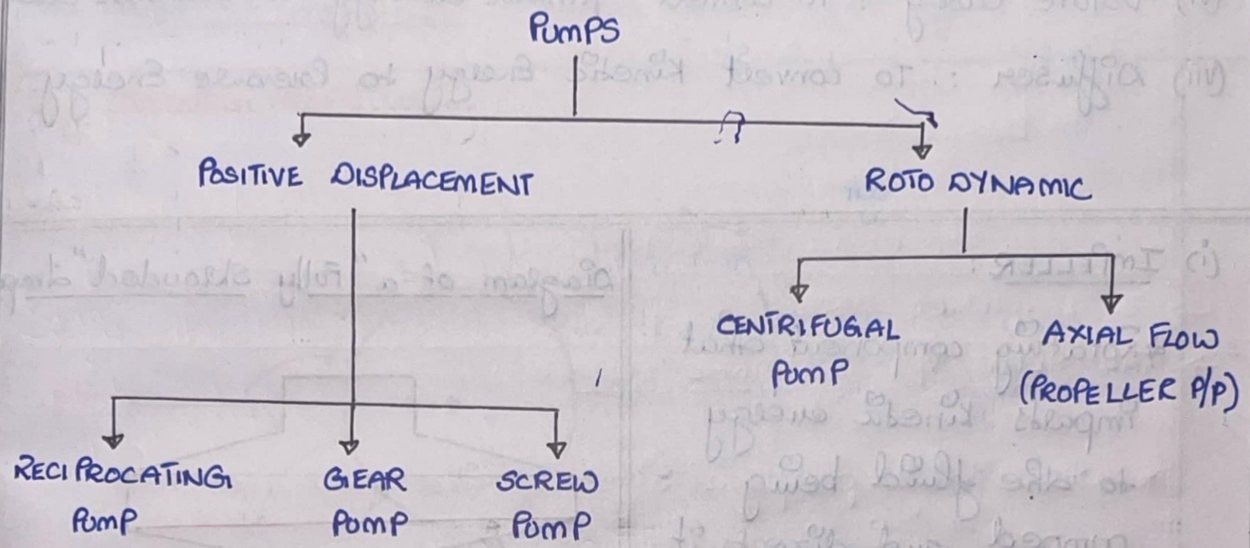
CONCEPT OF PUMPS, PRINCIPLES OF OPERATION AND USES

- Pump: "A mechanical device/system used for transfer of liquids"
  → A pump is used to transfer fluids/liquid from one point to another.
  → Although flow is easy from a higher position to lower position (-ed T/K), the pump is used to perform a reverse operation



- CENTRIFUGAL PUMPS:
  - It operates on the principle of centrifugal forces.
  - Advantages: ① High Discharge Capacity
    ② Simple in construction
    ③ Simple to operate
    ④ Can handle any liquid i.e., water, oil, lubes
    ⑤ Easy Control
  - Disadvantage: ① Cannot deal with
    ② Requires priming (removal of air)
    ③ Direction sensitive (cannot run in opposite direction)
  - Uses: Main Sea Water P/P, JCW P/P, Main Engine L.O. P/P (Lubricating submerged P/P)

- COMPONENTS OF A CENTRIFUGAL PUMP

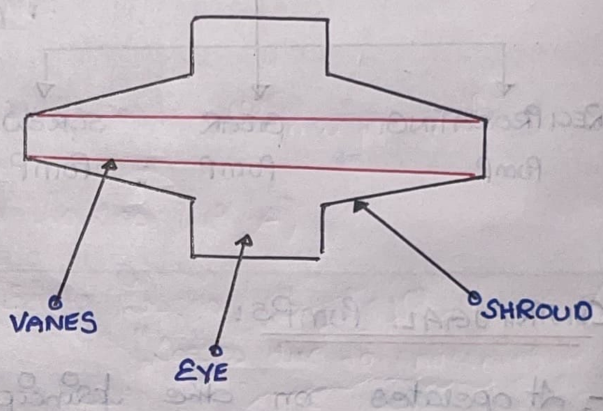
(i) Impeller : To transfer energy input of the prime mover to the fluid
(ii) shaft : To connect the impeller to prime-mover
(iii) Wear ring / casing ring : "Sacrificial rings" to prevent Impeller wear
(iv) shaft sleeve
(v) gland / Mechanical seal
(vi) Volute Casing : To convert Kinetic energy to Pressure Energy
(vii) Diffuser : To convert Kinetic Energy to Pressure Energy.

(i) IMPELLER :

a) Rotating component that imparts kinetic energy to the fluid being pumped and directs it towards the casing
b) Its primary function is to impart energy to the fluid that is provided by the prime mover
c) Consists of vanes/blades that are designed to move the fluid radially
d) When the impeller rotates, it draws in the fluid at its eye and accelerates it, thereby increasing its kinetic energy

Material of Impeller
(1) SW Pump: Brass
(2) FW PUMP: Stainless Steel

Diagram of a "Fully Shrouded" Impeller



* Shroud : Enclosure on the vanes
* Based on shrouds, the impellers are of the following type
  i) closed / fully shrouded
  ii) Semi open (shroud on one end)
  iii) Open (N

a) closed impellers provide high pumping capacity, eff
- used for clean liquid (No solids i.e, Sea Water, JCW, Boiler FW, Piston Cooling, Hydrophore

b) Semi-open Impellers (or) open Impellers : "Normally used-shore"

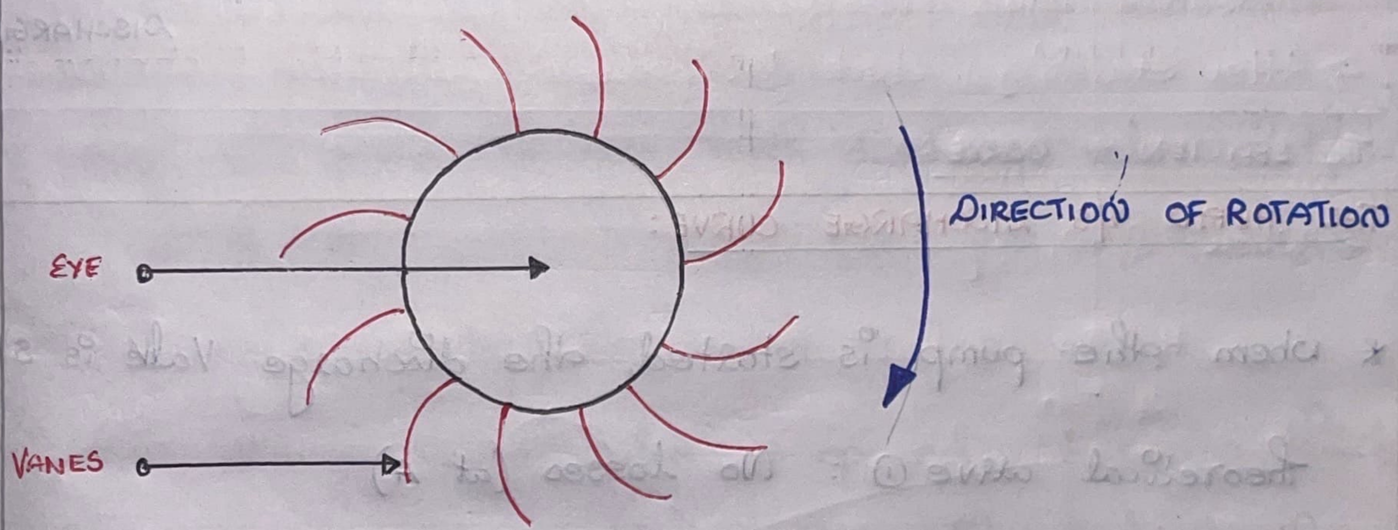
- Used where there's a possibility of solids (sewage P/P)

- Presence of solids, can block the vanes in case of a closed type of Impellers.

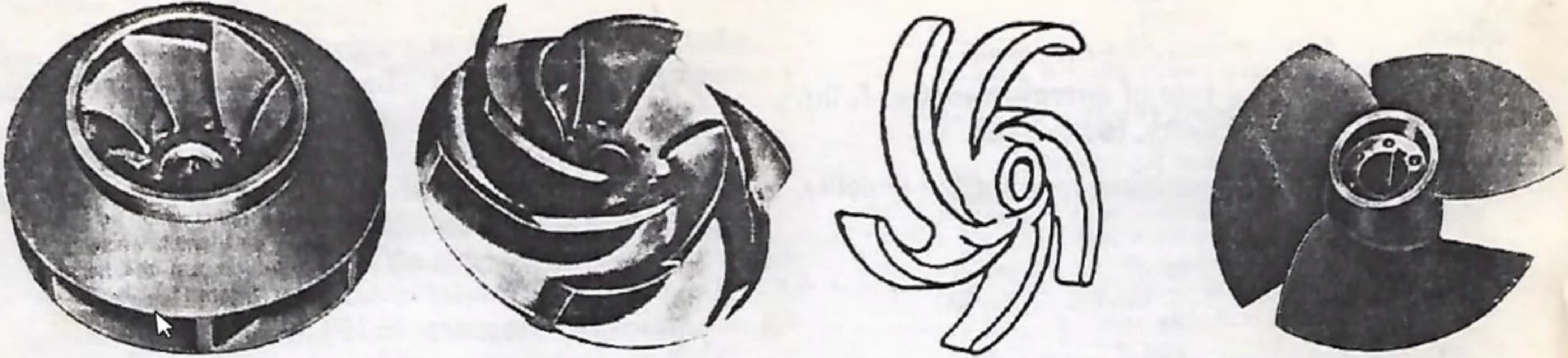
c) Open Impellers: As discussed previously, in Sewage P/P.

d) Propeller Impellers : Used earlier (Mostly on steam ships)

Q: Why Direction Sensitive?



* If rotated in opposite direction, pump will not discharge as it loses suction.



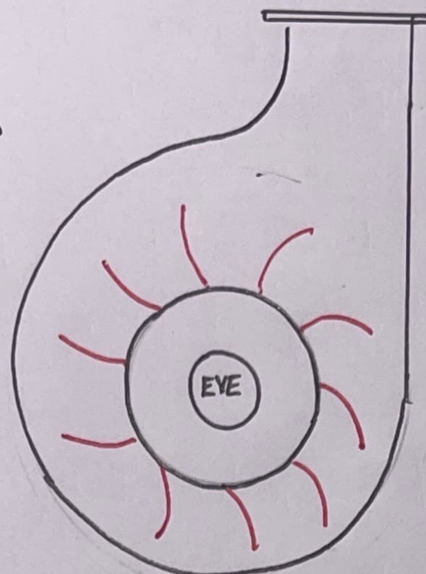
(*a*) Closed impeller (*b*) Semiopen impeller (*c*) Open impeller (*d*) Propeller

Fig. 2 Centrifugal pump impellers (Courtesy Dresser Pump Division)

TYPES OF CASING

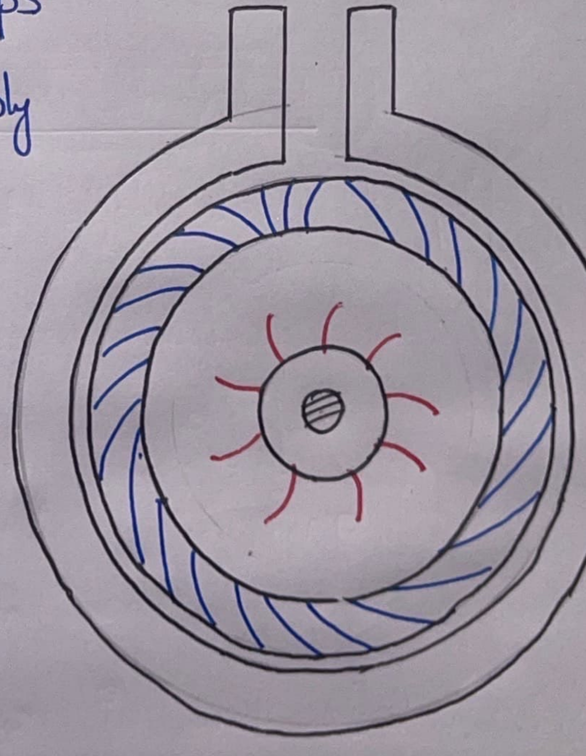
i) **VOLUTE CASING** : Work's on Bernoulli's Principle

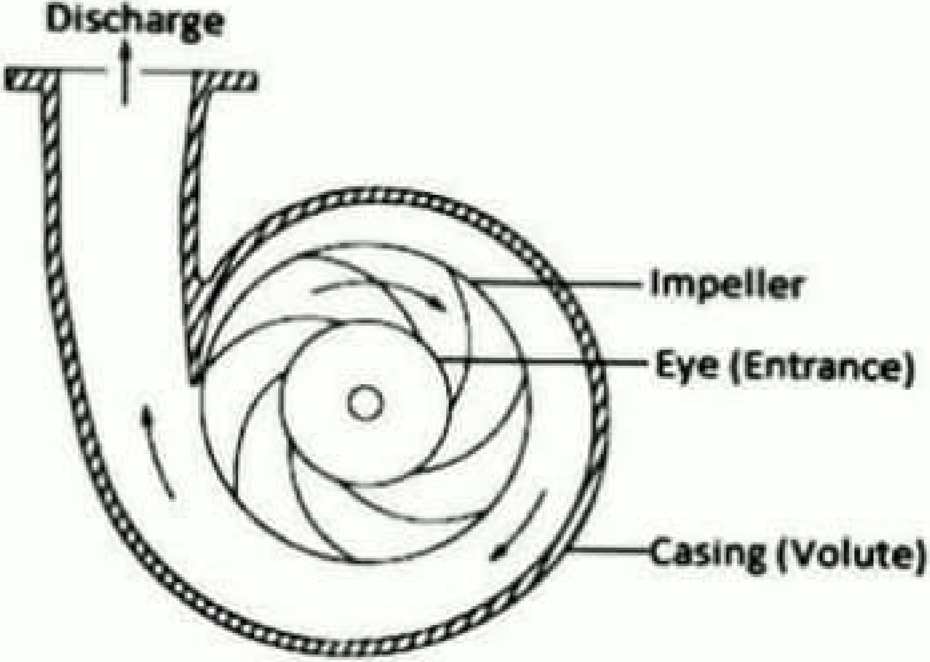
* Increasing Cross-sectional area results in conversion of Kinetic Energy (due to centrifugal force of liquid at high velocity) into pressure energy



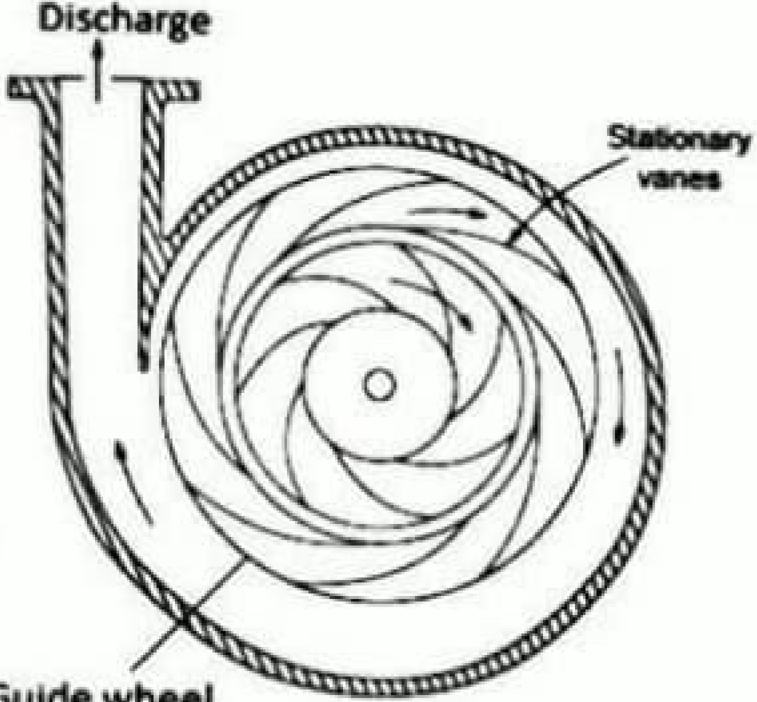
ii) **DIFFUSER TYPE**

- Similar principle of operation
- Useful in high speed pumps
- An additional vane assembly is utilized
- closer at the vicinity of impeller and then gradually extend away from impeller periphery



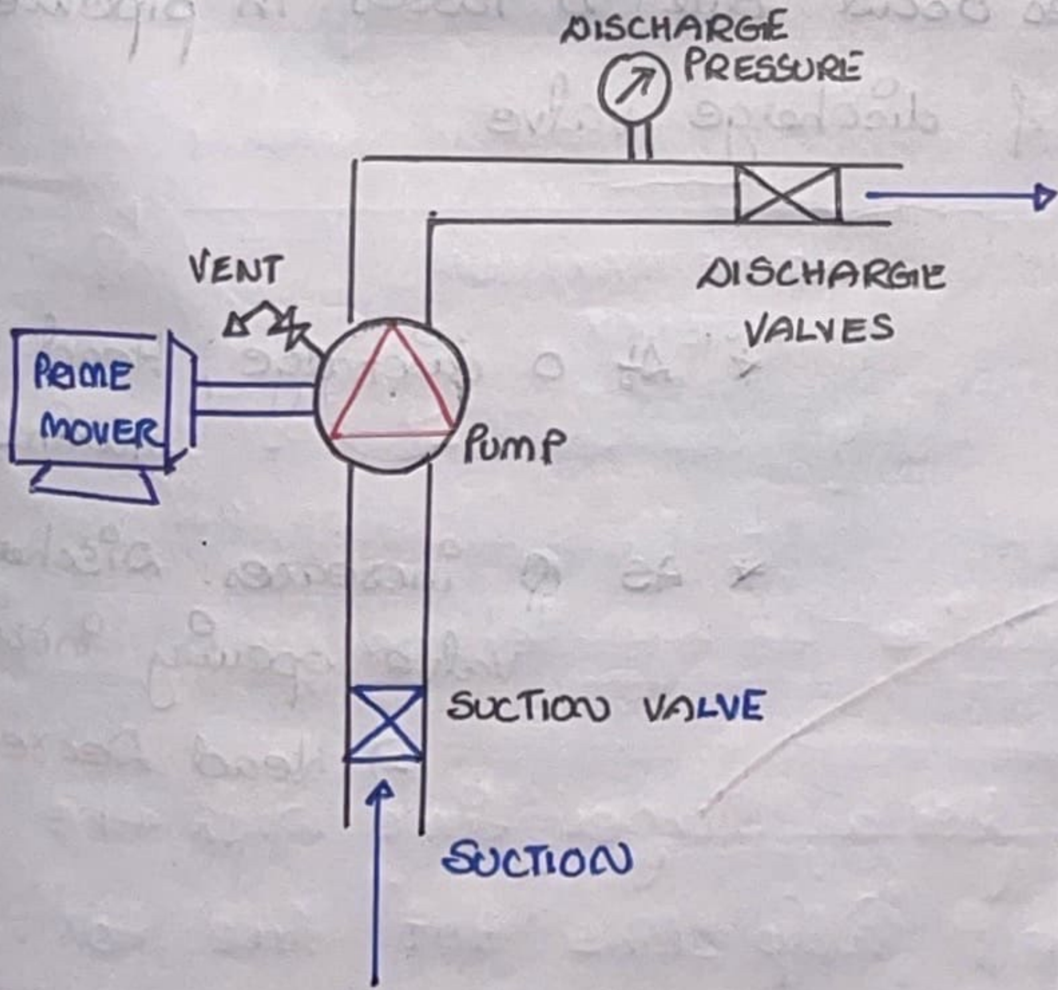


(a) Volute pump



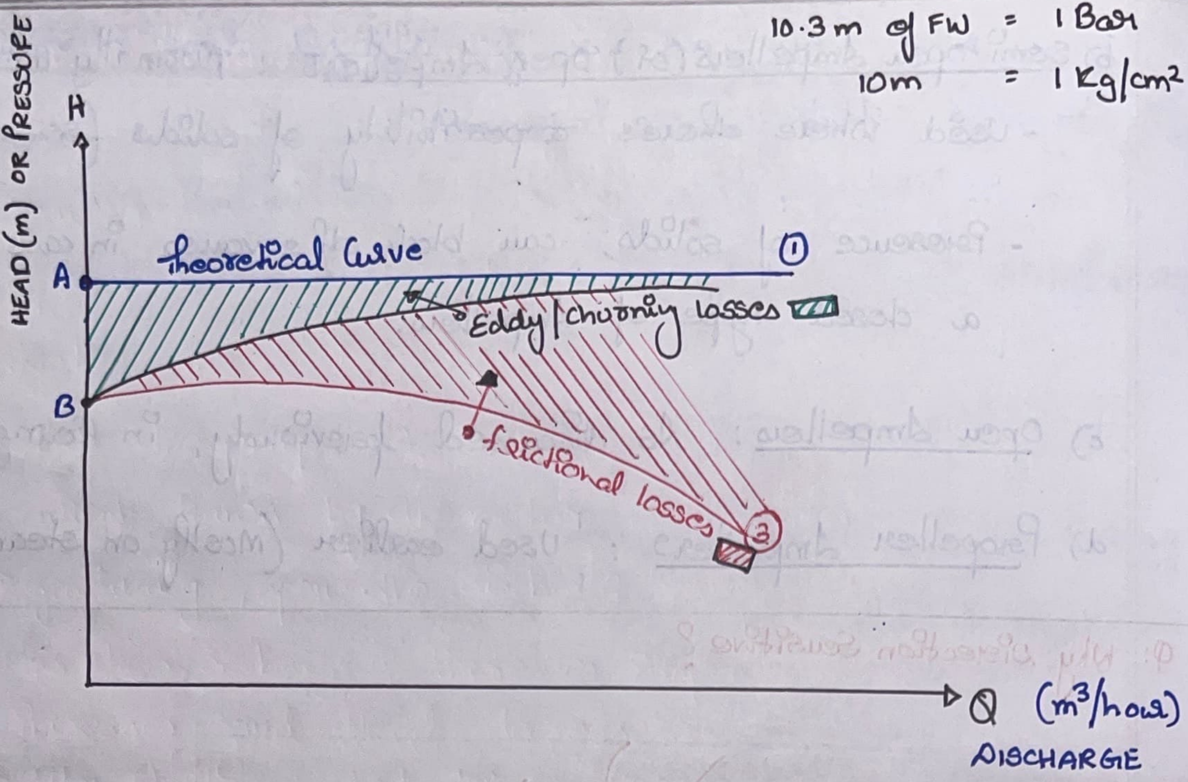
(b) Diffusion pump

- DISCHARGE CHARACTERISTICS OF CENTRIFUGAL PUMP



* The kinetic energy coming out of an impeller is harnessed into the pressure energy by creating a resistance to the flow
* First resistance is offered by the pumps volute casing
* At the discharge side, the liquid further decelerates and its velocity is converted to pressure energy : Bernoulli's principle

10.3 m of FW = 1 Bar
10m = 1 Kg/cm²



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→ THE HEAD V/S DISCHARGE CURVE:

* When the pump is started, the discharge Valve is shut.

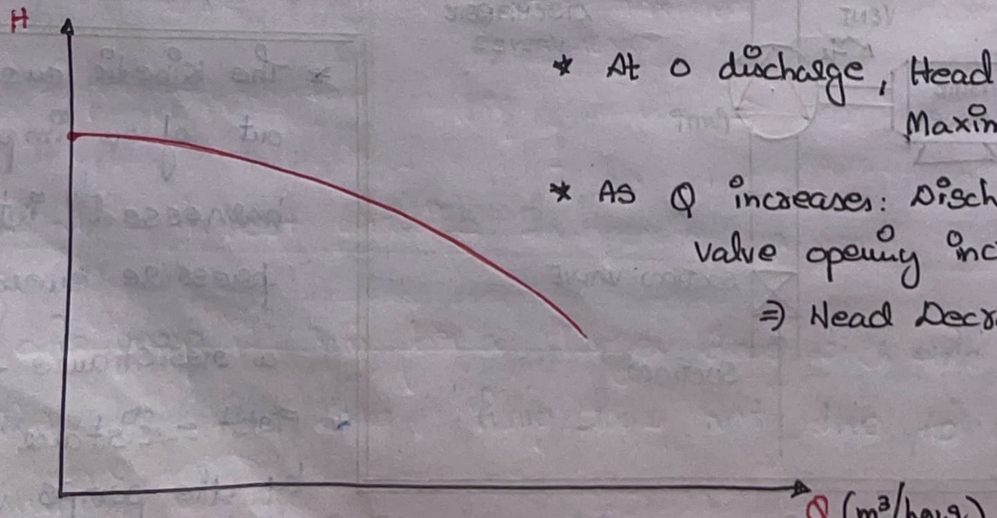
Theoretical curve ①: No losses (at A)

Practical H-Q curve ②: Eddy Losses / Circulating losses (A to B) "Losses due to churning of water)

- As flow increases, eddy losses decrease and frictional losses increase ⇒ "Actual curve" : ③

⇒ "frictional losses occur due to losses in pipeline between casing & discharge valve

∴ Actual H-Q Curve



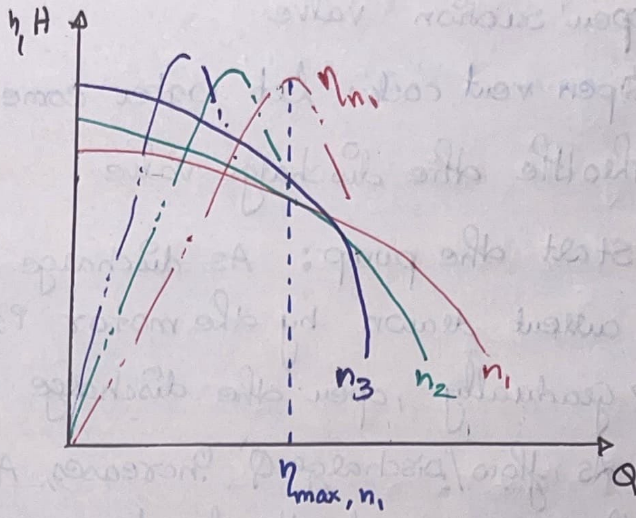
* At 0 discharge, Head is Maximum

* As Q increases: Discharge valve opening increased ⇒ Head Decreases

- When same pumps are used for different rpms, the curve becomes steeper (slope increases)

i.e., if $n_3 > n_2 > n_1$

- If efficiency curve is considered, for n_1, n_2 & n_3, at one specific head & quantity/flow, maximum efficiency is attained. "Operating Point"

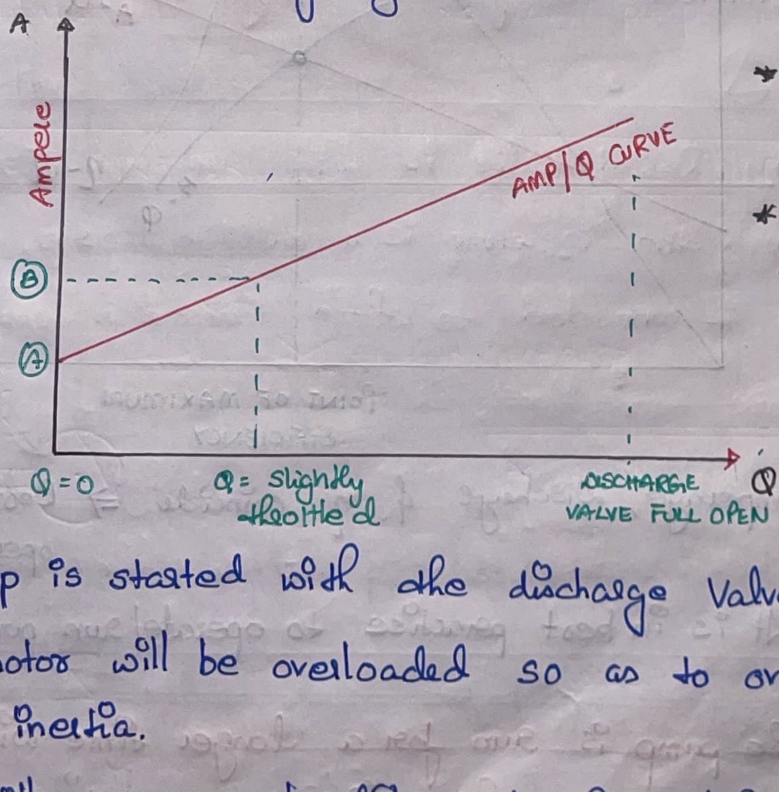


→ THE AMPERE V/S DISCHARGE CURVE

* When the pump is run with discharge valve shut/throttled
  ⇒ Q = 0

- Amperes drawn by the motor is low.

* When the discharge valve is opened, to pump fluid, current drawn is very high which will overload the motor.



* At Q = 0 drawn current is less "A"
* At Q = throttled drawn current is slightly higher "B"

- If Pump is started with the discharge Valve open, the motor will be overloaded so as to overcome the initial inertia.
- This will cause overloading of the motor. and to prevent this, pump is started with its discharge valve shut or throttled so as to limit starting torque

METHOD OF STARTING A CENTRIFUGAL PUMP

- Check the free rotation of the pump by hand
- Open suction valve
- Open vent cock: Let water come out to ensure air is vented
- Throttle the discharge valve
- Start the pump: As discharge valve is throttled, the current drawn by the motor is also less

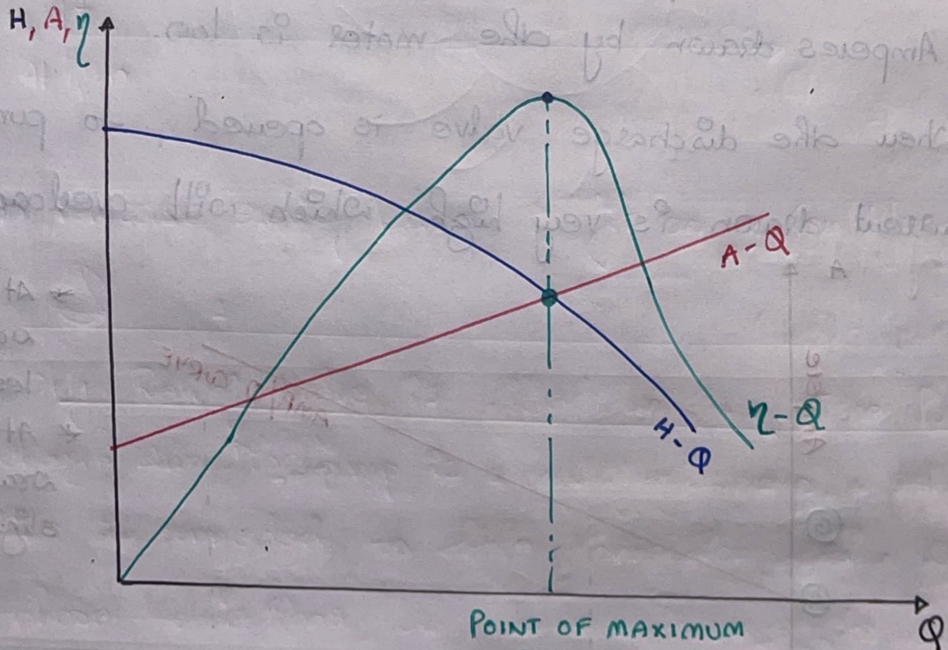
→ gradually, open the discharge valve.

As flow/Discharge 'Q' increases, Amperage also gradually increases and Head decreases.

→ After starting, check for pressures, vibration & abnormality

→ THE EFFICIENCY CURVE:

→ When $Q = 0$, $\eta = 0$



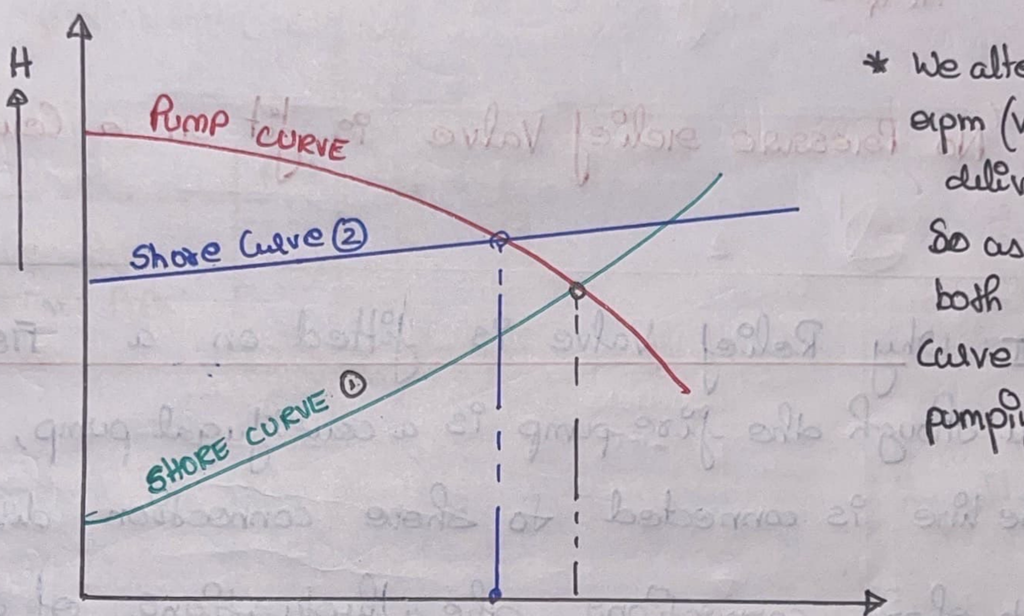
→ When Amperage, Discharge & η coincide ⇒ Best optimum operation range

i.e., why, it is in best practise to operate/run pump in this range.

- NOTE: If the pump is run for a longer time with the pump discharge valve shut, "Pump runs Hot" due to churning losses.

- PUMP - SHORE CHARACTERISTIC CURVE:

- when we discharge cargo at various ports, the discharge characteristics of the pump may vary as the storage tanks at the ports may be at different distances from the vessel
- Before starting the pump, the shore curve is analysed taking the above factors under consideration allowing the pump to be run at certain set/specific rpm so as to obtain maximum discharge rate and also to facilitate the operation of the pump at maximum efficiency.

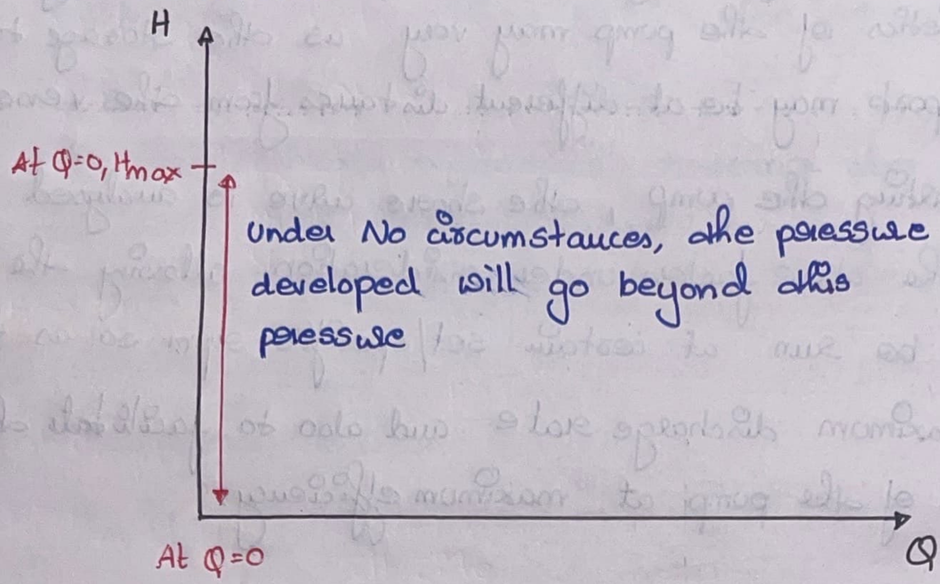


* We alter the rpm (variable delivery pump) So as to match both P/p & shore curve for best pumping efficiency.

* NOTE: If Amperage is high, pressure is low & then there's no noise/vibration:
⇒ Pump is working perfectly (this may be due to high head)

∴ throttle the discharge ⇒ Q ↓ but Amps ↓
Also, η also decreases

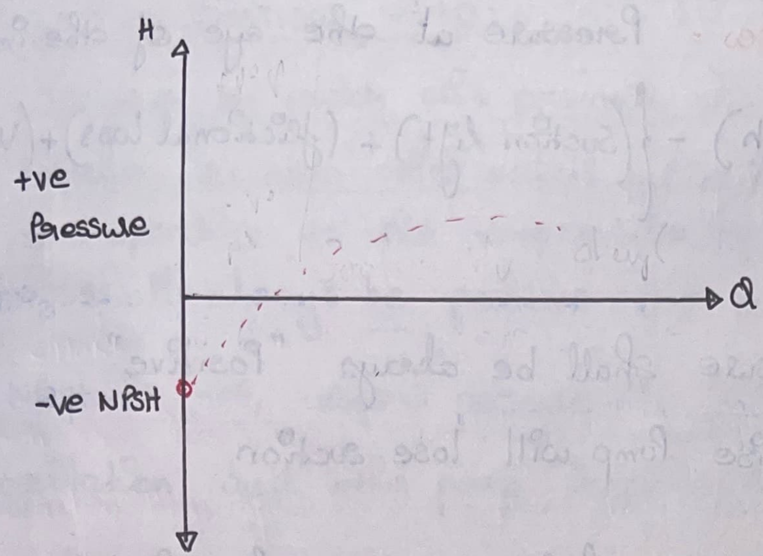
- **NOTE: I** CENTRIFUGAL PUMPS HAVE NO RELIEF VALVE:
  - Even if the pump is run with the discharge valve shut, the maximum pressure developed cannot go beyond the design pressure.
  - If the casings and pipeline are designed considering the above pressure rating, effects of overpressurisation are eliminated.



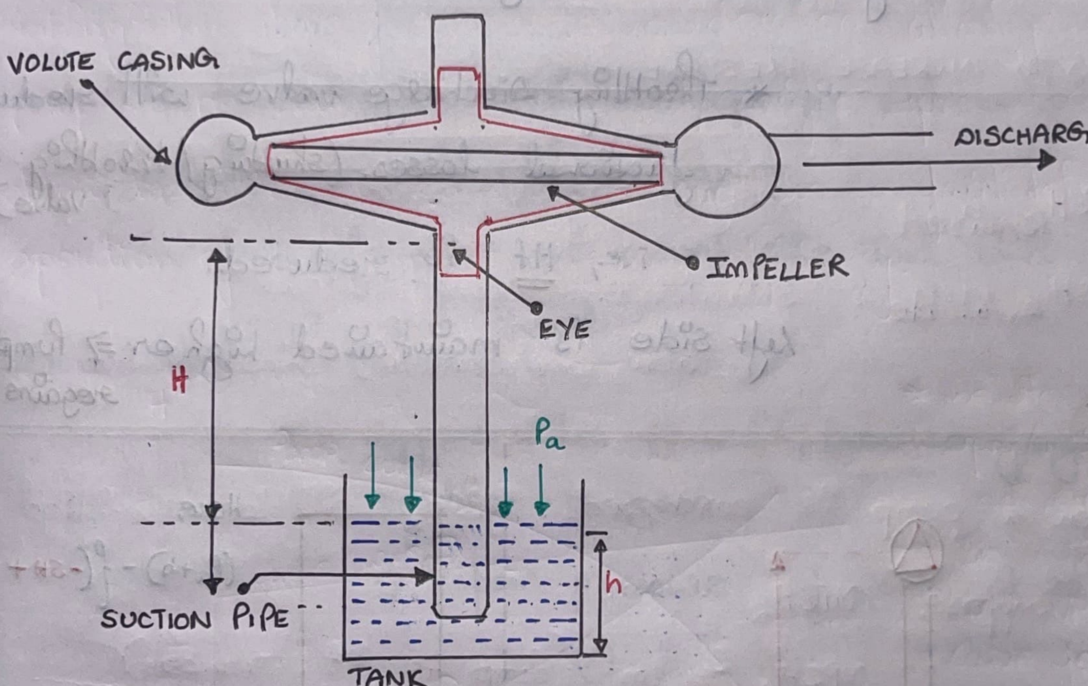
"No Pressure relief Valve is fit on a Centrifugal Pump"

- **NOTE II**: Why Relief Valve is fitted on a "Fire Pump"? (Line)
  - Even though the fire pump is a centrifugal pump, a relief v/v is fit
  - Fire line is connected to shore connection during Drydock
  - With shore connections, the fluctuations of pressures are fluctuating and may be very high
  - This is why a relief valve is fit on the fire line

- **NOTE III**: "Never throttle the suction Valve"
  - If suction valve is throttled, it will cause the creation of vacuum ⇒ Cause boiling of liquid ⇒ bubbles → "Cavitation" ⇒ Erosion of Impeller, Casing



- SUCTION CHARACTERISTICS OF CENTRIFUGAL PUMP:



Here, H: Height of the suction pipe from eye of impeller "Suction" Lift
h: Sounding at the tank
Pa: atmospheric pressure

Pressure at mouth of the suction pipe - '$P_a + h$'

Pressure at the mouth of the impeller : $(P_a + h)$ - Losses

(Pa + h) − Losses = Pressure at the eye of the impeller

$= (P_a + h) - \{(\text{Suction Lift}) + (\text{frictional loss}) + (\text{Vapour loss})\}$

This pressure shall be always "Positive"

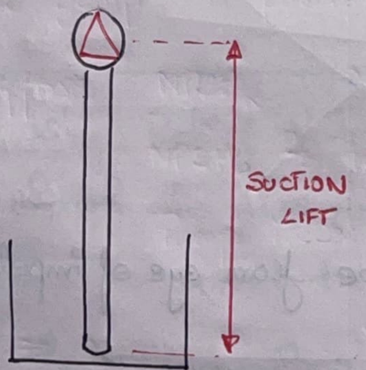
– otherwise Pump will lose suction

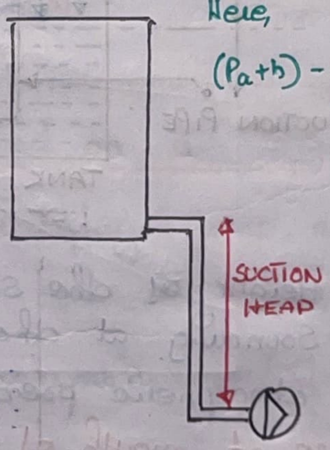
i.e., $\underbrace{(P_a + h)}_{\text{Left side}} - \underbrace{\{(SL + Hf + Hv)\}}_{\text{Right side}}$ shall be > 0

* Throttling Discharge valve will reduce frictional losses. (shutting / throttling discharge valve)

  i.e., $\underline{\underline{Hf}}$ is reduced.

  Left side is maintained higher ⇒ Pump regains suction





Here,
$(P_a + h) - \{(-SH + Hf + Hv)\}$

If hot liquids (Boiler FW) or volatile liquids are being handled (LPG, LNG, Naptha)

⇒ Hot liquids: position the pump as low as possible from suction so as to minimise vapour losses (As in the case of Hot well and BLR FW P/P)

⇒ Hot volatile Liquids: Submerged in Tanks (to prevent suction drop/loss) (vapour pressure is very high)

- **NET POSITIVE SUCTION HEAD:**

  - "Amount by which the pressure at the eye of the impeller exceeds the vapour pressure of the liquid" corresponding to the temperature of the liquid.

- NPSH shall always be positive: for pump to take suction

  If NPSH is -ve, vapour pressure is higher resulting in cavitation and the pump loses suction

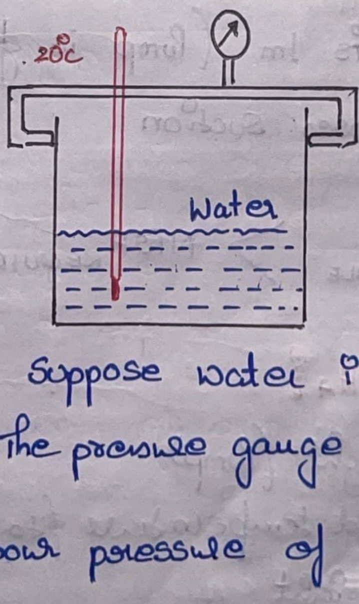
- NPSH = Pressure at the eye of the impeller − Vapour pressure of the liquid.

* Here, to understand the concept of vapour pressure imagine a tank with a liquid.

- Cover the tank and mount the Tank with a pressure gauge and insert

- CASE I: Suppose water @ 20°, Pressure gauge reading is zero

  ⇒ "Vapour pressure of water at 20° is Zero"



- CASE II: Suppose water is heated to 60°c.
  - The pressure gauge displays "1 Bar"

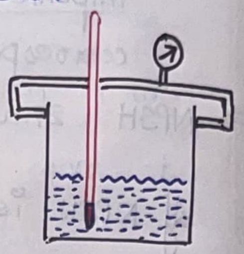
  ⇒ Vapour pressure of Water at 60°c is 1 Bar

In a boiler, same phenomenon happens as at 140°c, the Vapour pressure is 4 Bar

In case of Petrol/Naphtha : (Highly volatile)

at 30°c, the Pressure Gauge shows 2 Bar

i.e., At 30°c, vapour pressure of Petrol is 2 Bar



→ which means, higher the vapour pressure, (lesser boiling Point)
" higher is the volatility.

This is why pumps must be submerged, otherwise NPSH will be -ve

• HOW TO INCREASE PRESSURE AT THE EYE OF THE IMPELLER

$NPSH_{Required}$: Design Criteria (cannot be altered)

$NPSH_{Available}$: Situation/operational Criteria
(Position, Environment) : Installation Criteria

When a pump is purchased, $NPSH_R$ will be specified

Suppose, $NPSH_R = 2m$

$NPSH_A$ is 1m (Pump is fit wrongly)

Pump loses suction

∴

$\Rightarrow NPSH_{AVAILABLE} > NPSH_{REQUIRED}$.

How to Increase $NPSH_A$?

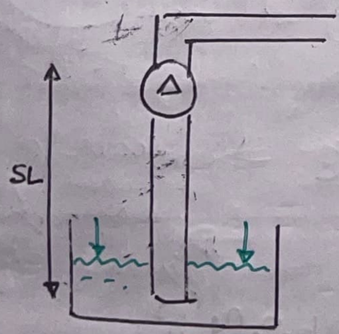
- Install at lower height (Pump)
- Monitor working fluid temperature (to be low)
- Install tank at a height
- Throttle the Discharge Valve

Q) How FWG Distillate P/p takes suction even though the FWG is in Vacuum?

- Distillate Pump is fit at a lower position thus, NPSH for the pump becomes '+ve' as suction lift becomes suction head (-ve).
- Also, temperature of the condensed water is very low
- the pump is designed with a low rate of discharge
  ⇒ H_f is reduced "frictional losses" are reduced.

Hence, FWG distillate Pump doesn't lose suction even if it takes suction under vaccuum.

* NOTE: Submerged pumps for Petrol, LPG and LNG (Volatile liquids)
- If pump was as shown and not submerged, Pressure drops at suction and at a point, the liquid will boil as it has high vapour pressure, and start vapourising. and lose suction



i.e., $(P_{atm}) - (SL + H_f + HV)$

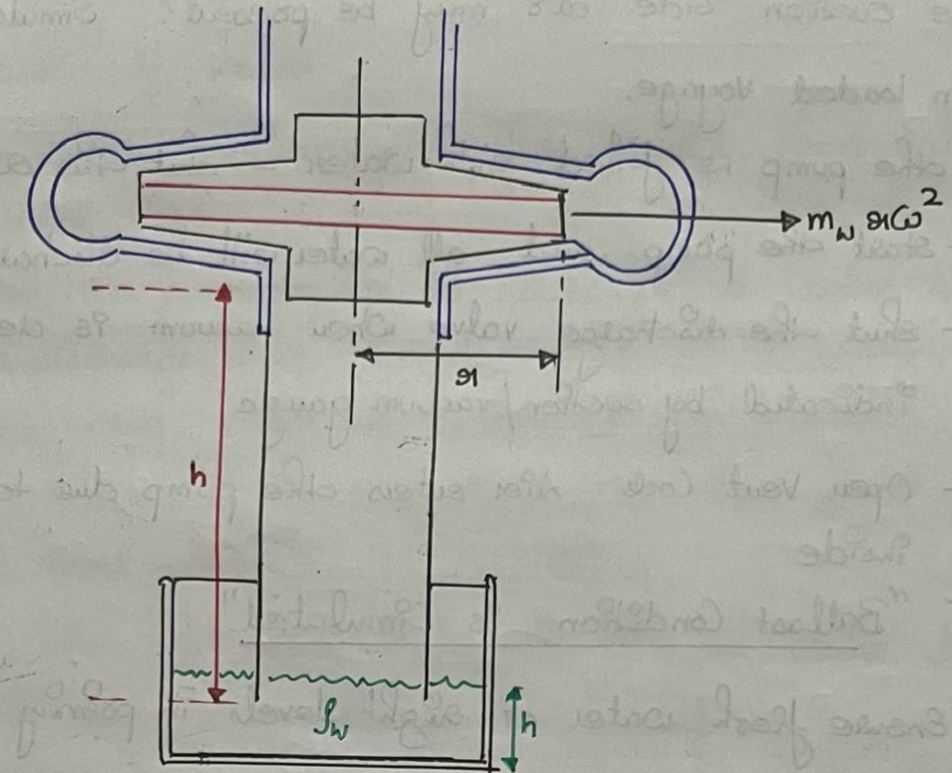
In such condition ⇒ HV ↑
and thus, Pressure at Impeller eye is -ve ⇒ Looses suction

Therefore, Pump is submerged inside the tank
⇒ Suction lift becomes Suction head (-ve) and Pump will not lose suction.

Q: Why Centrifugal Pumps cannot handle air and Require priming? Air blowers require no priming & operate on same principle.

Ans:
* Force require to lift up the water through height 'h' = $\rho_w gh$

This force is created by the centrifugal force of the impeller. i.e., $m_w r\omega^2$



* If air is present, density of air is significantly less

i.e., $1m^3$ of air $\simeq$ 1.2 Kg

$1m^3$ of water $\simeq$ 1000 Kg

then, centrifugal force = $m_a r\omega^2$, m_a = mass of air

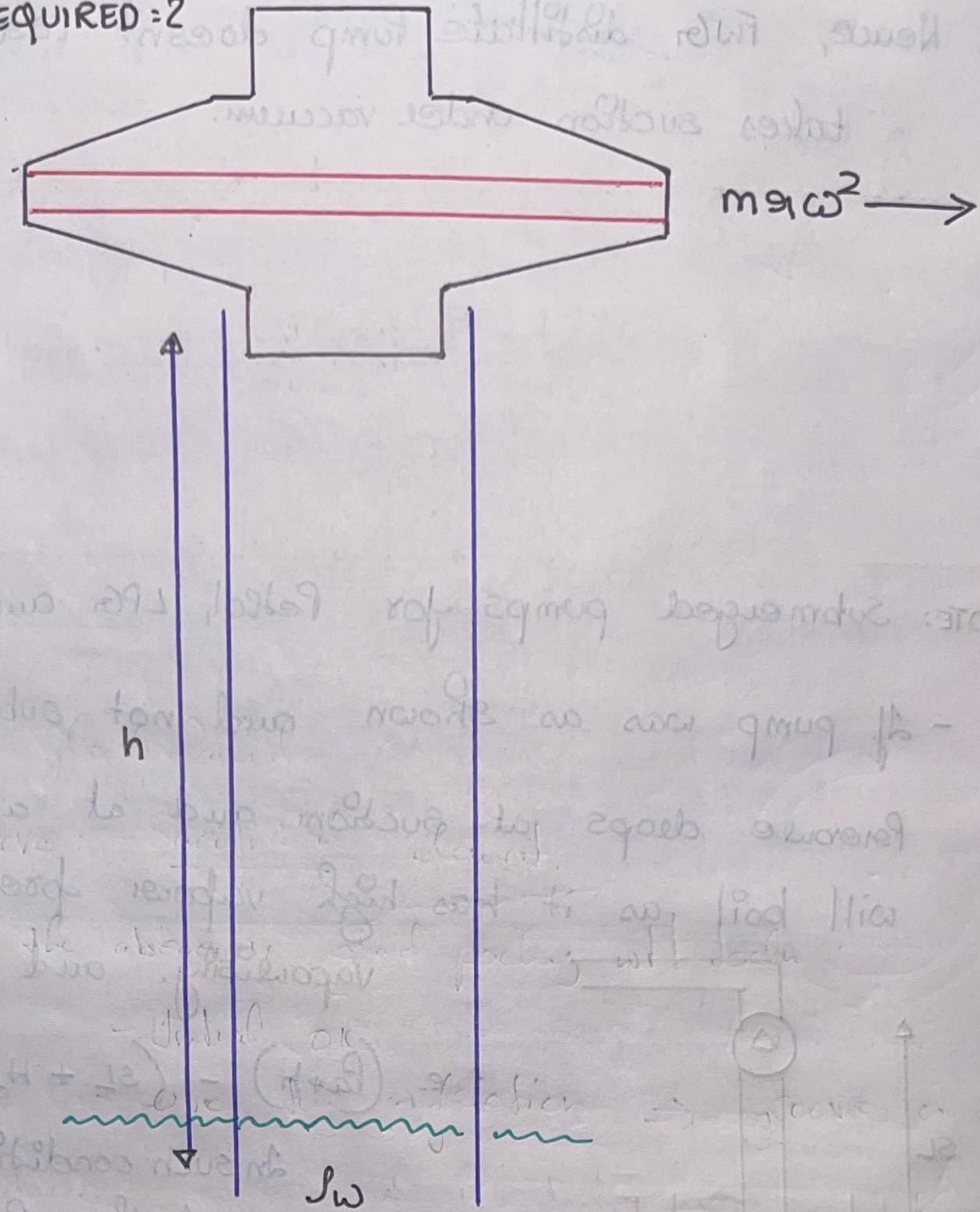
then, $m_a r\omega^2 << \rho_w gh$, hence won't take suction

If both side has water, $m_w r\omega^2 >> \rho_w gh \rightarrow$ Suction

i.e., Priming enables centrifugal pumps to take suction and discharge fluid.

In case of blowers, both the sides have air and air is drawn and discharged. i.e., $m_a r\omega^2 >> \rho_a gh$

Q) WHY PRIMING IS REQUIRED :2



① Force required to lift up water by height 'h'

$$= \rho_w g h$$

this force is created due to the centrifugal force developed by the impeller rotation : $mr\omega^2$

$$\therefore mr\omega^2 > \rho_w g h$$

(2) Suppose there's air at suction.

then, "$m_a r \omega^2$"

also, density of water is almost 800 times of air

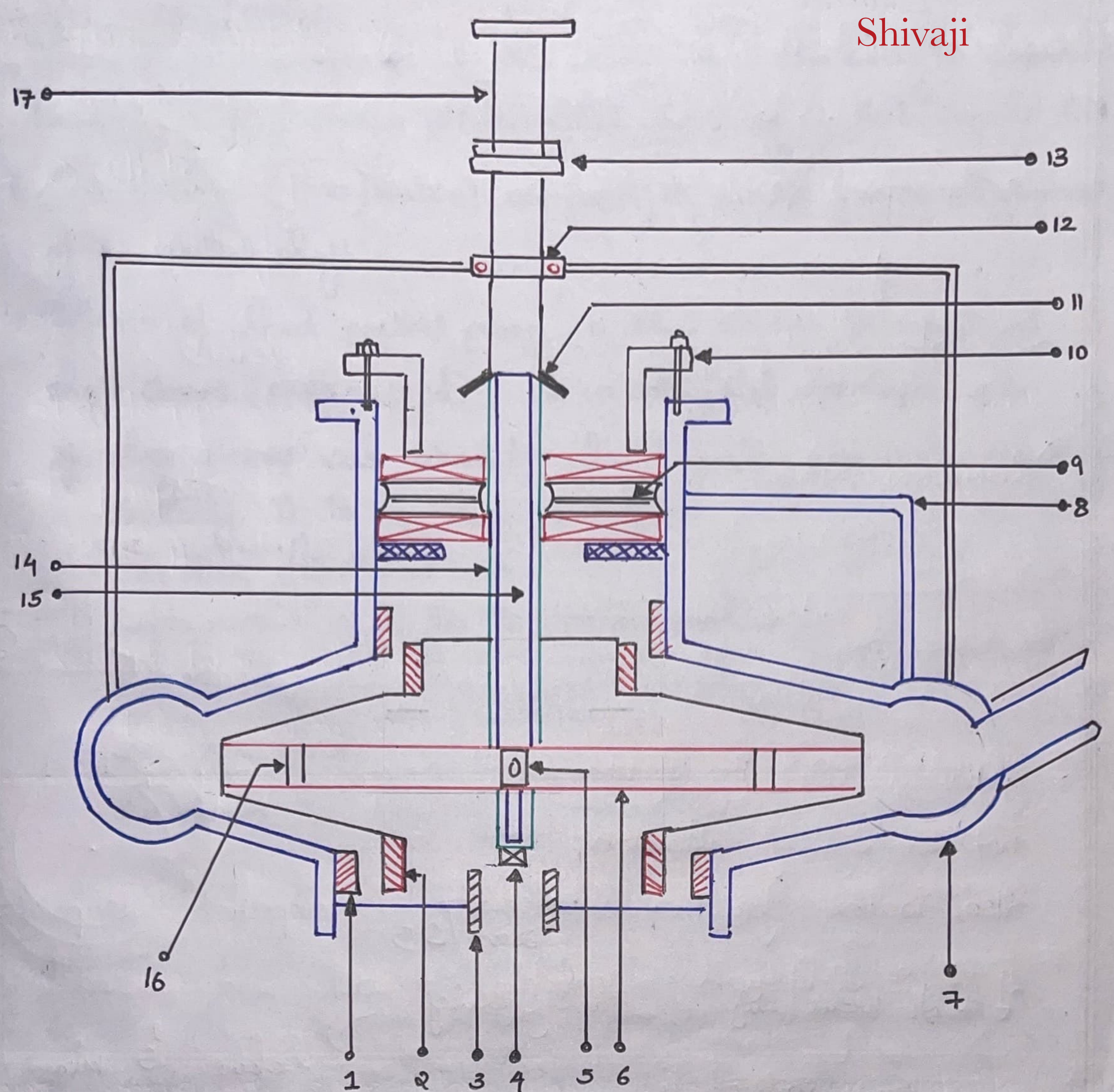
($1 m^3$ of water = 1000 kg

$1 m^3$ of air = 1.2 kg)

$$m_a r \omega^2 < m_w r \omega^2$$

generated centrifugal force required to lift up water will be very low.

* In case of blowers, both sides air → so $m_a r \omega^2 > \rho_a g h$
air drawn at suction and air discharged so no mismatch.



1. CASING RING
2. WEAR RING
3. LINE BEARING
4. IMPELLER NUT
5. KEY
6. VANES / BLADES
7. VOLUTE CASING
8. SEALING / COOLING WATER LINE
9. LANTERN RING
10. GLAND
11. FLINGER
12. DEEP GROOVED BALL BEARING
13. COUPLING
14. SHAFT SLEEVE
15. SHAFT
16. BALANCING HOLES
17. DISTANCE PIECE / INTERMEDIATE SHAFT

MATERIAL FOR PARTS

① Casing Ring: Brass / Carbon / S.S
② Wear ring: Same as impeller
③ Line BRG: Brass / Carbon
④ Shaft sleeve: Stainless steel
⑤ Impeller:
Sea Water P/p: Brass
Fresh Water P/p: Stainless steel
⑥ CASING:
Sea Water P/p: Brass
FW P/P: Cast steel
⑦ Lantern Ring: Brass / teflon
⑧ Gland: Hemp

System Configuration:

* Impeller is mounted on to the shaft by a key and is sandwiched between 2 shaft sleeve pieces held tight by a nut (Impeller Nut)
* Line bearings (Brass/Carbon) are used to ensure proper alignment of a vertical shaft.
* In case of gland packed pump, a shaft sleeve is required shaft sleeve (stainless steel) is a sacrificial element.
  If shaft sleeve was absent, gland packing will touch the shaft.
  - Initially, it is an okay condition
  - Over time, frictional wear leaves grooves on shaft and replacement of shaft is not economical
  - That is why sleeves are used as they can be replaced and are less expensive
  - The sleeve is slid on to the shaft "slide fit"

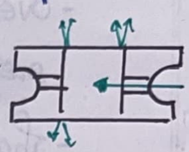
* Since the suction is at lower pressure and discharge at high pressure, sealing is required (as leak or short cycling from HP to LP will cause cavitation and cause wear down of impeller and casing. which are again expensive to replace)
* Hence, sacrificial wear rings & casing rings are used.
  Wear ring (same material as Impeller) and casing ring (brass/ S.S.), usage provides minimal leakage.
  - Over time, they wear out → clearance increases due to which there's sudden drop in pressure & efficiency, Also air/vapour on suction side leading to pump losing suction.
* The diagram shows a double entry impeller having 2 sets of wear rings and casing rings
* Replacement of worn out wear rings & casing rings are economical.
* Volute Casing: Works on principle of Bernoulli's Equation
  - As area of cross section increases, kinetic energy is converted into Pressure energy.
* Weight of the impeller is taken up by the ball bearing

Earlier, Gland Packing : Asbestos
Now → Hemp Packing

Gland Packing provides sealing by preventing entry of air and leakage of water from

→ The gland packing needs to be lubricated & cooled this is achieved by the Lantern Ring

* LANTERN RING: Made up of Brass or Ebonite
  - Water from discharge side of the pump enters the lantern ring and is spread over the glands for lubrication.



* Gland Packing is tightened in such a way that it is not too tightly attached.
  Also, water for its lubrication is expelled dropwise
  - If it is tightened extremely, it will cause overheating

* FLINGERS : to prevent water from entering into the bearings as dropwise water from gland packing is allowed.

The clearance between Wear ring & casing ring shall not increase as:
- short cycling between High Pressure & Low Pressure Side: Cavitation
- Amperes are high, heavy vibration & noise
- Discharge pressure will be low
- Pump will loose suction

CENTRIFUGAL PUMP "OVERHAUL":

i) Shut Suction Valve.

ii) Shut Discharge Valve. Isolate the Motor Supply.

iii) Open Vent. or purge cock.

- Ensure Water stops after sometime. "Valves are Holding"
- If water oozes with force for a prolonged period, this means valves aren't holding. In such case, do not open pump as it may cause engine room flooding.

iv) Jack the joint between the casings after slackening the casing bolts. (if water comes out continuously, valves may not be holding)

The half of the casing comes out. (If case of Mechanical seal, remove mechanical seal first

v) Sometimes, Motor may have to be removed (vertical P/P) otherwise, dismantle the distance piece (if not provided, may have to remove the Motor after making markings)

vi) Take out the shaft assembly with the impeller

vii) Dismount the impeller from the shaft by removing the key & slackening the impeller nut

viii) check the condition of bushing in the coupling

ix) check the condition of bearings

x) check the condition of casing & impeller, shaft for bending

If shaft sleeve is slightly grooved: Polish it on Lathe Machine

If heavily grooved, Replace.

* check Casing condition : Corrosion / Erosion
* check the clearance between Casing Ring

→ Take outer diameter of Wear Ring "y"

→ Inner diameter of Casing Ring "x"

$x - y \Rightarrow$ "Clearance" $\cong$ 0.5% of diameter of eye of the impeller

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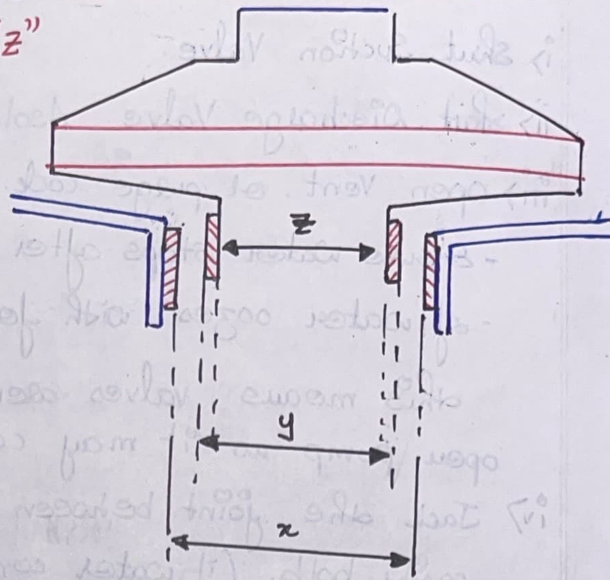
* $x - y = 0.5\%$ of eye-of the impeller diameter "z"

* Maximum Allowable = 1%.



REMOVAL OF WEAR RING AND CASING RING

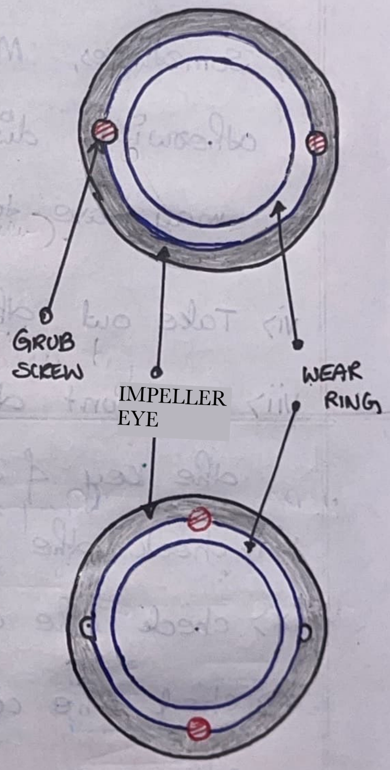
The Wear ring is held on the mouth/eye of the impeller by "glub screws (allen)"

To replace Wear Ring: Removal:

- remove glub screws using allen key
- remove wear ring.

To renew

- Drill a hole such that half the hole is on the eye of impeller and half on the wear ring.
- This drill ($\cong$ 3mm) is drilled at a different position than the already existing holes
- Tap the hole drilled to attain threading
- Tighten the glub screws with an allen key.



Casing rings are easy to remove & replace by hand.

NOTE: What to do when there's No wear ring?

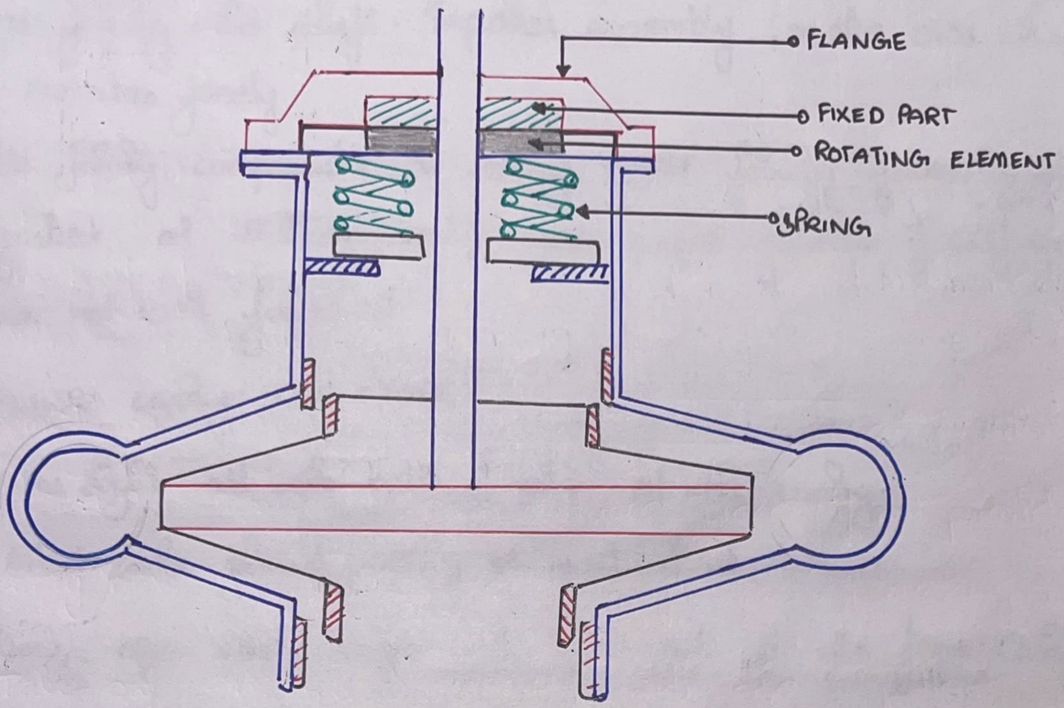
- Usually, both wear ring and casing ring wear down occurs together
- changing only the casing ring can provide temporary solution
- as slight improvement will be attained

NOTE II: Axial thrust is taken up by: Balancing holes or double entry impeller

Radial thrust is taken up by: Ball bearing.

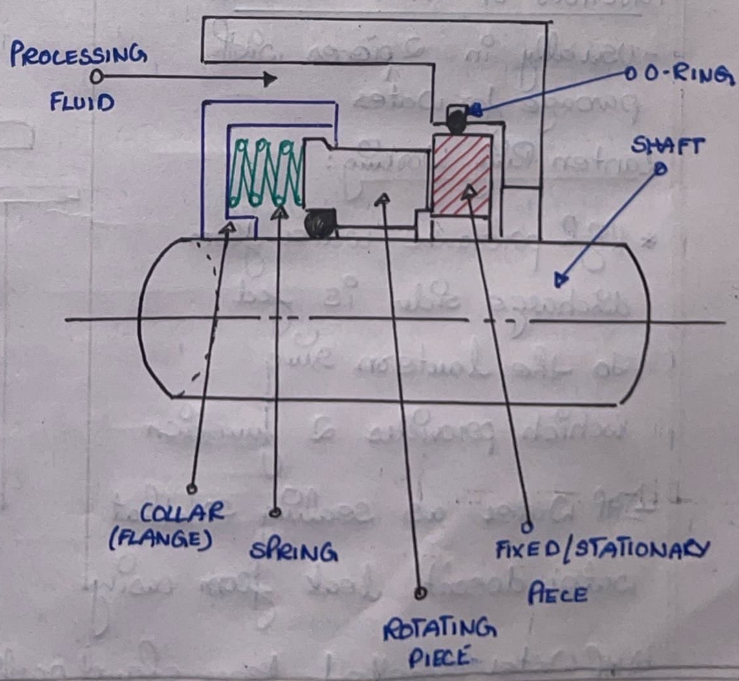
MECHANICAL SEALS:

- Nowadays, Mechanical Seals are utilized over conventional glandpacking.
- shaft sleeve is eliminated
- 2 components: Rotatic Element : attached to shaft : Carbon/Graphite
  Fixed Element : Silica/Ceramic



Description:

- The working fluid (process), provides lubrication for the seal faces
- The seal faces are designed with extreme precision, which provides primary sealing of the seal.
- The sealing action is maintained by the closing forces acting on the faces due to spring pressure and pressure of process fluid. These forces keep the rotating & stationary pieces pressed together.
- A small amount of opening force allows controlled flow of process fluid between seal faces for cooling & lubrication : "Seal performance"



FUNCTION OF LANTERN RING

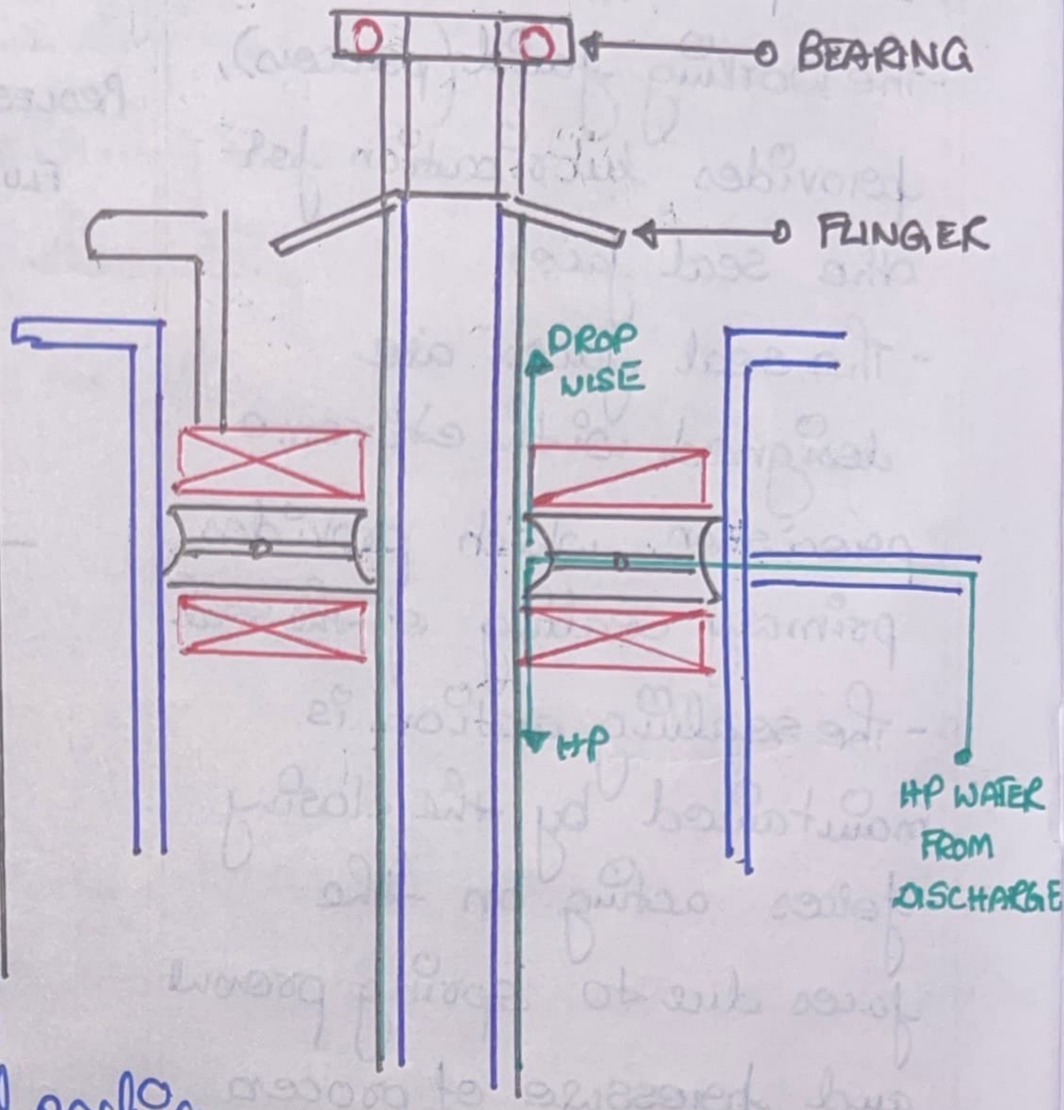
- Usually in 2 pieces with passage for water

Lanten Ring Working:

* High pressure water from discharge side is fed to the lantern ring which provides 2 function

a) HP Water as sealing so that water doesn't leak from casing

b) HP Water expelled from gland packing for cooling & lubrication - prevent entry of air into casing.



If a mechanical seal leaks, it is most likely to be replaced after ascertaining its condition

- If no seal is available, lap the seal faces on a glass plate using (cylinder oil) and not lapping paste

- BOX BACK OF THE PUMP:

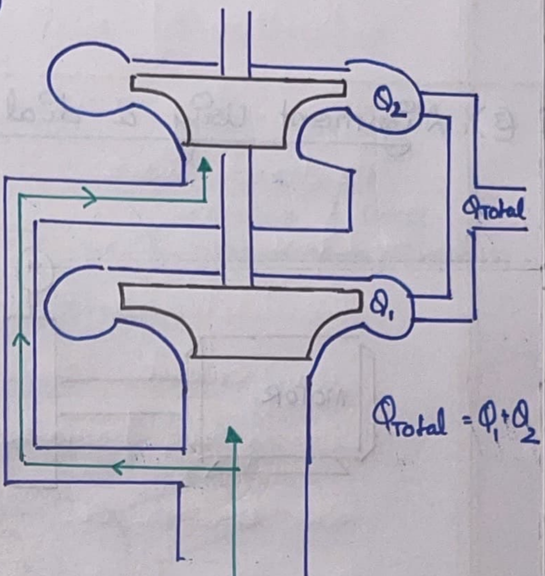
- After fitting the shaft - impeller assembly, make sure that it rotates freely
- Use joining compounds on casing cover joining faces (form-A gasket of Silicon (red). Use paper gaskets if surfaces are not well finished
- Ensure casings are clean
- Even tight all the bolts & nuts of the casing
- Attach the gland packing or mechanical seal
- Now, open vent/purge cock - to vent all air from casing
- Open inlet valve (for priming)
- Close the vent as water starts coming out of it.
- observe the casing & seal/gland for leaks
- (Grease the bearing upon operation)
- Start the pump & monitor vibration
- Open Discharge valve gradually : Observe abnormal noise.
- In case of gland packing, make sure water is expelled dropwise indicating efficient lubrication

- MULTI-STAGE PUMPS:

(1) IMPELLERS IN SERIES: To obtain higher pressures
- As in the case of Boiler FW pumps
- Discharge of first impeller is suction of 2nd Impeller

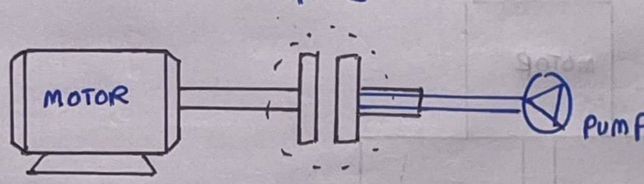
(2) IMPELLERS IN PARALLEL: - Higher Quantity
- Low Pressure

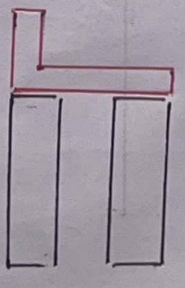
+ Used in ME L.O. P/P
* Used in



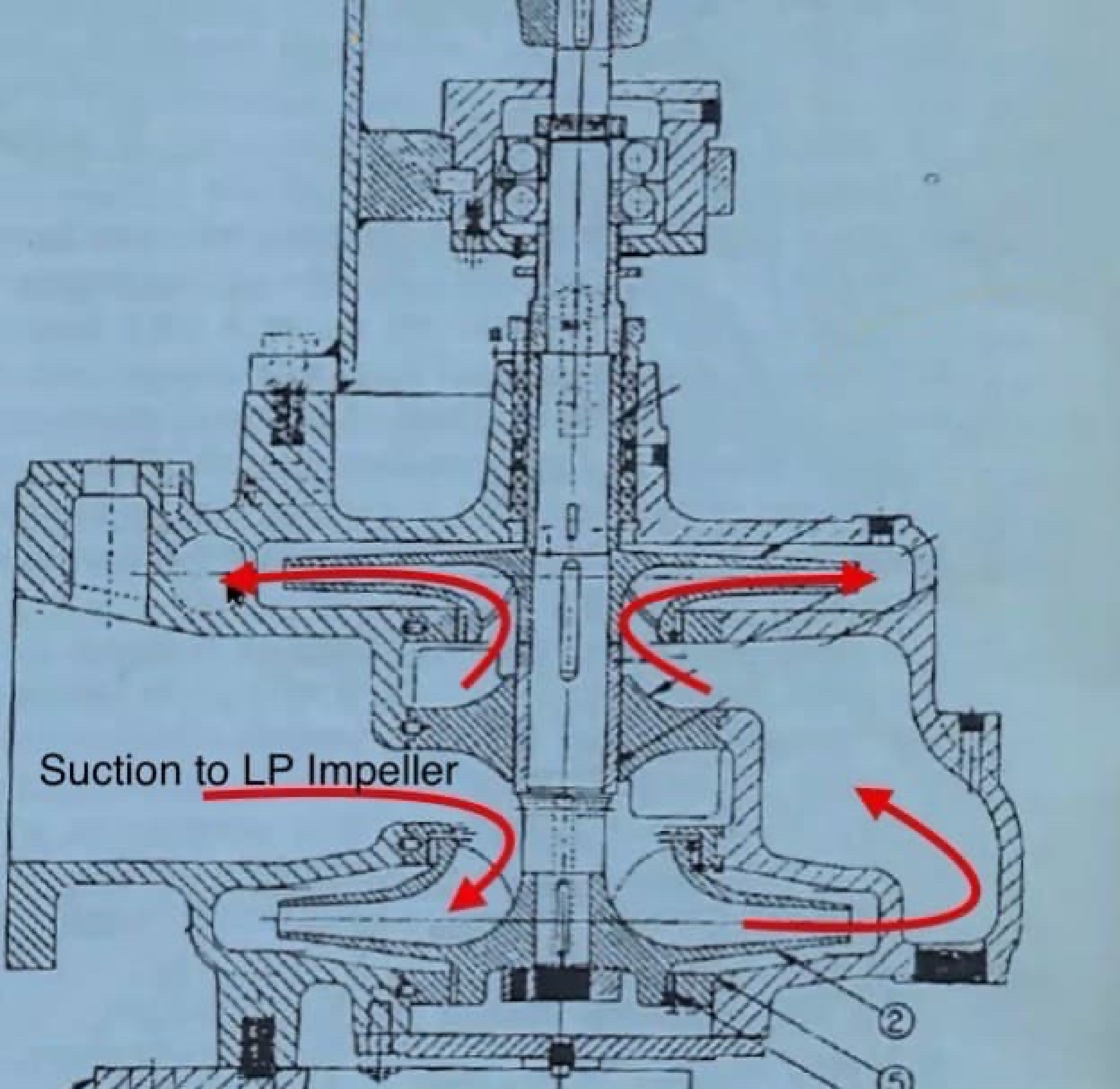
- METHODS OF CHECKING ALIGNMENT:

(1) Parallel Allignment: Using a template
- There shall be no gap b/w the template & coupling





* No gap between the template & coupling ensures Parallel alignment.



Suction to LP Impeller
②
⑤

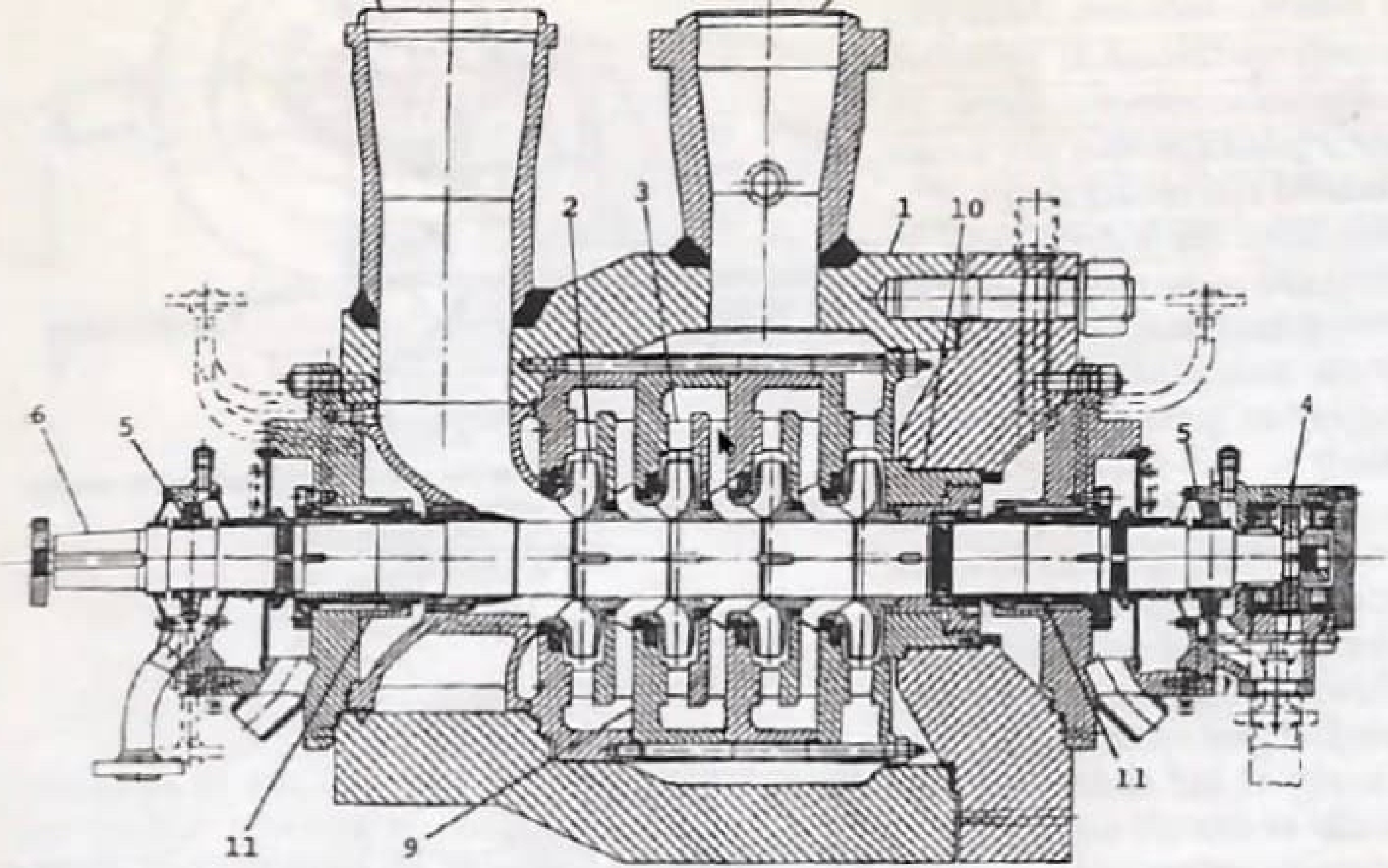
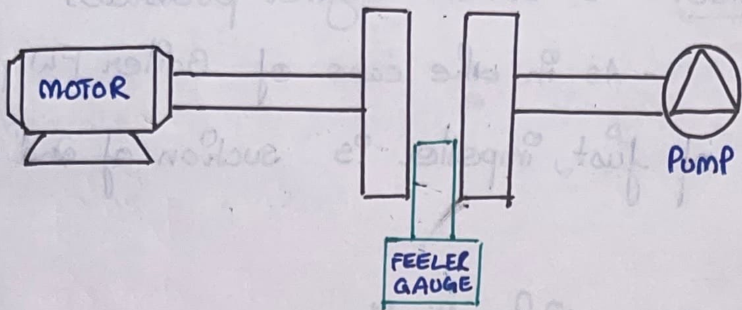
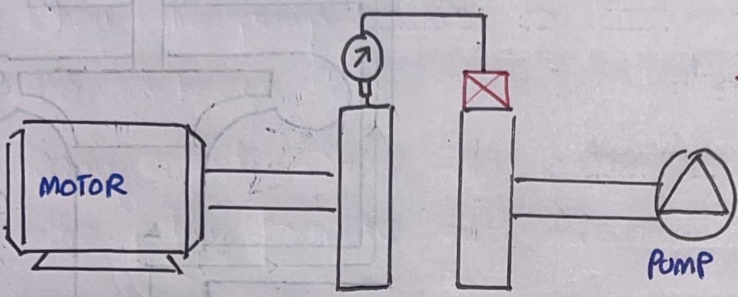


Fig.

(2) Angular Alignment : Using a feeler Gauge.



(3) Alignment Using a dial Gauge: and Magnetic Block

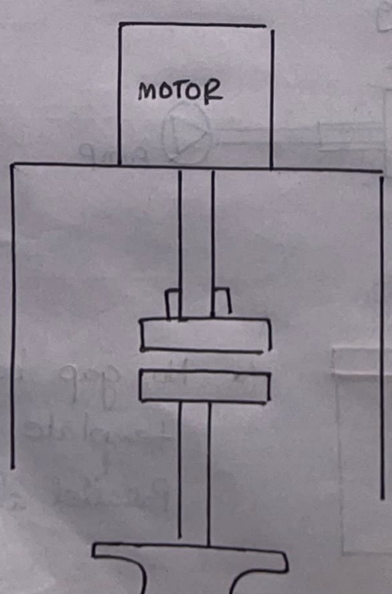


- Place Magnetic block on the coupling of pump
- Dial gauge on coupling of Motor
- Turn the coupling and observe the dial gauge.

* Maximum Allowable = 0.2 mm

* Adjusted using shims under the motor foundation (Pump cannot be shifted due to pipelines and other factors)

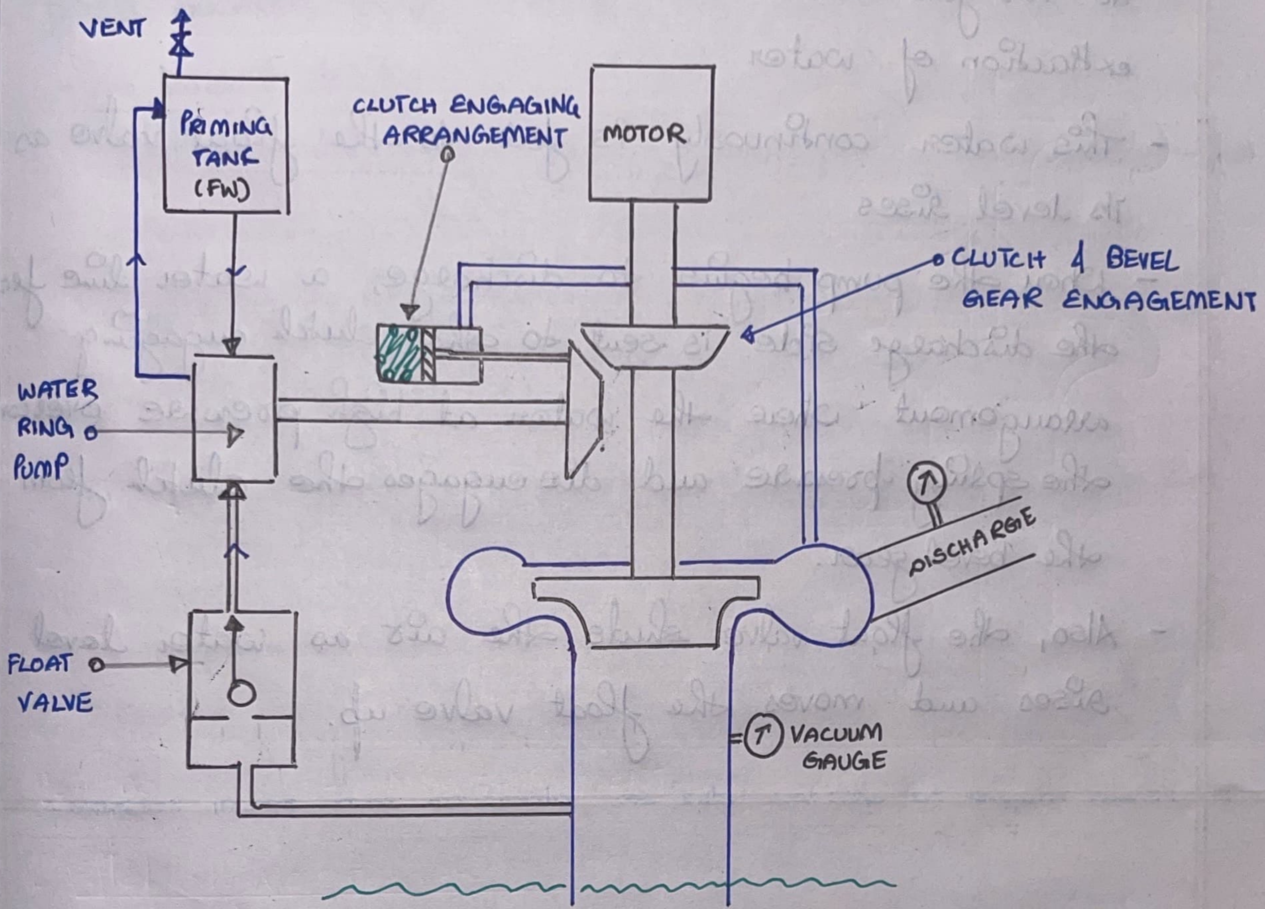
In case of a vertical pump: similar methods for alignment



SELF PRIMING ARRANGEMENT OF EMERGENCY FIRE PUMP:

→ Emergency fire pumps are fit/installed as low as possible for a positive head at all times.

→ They are also provided with a priming arrangement.

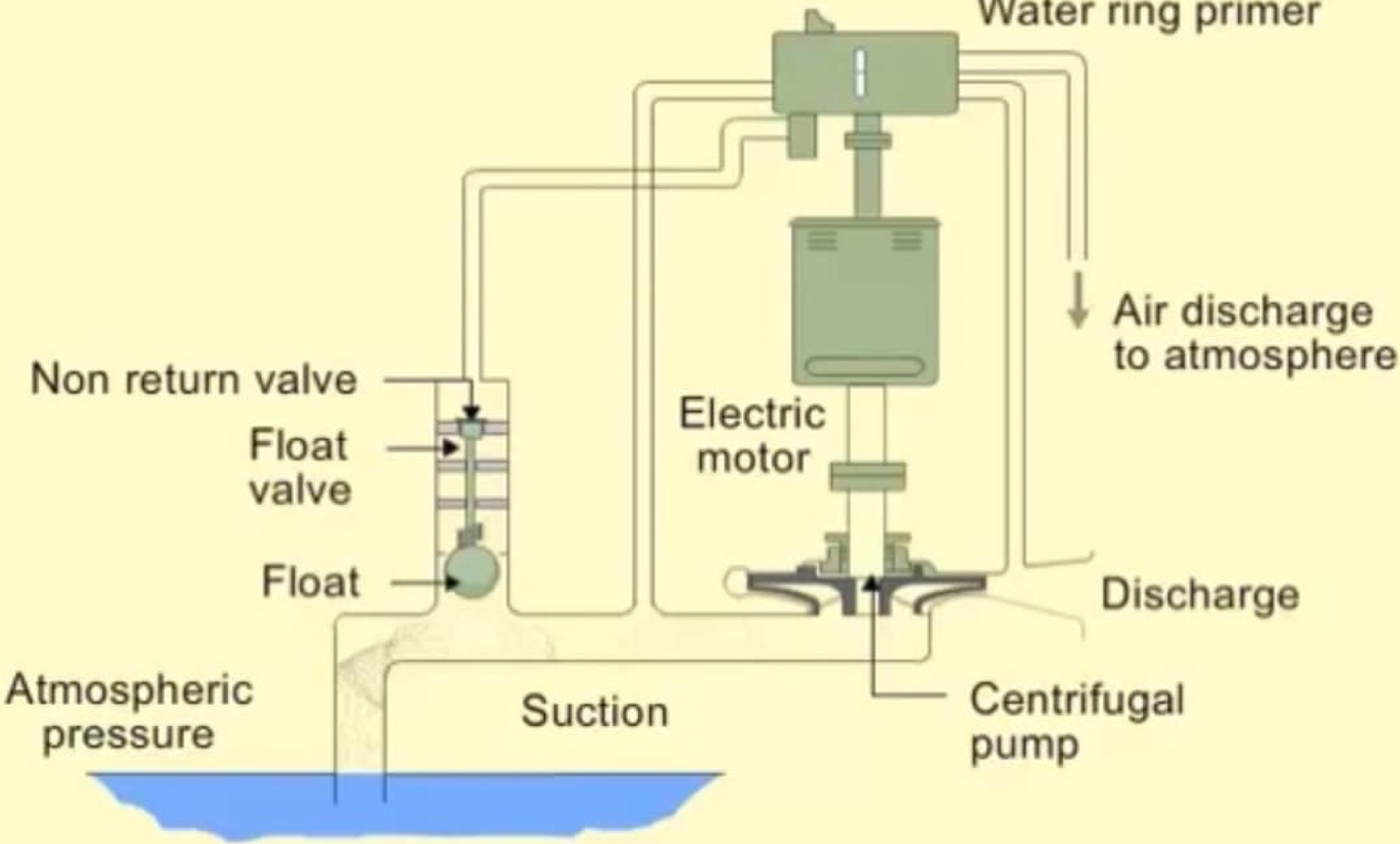


Shivaji

- OPERATION:

- When water level is low, the suction side pipe is filled with air
- clutch is engaged due to spring pressure
- As motor is started, since the clutch is engaged, it drives the water priming pump while driving the pump impeller

- The water ring priming pump continuously draws fresh water from Priming Tank and air from suction side of the pump
- Air gets drawn through a float valve and is fed to the priming tank, where it gets vented.
- As air gets drawn out, Vacuum is created which causes extraction of water
- This water continuosly is fed to the float valve as its level rises
- When the pump begins to discharge, a water line from the discharge side is sent to the clutch engaging arrangement where the water at high pressure overcomes the spring pressure and dis engages the clutch from the bevel gear.
- Also, the float valve shuts the air as water level rises and moves the float valve up.



Water ring primer
Air discharge
to atmosphere
Non return valve
Float
valve
Float
Electric
motor
Discharge
Atmospheric
pressure
Suction
Centrifugal
pump

- HOW TO CHECK THE PRIMING UNIT DURING A LOADED VOYAGE FOR ITS OPERATION IN CASE OF A BALLAST VOYAGE:

During loaded condition, the pump is well below sea water level and hence, ample water in suction side

- But to check for its operation in a ballast situation where suction side air may be present? "Simulate this"
  - In loaded voyage,
    the pump is filled with water - shut the suction valve
    - start the pump and all water will be discharged
    - shut the discharge valve when vacuum is created as indicated by suction/vacuum gauge
    - Open Vent Cock: Air enters the pump due to vacuum inside
    - "Ballast Condition is Simulated"

- Ensure fresh water at right levels in priming tank
- As there's no water on discharge side, clutch would be in engage position due to spring force
- ~~Open Suction Valve and Start Pump~~
- Start Pump → Suction creates Vacuum open suction valve

  Water will be drawn in and discharged (Discharge V/V is still shut)
  - As water gets discharged, it will disengage the clutch as shown & discussed earlier
  - Also, float valve gets operated and water ring priming pump stops