UNIT -7
Hydraulic Devices

Course Objectives:

CO6:Understand and apply the basic concepts of hydraulic devices like accumulator, intensifier, fluid coupling and torque convertor.

Topics

1. Hydraulic Accumulator
2. Differential Accumulator
3. Intensifier
4. Fluid Coupling
5. Air Lift Pump
6. Vane Pump

Hydraulic accumulator

A hydraulic accumulator is a pressure storage reservoir in which a non-compressible hydraulic fluid is held under pressure by an external source. The external source can be a spring, a raised weight, or a compressed gas. An accumulator enables a hydraulic system to cope with extremes of demand using a less powerful pump, to respond more quickly to a temporary demand, and to smooth out pulsations. It is a type of energy storage device.

RAISED WEIGHT ACCUMULATOR

- A raised weight accumulator consists of a vertical cylinder containing fluid to the hydraulic line.
- The cylinder is closed by a piston on which a series of weights are placed that exert a downward force on the piston and thereby energizes the fluid in the cylinder.
- Gravity acts on the weight to pressurize the hydraulic system fluid, thus storing energy.

HISTORY

- First Hydraulic accumulator was made by **William Armstrong** in 1846 built a crane powered by water of town mains at Newcastle, United Kingdom.

- Later 1852 ,Armstrong used Grimsby Dock Tower for the constant pressure for cranes, lock gates and sluices.

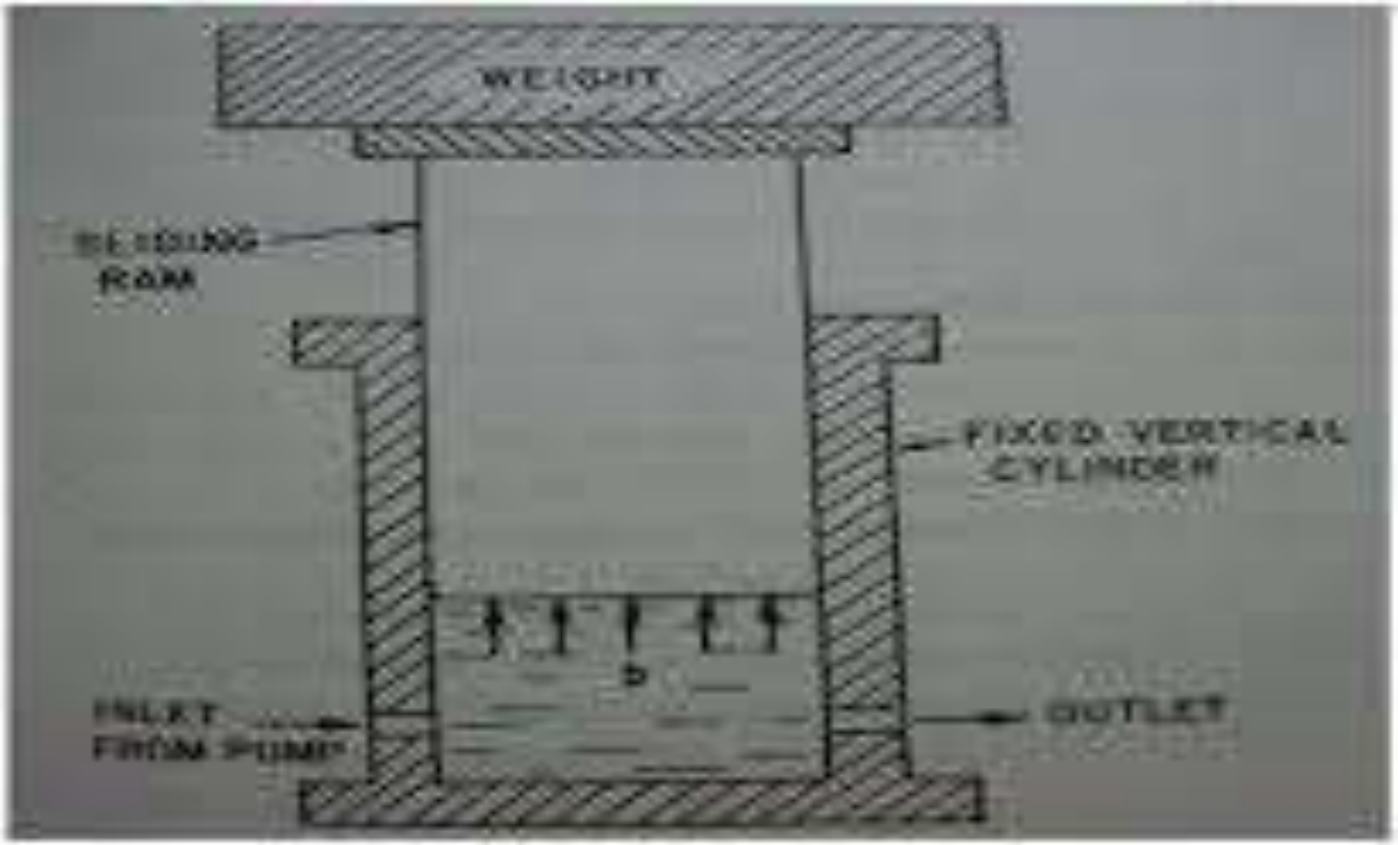
- Grimsby Dock Tower is hydraulic accumulator is used for the purpose of containing a 30,000UK gallon (136 m^3) hydraulic wrought iron reservoir at a height of 300feet (91 m) to provide power for lock gates and cranes of Grimsby Dock.

INTRODUCTION

A Hydraulic Accumulator is energy storage device.

- It is pressure storage reservoir in which a non-compressible hydraulic fluid is held under pressure by an external source.
- The external source used can be a spring, a raised weight, or a compressed gas.
- The main reasons that an accumulator is used in a hydraulic system, is that the pump doesn't need to be so large to cope with extremes of demand and supply circuit can respond quickly to any temporary demand and to smooth pulsation.

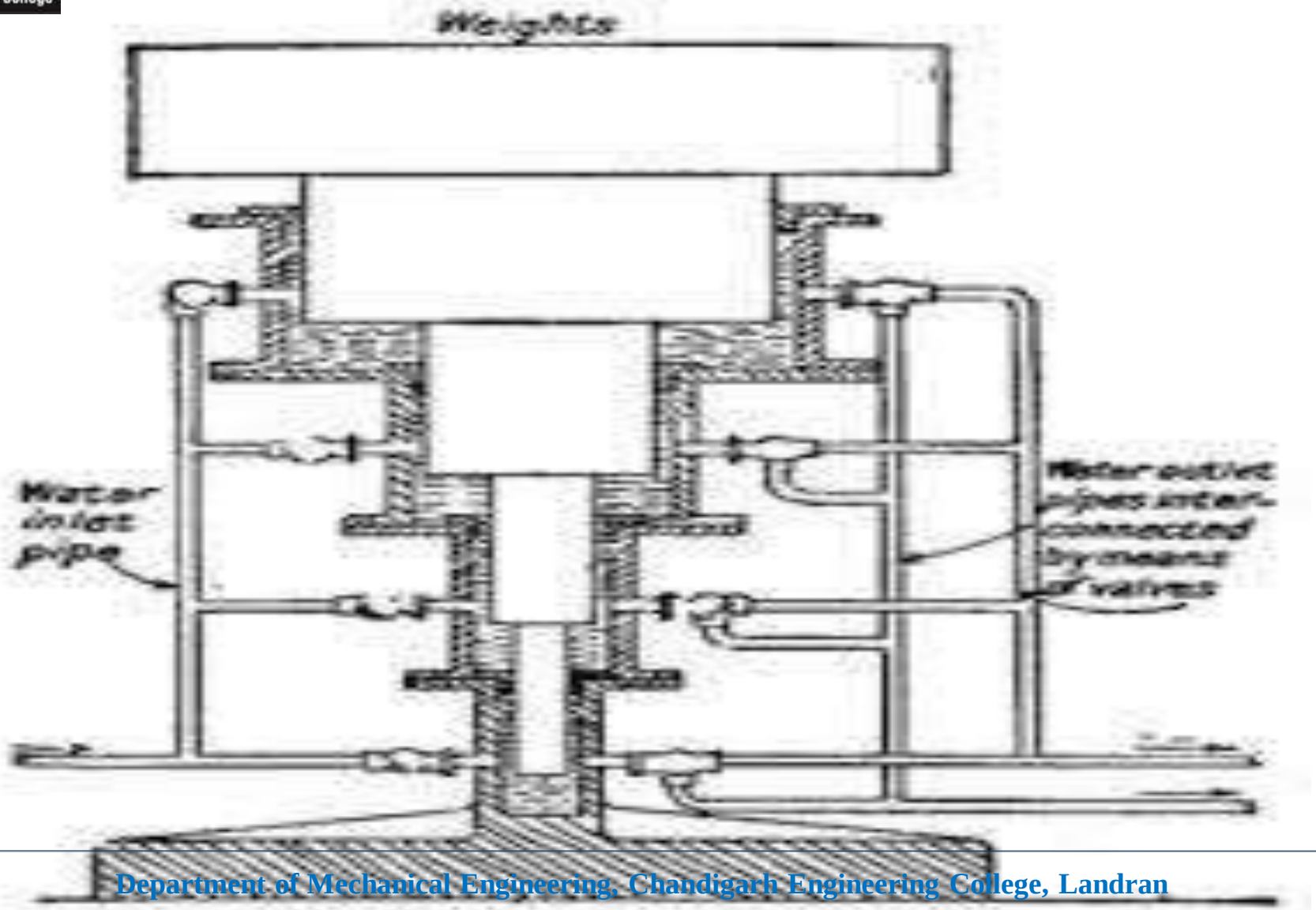
Hydraulic Accumulator



Differential Hydraulic Accumulator

- It is a device in which the liquid is stored at a high pressure by a comparatively small load on the ram. It consists of a fixed vertical cylinder of small diameter

DIFFERENTIAL ACCUMULATOR



APPLICATIONS

Accumulators are devices used to store fluid power to do the following:

- Dampen pulsations and shocks of a periodic nature
- Increase the speed of the operational circuit.
- Clamping devices to hold the jaw vices and fixtures
- Standby power supply circuits.
- Surge reduction circuits
- Agricultural Machinery & Equipment
- Forestry Equipment
- Oil Field & Offshore
- Machine Tools and Off- Road Equipment
- Mining Machinery & Equipment
- Mobile & Construction Equipment
- Suspension in vehicles

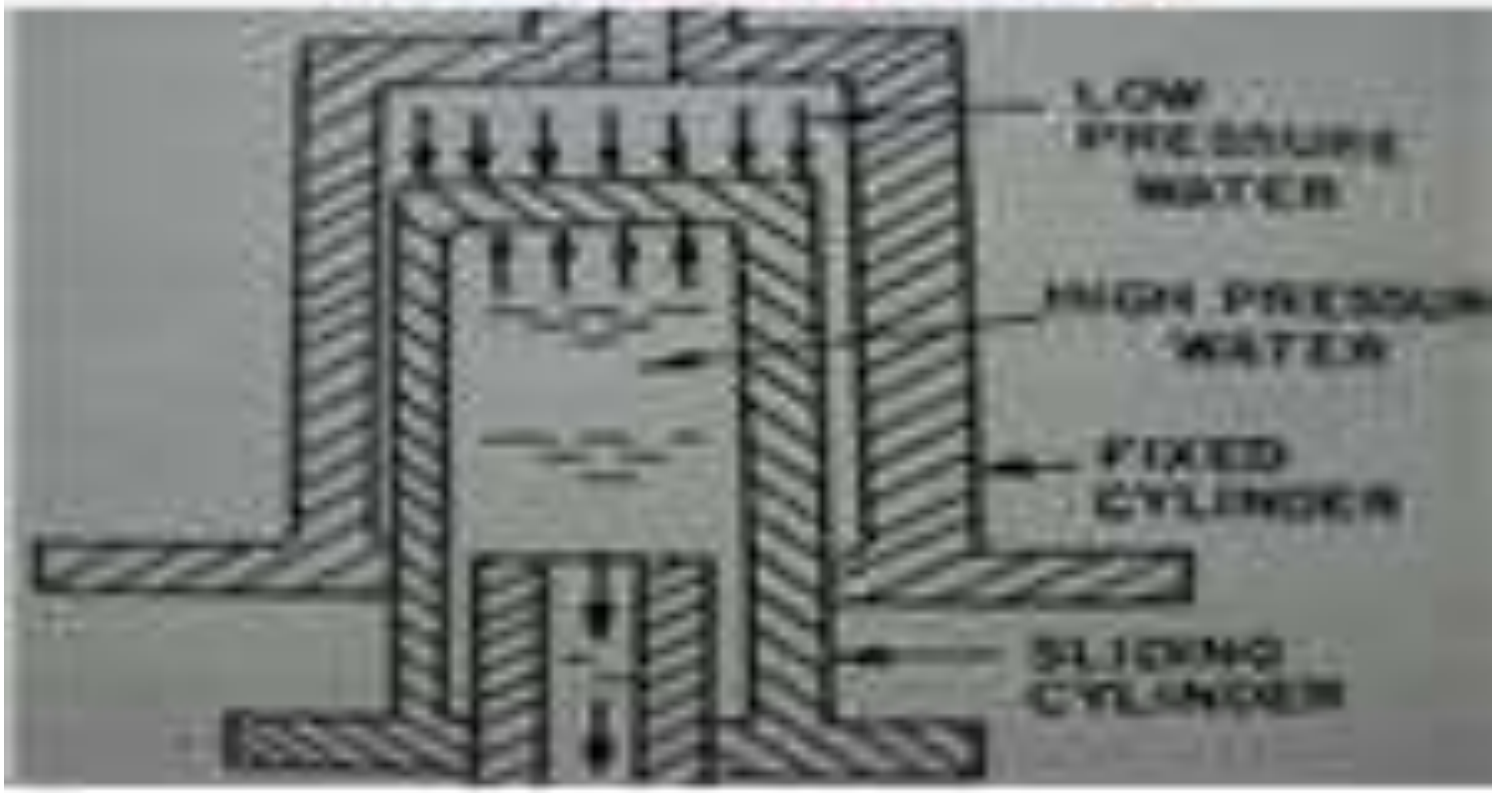
Hydraulic intensifier

- hydraulic intensifier is a device which is used to increase the intensity of pressure of any hydraulic fluid or water, with the help of the hydraulic energy available from a huge quantity of water or hydraulic fluid at a low pressure. Know about the components and construction of intensifiers.

Need

- In most of the hydraulic machinery used, the usual pressure of 80 to 100-psi may not be sufficient to operate certain spool valves and other mechanisms. To cater to the need for a high pressure requirement for a comparatively short period of time, pumps and accessories are definitely *not* the solution. But the substitute *can be* hydraulic intensifiers which can increase the pressure from 100 psi to 40,000 psi, using small volumes of fluid.

Intensifier--Working



WORKING

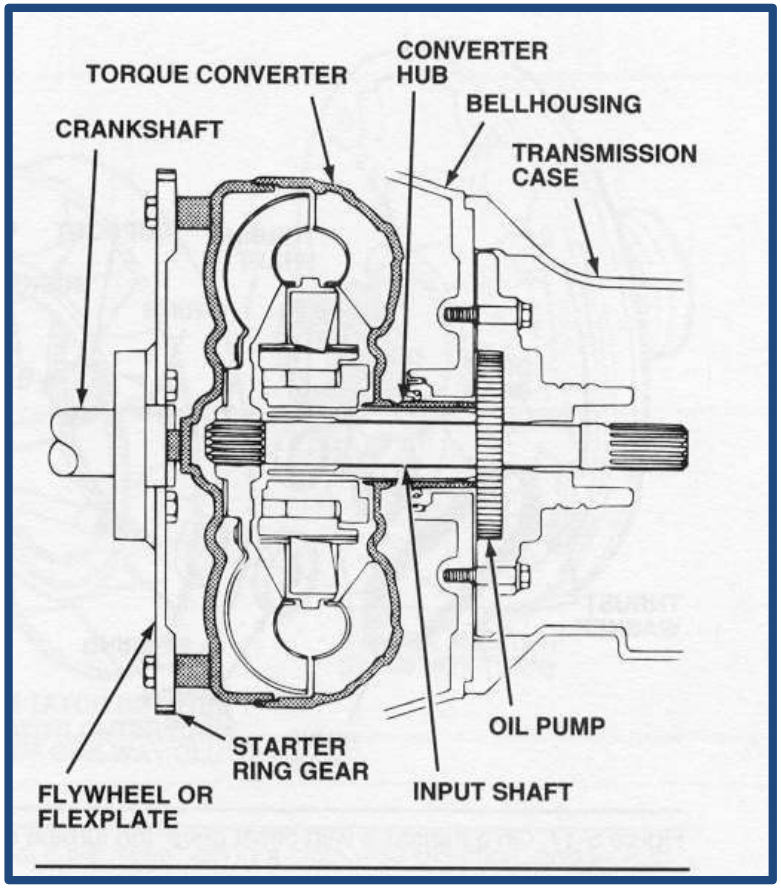
- A hydraulic intensifier is a device which is used to increase the intensity of pressure of any hydraulic fluid or water, with the help of the hydraulic energy available from a huge quantity of water or hydraulic fluid at a low pressure. These devices are very important in the case of hydraulic machines, mainly hydraulic presses, which require water or hydraulic fluid at very high pressure which cannot be obtained from the main supply directly.

- There are three main parts in the hydraulic intensifiers to be noted. They are
- Fixed ram,
- Hollow inverted sliding cylinder,
- Fixed inverted cylinder.
- A hydraulic intensifier consists of fixed ram through which the water, under a high pressure, flows to the hydraulic machine. A hollow inverted sliding cylinder, containing water under high pressure, is mounted over the fixed ram. The inverted sliding cylinder is surrounded by another inverted fixed cylinder which contains water from the main supply at a lower pressure.

Fluid coupling

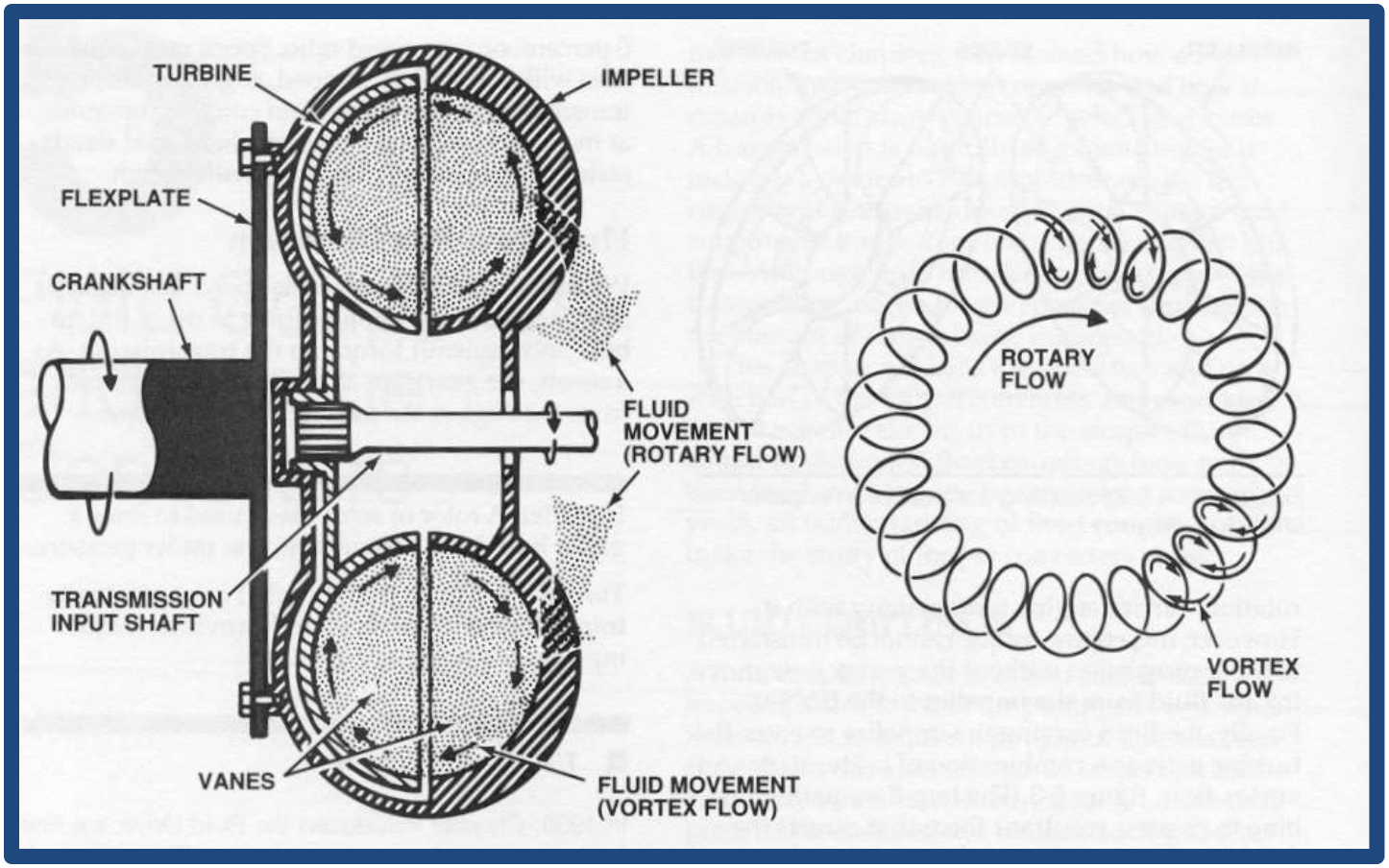
- A **fluid coupling** or **hydraulic coupling** is a hydrodynamic device used to transmit rotating mechanical power. It has been used in automobile transmissions as an alternative to a mechanical clutch. It also has widespread application in marine and industrial machine drives, where variable speed operation and controlled start-up without shock loading of the power transmission system is essential.

Components



- Flexplate drives T.C.
- Torque Converter Hub drives oil pump
- Impeller drives Turbine
- Turbine drives input shaft
- Input shaft drives Clutch Hub

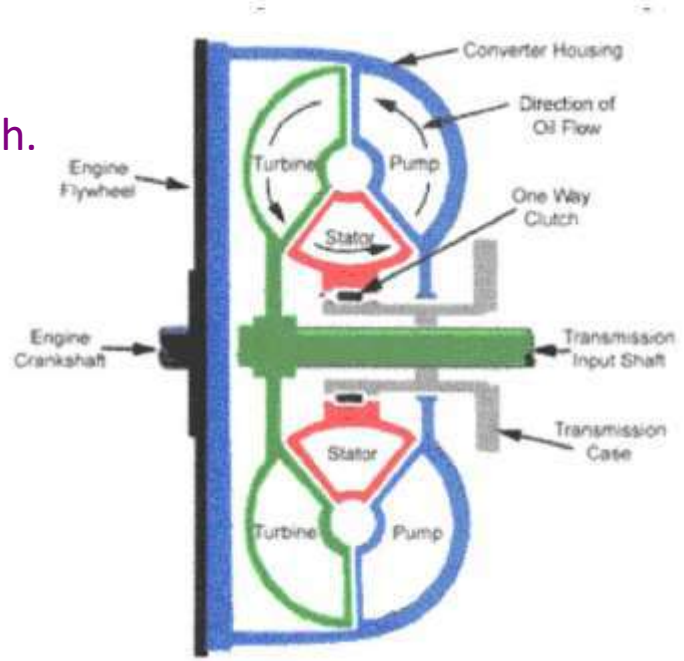
Fluid Coupling

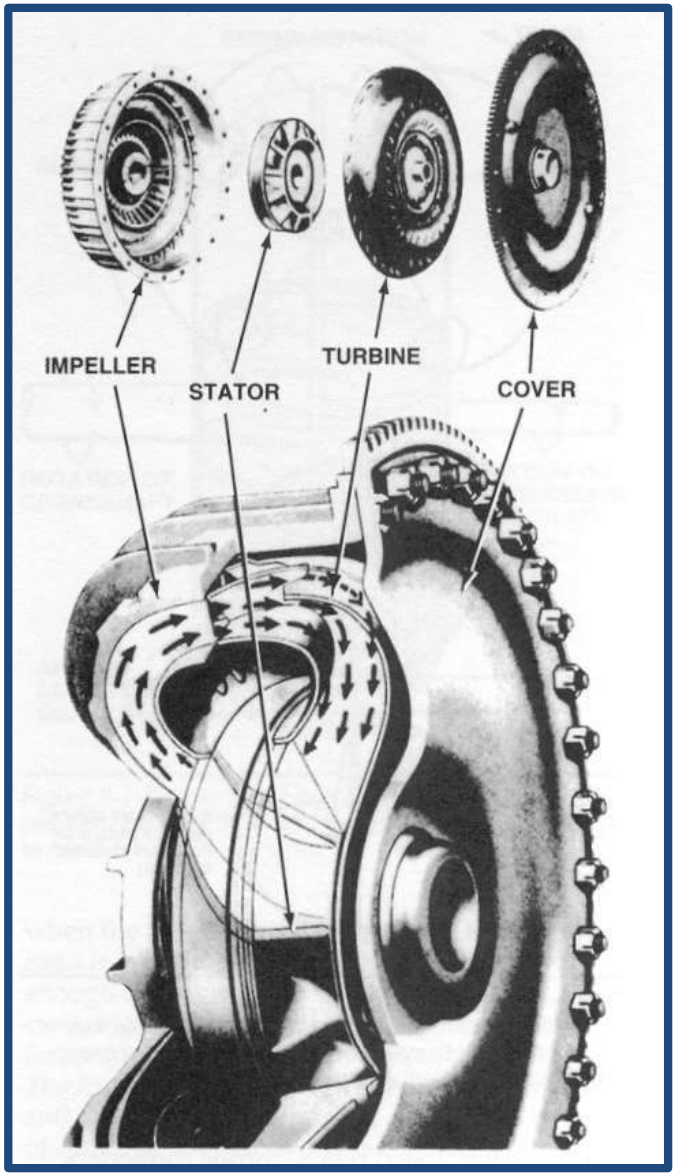


Fluid travels either in a rotary or vortex motion

Stator Operation

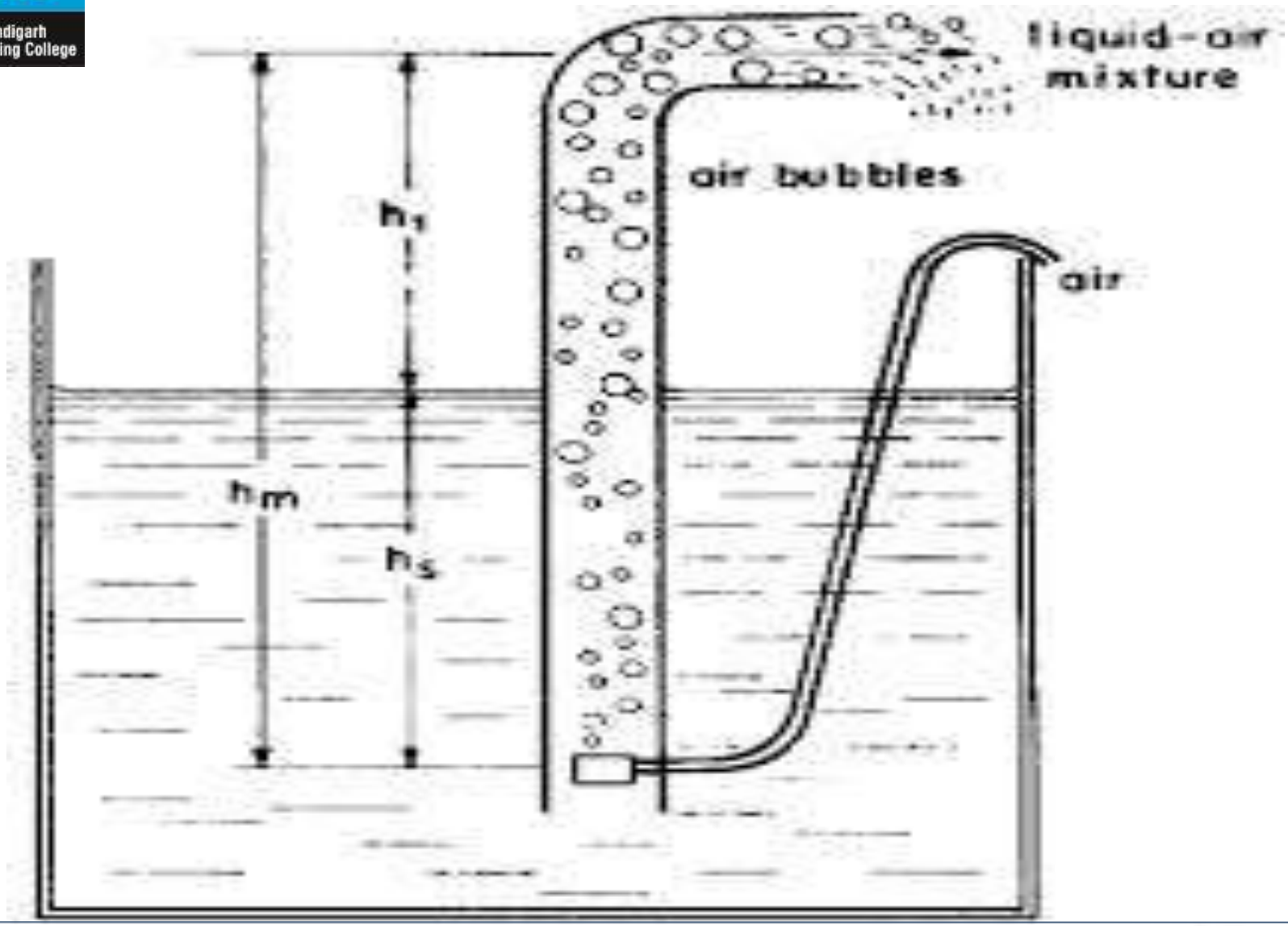
- Stator assembly mounts on One-way clutch.
- Stator multiplies torque
- At 90% speed ratio, the stator rotates same speed as turbine and impeller and “coupling phase” occurs.





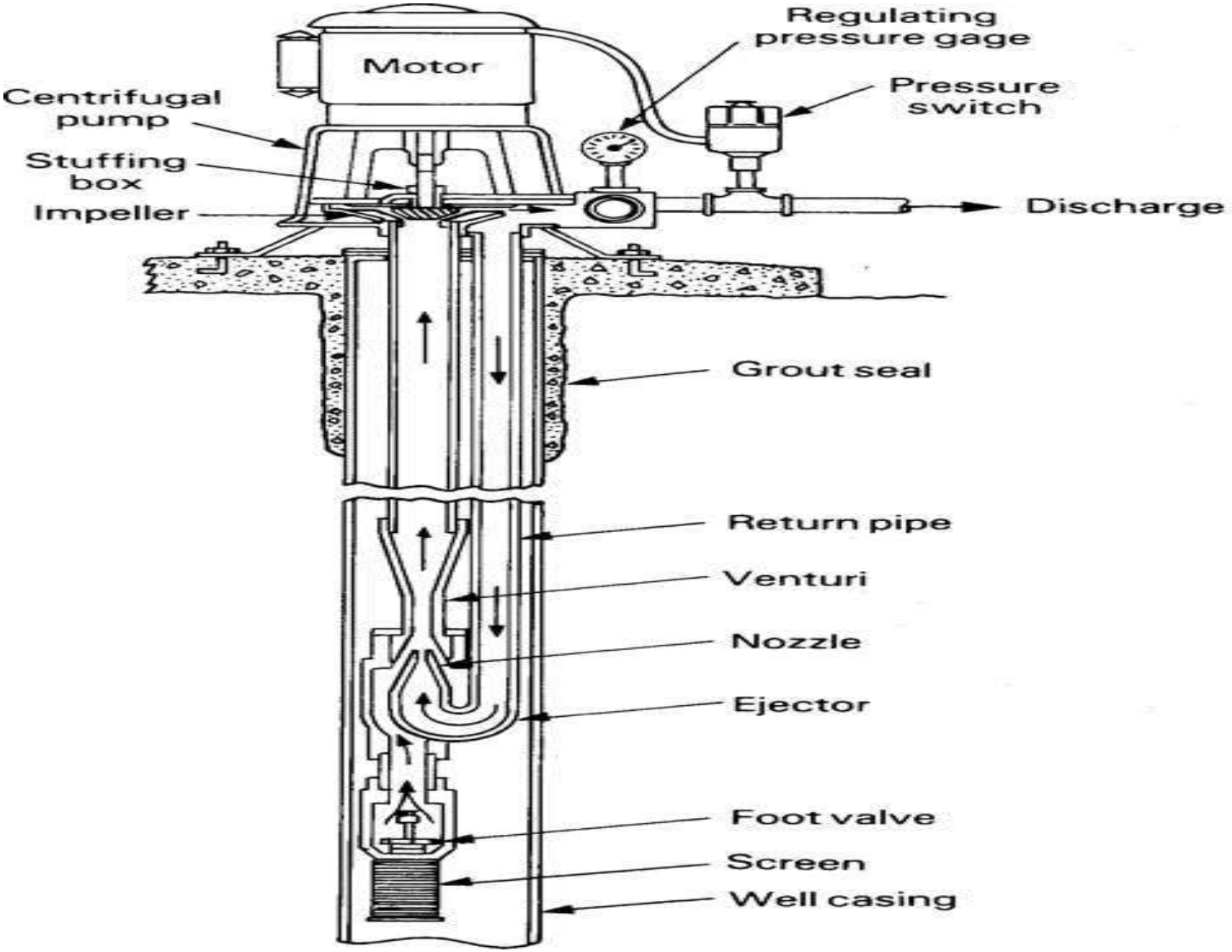
- Early Converter were repairable
- Older converters had drains

AIR LIFT PUMP



An **Airlift 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. Solids may be entrained in the flow and if small enough to fit through the pipe, will be discharged with the rest of the flow at a shallower depth or above the surface. Airlift pumps are widely used in Aquaculture to pump, circulate and aerate water in closed,

JET PUMP


Motor
Regulating pressure gage
Pressure switch
Centrifugal pump
Stuffing box
Impeller
Discharge
Grout seal
Return pipe
Venturi
Nozzle
Ejector
Foot valve
Screen
Well casing

- An **injector**, **ejector**, **steam ejector**, **steam injector**, **eductor-jet pump** or **thermocompressor** is a type of pump. There are two varieties of injector, non-lifting and lifting. The non-lifting injector cold water input is fed by gravity. It uses the principle of induced current (Impulse (physics)) to push water up to the boiler check valve. It avoids the premature boiling of feed water at very low absolute pressure, by avoiding the Venturi effect. The steam cone minimum orifice diameter is kept larger than the combining cone minimum diameter.

VANE PUMP

Advantages

- Handles thin liquids at relatively higher pressures
- Compensates for wear through vane extension
- Sometimes preferred for solvents, LPG
- Can run dry for short periods
- Can have one seal or stuffing box
- Develops good vacuum

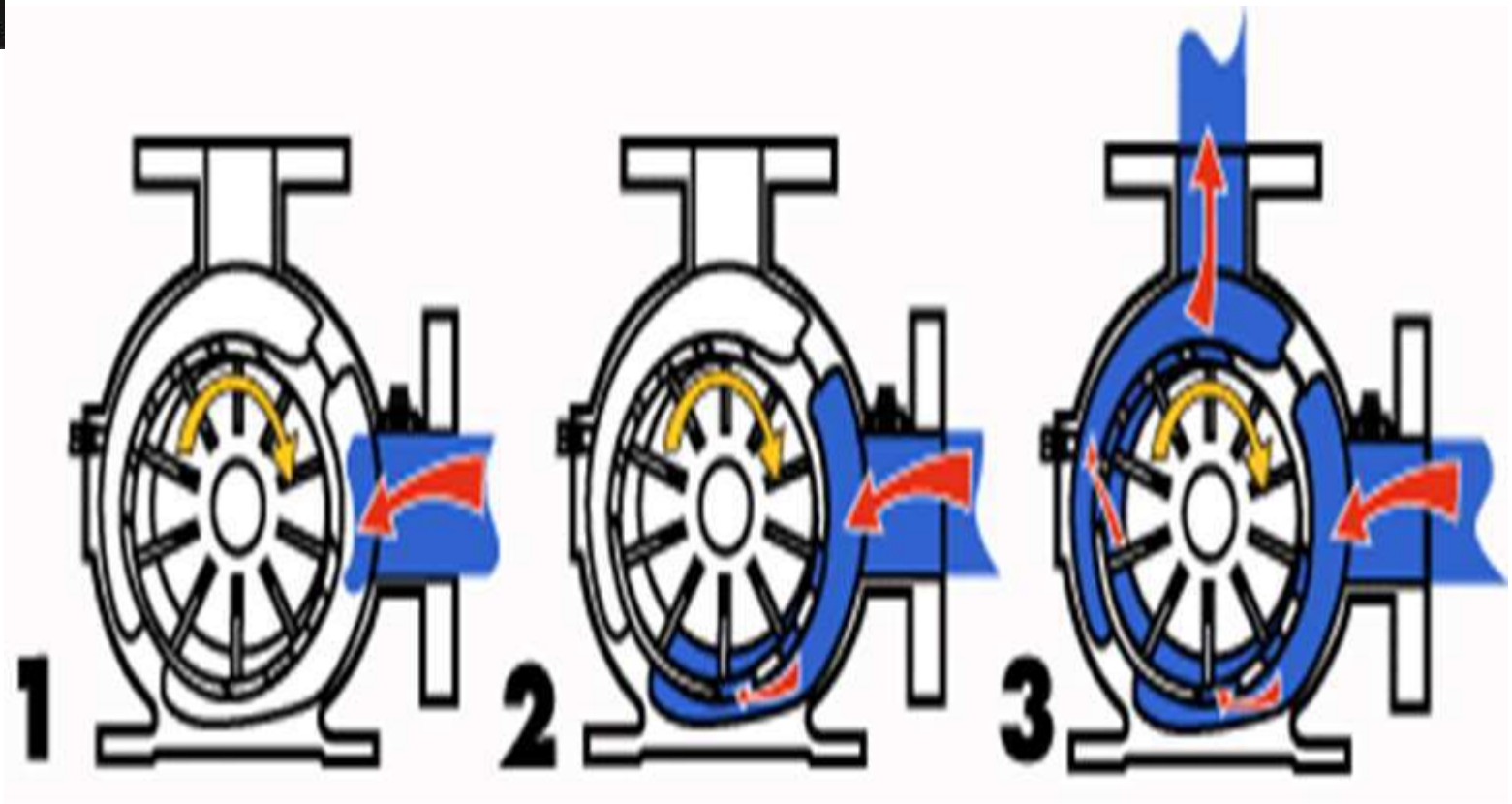
Applications

- Aerosol and Propellants
- Aviation Service - Fuel Transfer, Deicing
- Auto Industry - Fuels, Lubes, Refrigeration Coolants
- Bulk Transfer of LPG and NH_3
- LPG Cylinder Filling
- Alcohols
- Refrigeration - Freons, Ammonia
- Solvents
- Aqueous solutions

How Vane Pumps Work

- A slotted rotor is eccentrically supported in a cycloidal cam. The rotor is located close to the wall of the cam so a crescent-shaped cavity is formed. The rotor is sealed into the cam by two sideplates. Vanes or blades fit within the slots of the impeller. As the rotor rotates (*yellow arrow*) and fluid enters the pump, centrifugal force, hydraulic pressure, and/or pushrods push the vanes to the walls of the housing. The tight seal among the vanes, rotor, cam, and sideplate is the key to the good suction characteristics common to the vane pumping principle.
- 2. The housing and cam force fluid into the pumping chamber through holes in the cam (*small red arrow on the bottom of the pump*). Fluid enters the pockets created by the vanes, rotor, cam, and sideplate.
- 3. As the rotor continues around, the vanes sweep the fluid to the opposite side of the crescent where it is squeezed through discharge holes of the cam as the vane approaches the point of the crescent (*small red arrow on the side of the pump*). Fluid then exits the discharge port.

WORKING



References

- **A Textbook of Fluid Mechanics and Hydraulic Machines**
  Dr. R. K. Bansal, Laxmi Publications

- **NPTEL VIDEO LECTURES**