TURBINE AND PUMP

- A **turbine** is a rotary engine that extracts energy from a fluid flow and converts it into useful work

  Eg: steam turbine, gas turbine, hydraulic turbine

- Hydraulic Turbines transfer the kinetic energy and potential energy of water into a rotation .

- We can generate electricity by coupling to electric generator
- Pump is work consuming device and it is just opposite to turbine.

  Eg. Centrifugal pump

CLASSIFICATION OF HYDRAULIC TURBINES:

1. BASED ON FLOW PATH

- Axial Flow
- Radial Flow
- Tangential Flow
- Mixed Flow

2. Based on flow path

- **Axial Flow Hydraulic Turbines:** flow path of the liquid mainly parallel to the axis of rotation. Eg: Kaplan turbine

- **Radial Flow Hydraulic Turbines:** liquid flowing mainly in a plane perpendicular to the axis of rotation.

- **Tangential Flow Hydraulic Turbines:** liquid flowing mainly in a plane tangential to the turbine. Eg: Pelton turbine

- **Mixed Flow Hydraulic Turbines:** For most of the Hydraulic Turbines used there is a significant component of both axial and radial flows. They are called as Mixed Flow Turbines.

  eg.Francis Turbine is an example of mixed flow type, in Francis Turbine water enters in radial direction and exits in axial direction.

3. BASED ON WORKING PRINCIPLE

- Impulse turbine
- Reaction turbine

Kinetic energy changes and pressure energy → Stator → runner → Kinetic energy changes but pressure energy remains constant

Fig Impulse machine

- Pressure change occur only in the nozzles of the machine. Eg : Pelton Turbine.

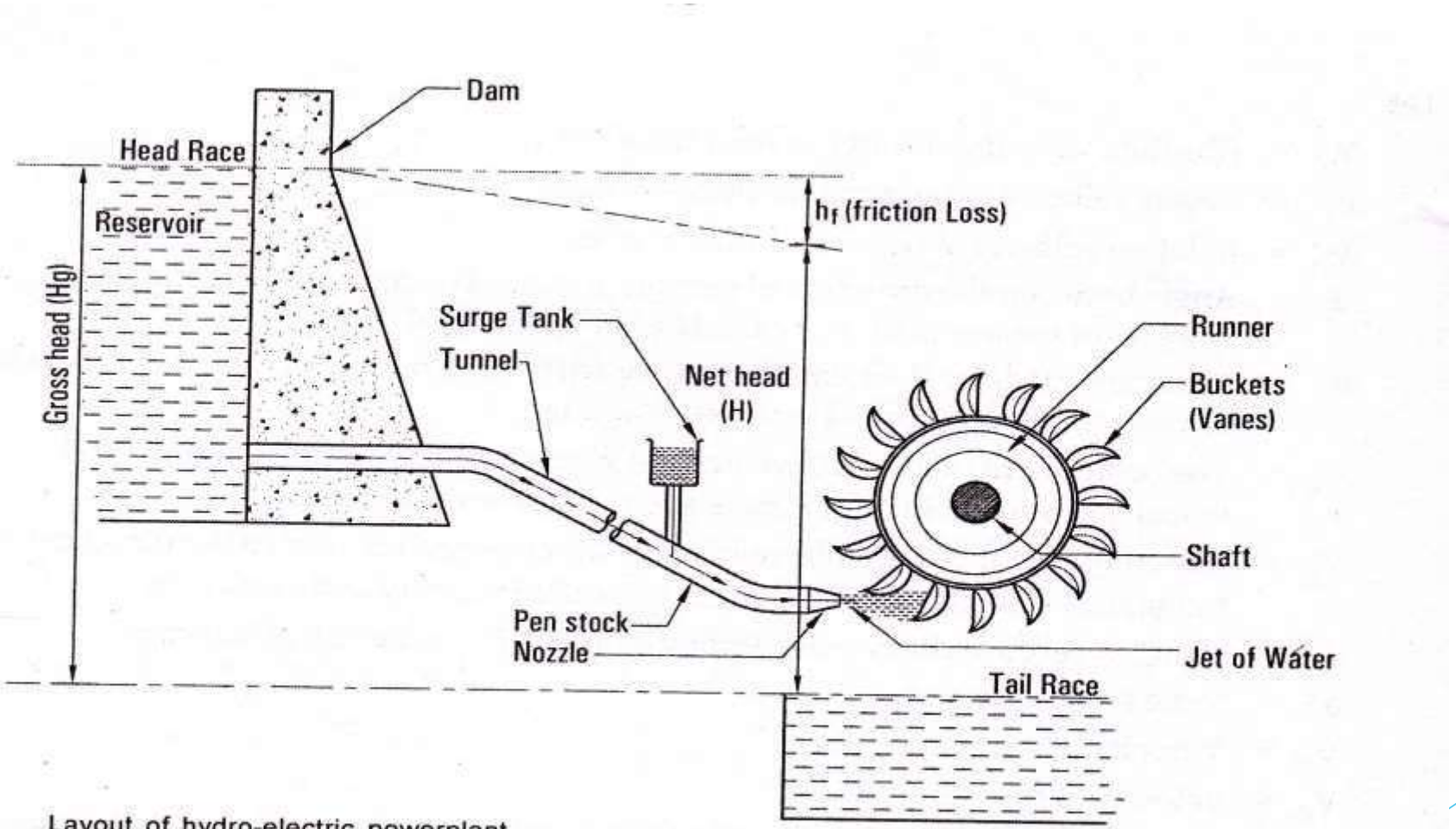
- The change in fluid velocity and reduction in its pressure causes a reaction on the turbine blades.

  Eg: Francis and Kaplan Turbines

Fig Reaction machine

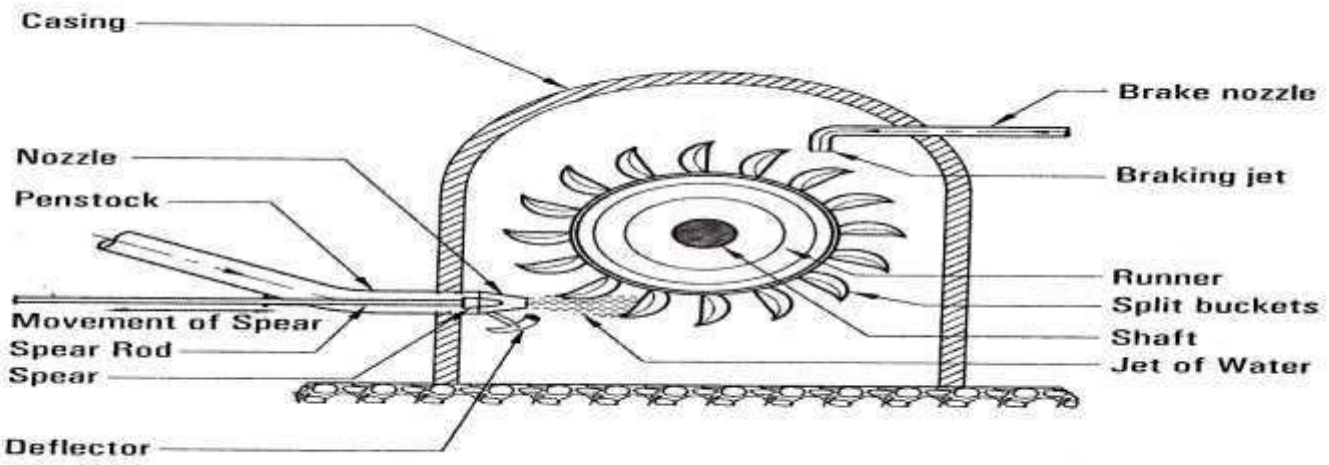
SL NO	IMPULSE TURBINE	REACTION TURBINE
1	Impulsive force is rotating the turbine	Reaction force is rotating turbine
2	Pressure of liquid is decreasing in nozzle before entering to turbine	Pressure decreases as it flows over the blades
3	Blades are of symmetrical profile	Blades having aerofoil profile
4	The size of turbine is small for the same power output	Size of reaction turbine is large for the same power output
5	Whole pressure energy of water is converted into kinetic energy before passed onto turbine wheel	Part of pressure energy only converted to kinetic energy
6	Water discharges directly from turbine wheel to tail race	Water discharges into a draft tube then it is finally discharged to tail race
7	Pressure of water will be atmospheric as it flows over moving blades	Pressure of water continuously decreases as it flows over the blades

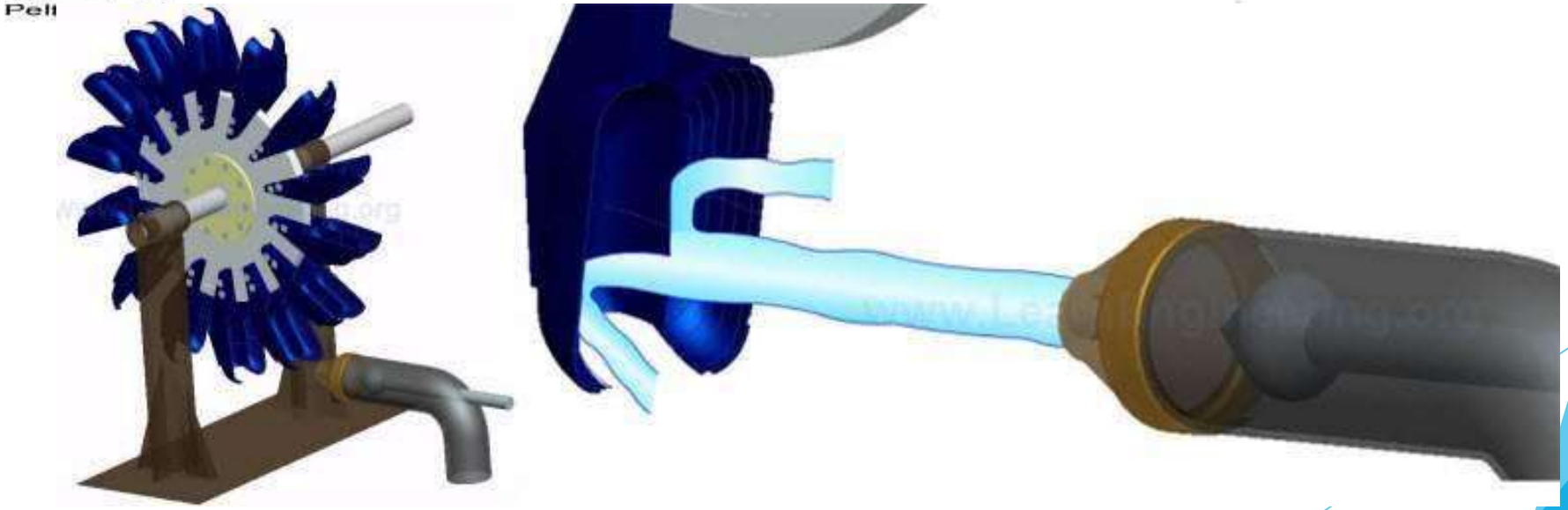
PELTON TURBINE POWER PLANT



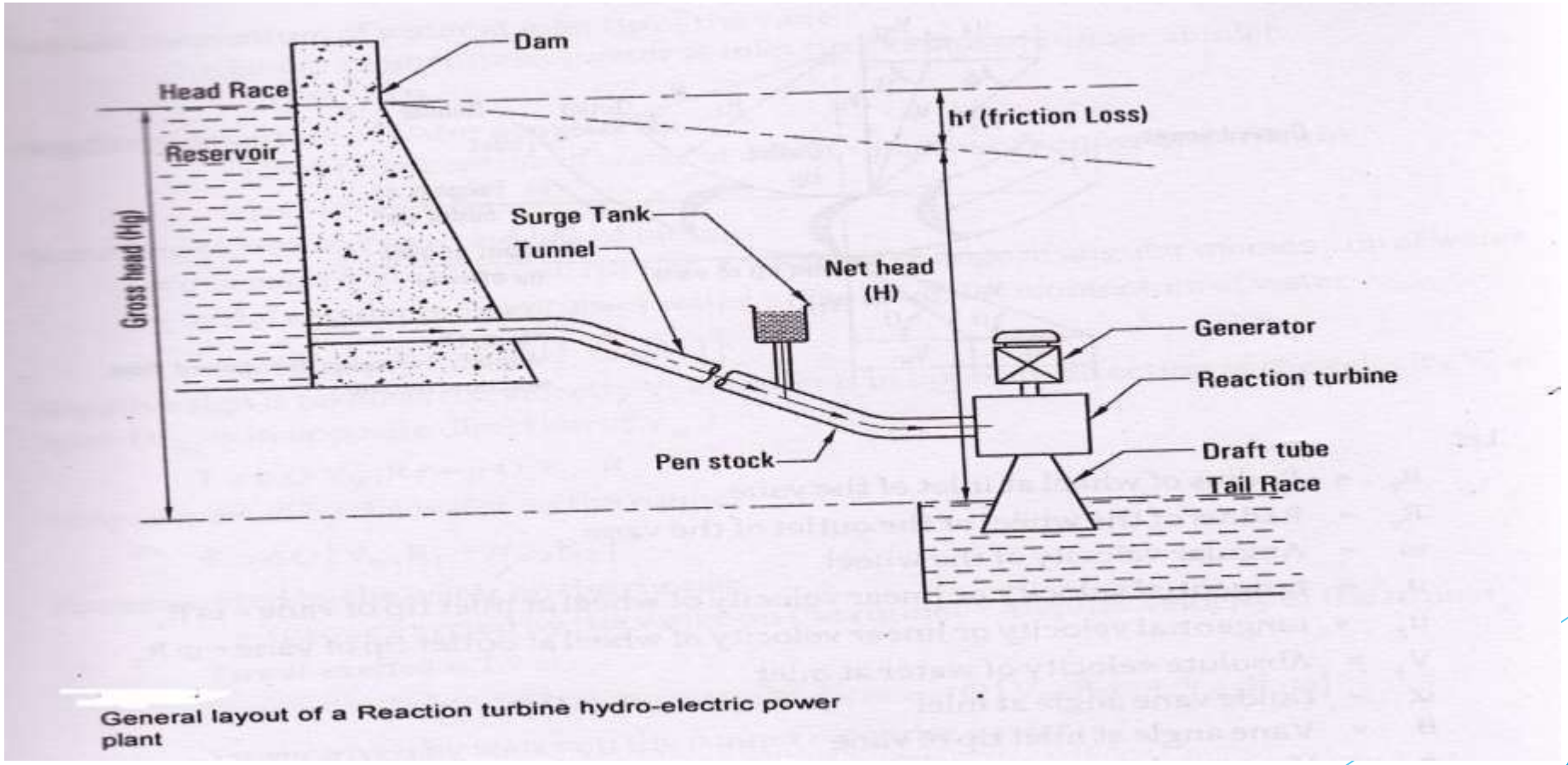
Layout of hydro-electric powerplant with pelton wheel

PELTON TURBINE



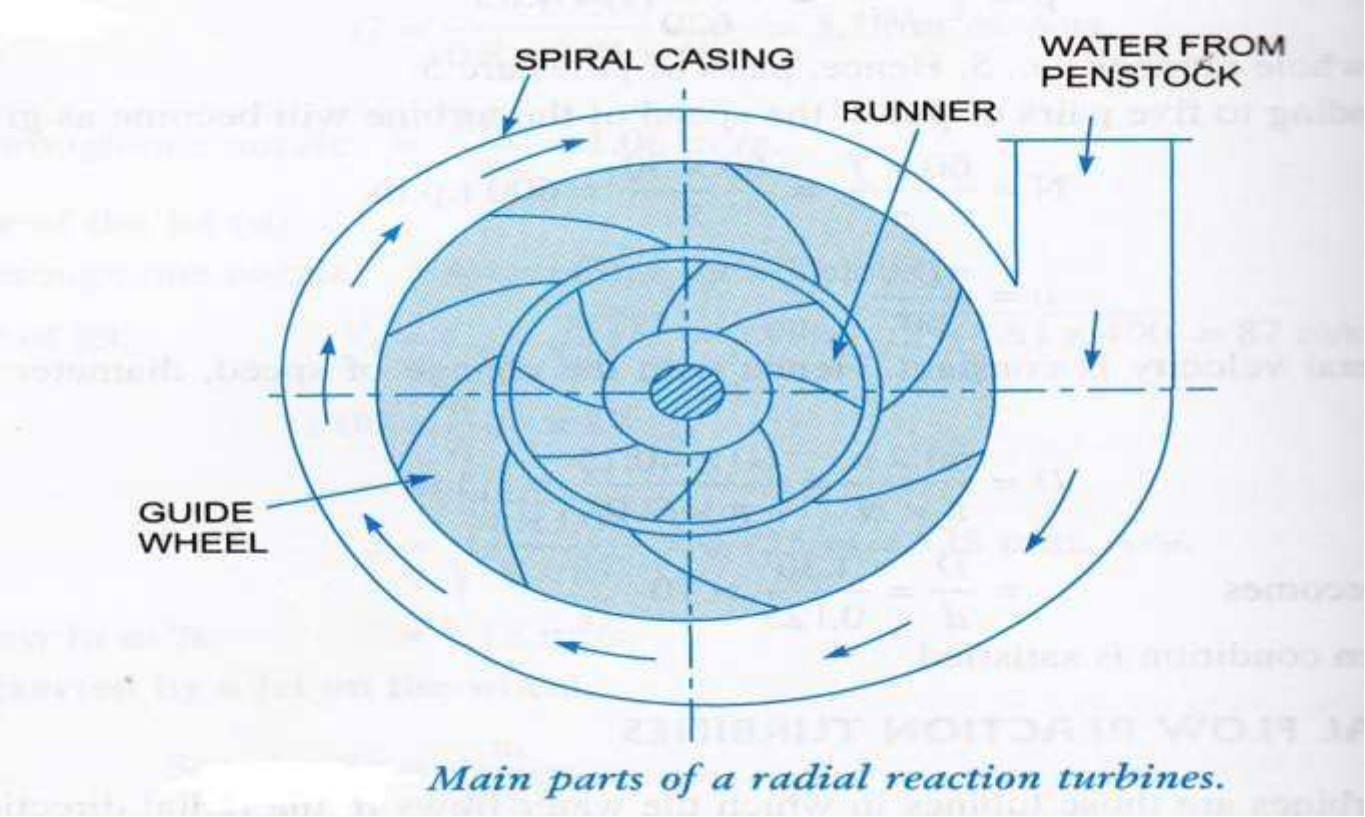


REACTION TURBINE



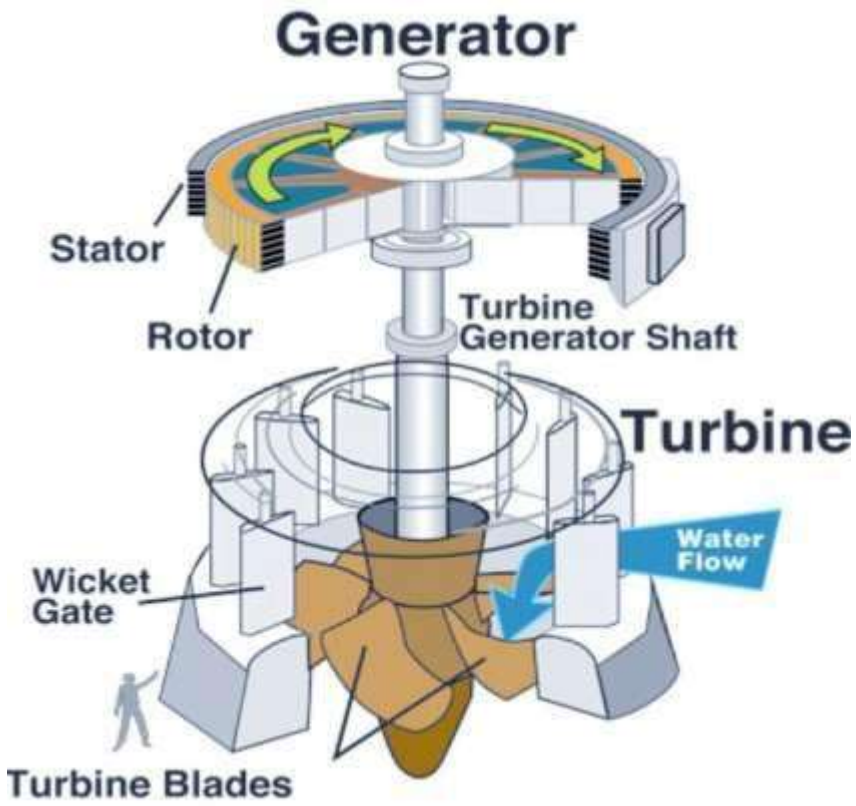
General layout of a Reaction turbine hydro-electric power plant

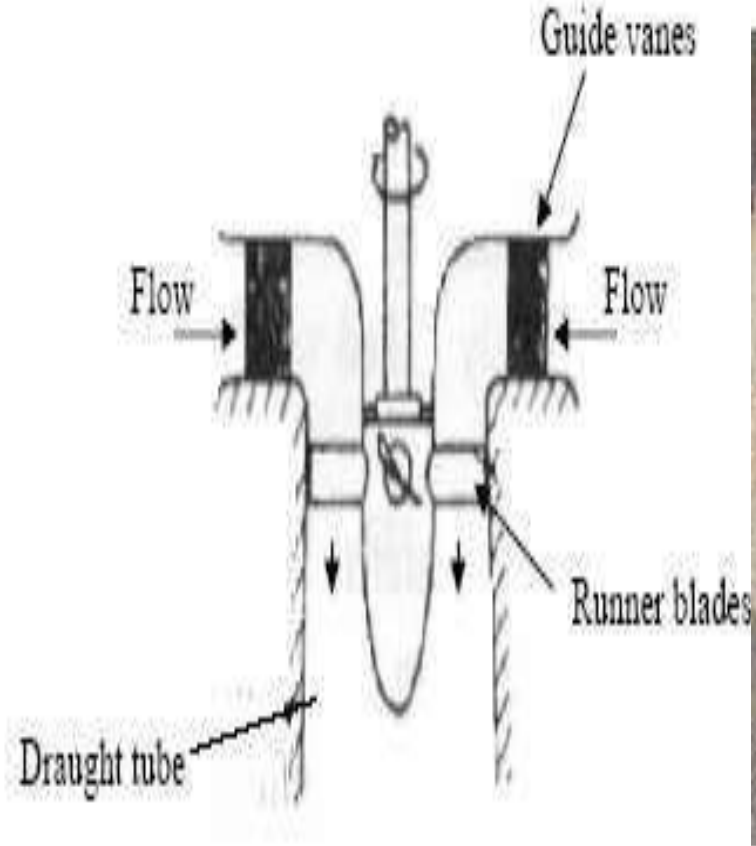
Francis Turbine



Main parts of a radial reaction turbines.

Kaplan Turbine:





CLASSIFICATION OF PUMPS

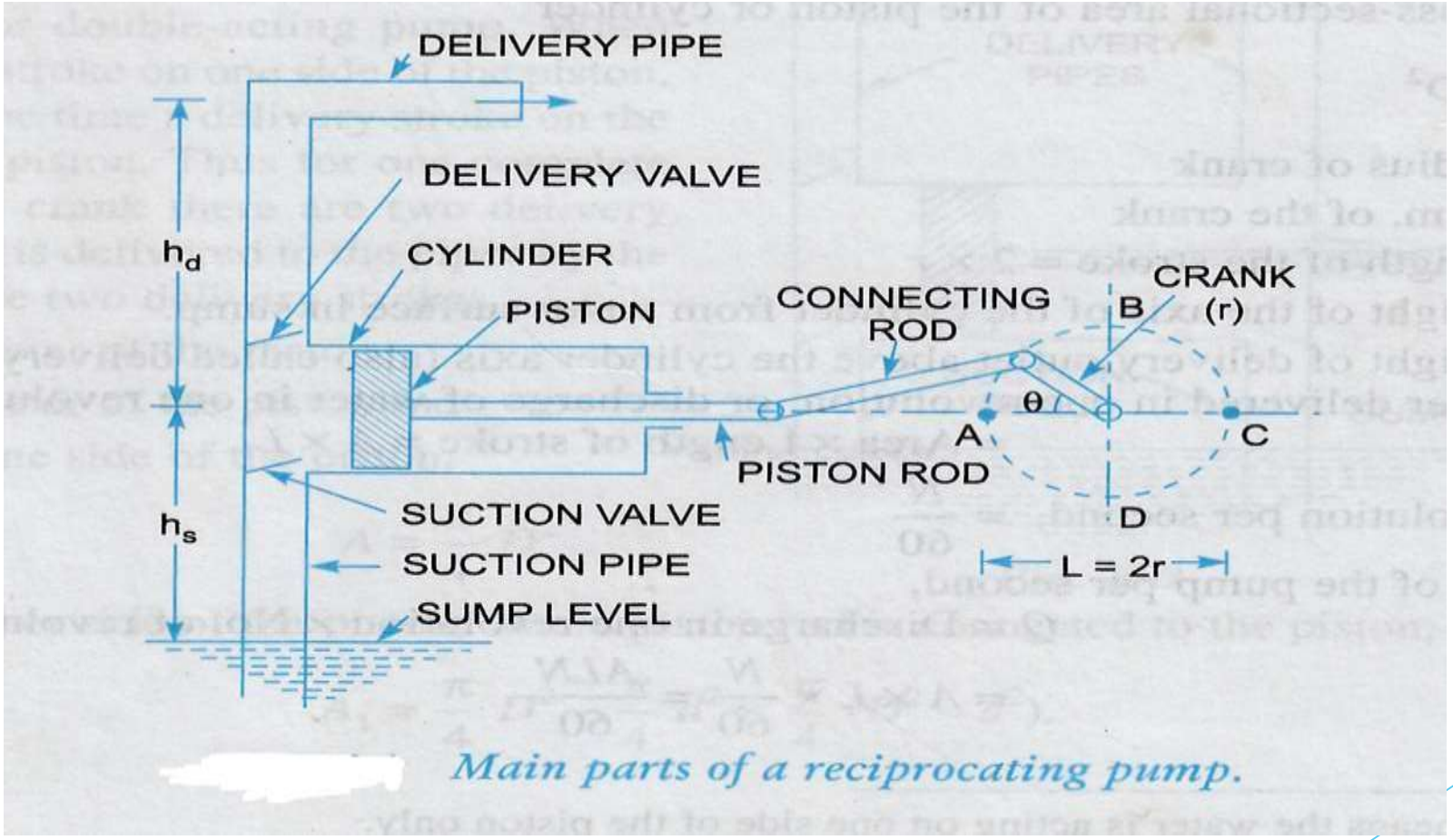
Pumps are broadly classified into

1. Positive- displacement pumps
2. Rotodynamic pumps

- Positive- displacement pumps: They make a fluid move by trapping a fixed amount and displacing the trapped volume into the discharge pipe. Discharge is directly proportional to speed.
  Eg : Reciprocating pump, Vane pump, Gear pump
- Rotodynamic pumps: It is a machine in which energy is continuously imparted to the pumped fluid by means of a rotor and thus fluid is raised to higher elevation.

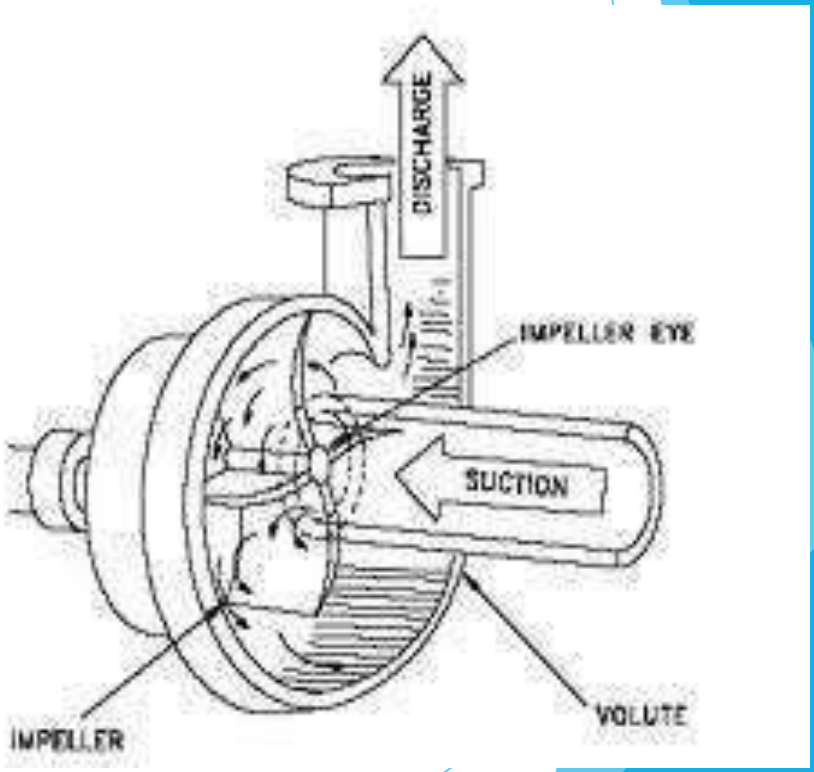
  Eg: Centrifugal pump

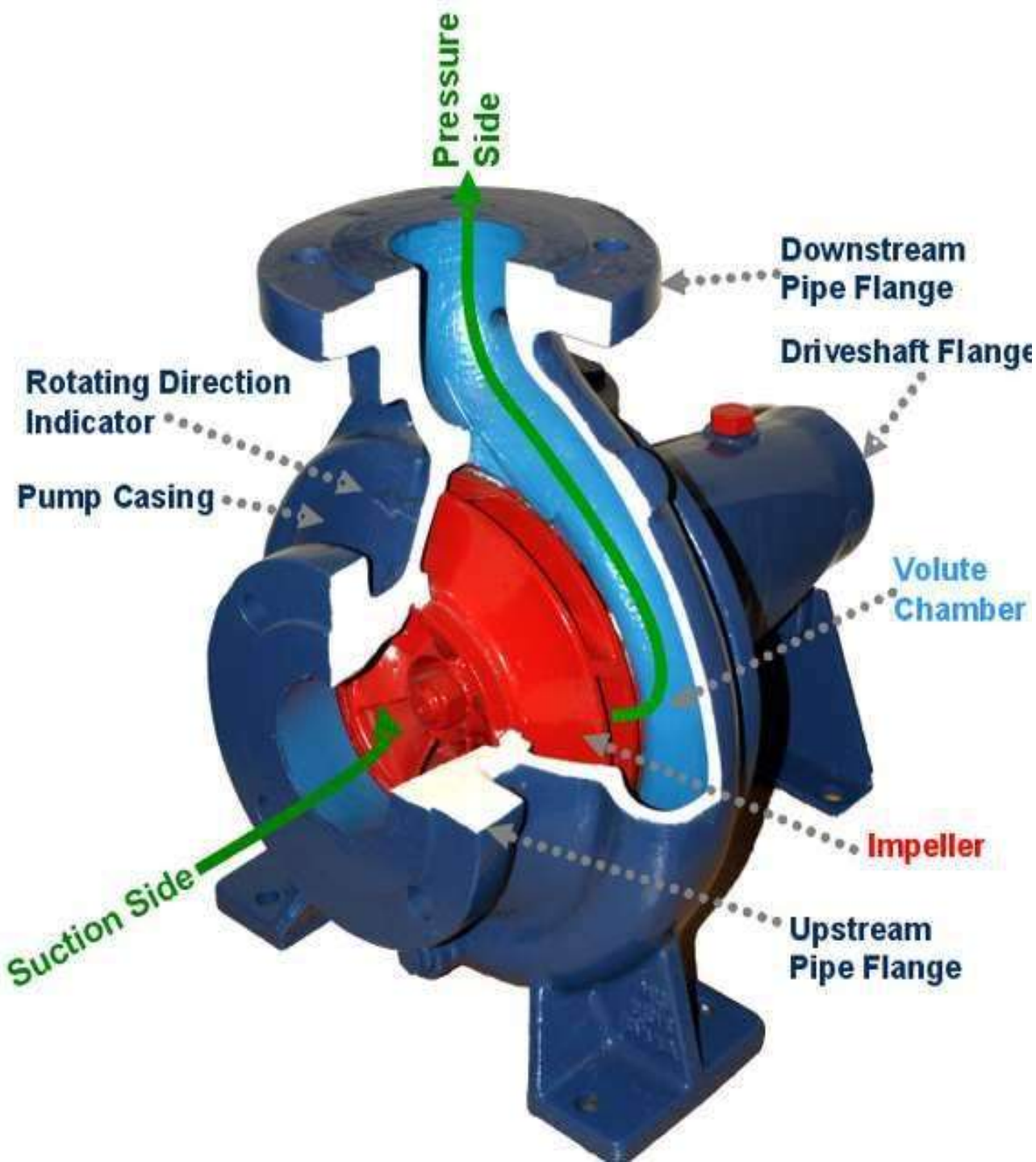
RECIPROCATING PUMP

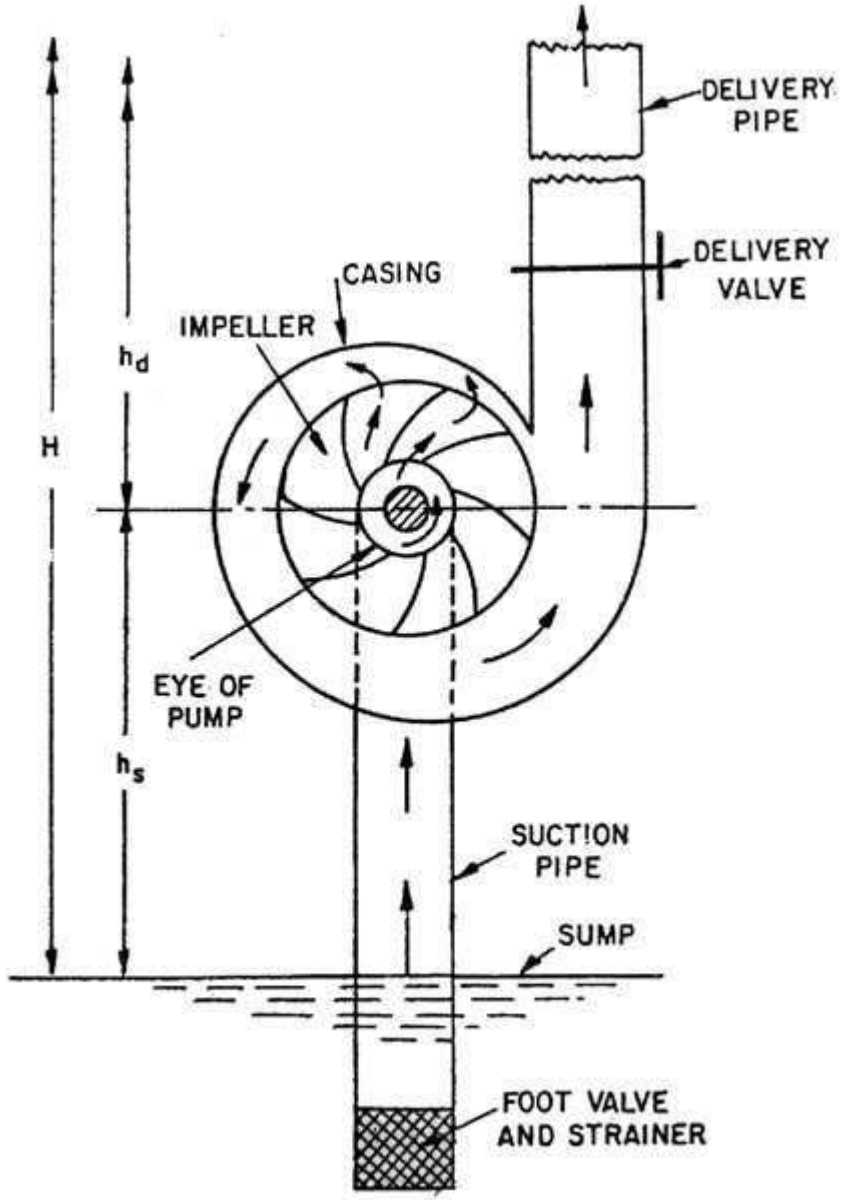


Main parts of a reciprocating pump.

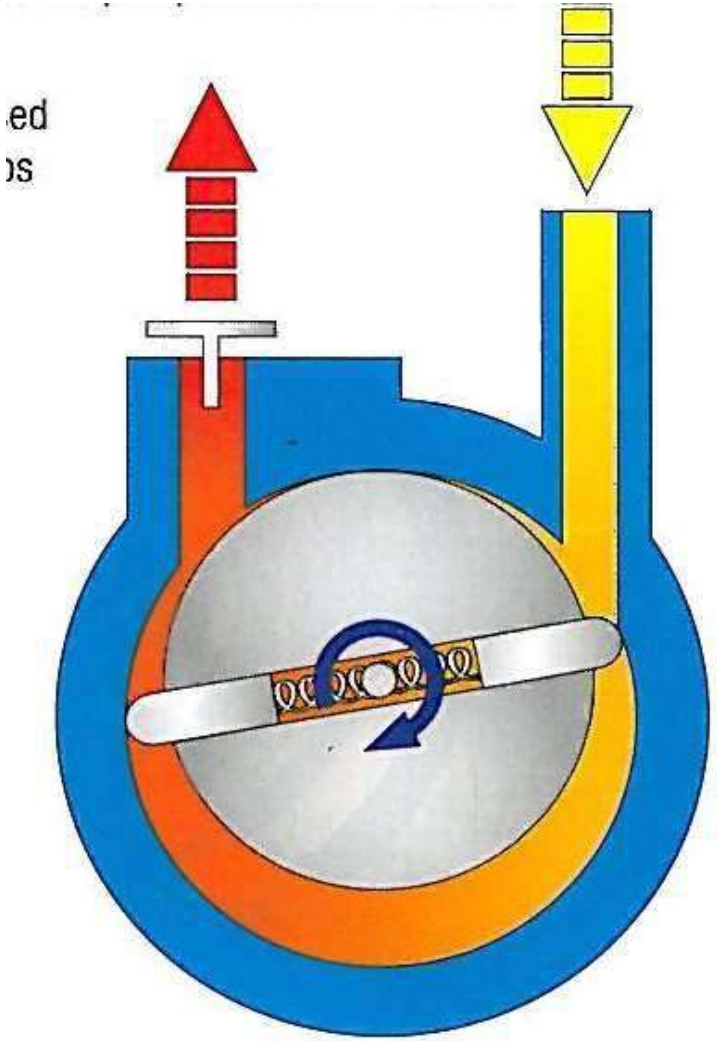
Centrifugal pumps



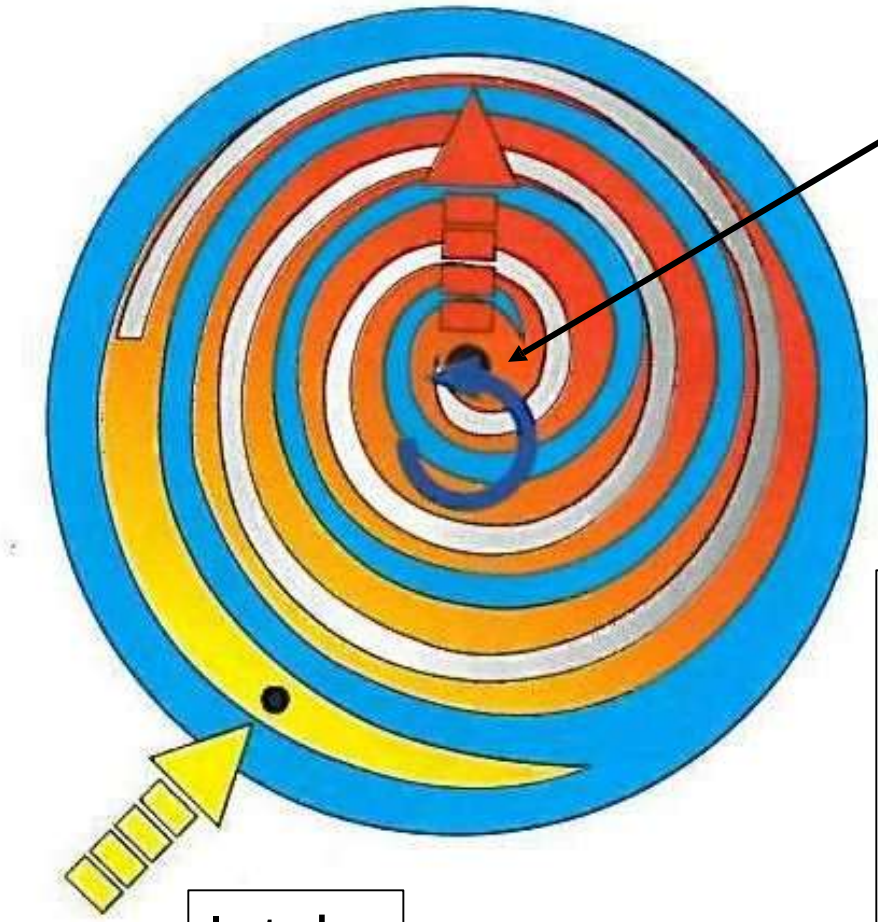

Pressure Side
Downstream Pipe Flange
Driveshaft Flange
Rotating Direction Indicator
Pump Casing
Volute Chamber
Impeller
Suction Side
Upstream Pipe Flange


DELIVERY PIPE
DELIVERY VALVE
CASING
IMPELLER
h_d
H
EYE OF PUMP
h_s
SUCTION PIPE
SUMP
FOOT VALVE AND STRAINER

Rotary vane pump



Scroll Pump



Exhaust port in center

Intake

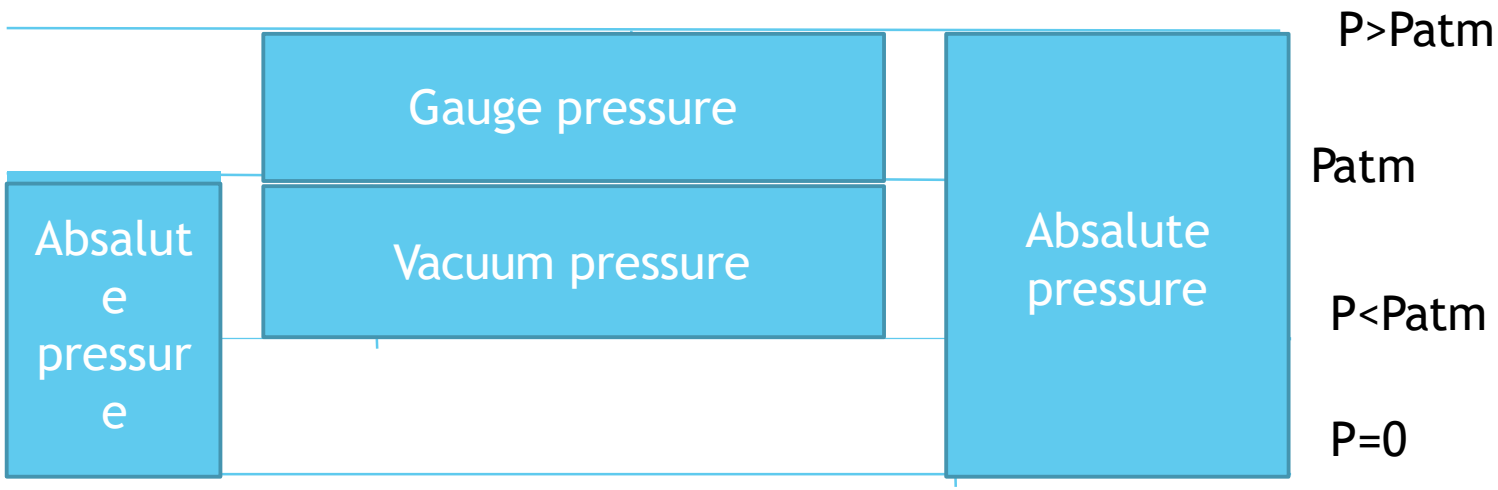
Blue area rotates counterclockwise with silver area sprung against it. Volume between parts decreases.

Pressure

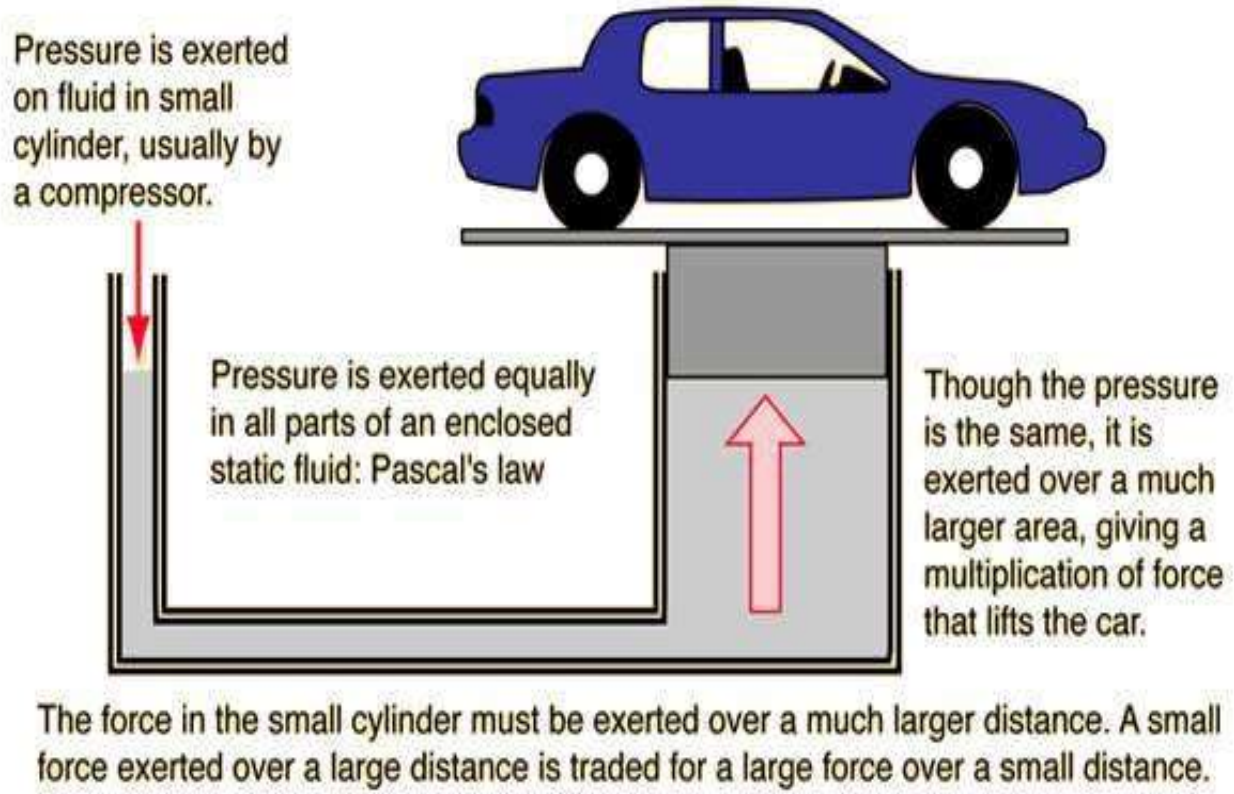
- Fluid pressure = $\frac{\text{Normal compressive force}}{\text{Area}}$
- It is compressive in nature
- S.I unit is Pascal
- 1 atm pressure=101325 pa
- 1 atm pressure=1.o1325 bar
- 1 atm pressure=101.325 Kpa
- 1 atm pressure=10.3 mtr of water
- 1 atm pressure=76cm of Hg
- Atm pressure is measured by barometer
- It is scalor quantity ⟶ Acq. To pascal law

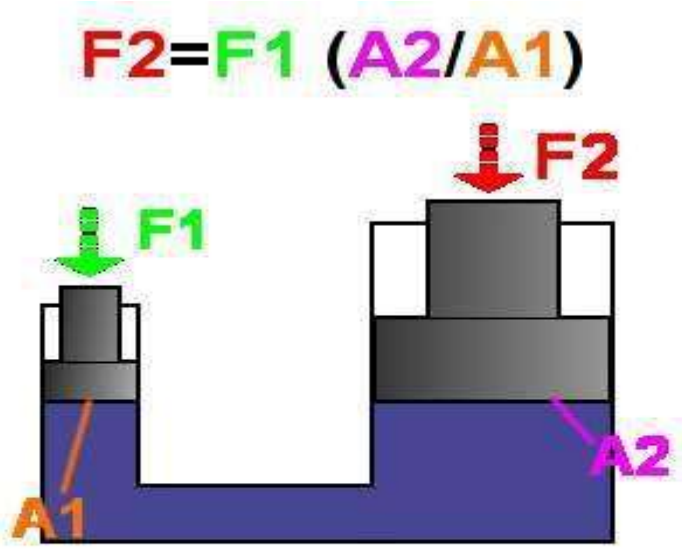
Pressure of fluid expressed in 3 forms

- **Absolute pressure**
- **Gauge pressure**
- Negative gauge



Pascal law:


Pressure is exerted on fluid in small cylinder, usually by a compressor.
Pressure is exerted equally in all parts of an enclosed static fluid: Pascal's law
Though the pressure is the same, it is exerted over a much larger area, giving a multiplication of force that lifts the car.
The force in the small cylinder must be exerted over a much larger distance. A small force exerted over a large distance is traded for a large force over a small distance.


F2=F1 (A2/A1)
F2
F1
A1
A2

Pressure Variation in a Fluid at Rest- Hydrostatic law

$$\frac{\partial p}{\partial x} = 0 \qquad \frac{\partial p}{\partial y} = 0 \qquad \frac{\partial p}{\partial z} = -\gamma$$

Pressure measuring instruments:

Simple manometers

- Peizometer
- U-tube manometer
- Single column manometer

Differential manometer

- 2piezometer d.f
- Inverted u-tube manometer
- U-tube differential manometer

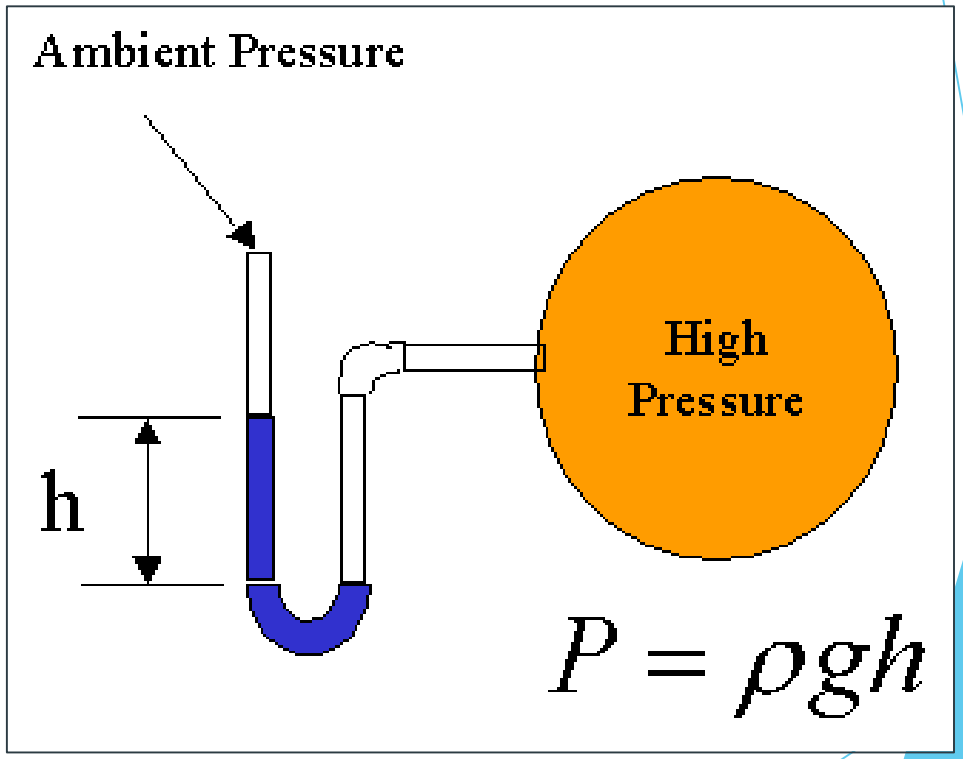
Pressure gauges

- Bourdon tube pressure gauges
- Diaphragam pressure gauges

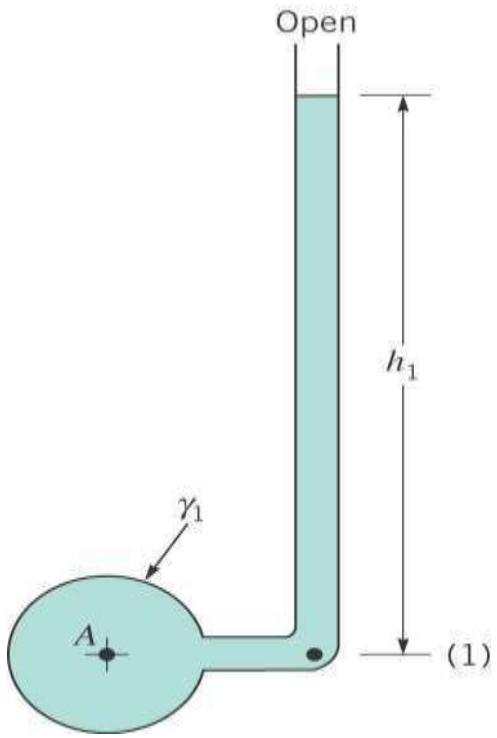
Manometers

Principle of operation: Manometers are devices in which columns of suitable liquid are used to measure the difference in pressure between two points, or between a certain point and the atmosphere (p_{atm}).

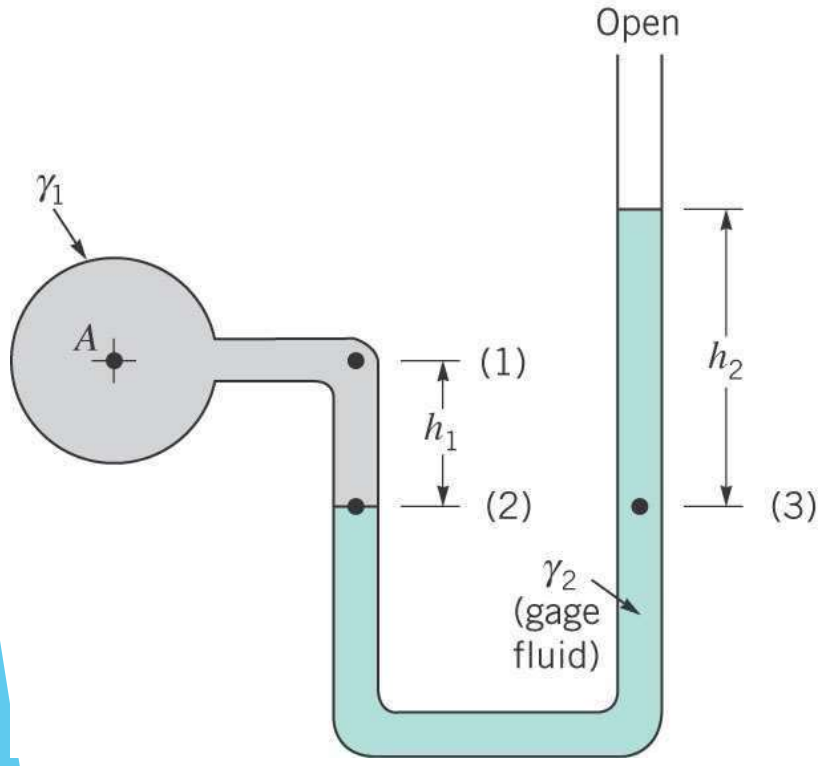
- Applying fundamental equations of hydrostatics the pressure difference, P, between the two liquid columns can be calculated.



PEIZOMETER



U-TUBE MANOMETER



Single column manometer

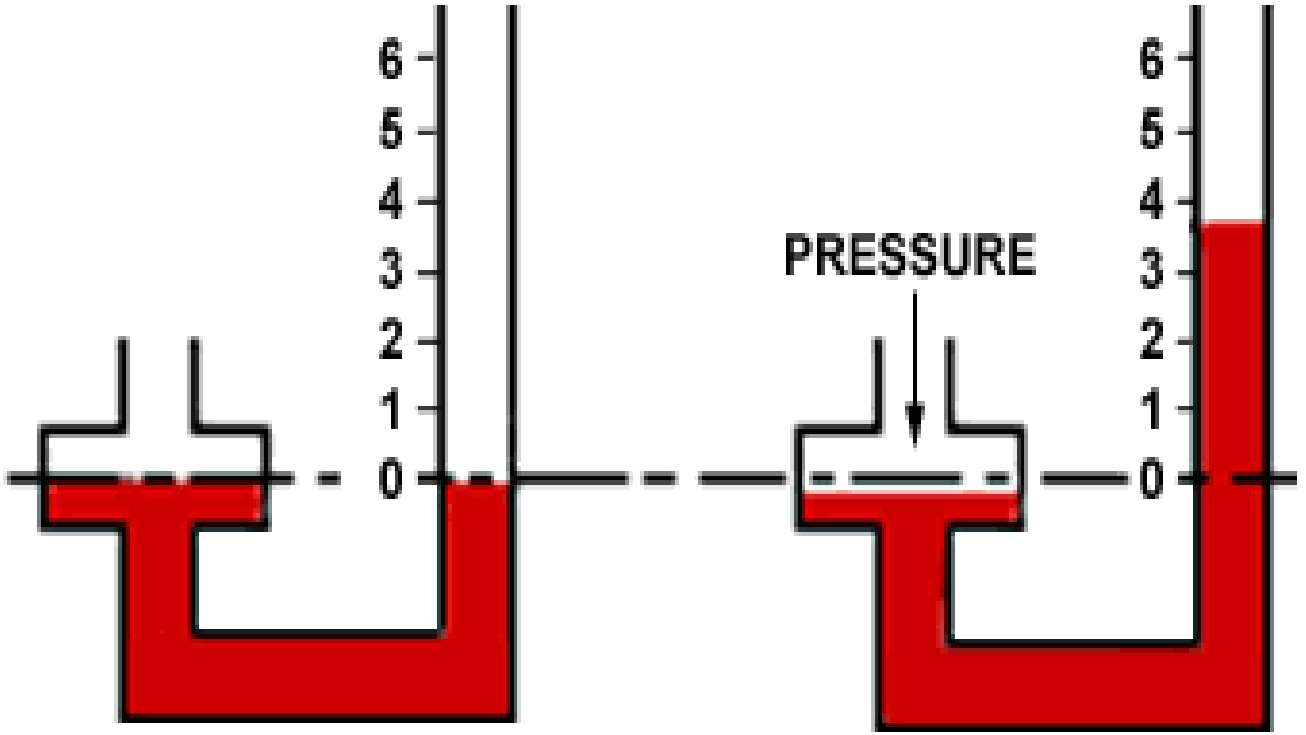
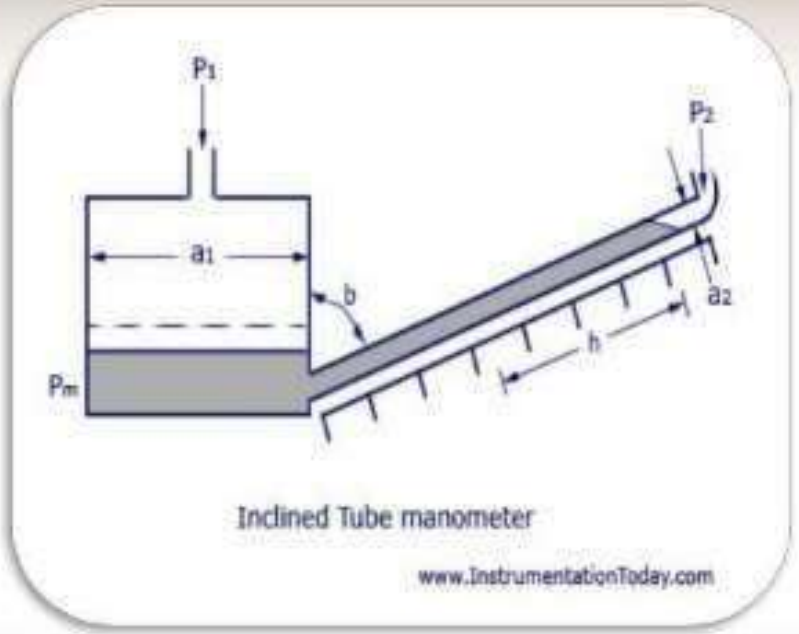


Fig. 2-4

Inclined tube manometer

- It is slant manometer.
- The angle of measuring leg is about 10º.
- Inclination is done to improve the sensitivity.
- This manometer is used to measure very small pressure difference.



U-tube differential manometer

Case 2 - U-tube upright differential manometer connected between two pipes at different levels and carrying different fluids

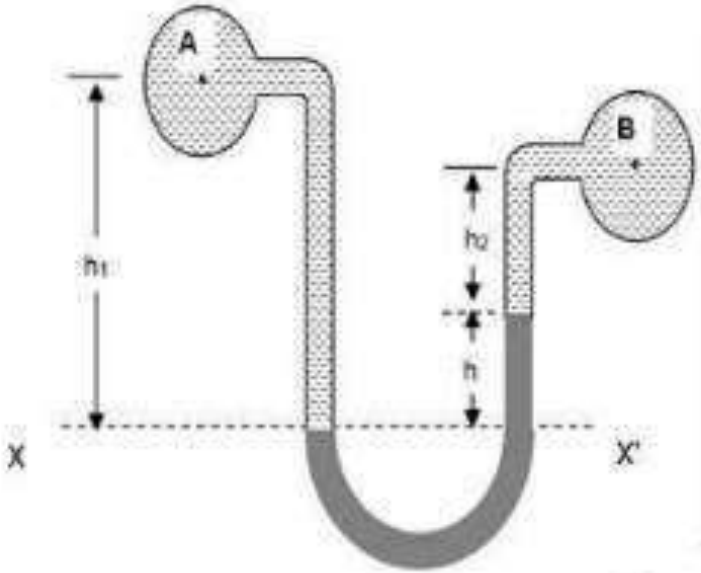
Left limb eq : $h_A + h_1 S_1$

Right limb eq : $h_B + h_2 S_2 + hS$

* Pressure is same at the datum line :

$$h_A + h_1 S_1 = h_B + h_2 S_2 + hS$$

$$h_A - h_B = h_2 S_2 - h_1 S_1 + hS$$

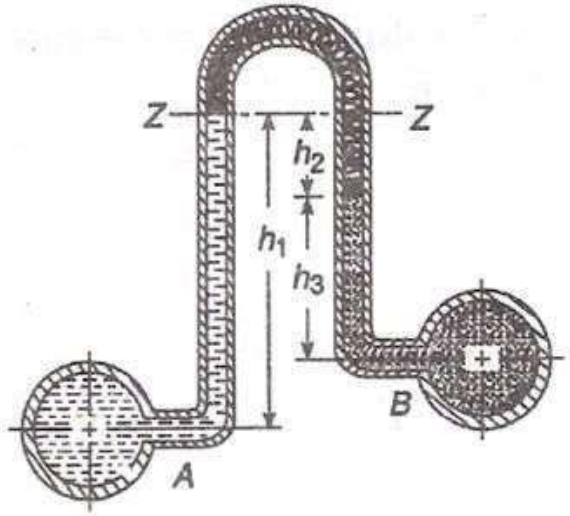


Inverted Differential Manometer:

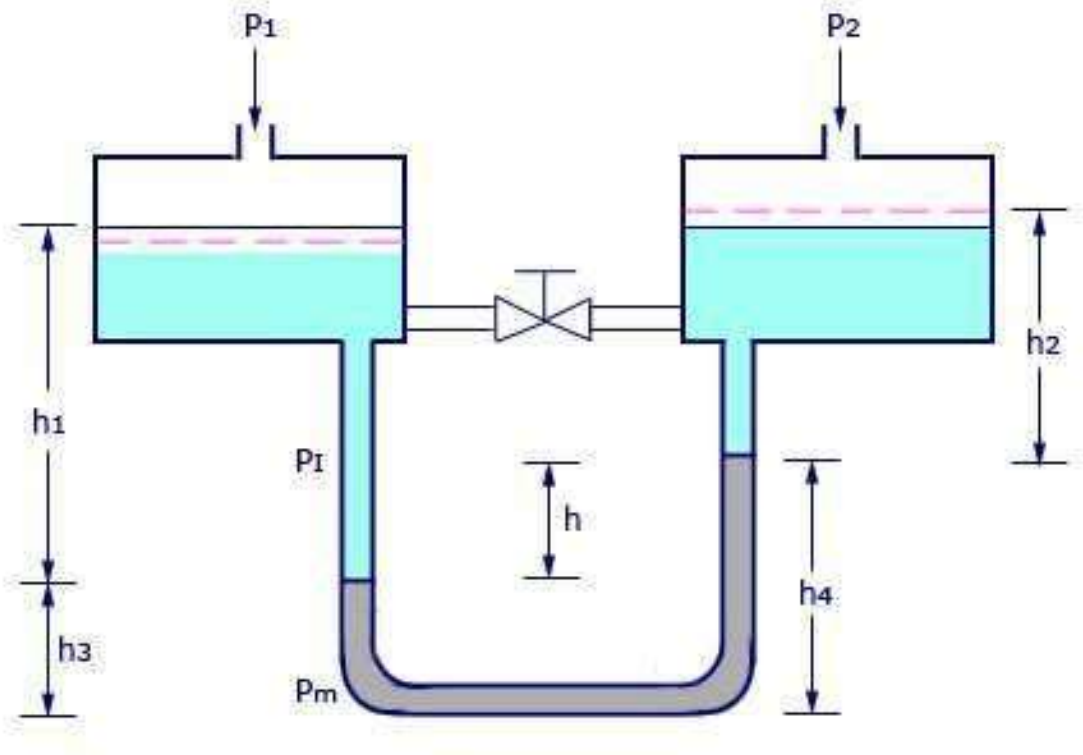
- Type of differential manometer in which an inverted U-tube is used.
- Used for measuring difference of low pressure.

1. Pressure head in the left limb above Z-Z = ha-s1h1
2. Pressure head in the right limb above Z-Z = hb-s2h2-s3h3
3. Equating we get, ha-s1h1 = hb-s2h2-s3h3

(Where; ha, hb are Pressure in pipes A and B expressed in terms of head of liquid, respectively)



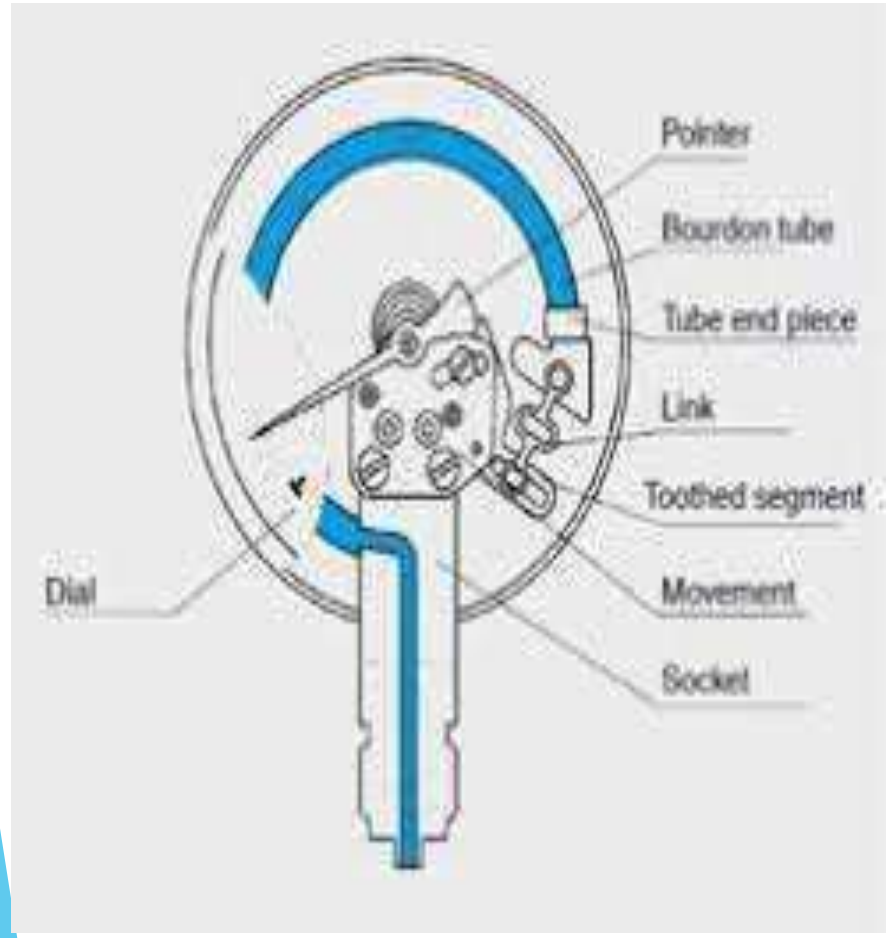
Micromanometer



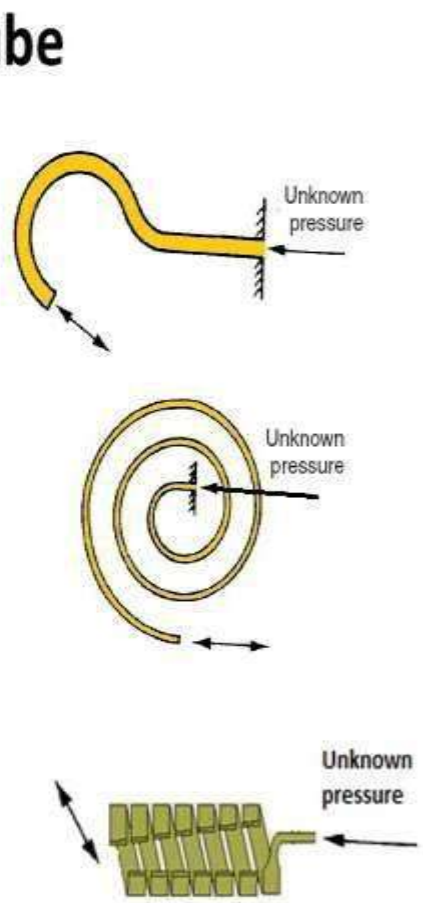
Manometer With Large Seal Pots

www.InstrumentationToday.com

Bourdon Gauge (Mechanical)



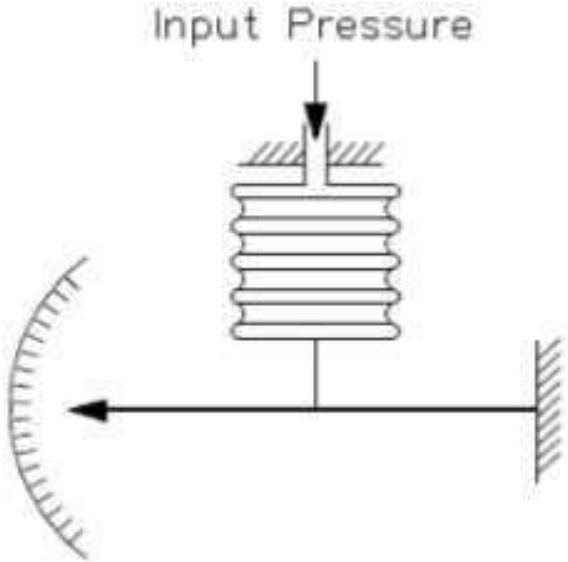
- The three common shapes of Bourdon tube are the C-type, the spiral type and the helical type.
- The maximum possible deflection of the free end of the tube is proportional to the angle subtended by the arc through which the tube is bent. For a C-type tube, the maximum value for this arc is somewhat less than 360°.
- Where greater measurement sensitivity and resolution are required, spiral and helical tubes are used.



Diaphragm pressure gauge

BELLOWS

- bellows sensor is an axially flexible, cylindrical enclosure with folded sides. When pressure is applied through an opening, the closed end extends axially.
- Bellows elements can measure absolute pressure, gauge pressure, vacuum, or differential pressure.



THANK YOU