HYDRAULIC MACHINES - 4th Module

AIR VESSELS

It is a cast iron made closed chamber containing compressed air in the upper part and liquid being pumped in the lower part.

Functions of air vessel

- To get continuous and smooth supply of liquid at uniform rate.
- To run the pump at higher speed without any danger of separation.
- To save the power required to run the pump.

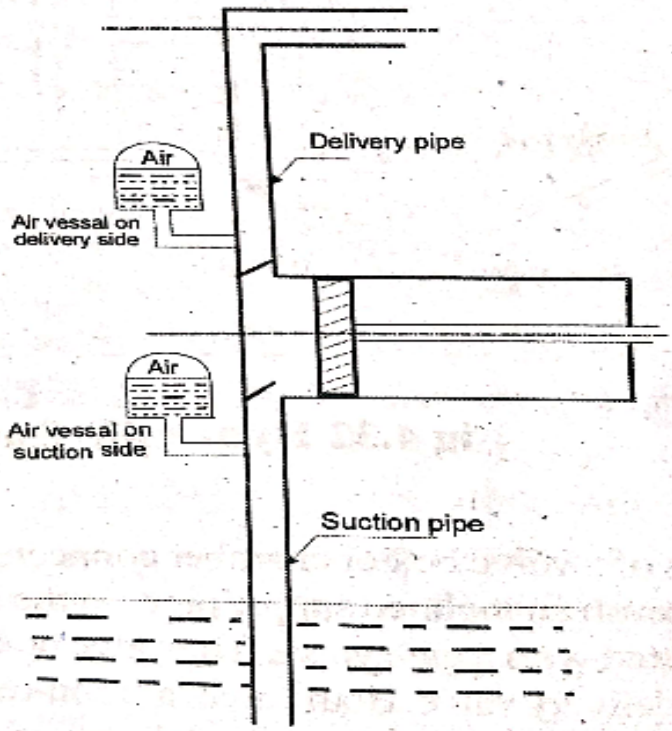


Fig 4.31 Reciprocating pump with air vessal

Working

Consider an air vessel fitted to the delivery pipe, during the first half of the delivery stroke, the piston moves with acceleration, thus forcing the water into the delivery pipe with a velocity more than the mean velocity. The excess flow of water, flows into the air vessel thus compressing the air inside the vessel.

During the second half of the delivery stroke, the piston moves with retardation thus forcing the water into the delivery pipe with a velocity less than the mean velocity. The water stored in the air vessel, then starts flowing into the delivery pipe, thus making up the deficiency of the flow.

HYDRAULIC RAM

Hydraulic ram is a pump which can be used to lift small quantity of water to a larger height.So it is suitable where large quantity of water available at low head. It does not require any external power. It works on the principle of water hammer.

Construction

It consists of a valve box or chamber connected to a low level water source through an inclined supply pipe.At the other end of the supply pipe is fitted with a gate valve.The valve box is fitted with a waste valve and delivery valve-non return valves.The delivery valve is fitted to an air vessel.

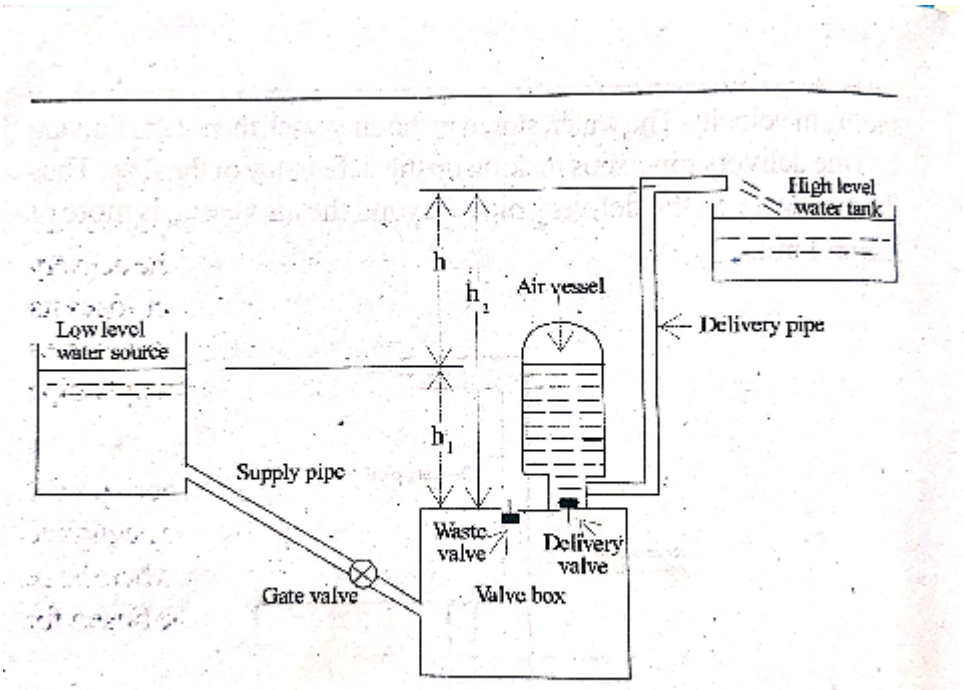


Fig 4.32 Hydraulic Ram

Working

At starting, the gate valve and the delivery valve remains closed and the waste valve remains open. Now the gate valve is opened and the water from the source starts flowing into the valve box through the supply pipe and the level

of water rises in the chamber and the waste valve begins to rise upward to close it. It may be noted that some water escape through the waste valve opening.Due to increase in pressure, at one stage, the waste valve closes suddenly, but the supply from the source is continuing.This produces water hammering due to the inertia of flowing water. So a thrust is produced in the valve box which is sufficient to open the delivery valve.Now the water is forced into the air vessel through the delivery valve. The water entering the air vessel compresses the air already present in the air vessel. In this way the pressure in the air vessel rises and ultimately closes the delivery valve.Now the water in the air vessel is forced by the compressed air to flow through the delivery pipe. Under this condition both the delivery and waste valves are closed. When water in the chamber loses its momentum, the waste valve opens and water from the chamber goes out through the waste valve. Now the flow through the supply pipe begins again and operation repeats.

AIR LIFT PUMP

An air lift pump is a pump that has low suction and moderate discharge of liquid and entrained solids.The pump injects compressed air at the bottom of the discharge pipe which is immersed in the liquid. The compressed air mixes with the liquid causing the air water mixture to be less dense than the rest of the liquid around it and therefore is displaced upwards through the discharge pipe by the surrounding liquid of higher density. Air lift pumps are widely used in aquaculture,dredging underwater archaeology, etc

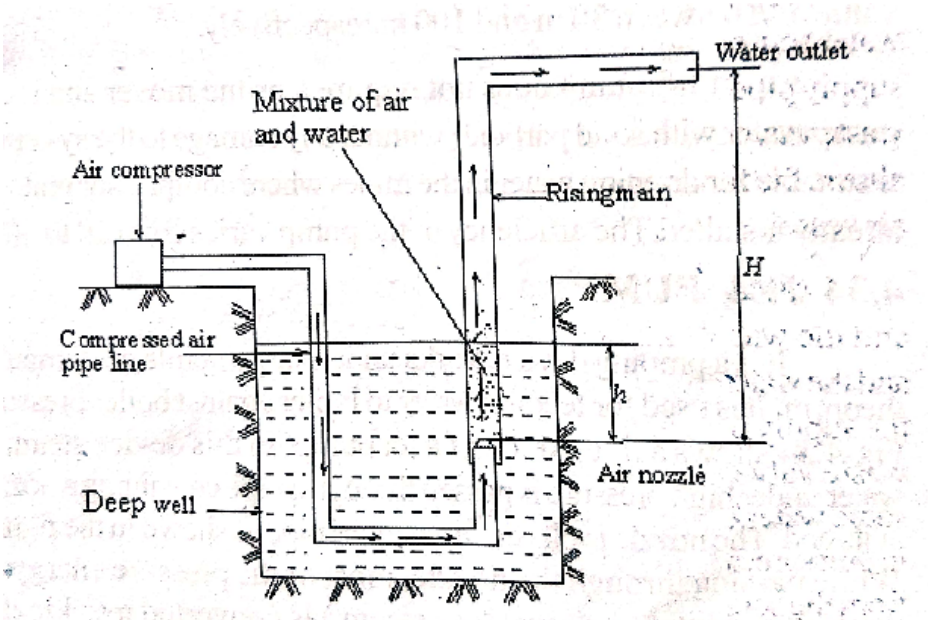
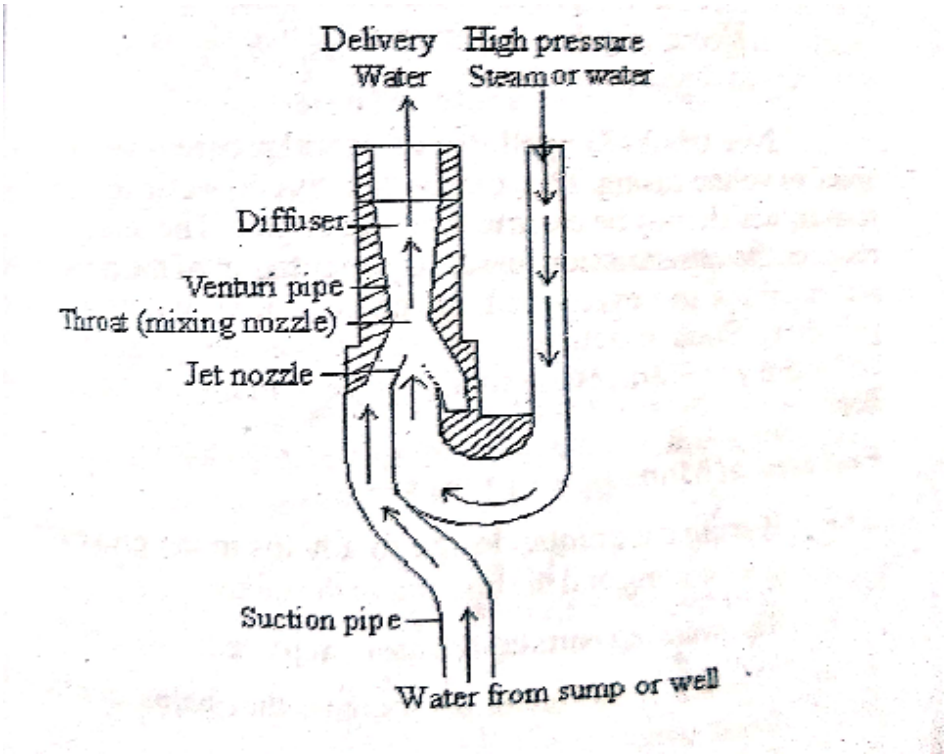


Fig 4.33 Air lift pump

JET PUMP

It is a pumping device works under the principle of Bernoulli theorem.In this device steam or water under high pressure is passed through a pipe containing a nozzle at its end. The nozzle is placed in a venturi pipe as shown in fig., while passing through the nozzle, most of the pressure energy of working medium is converted into kinetic energy. As a result, pressure around the nozzle drops much below atmospheric pressure. This causes water to flow through the suction pipe.The two flows meet in the throat of the venturi pipe. This portion is called mixing nozzle. The mixing of the two flows in the mixing nozzle results in increase in pressure.There is further increase in pressure in the diffuser due to the decrease in velocity in the diffuser.Jet pumps are mostly used in mines and pumping oil.



MONOBLOCK PUMP

It is the most common type of centrifugal pump,it consist of impeller and progressively widening spiral or volute casing.The pump is directly connected to the electric motor.The direct coupling reduces the transmission losses.Upon rotation of the impeller, the water enters the eye, which is thrown radially outward to the periphery. Such an action causes vacuum at the eye and thus more water enters the suction pipe to maintain the continuous flow. The main applications are industrial & public water supply, Domestic water supply,dewatering of mines and platforms.

SUBMERSIBLE PUMP

A submersible pump is a device which has a hermetically sealed motor close - coupled to the pump body. The whole assembly is submerged in the fluid to be pumped.Electric submersible pumps are multistage centrifugal pumps operating in a vertical position.Liquids accelerated by the impeller,lose their kinetic energy in the diffuser where a conversion of kinetic to pressure energy takes place.This is the main operational mechanism of radial and mixed flow

pumps.The sealed electric motor spins a series of impellers,each impeller in the series forces water through a diffuser into the eye of the one above it.The main applications are sewage pumping,water extraction in wells,oil extraction in offshore drilling rigs etc.

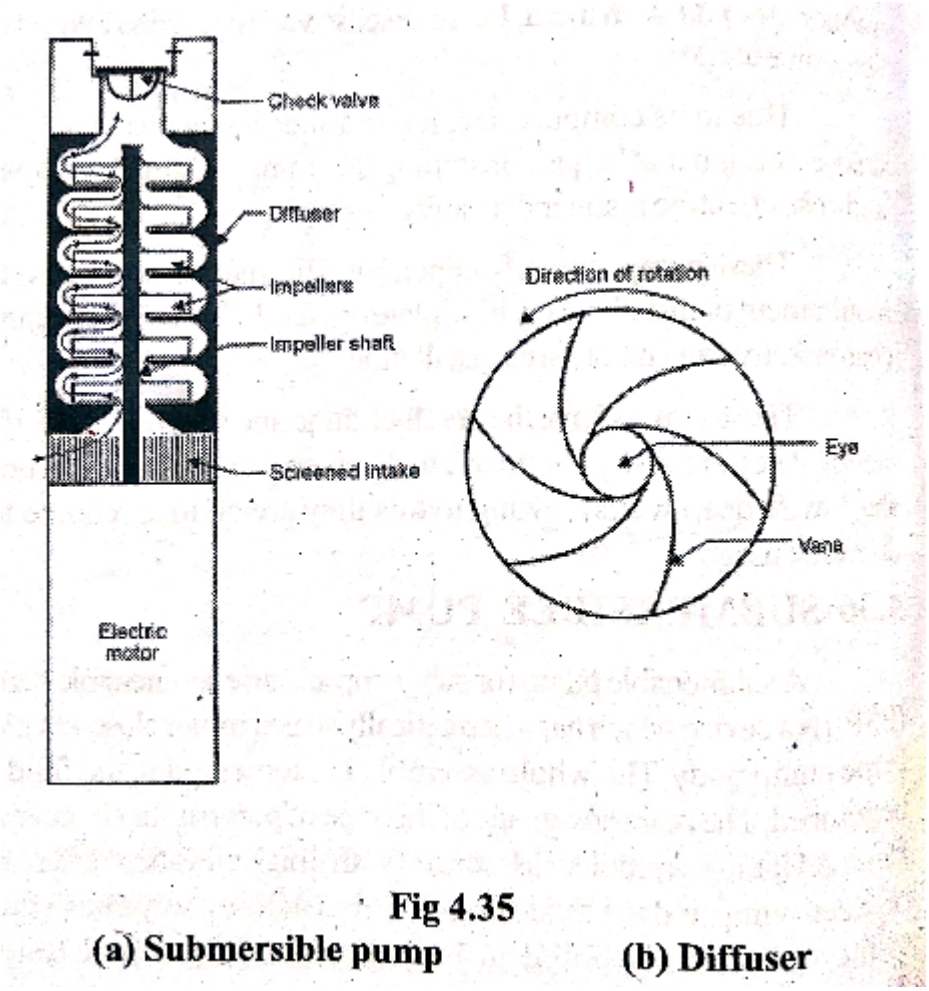


Fig 4.35

(a) Submersible pump **(b) Diffuser**

Types of Submersible pumps - Open well and Deep well submersible pumps.

- **Single phase open submersible pumps** are extensively used for domestic water supply,irrigation,springlers, high pressure washing garages.

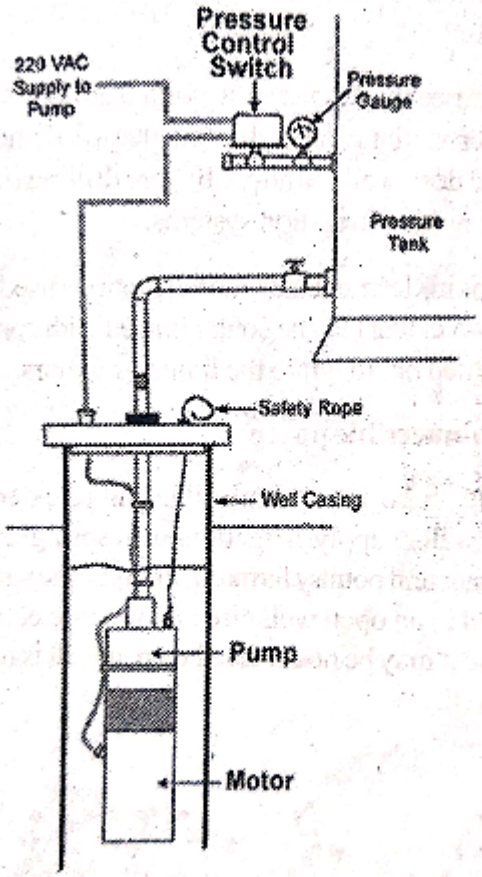


Fig 4.36 Open well Submersible pump

- **Deep well submersible pumps** are multistage centrifugal pump.Its impellers are mounted in series on the same shaft. So it can develop high head.

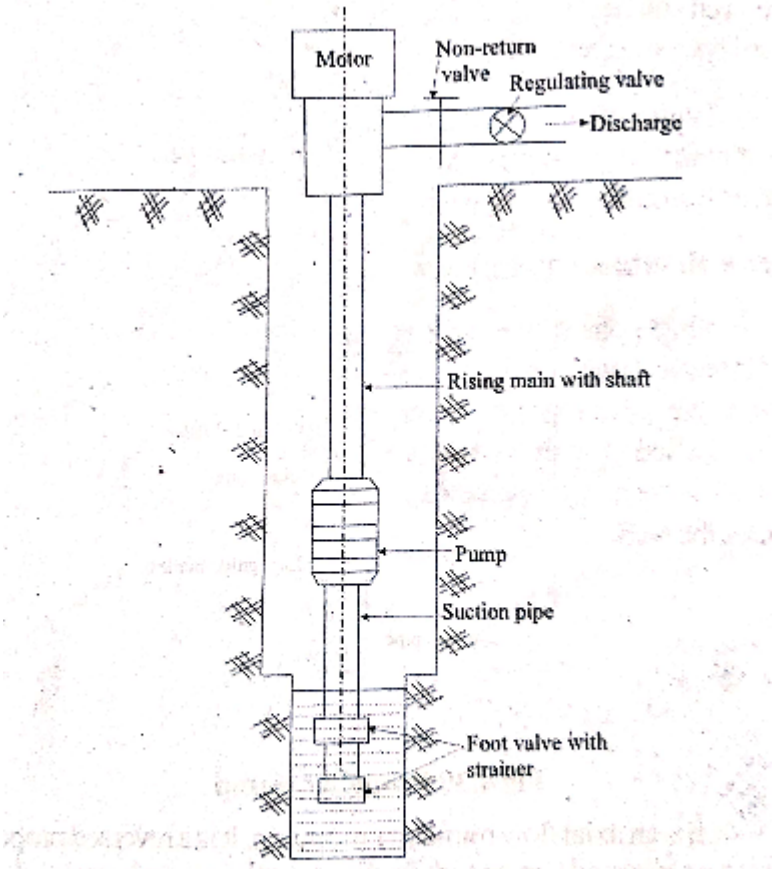


Fig 4.38 Submersible deep well pump

AXIAL FLOW OR PROPELLER PUMP

Propeller pump is a reversed propeller turbine. It consist of a shaft carrying a boss at one end.The vanes fitted on the boss is driven by a prime mover.It has a small suction pipe and a delivery pipe.When the propeller vanes rotates,suction is created and the liquid is sucked up in the suction pipe.It then passes through a set of guide blades into the vanes fitted to the boss and finally through another set of guide blades into the delivery pipe.Propeller pumps are used for all types of low head and large discharge works such as drainage,irrigation etc.

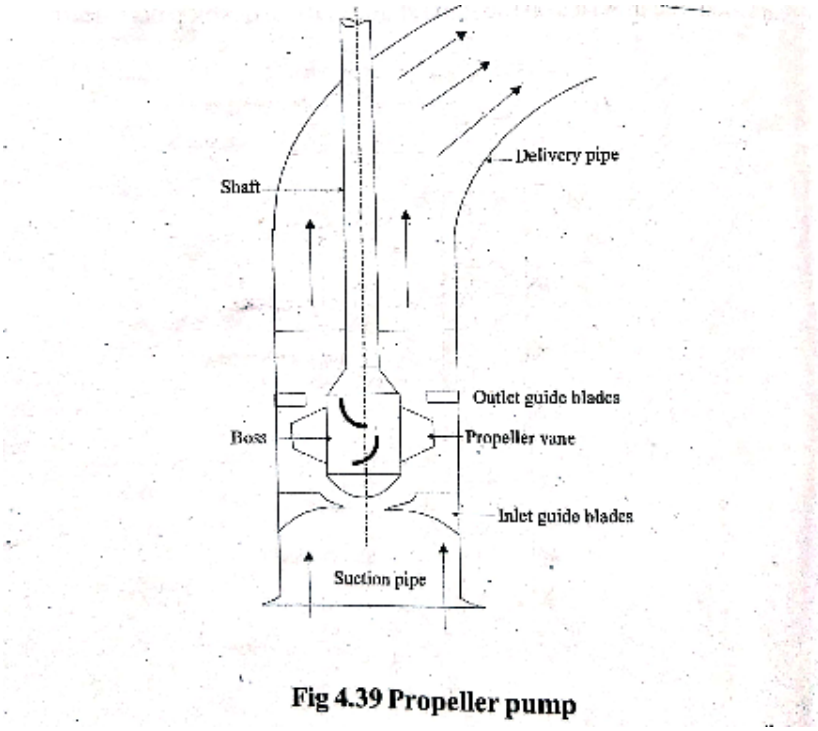


Fig 4.39 Propeller pump

TURBINE PUMPS

In this turbine ,the impeller is surrounded by diffuser vanes which provide gradually enlarging passages in which the velocity of the water leaving the impeller is gradually reduced. This increases the pressure being applied to the water. The turbine type pump is used where greater lifting action is required, as in water wells.

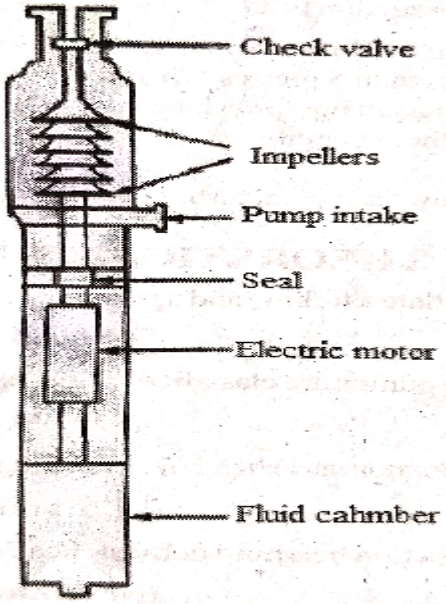


Fig 4.40 Turbine pump