- The Centrifugal pump acts as a reverse of an inward radial flow reaction turbine.
- The flow in centrifugal pumps is in the radial outward directions.
- The Centrifugal pump works on the principle of forced vortex flow which means that when a certain mass of liquid is rotated by an external torque., the rise in Pressure head of the rotating liquid takes place.
- The rise in Pressure head at any point of the rotating liquid is proportional to the square of tangential velocity of the liquid at that point

  Rise in Pressure head $= \frac{V^2}{2g}$ (or) $\frac{w^2 r^2}{2g}$

- Thus at the outlet of the impeller, where radius is more, the rise in Pressure head will be more and the liquid will be discharged at the outlet with a high Pressure head.
- Due to this high Pressure head, the liquid Can be lifted to high level.

MAIN PARTS OF A CENTRIFUGAL PUMP

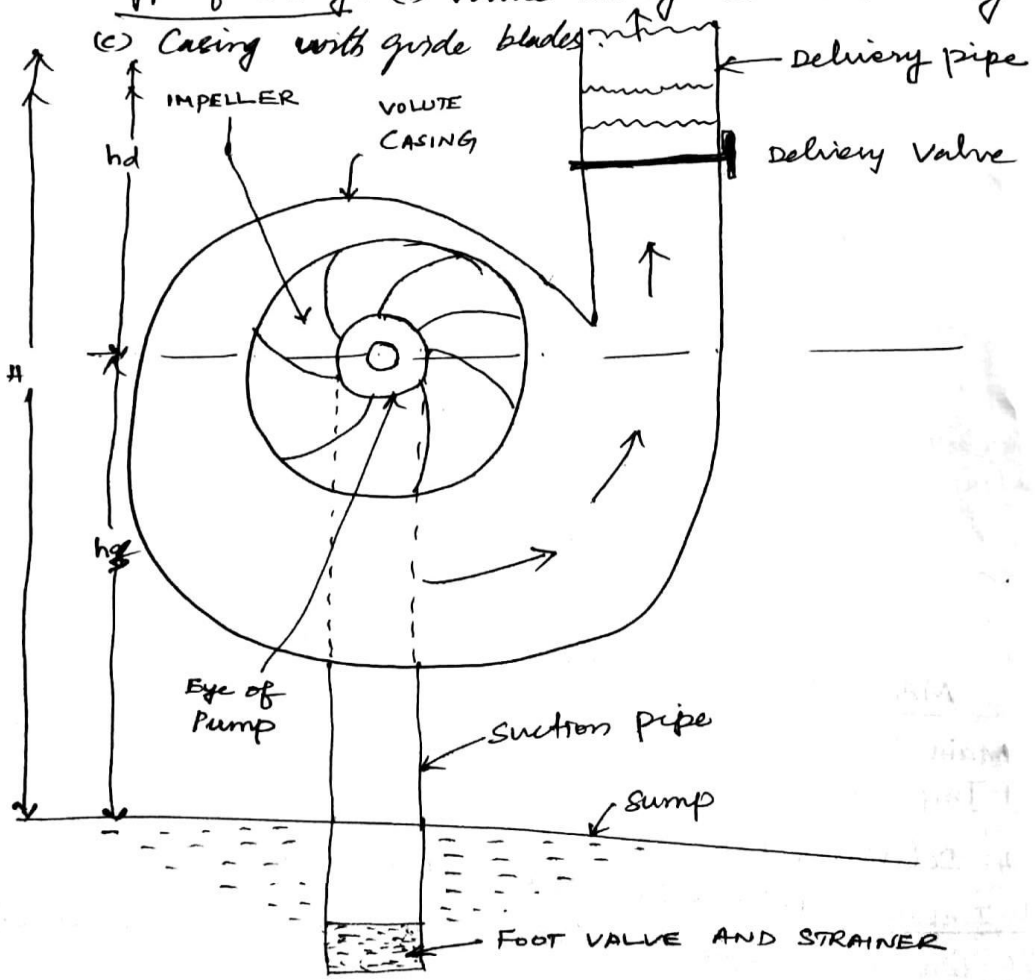
Main Parts:
1. Impeller 2. Casing 3. Suction pipe with a foot valve a Strainer
4. Delivery pipe.

1. Impeller: Rotating Part of a Centrifugal pump is Called impeller It Consists of a backward Curved Vanes. The impeller is mounted

on a shaft which is connected to the shaft of an electric motor.

2. Casing: It is similar to the casing of a reaction turbine. It is an air-tight passage surrounding the impeller and is designed in such a way that the kinetic energy of the water discharge at the outlet of the impeller is converted into pressure energy before the water leaves the casing and enters the delivery pipe.

Types of casing: (a) volute casing (b) vortex casing (c) casing with guide blades.



VOLUTE CASING: Volute Casing, which surrounds the impeller. It is of spiral type in which area of flow increases gradually. The increase in area of flow decreases the velocity of flow.

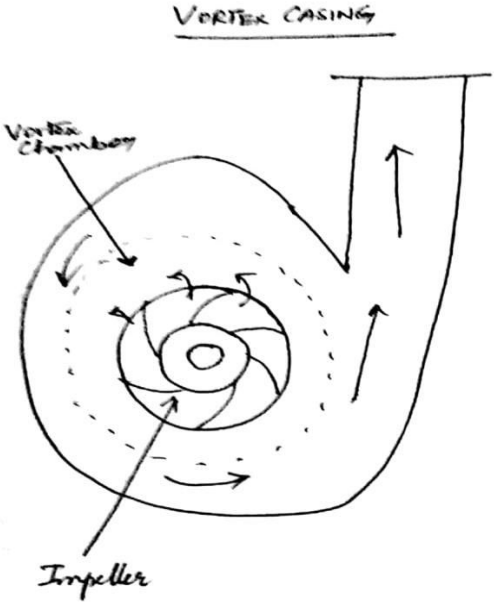
The decrease in velocity increases the Pressure of the water flowing through the casing. It has been observed that in case of volute casing, the efficiency of the pump increases slightly as a large amount of energy is lost due to the formation of eddies in this type of casing

(b) Vortex Casing: If a circular chamber is introduced between the casing and the impeller as the casing is known as vortex casing
The η_p of the pump is more than the efficiency when only volute casing is provided.

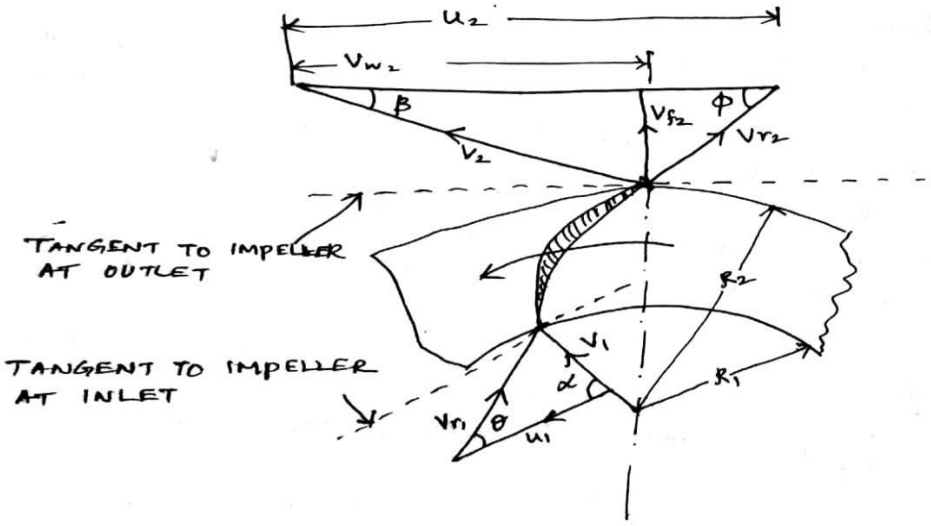
(c) Casing with Guide Blades: The impeller is surrounded by a series of guide blades mounted on a ring which is known as diffuser.

(3) Suction pipe with a foot valve and a strainer:
A pipe whose one end is connected to the inlet of the pump and other and dips into water in a sump is known as suction pipe. A foot valve which is a non-return valve or one-way type of valve is fitted at the lower end of the suction pipe. The foot valve opens only in the upward direction. A strainer is also fit at the lower end of the suction pipe.

(4) Delivery pipe: A pipe whose one end is connected to the outlet of the pump and other end delivers the water at a required height is known as delivery pipe.



WORK DONE BY THE CENTRIFUGAL PUMP (OR BY IMPELLER) ON WATER



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- In centrifugal pump, work is done by the impeller on the water.
- The water enters the impeller radially at inlet for best efficiency of the pump, which means the absolute velocity of water at inlet makes an angle of 90° with the direction of motion of the impeller at inlet.

Hence Angle $\alpha = 90°$

$V_{w1} = 0$

For drawing the velocity triangle, the same notations are used as that for turbines.

The velocity triangles at the inlet and outlet tips of the vanes fixed to an impeller.

Let N = Speed of the impeller in rpm

D_1 = diameter of impeller at inlet

u_1 = Tangential velocity of impeller at inlet.

$= \frac{\pi D_1 N}{60}$

D_2 = Diameter of impeller at outlet

u_2 = Tangential velocity of impeller at outlet

$= \frac{\pi D_2 N}{60}$

V_1 = Absolute velocity of water at inlet.

V_{r1} = Relative velocity of water at inlet.

α = Angle made by absolute velocity (V_1) at inlet with the direction of motion of Vane.

θ = Angle made by relative velocity (V_{r1}) at inlet with the direction of motion of vane and V_2

V_{r2}, β and ϕ are the corresponding values at outlet

As the water enters the impeller radially which means the absolute velocity of water at inlet is in the radial direction and hence angle $\alpha = 90°$ and $V_{w1} = 0$.

A Centrifugal pump is the reverse of a radially inward flow reaction turbine. But in Case of a radially inward flow reaction turbine, the work done by the water on the runner per Second per unit weight of the water Striking per Second is given by

$$= \frac{1}{g}\left[V_{w_1} u_1 - V_{w_2} u_2\right]$$

∴ work done by the impeller on the water per Second per unit weight of water Striking per Second.

$$= - \text{ work done in Case of turbine}$$

$$= -\left[\frac{1}{g}\left(V_{w_1} u_1 - V_{w_2} u_2\right)\right]$$

$$= \frac{1}{g}\left[V_{w_2} u_2 - V_{w_1} u_1\right]$$

$$= \frac{1}{g} V_{w_2} u_2 \qquad (\because V_{w_1} = 0 \text{ here}) \qquad \text{——— (1)}$$

work done by impeller on water per Second

$$= \frac{W}{g} V_{w_2} u_2 \qquad \text{——— (2)}$$

where W = weight of water = $\rho \times g \times Q$

Q = Volume of water

and Q = Area × velocity of flow = $\pi D_1 B_1 \times V_{f_1}$

$$Q = \pi D_2 B_2 \times V_{f_2} \qquad \text{——— (2-A)}$$

where B_1 and B_2 are width of impeller at inlet and outlet and V_{f_1} and V_{f_2} are velocities of flow at inlet and outlet.