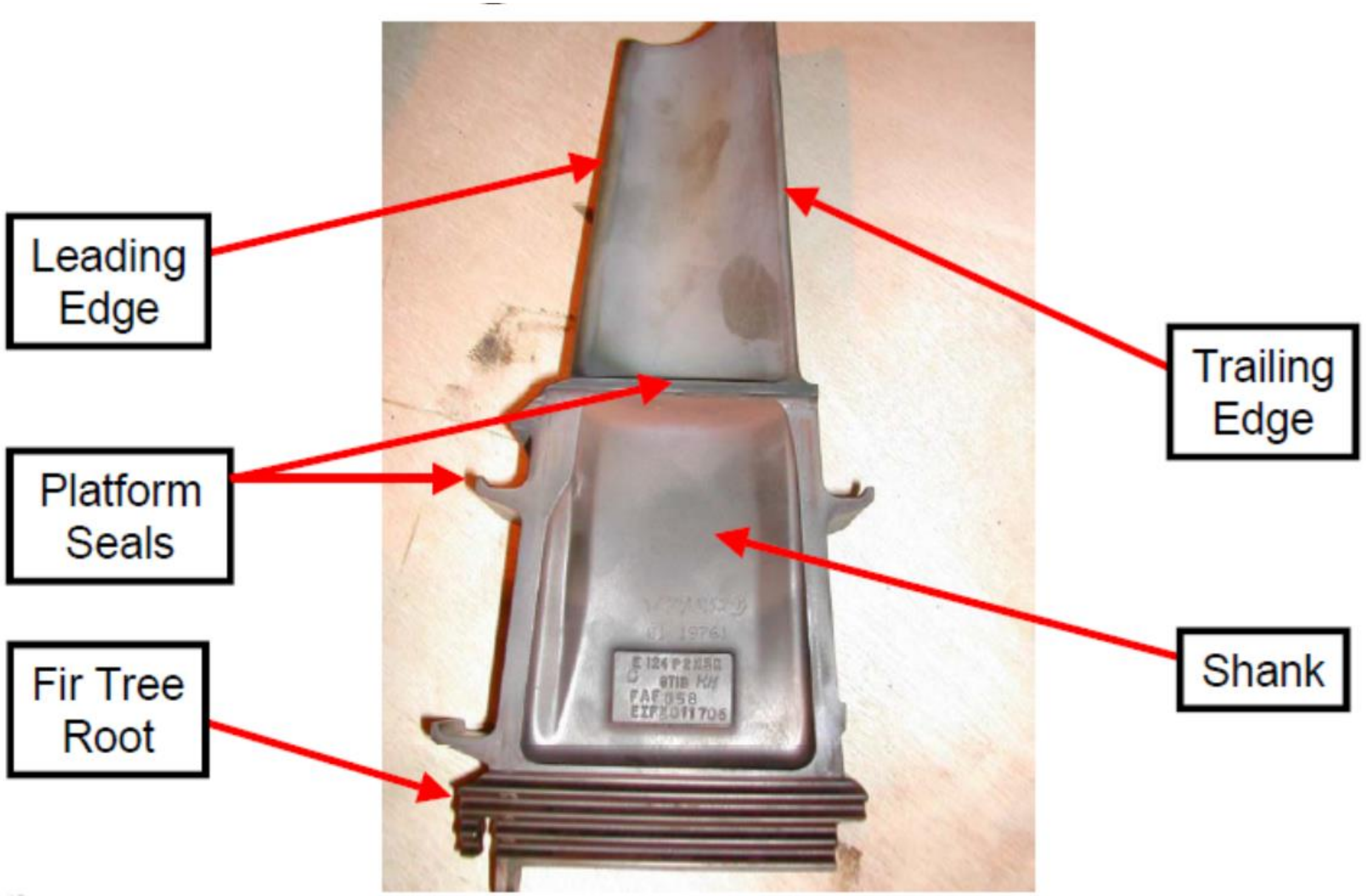
Turbine Section

- **The Turbine section is designed to extract energy from the hot gas stream.**
- **Constructed from highly heat resistant materials.**
- **Made up of stages – *Rotors* and *Nozzles* (or Nozzle Guide Vanes).**

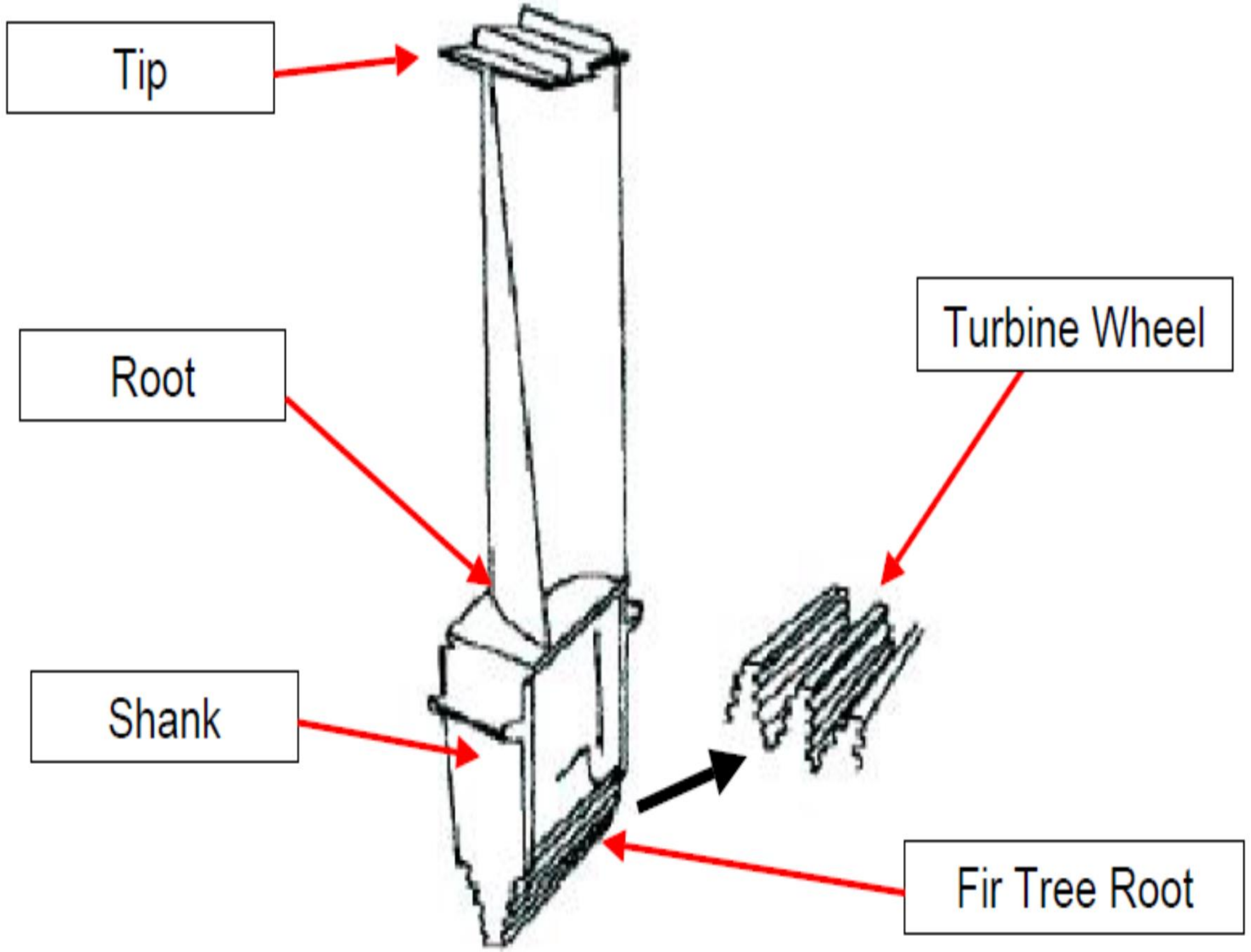
Turbine Rotor Section

Turbine Rotor Blades ("Buckets")

- **Each blade is slotted into a solid 'disc' or 'wheel'.**
- **Blades may be shrouded to prevent tip leakage and vibration.**
- **The most critical temperature in a Gas Turbine is the Turbine Entry Temperature – TET. • Therefore, blades must be made from high temperature materials.**



Turbine Blading



Turbine Blading

- **Each blade is usually twisted. This gives 2 distinct profiles blended together, called *'Impulse'* and *'Reaction'* sections.**
- **The Impulse section is at the root, and the Reaction section at the tip of the blade.**
- **This combination is called *'Vortex'* blading.**

Nozzles

- They are of aerofoil section.
- Direct gases onto the Rotor at the correct angle.
- Increase gas velocity.