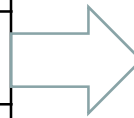


ME265: Thermal Engineering & Heat Transfer

Chapters
1. Energy Scenario
2. Thermodynamics
3. Mechanical Machines & Systems
4. Heat Transfer



3.1	IC Engines
3.2	Gas Turbines, Jet Engines
3.3	Steam Turbines
3.4	Boilers
3.5	Refrigeration & AC systems

A view of Steam Turbine in a Power Station



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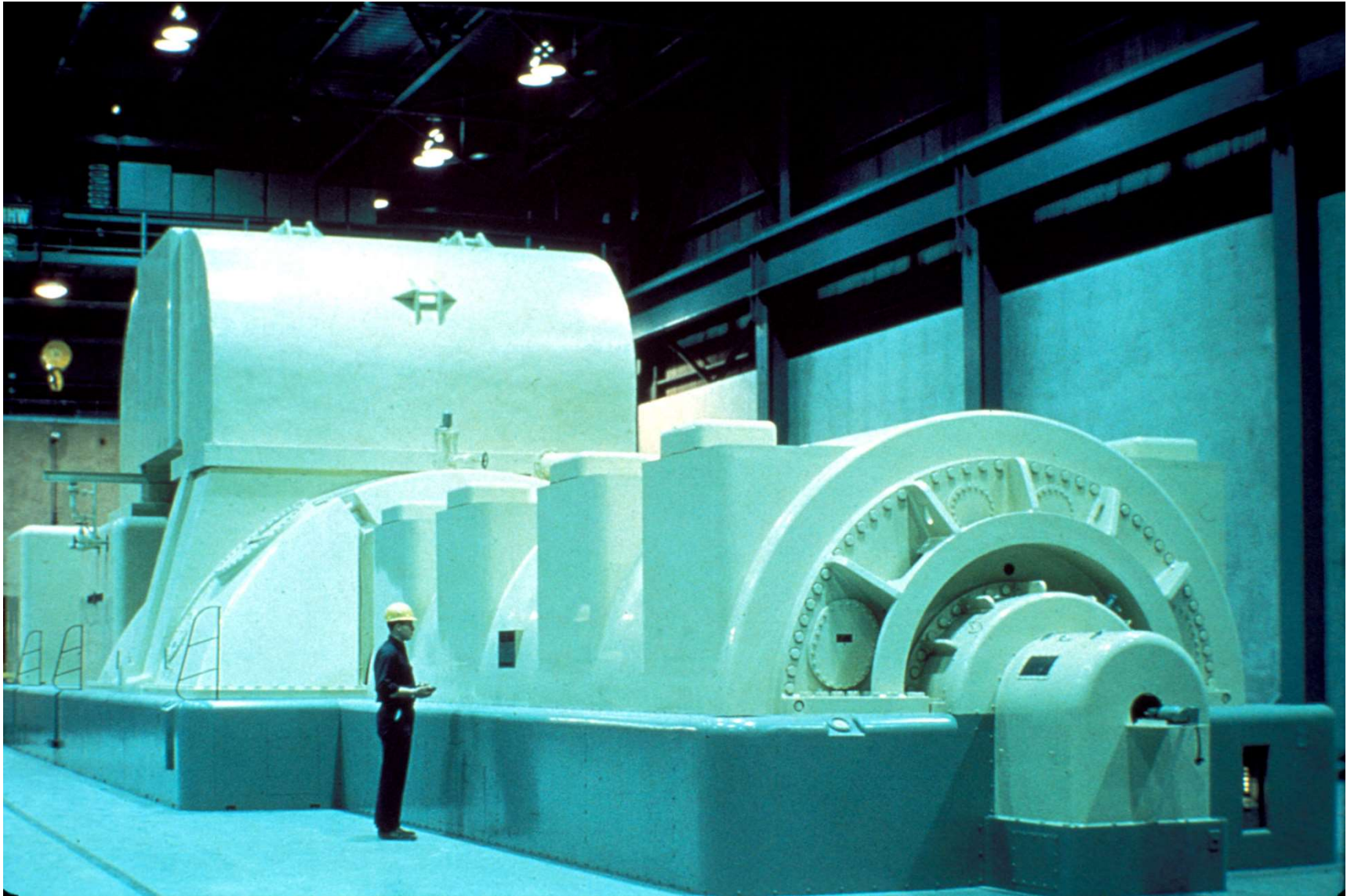
A view of Steam Turbine in a Power Station



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A view of Steam Turbine in a Power Station

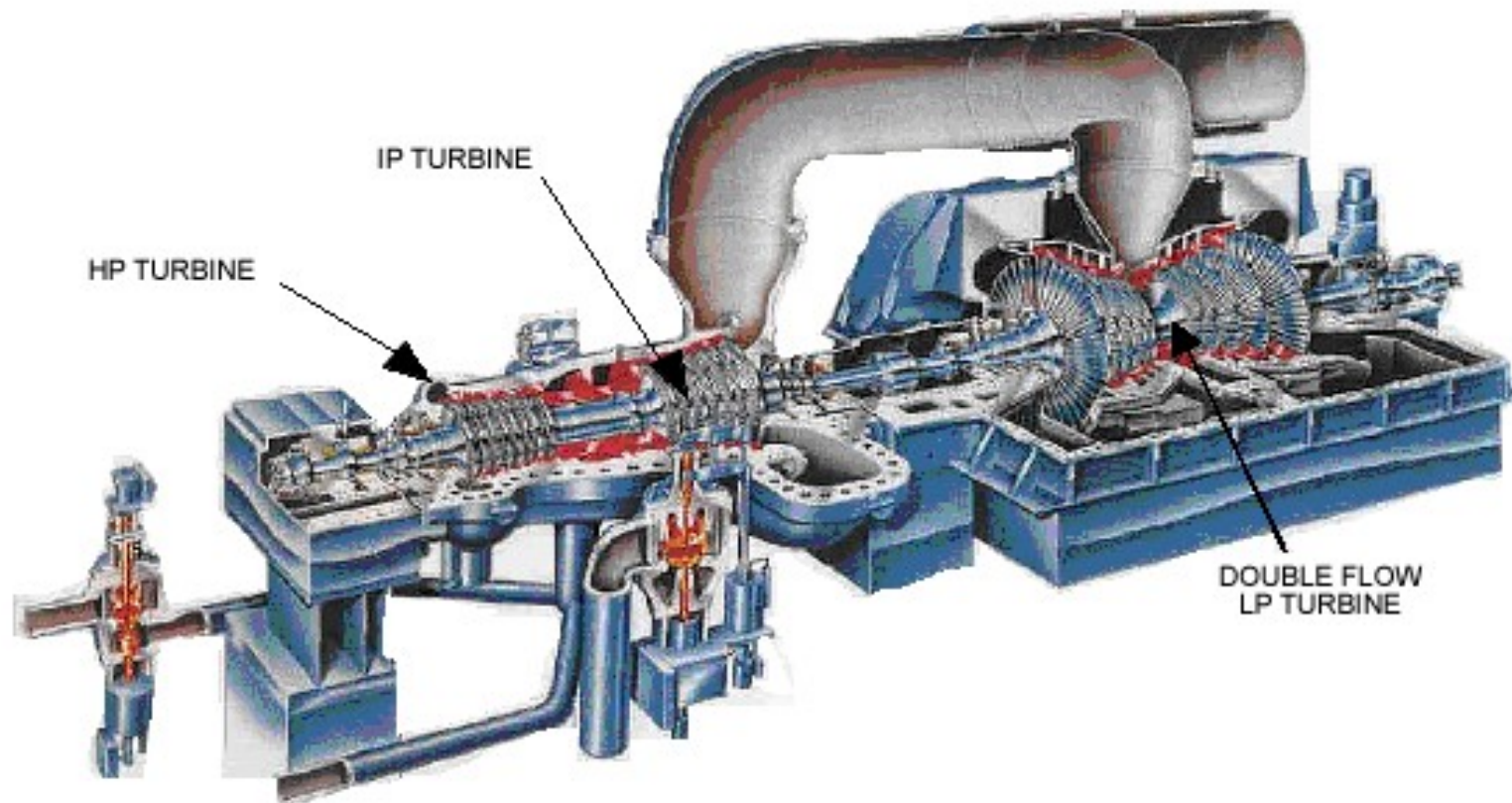


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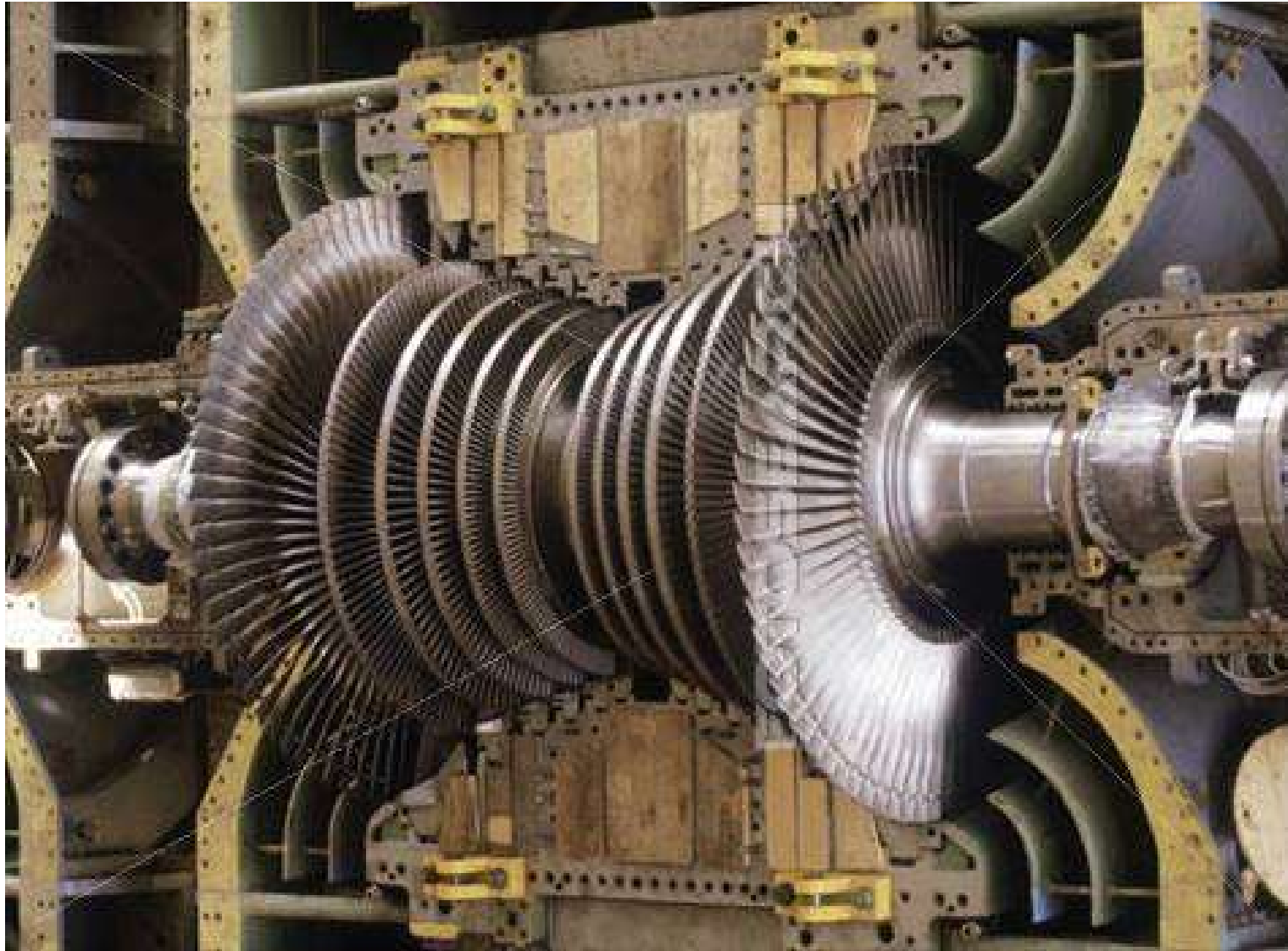
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A view of Steam Turbine in a Power Station



VIEW OF THE INTERNALS OF A TYPICAL POWER STATION STEAM TURBINE

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Steam Turbine

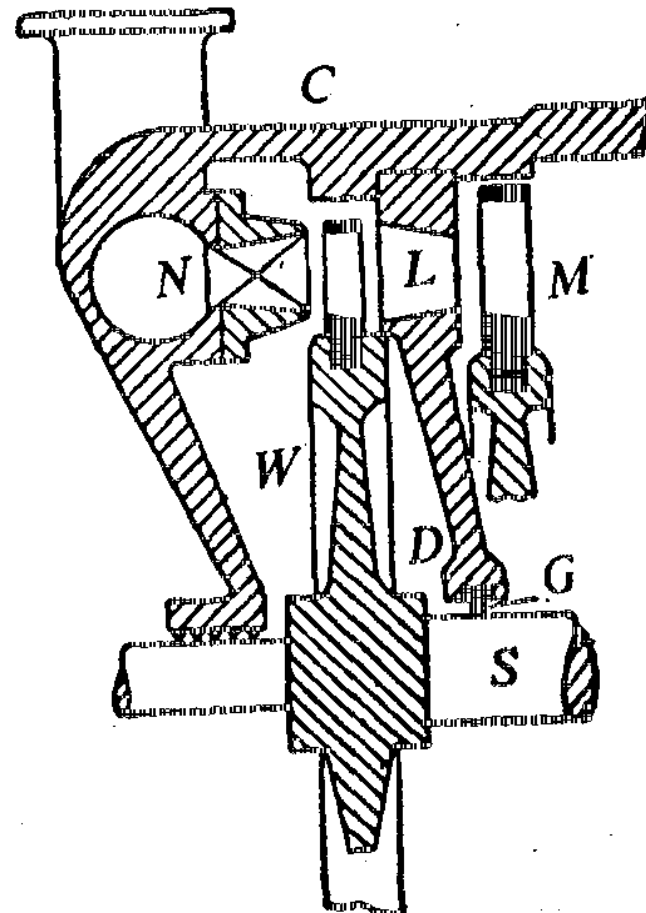
- A steam turbine is prime mover which uses steam as its working fluid.
- It operates by performing two functions : (i) a part or whole of the pressure energy of steam is transformed into kinetic energy by means of expansion through suitable passages such as nozzles and (ii) then the kinetic energy and the remaining portion of the pressure energy of steam, if any, are converted into mechanical work with the help of moving blades fitted on the wheel.
- Therefore, a steam turbine may be defined as a form of heat engine in which the pressure energy of steam is transformed into kinetic energy by means of expansion through nozzles or similar devices and then the kinetic energy and the remaining portion of pressure energy are converted into mechanical work with the help of moving blades.
- Basically, a steam turbine is an assemblage of nozzles and blades

Turbine Details

A steam turbine mainly consists of

- (a) Nozzles,
- (b) Blades or buckets,
- (c) Wheel or rotor,
- (d) Casing or cylinder
- (e) Diaphragms, and
- (f) Glands

The blades, called moving blades, are fitted over the circumference of the wheel which is again mounted over a shaft. The wheel is covered with a casing or cylinder. The nozzles and fixed blades are fitted with the cylinder.

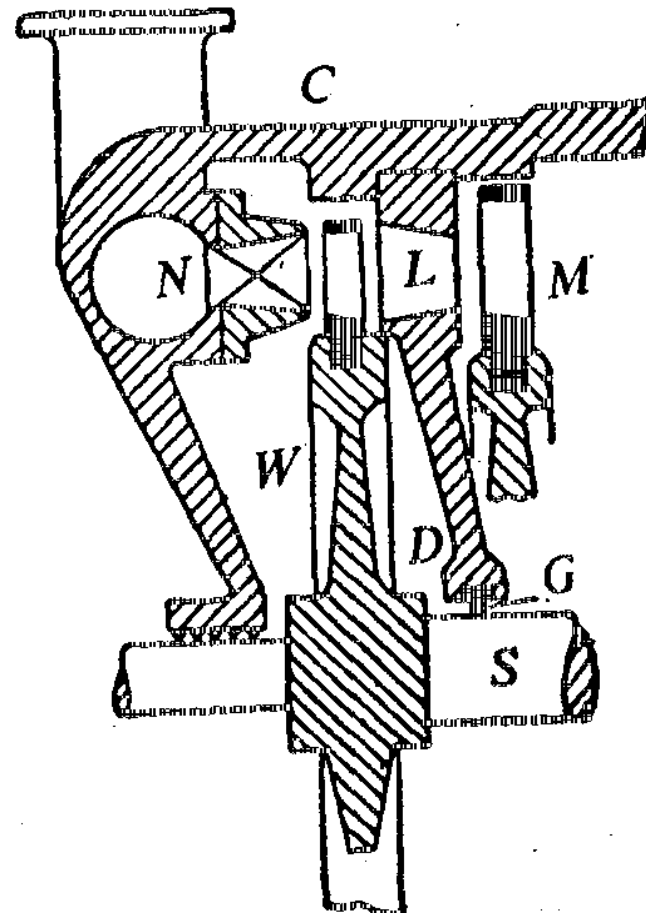


**W-Wheel; S-Shaft; M-Moving blades;
L-Fixed blade/nozzle; C-Casing;
D-Diaphragm; G-Gland; N-Nozzle**

Nozzles:

A nozzle is a steady flow device and is nothing but a passage of varying cross section for the flow of steam in order to increase its velocity by expansion with decrease of pressure. Its main function is to convert the available enthalpy into kinetic energy by producing a jet of steam at a high velocity.

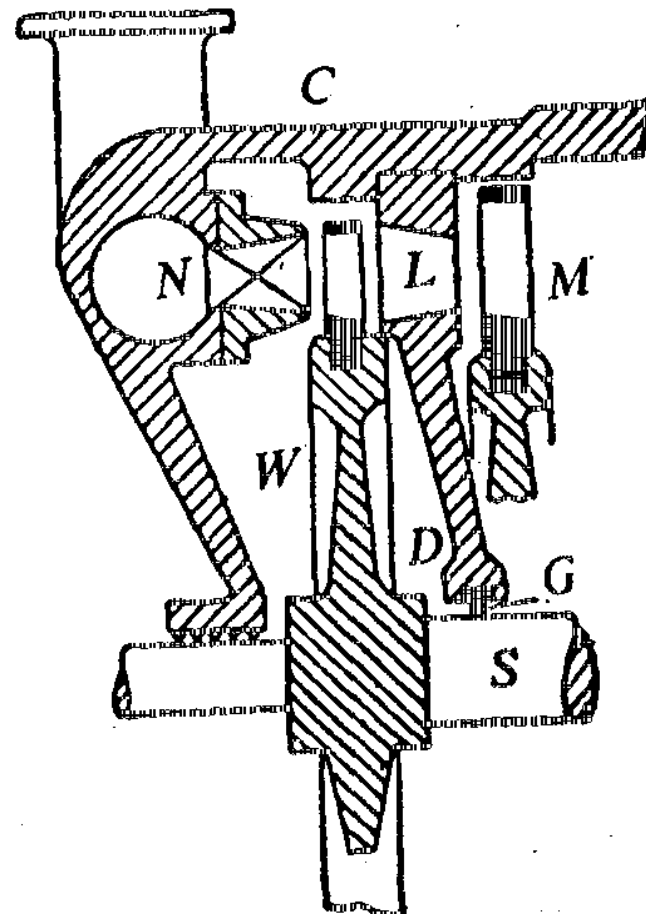
The section of a nozzle may be round, square, or rectangular. They are used in impulse turbines and fitted with the casing or with diaphragms.



**W-Wheel; S-Shaft; M-Moving blades;
L-Fixed blade/nozzle; C-Casing;
D-Diaphragm; G-Gland; N-Nozzle**

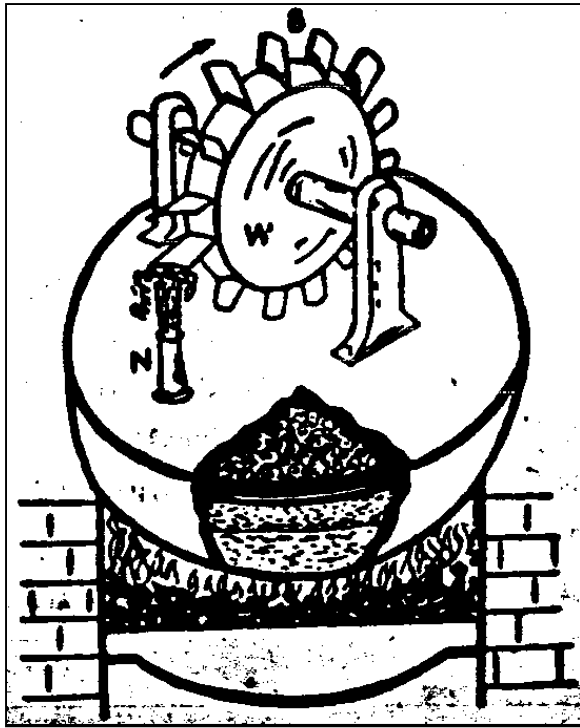
Blades:

Turbine blades also called *buckets* may be classified according to its shape as **impulse blades** and **reaction blades**. The blades of both the groups may be of *moving type* or of *stationary type*. Moving blades are fixed on the rim of the wheel or rotor and stationary or guide or fixed blades are fitted with the casing.

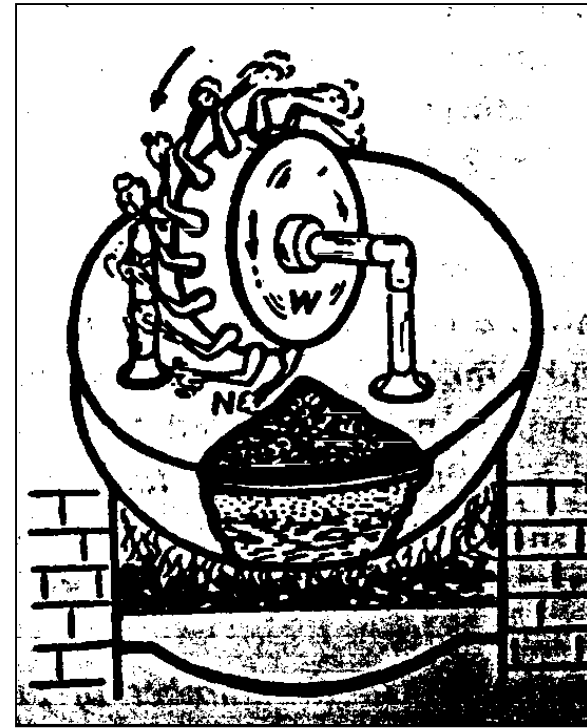


**W-Wheel; S-Shaft; M-Moving blades;
L-Fixed blade/nozzle; C-Casing;
D-Diaphragm; G-Gland; N-Nozzle**

Impulse and Reaction principles



Impulse



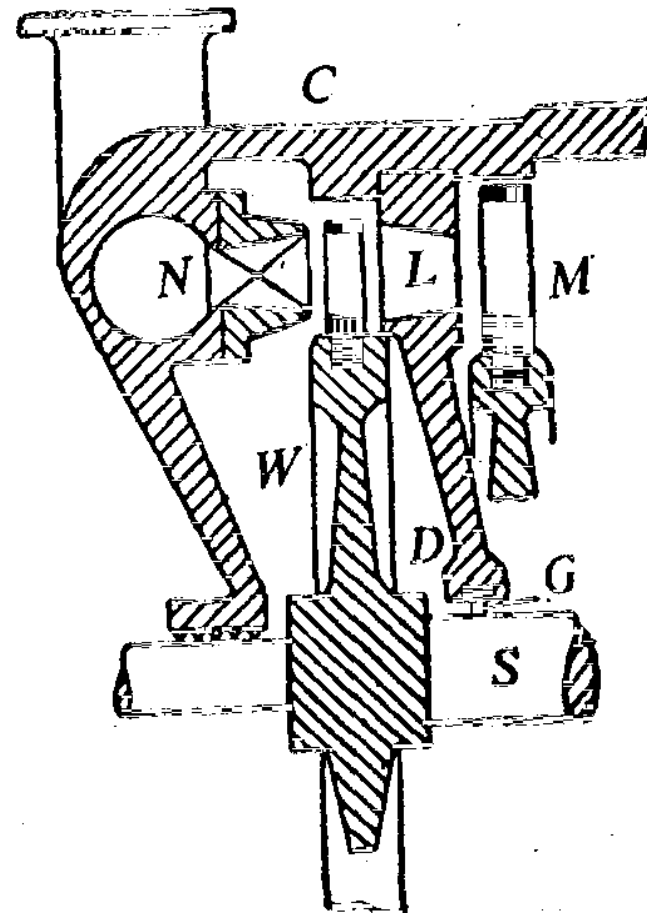
Reaction

Wheel and rotors:

A turbine wheel in its simplest form is like a flat disc mounted on a shaft. It is also called the disc. Moving blades are fitted over the rim of the wheel in the form of a ring. The rotor consists of several discs.

Diaphragms:

The diaphragm is in the form of a disc which is fitted inside the cylinder. It serves the purpose of separating walls between the different stages of the turbine and carries nozzles and fixed blades. It must be strong enough to withstand the high temperature and the pressure difference of working fluid.



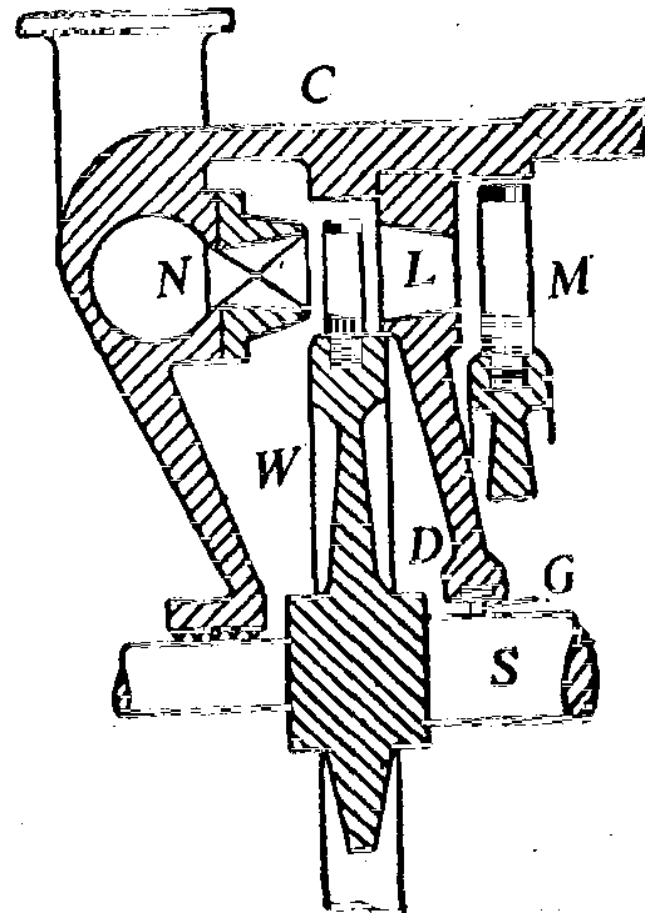
**W-Wheel; S-Shaft; M-Moving blades;
L-Fixed blade/nozzle; C-Casing;
D-Diaphragm; G-Gland; N-Nozzle**

Glands:

Glands are required to prevent

- (a) the leakage of working fluid from the cylinder to the outside if its pressure is above the atmosphere,
- (b) the leakage of air from outside to the cylinder if the inside pressure is less than the atmosphere,
- (c) the leakage of working fluid from one stage to the other.

Glands are fitted in the place where the shaft enters into the cylinder and the passage between the rotor and the diaphragms.



**W-Wheel; S-Shaft; M-Moving blades;
L-Fixed blade/nozzle; C-Casing;
D-Diaphragm; G-Gland; N-Nozzle**

Depending on the types of blades and methods of energy transfer from fluid to rotor wheel, turbines may be of two types:

1. Impulse Turbine
2. Reaction Turbine

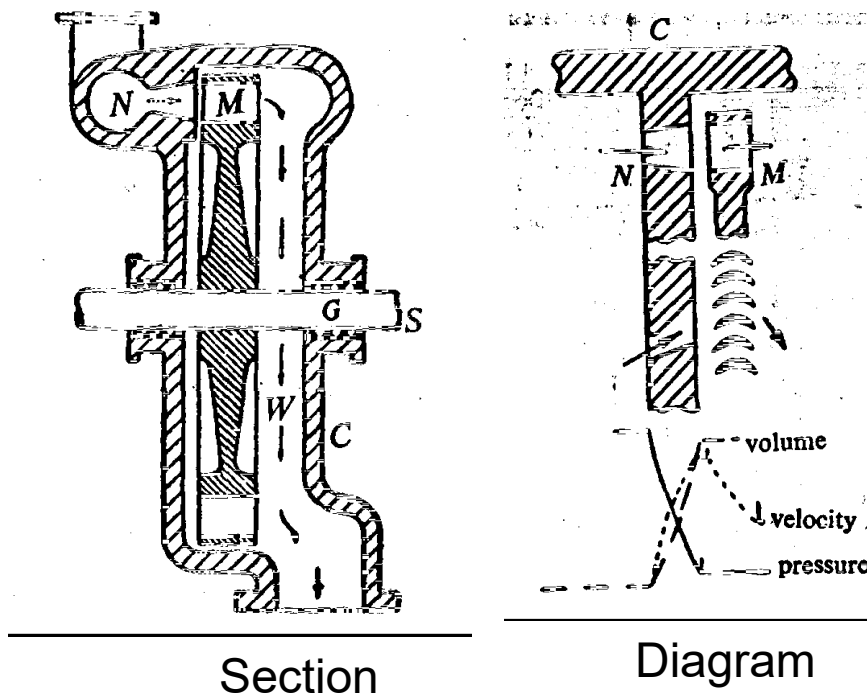


Fig. 3: Simple impulse turbine

**W-Wheel; S-Shaft; M-Moving blades;
C-Casing; G-Gland; N-Nozzle**

In an impulse turbine, the steam taken from the boiler first comes to the steam chest and then it passes through nozzles and impacts on the moving blades.

Due to the impulse of steam over the moving blades, the wheel rotates and so the power is available from the shaft.

As the steam expands through the nozzle, the velocity and the volume of steam are increased with decrease in pressure

Reaction Turbine

- Constructed of rows of fixed and moving blades
- Fixed blades act as nozzles
- Moving blades move as a result of change of momentum of steam and also as a result of expansion.

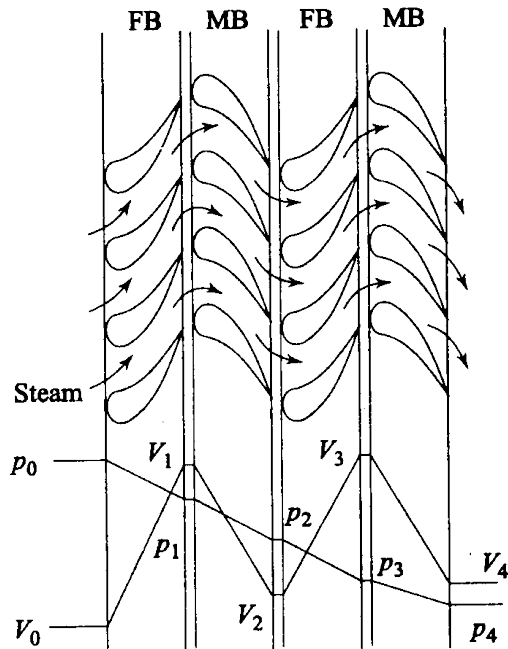


Fig. Two stages of reaction turbine

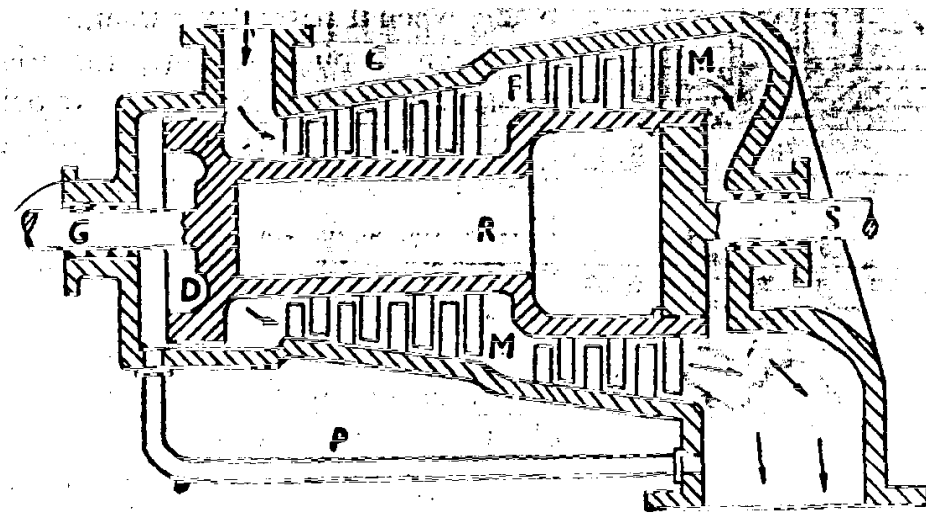


Fig. Multi-stage reaction turbine

Compounded Impulse Turbines

To eliminate the disadvantage of high speed of a simple impulse turbine, the compounding is used.

It consists of one or more sets of nozzles and more than one sets of impulse blades

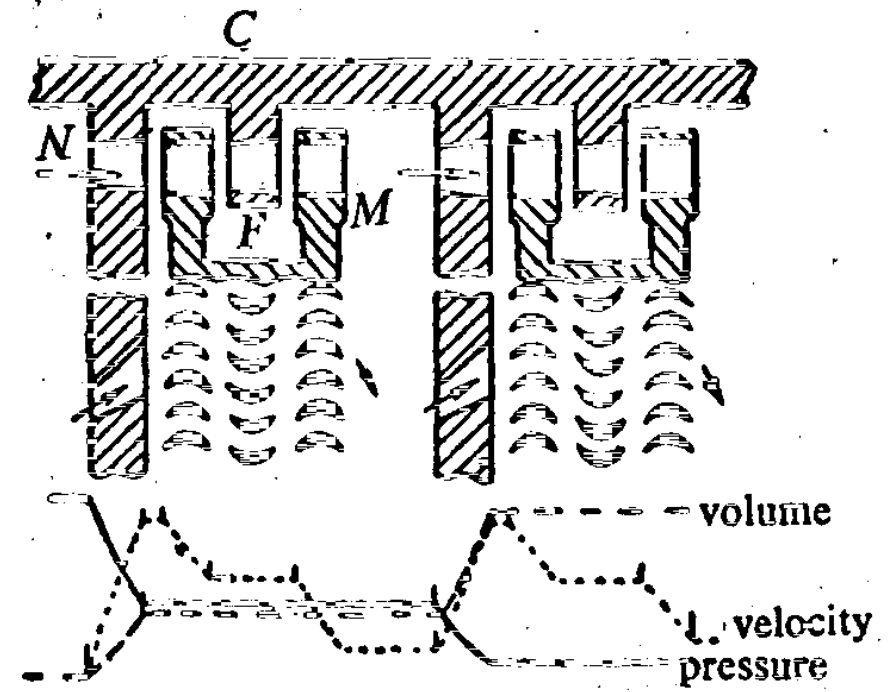
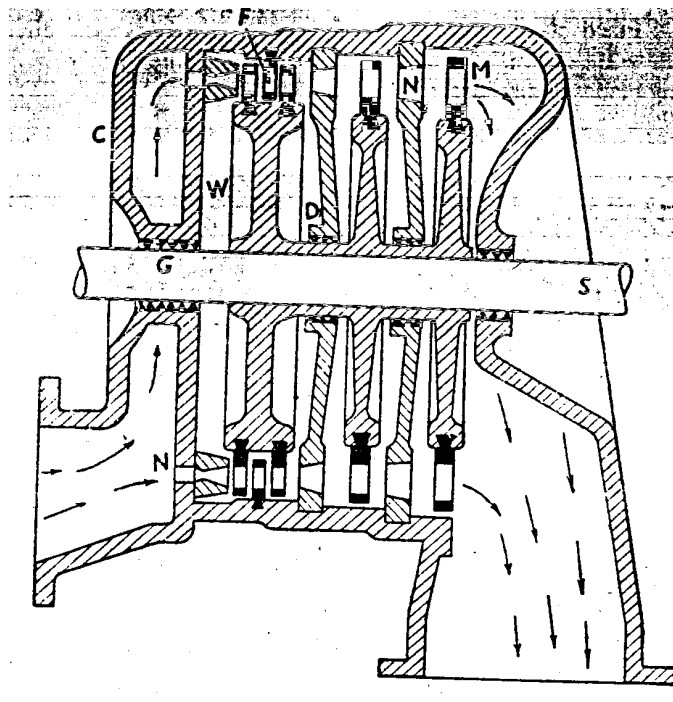
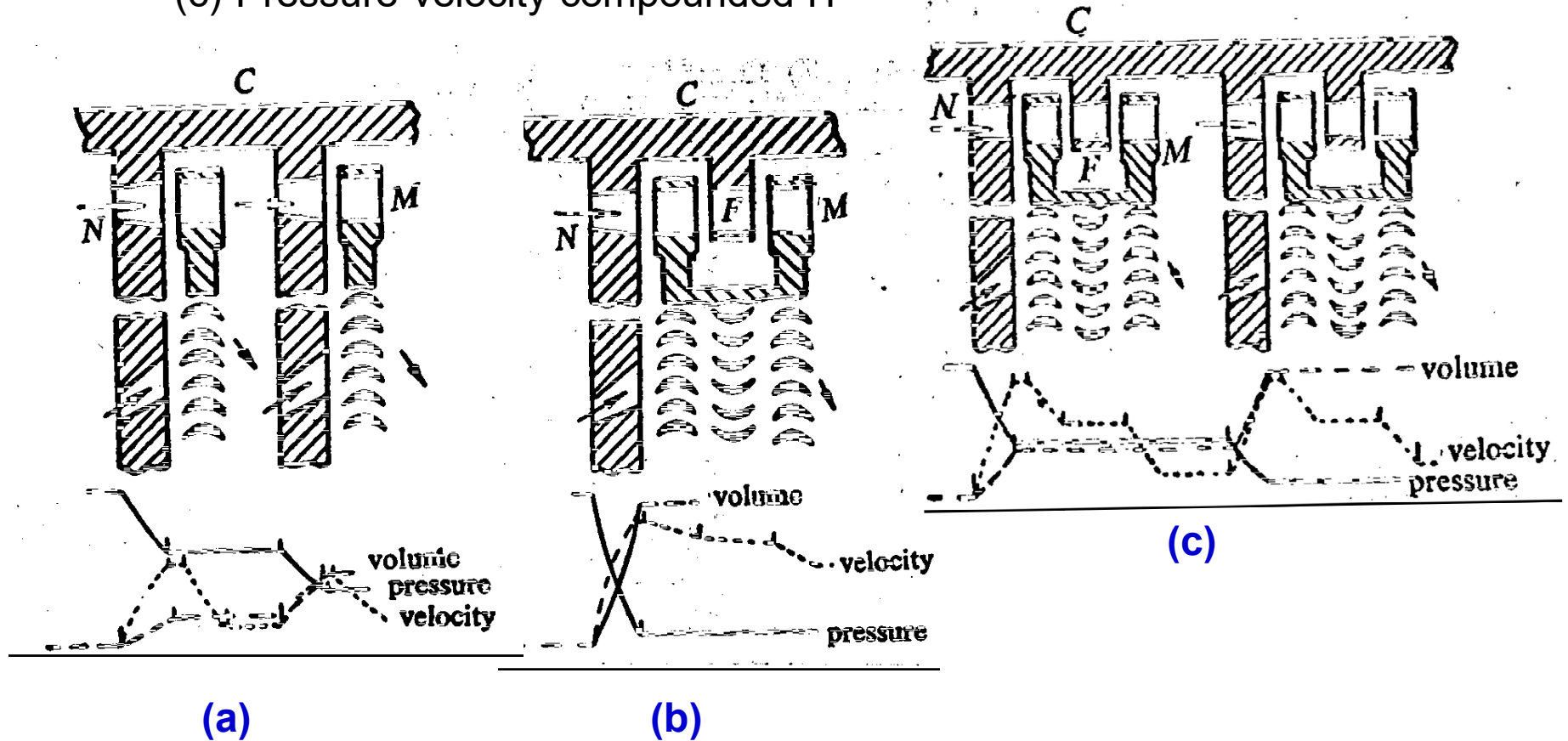


Fig. Compounded impulse turbine

Compounded Impulse Turbines (IT) may be classified as:

- (a) Pressure compounded IT (Rateau stage)
- (b) Velocity compounded IT (Curtis stage)
- (c) Pressure-velocity compounded IT



Combination turbine:

- Early turbines were either impulse or reaction types
- Next popular arrangements were used to be Curtis stage (VCIT) or Rateau stage (PCIT)
- More common arrangements now-a-days are
Curtis stage + reaction stages

EXAMPLE: 15 stage turbine

2-row curtis stage

N MB FB MB

14 reaction stages

FB MB FB MB FB MB

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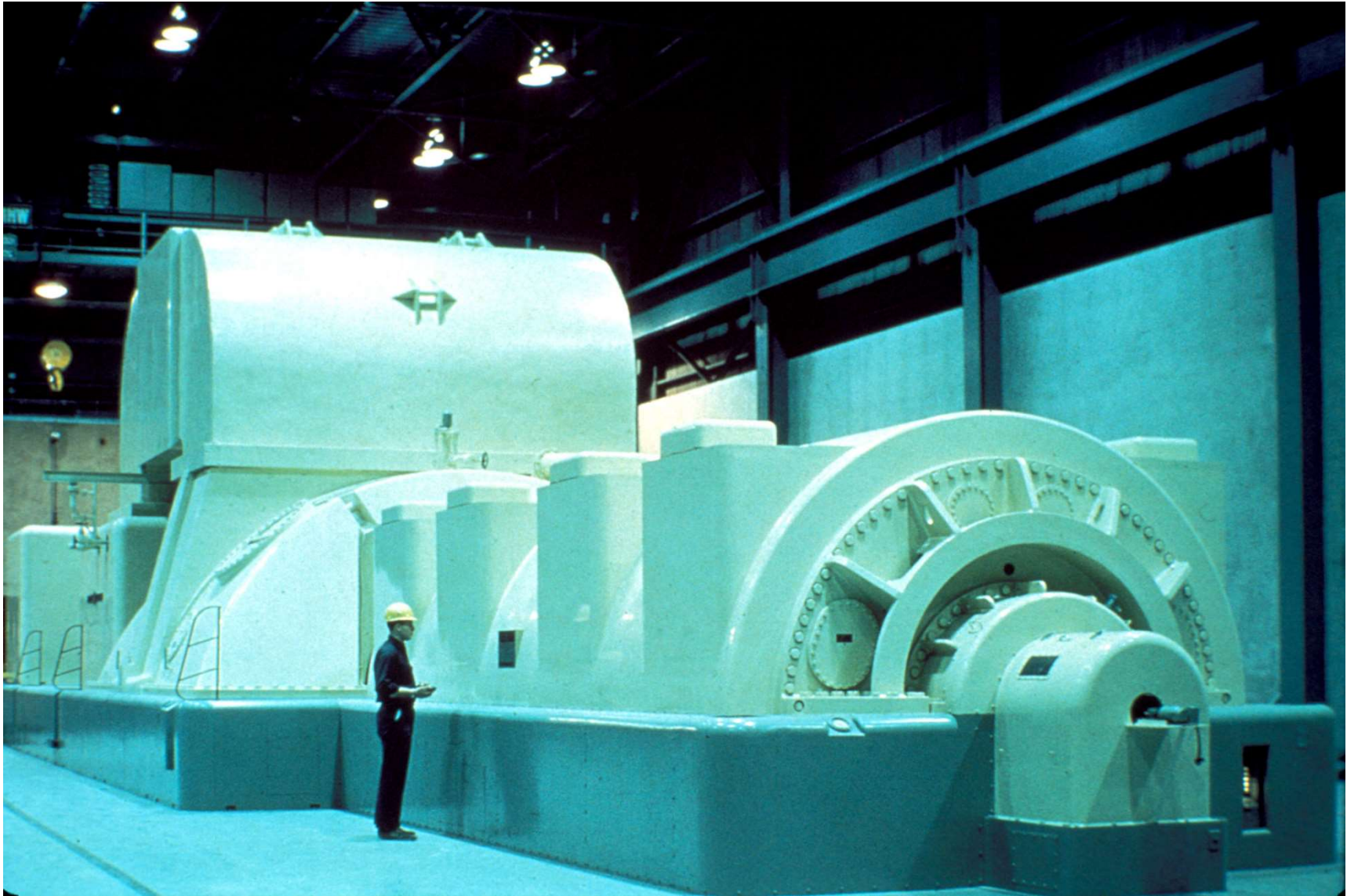


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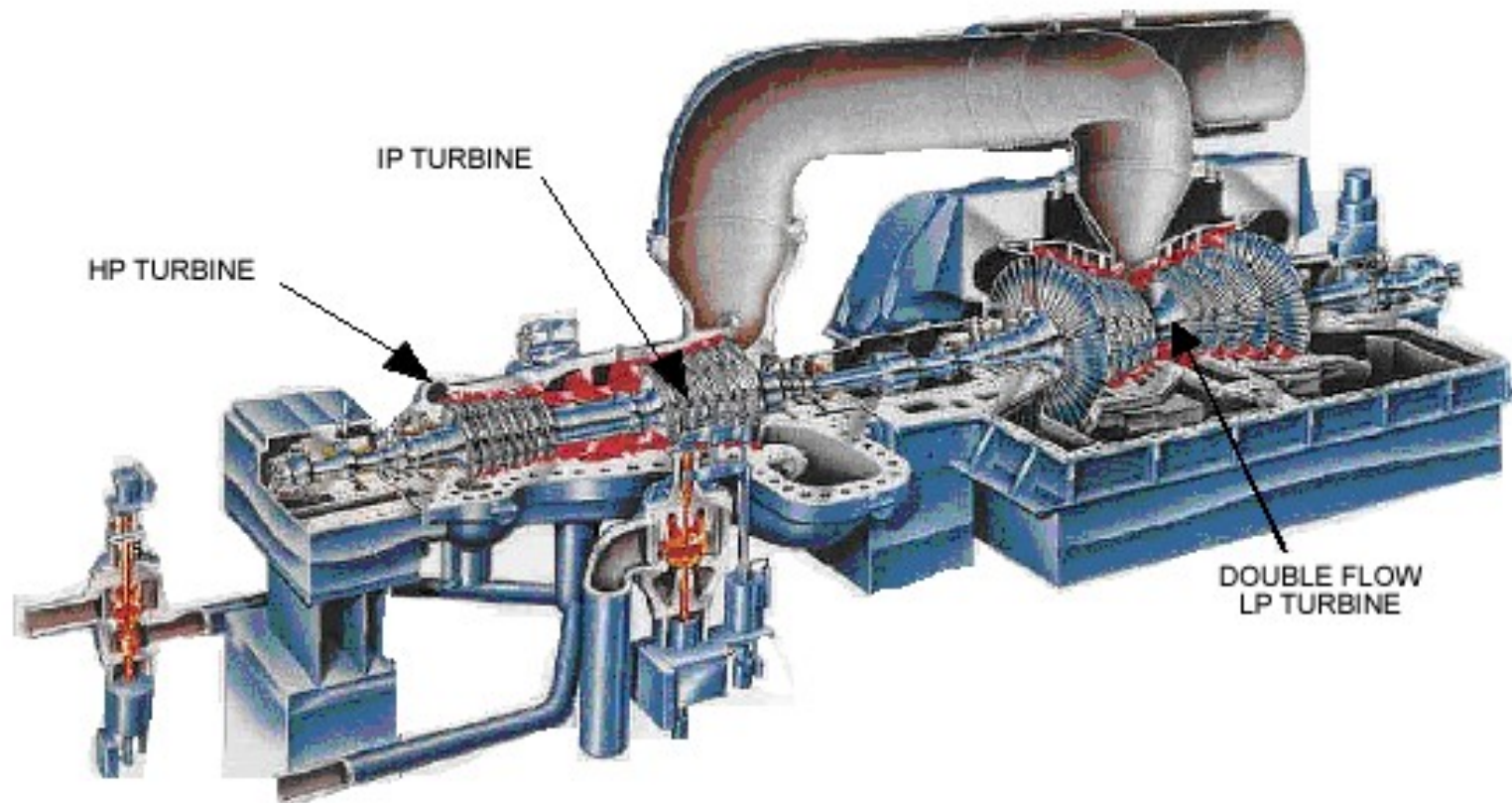


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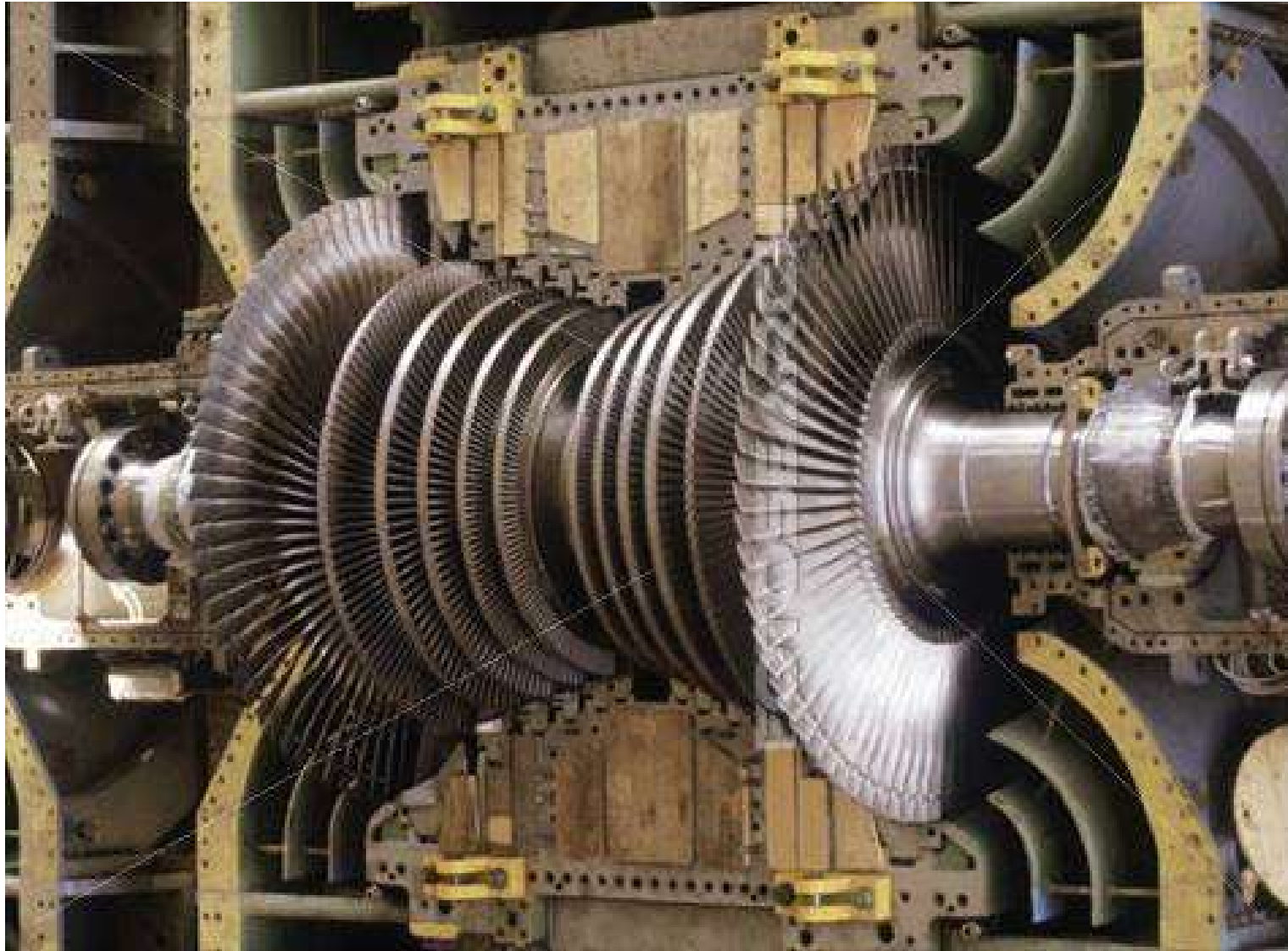
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