



**JYOTHISHMATHI INSTITUTE OF  
TECHNOLOGY & SCIENCE**

**Sub: Thermal Engineering-I**

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**AIR COMPRESSORS**

**BY**

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# AIR COMPRESSOR

- ▶ **Pneumatics:** A system which uses compressed air is called pneumatics.
- ▶ It deals with the study of behavior & application of compressed air
- ▶ A basic pneumatic system consist of a source of compressed air, control valves, pipelines & pipe fittings and pneumatic accessories like filter, regulator and lubricator

## APPLICATION OF COMPRESSED AIR

- ▶ For operating pneumatic tools such as drills, screw drivers, hammers, chisels
- ▶ For pneumatic cranes
- ▶ For pneumatic brakes of automobiles, railways and presses
- ▶ For agricultural accessories such as dusters and sprayers

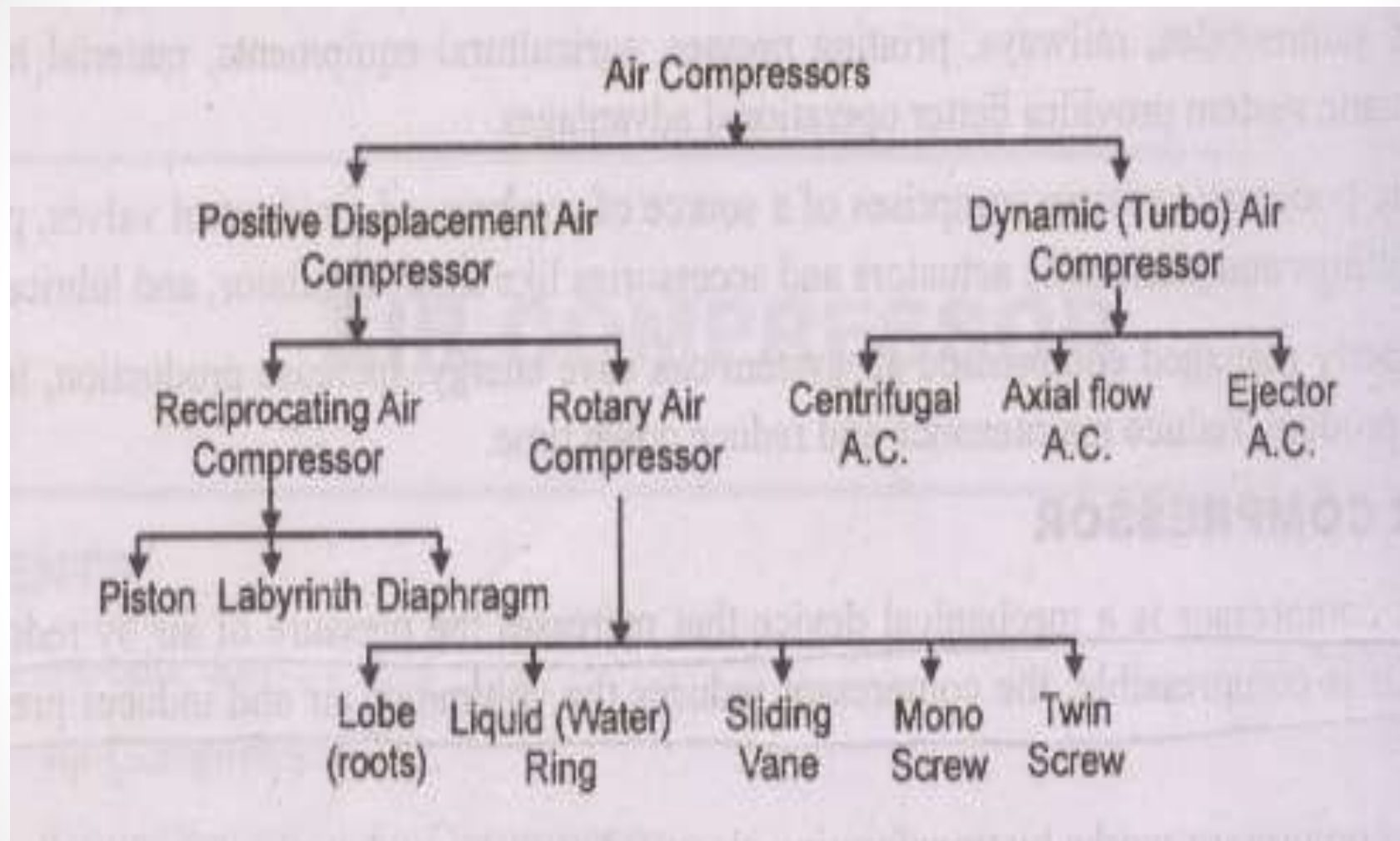
# INTRODUCTION TO COMPRESSORS

- An air compressor is a mechanical device that increases the pressure of air by reducing volume.
- Air is compressible, the compressor reduces the volume of air and induces pressure in the air
- An air compressor converts electrical energy into kinetic energy in the form of the air

## CLASSIFICATION OF AIR COMPRESSORS

- Air compressors are classified according to method of energy transfer and pressure generation i.e. **positive displacement and dynamic compressors**
- **Positive displacement compressors** work on the principle of increasing the pressure of air by reducing the volume of air in an enclosed chamber

- **Dynamic compressors** works on the principle of imparting the energy by rotating vanes of impeller on air flowing through casing that increases pressure in air



## According to number of stages

Single stage, double stage, three stage or multiple stage

## According to action

Single acting or double acting

## According to position of cylinder w.r.t. crankshaft

Cylinders inline, vertical, radial position, V-type cylinder arrangement

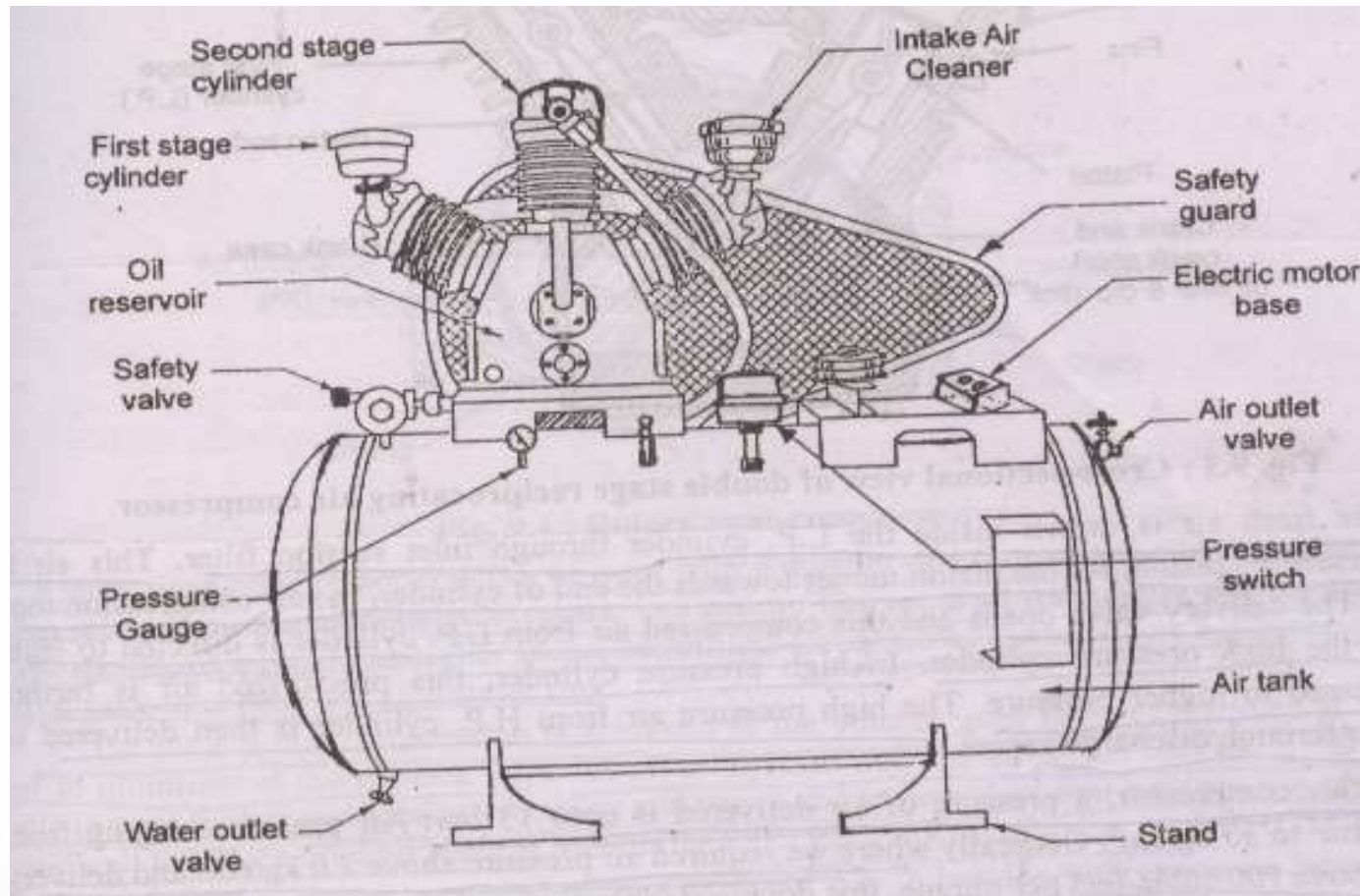
## According to prime mover

Electric motor drive or IC engine drive, Gas turbine drives

## According to cooling medium

Air cooled, water cooled air compressors

# RECIPROCATING AIR COMPRESSORS (Double Stage)



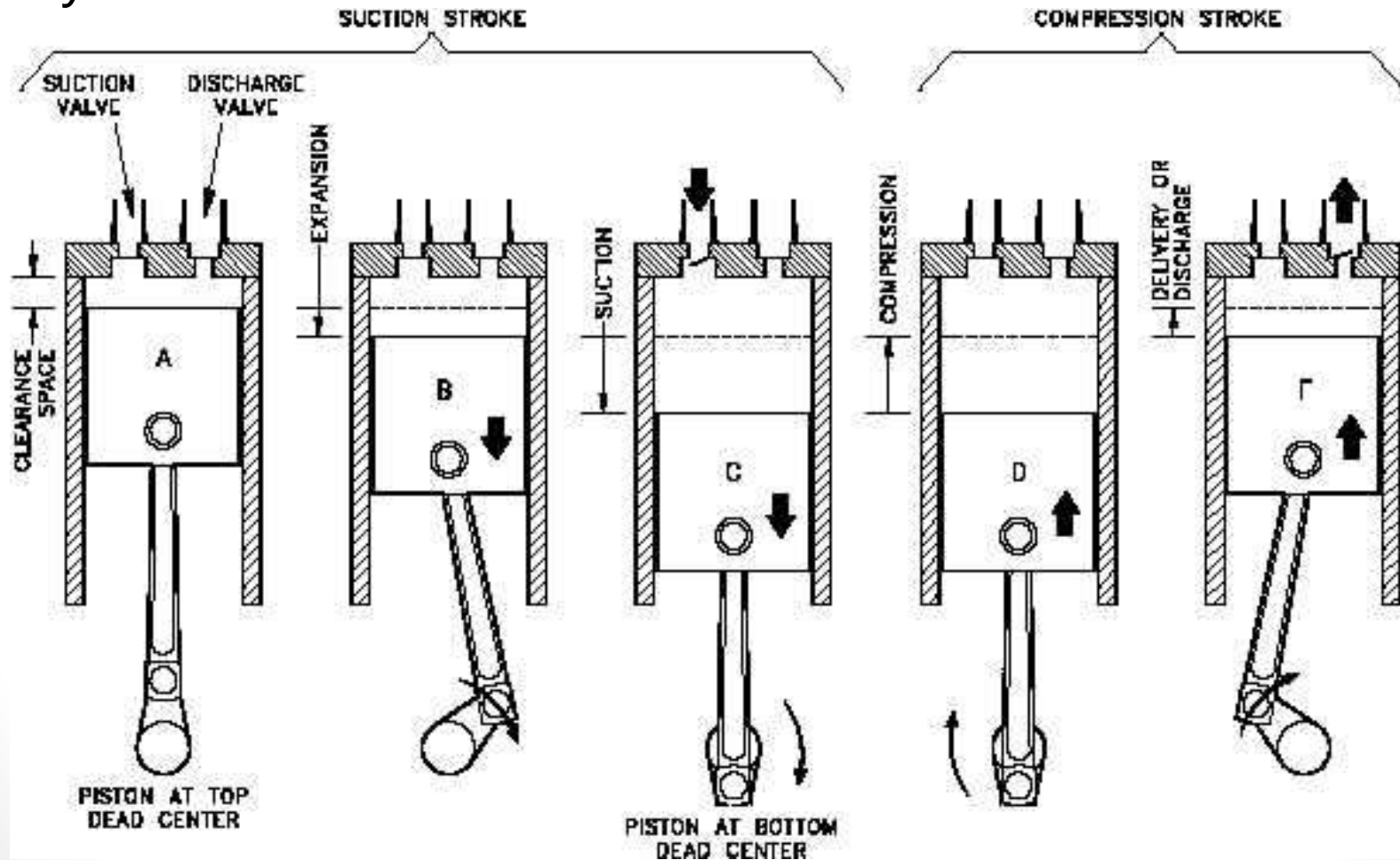
**Reciprocating air compressors** are positive displacement type of air compressors.

- ▶ These are piston & diaphragm type, vane type, gear type, screw type compressors.
- ▶ The principle of operation is same but according to stages the delivery pressure is different in each compressor.
- ▶ A reciprocating air compressor consist of a piston which is enclosed within a cylinder and equipped with suction and discharge valve
- ▶ The piston receives power from electric motor or IC engine.
- ▶ The compression of air is done by first drawing a volume of air into the cylinder through suction valve during suction stroke of piston and then compressed and discharged through delivery valve during delivery stroke



# SINGLE STAGE RECIPROCATING AIR COMPRESSORS

- In this type the entire compression is carried out in a single cylinder

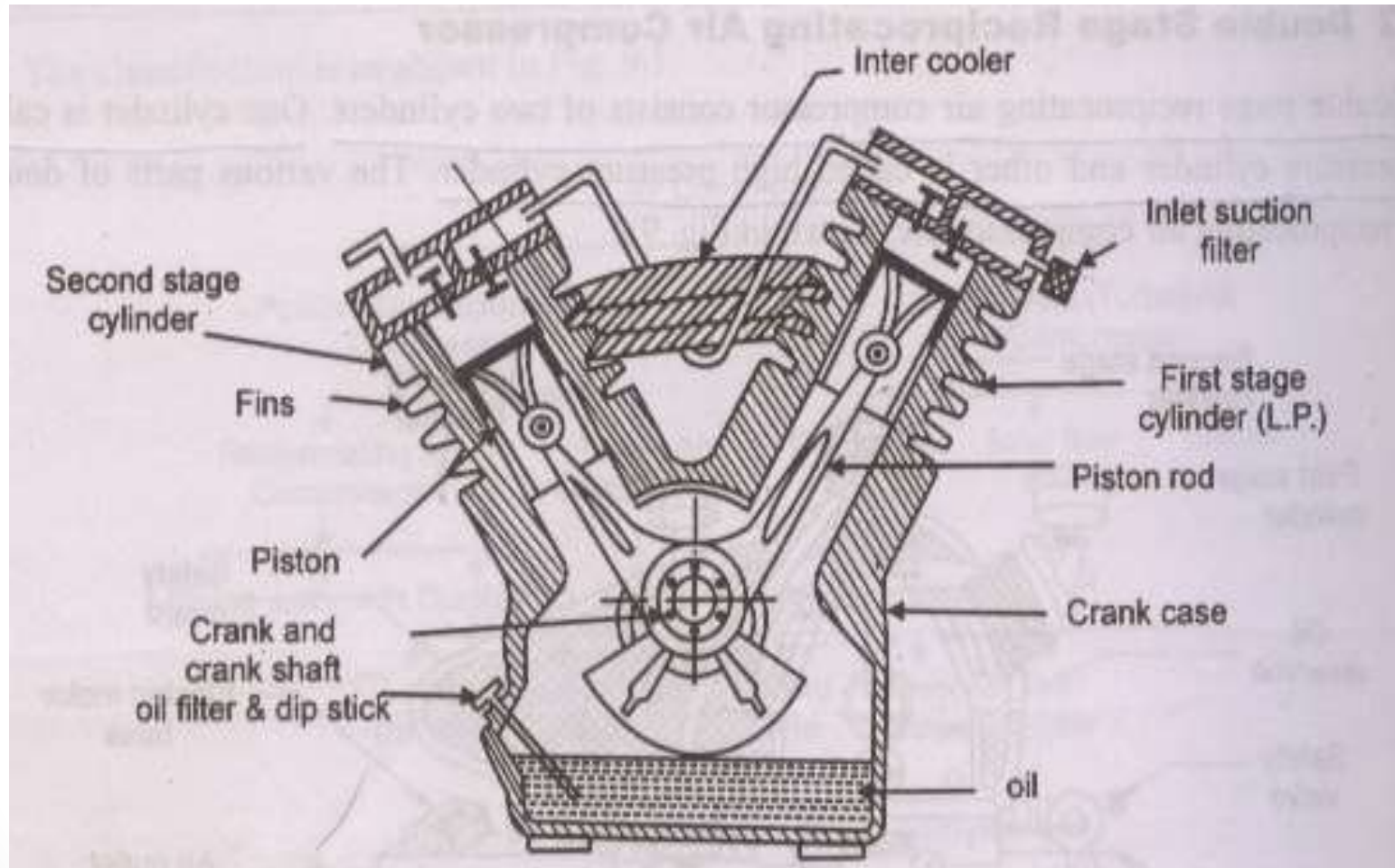


- ▶ When piston starts moving downwards, the pressure inside the cylinder falls below atmospheric pressure that opens suction valve.
- ▶ The pressure of the air in the cylinder rises during compression and at the end of compression, delivery valve opens and discharges the compressed air into the receiver tank.
- ▶ Single stage air compressor develop pressure upto 7 bar.
- ▶ For higher pressures multistage compressors are suitable

### **DOUBLE STAGE RECIPROCATING AIR COMPRESSORS**

- ▶ It consist of two cylinders – low pressure cylinder and high pressure cylinder
- ▶ Piston, crankcase, piston rod, crank, crankshaft, oil, fins etc.

# DOUBLE STAGE RECIPROCATING AIR COMPRESSOR



- ▶ The fresh air is drawn inside the L.P. cylinder through inlet suction filter.
- ▶ This air is compressed by piston
- ▶ As the piston moves towards the end of cylinder, the air compression took place.
- ▶ The delivery valve opens and this compressed air from L.P. cylinder is directed to enter inside the high pressure cylinder.
- ▶ In high pressure cylinder this pressurised air is further compressed to higher pressure.
- ▶ The high pressure air from H.P. cylinder is then delivered to receiver through discharge valves.
- ▶ In this compressor, a pressure of air delivered is upto 13 bar.

## ADVANTAGES

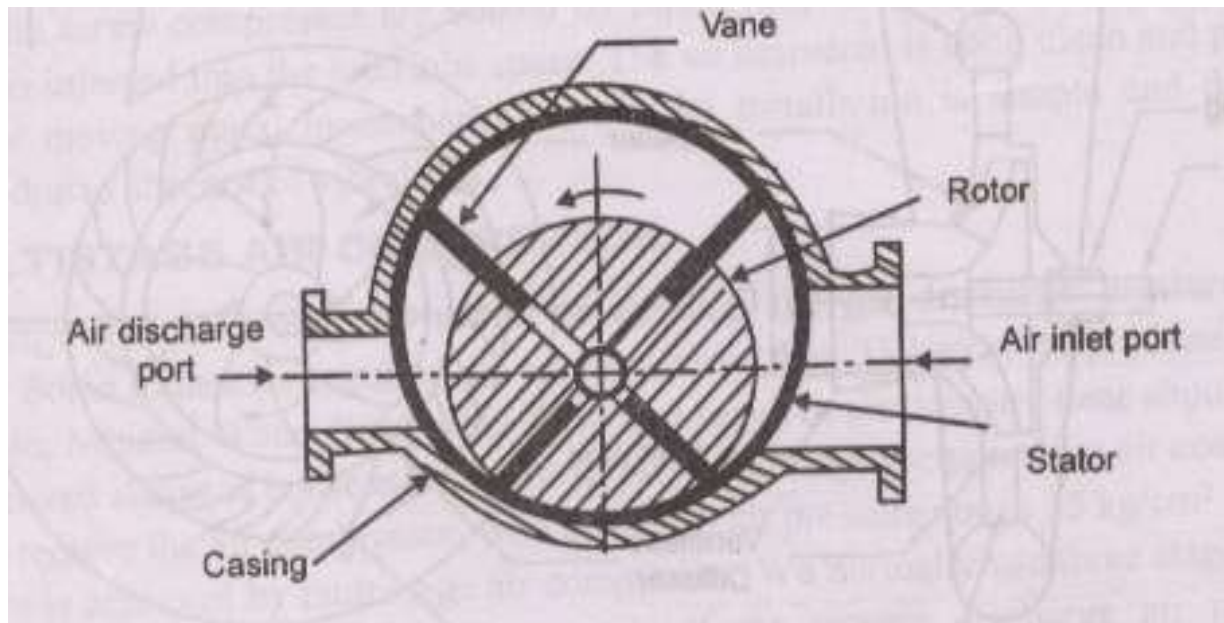
- Simple in design
- Lower initial cost
- Easy to install
- Higher efficiency

## DISADVANTAGES

- Number of moving parts are more
- Higher maintenance cost
- Heavy foundation is required as it has vibration problem
- Cannot run at full capacity

# ROTARY VANE COMPRESSOR

- ▶ It is positive displacement type compressor.
- ▶ It provides higher efficiency and flow rates over a wide range of pressure
- ▶ Rotary vane compressor consist of rotor with a number of vanes inserted in the radial slots cut in rotor.



- ▶ The rotor is mounted eccentric in a casing.
- ▶ The vanes slides radially in and out of the rotor.
- ▶ As the rotor rotates at higher speed, centrifugal force throws the vanes outward keeping the end of vane in contact with the stator ring.
- ▶ As the rotor turns, compression is achieved as the volume goes from a maximum at intake port to minimum at the exhaust port.
- ▶ An oil is injected into the air intake and along the stator walls to cool the air and lubricate bearing and vanes and to provide a seal between the vane and stator wall to reduce internal leakage.

## ADVANTAGES:

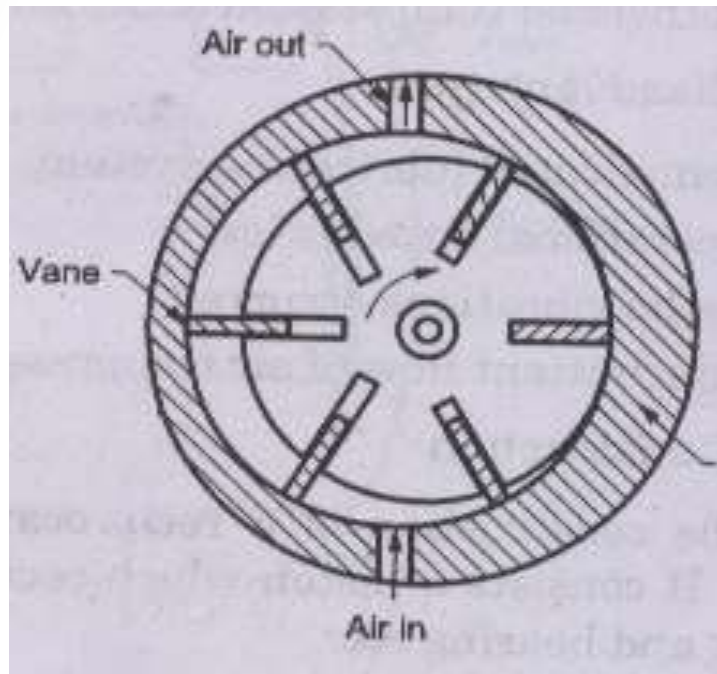
- ▶ Simple design
- ▶ Compact in size
- ▶ Light in weight
- ▶ Easy to install
- ▶ Low cost
- ▶ Low maintenance cost
- ▶ Longer life
- ▶ Few moving parts
- ▶ Low rotational speed
- ▶ Expensive foundation not required

## DISADVANTAGES:

- ▶ Lower efficiency
- ▶ Difficulty with higher pressure above 200 psi
- ▶ Oil injected designs have oil carryover

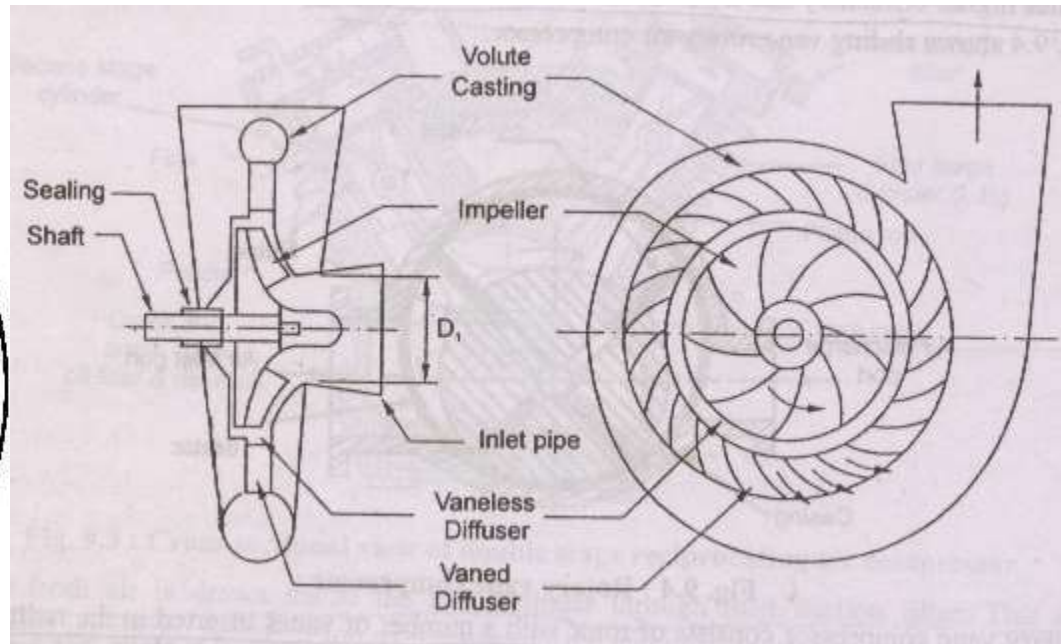
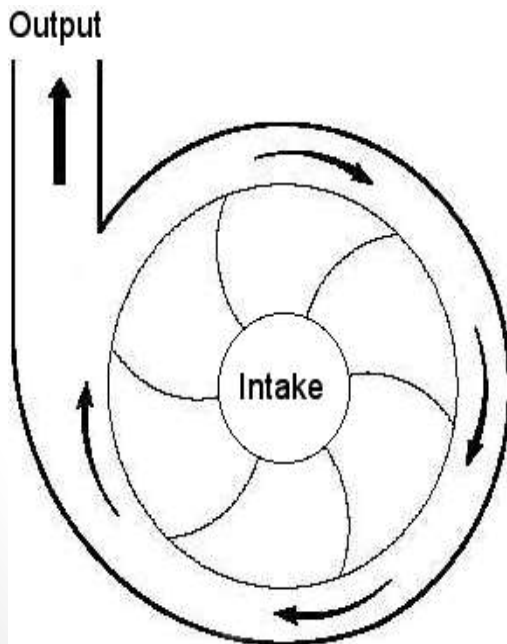


# VANE TYPE ROTARY COMPRESSOR

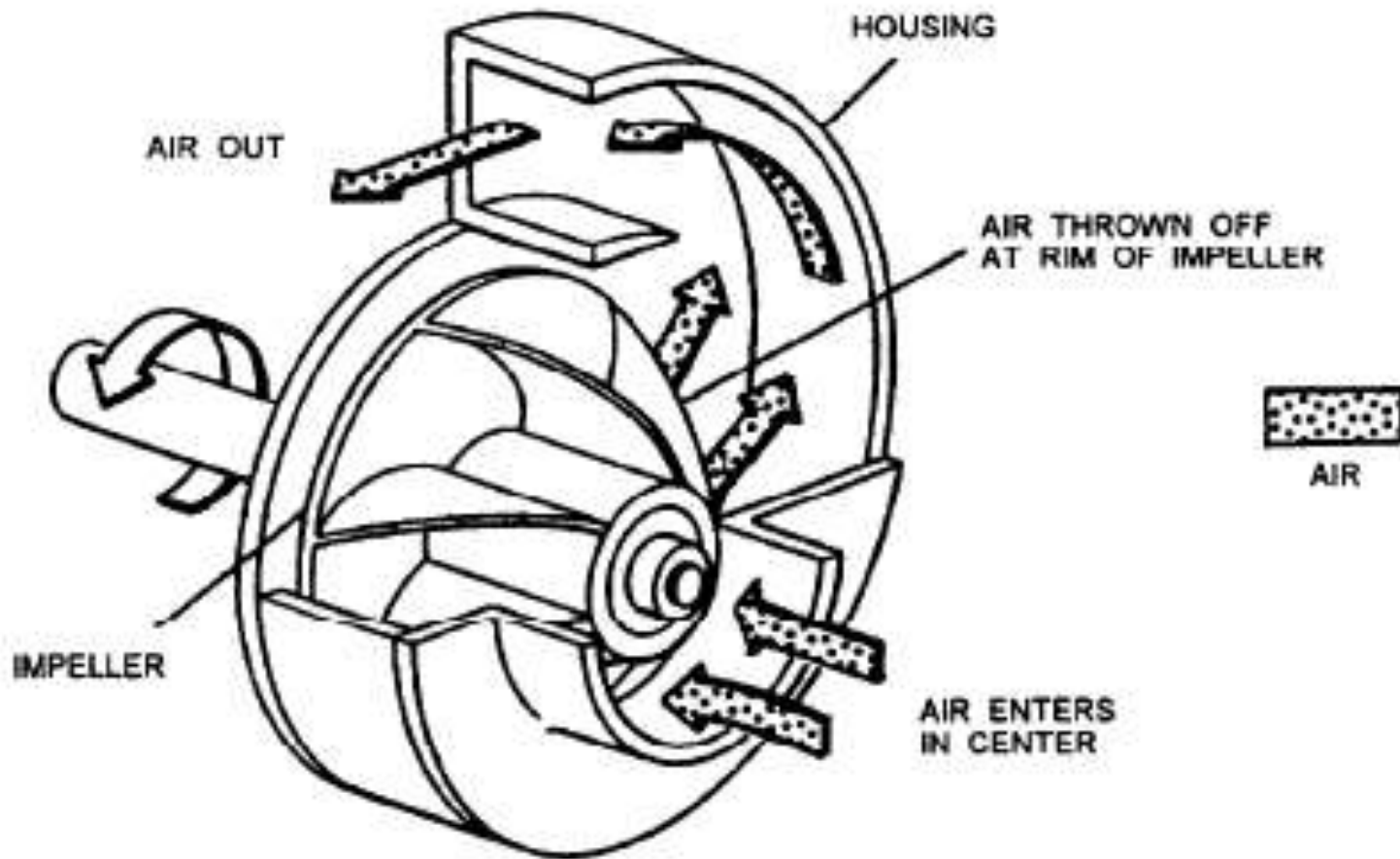


# CENTRIFUGAL COMPRESSOR

- ▶ It is dynamic compressor.
- ▶ It consist of a rotating impeller which rotates at higher speed (up to 60000 rpm)
- ▶ An impeller fitted inside casing force the air to the rim of impeller, increasing velocity of air.



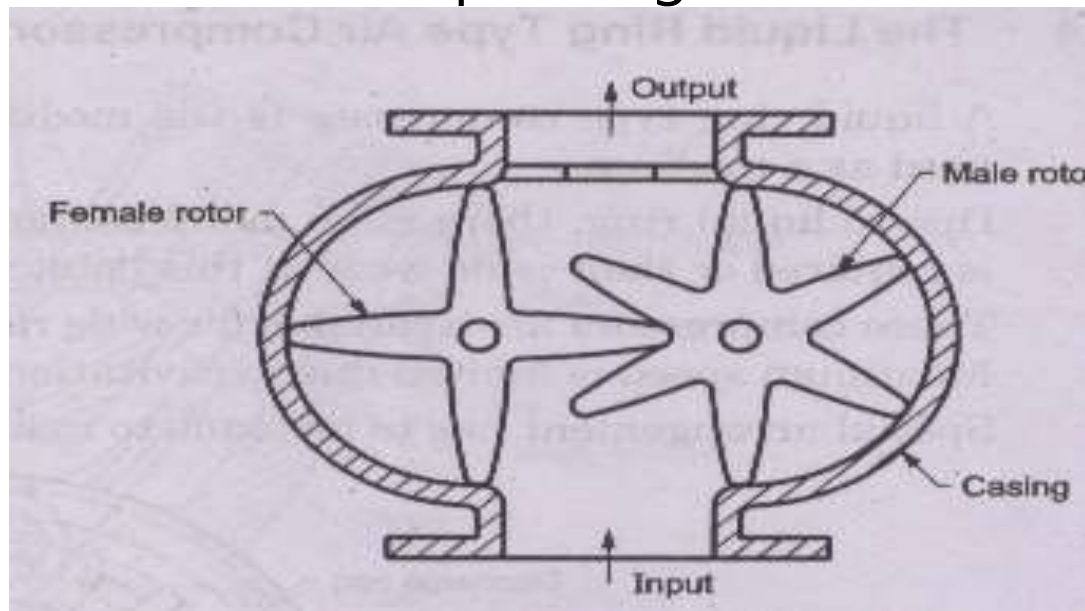
# CENTRIFUGAL SUPERCHARGER



- ▶ A diffuser (divergent shape of casing) section converts the velocity of air to cause an increase in pressure. This process is called dynamic compression.
- ▶ These compressors are used for continuous, stationary services in industries like oil refineries, chemical and petrochemical plants, natural gas processing plants.
- These are also used in IC engine superchargers and turbochargers.
- In gas turbine plants
- It can provide extremely high output pressures greater than 10000psi.

# SCREW COMPRESSOR

- It consists of two screws - one with convex and the other with concave contour mostly called male and female rotor respectively.
- These two screws get rotating by means of gear trips there by sucking the air through an inlet port in chamber and then compressing the same



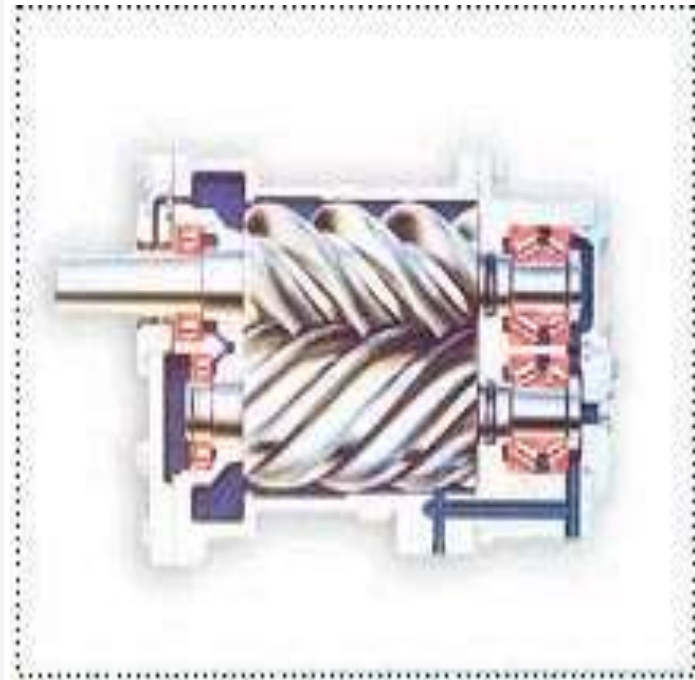
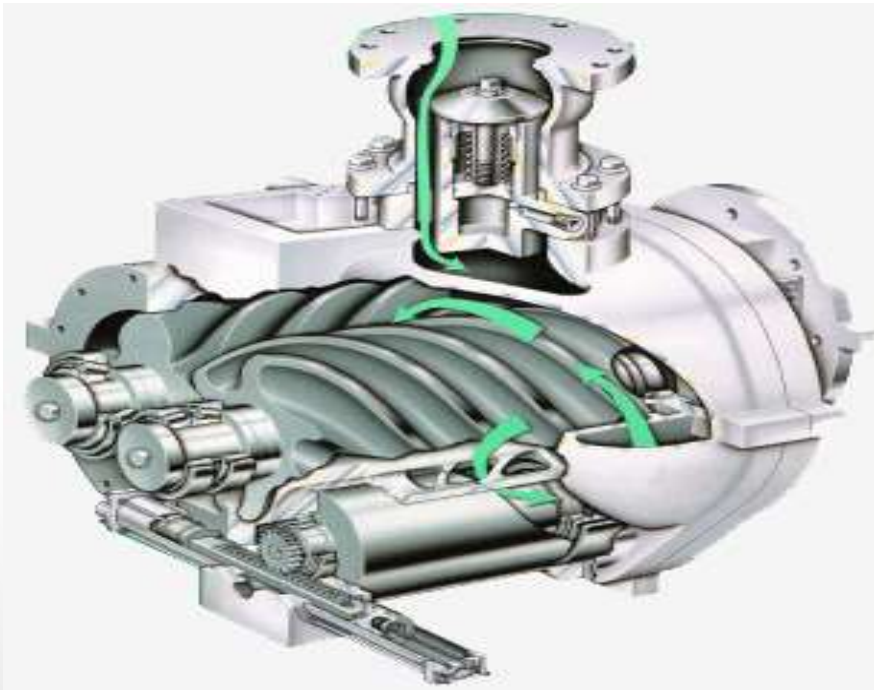
- The helix of the male and female rotor screw is designed to permit complete charging of the inter lobe space before the re-mesh.
- On completion of the filling operation the inlet end of male and female lobes begins to re-engage thus reduces the volume of air continuously.



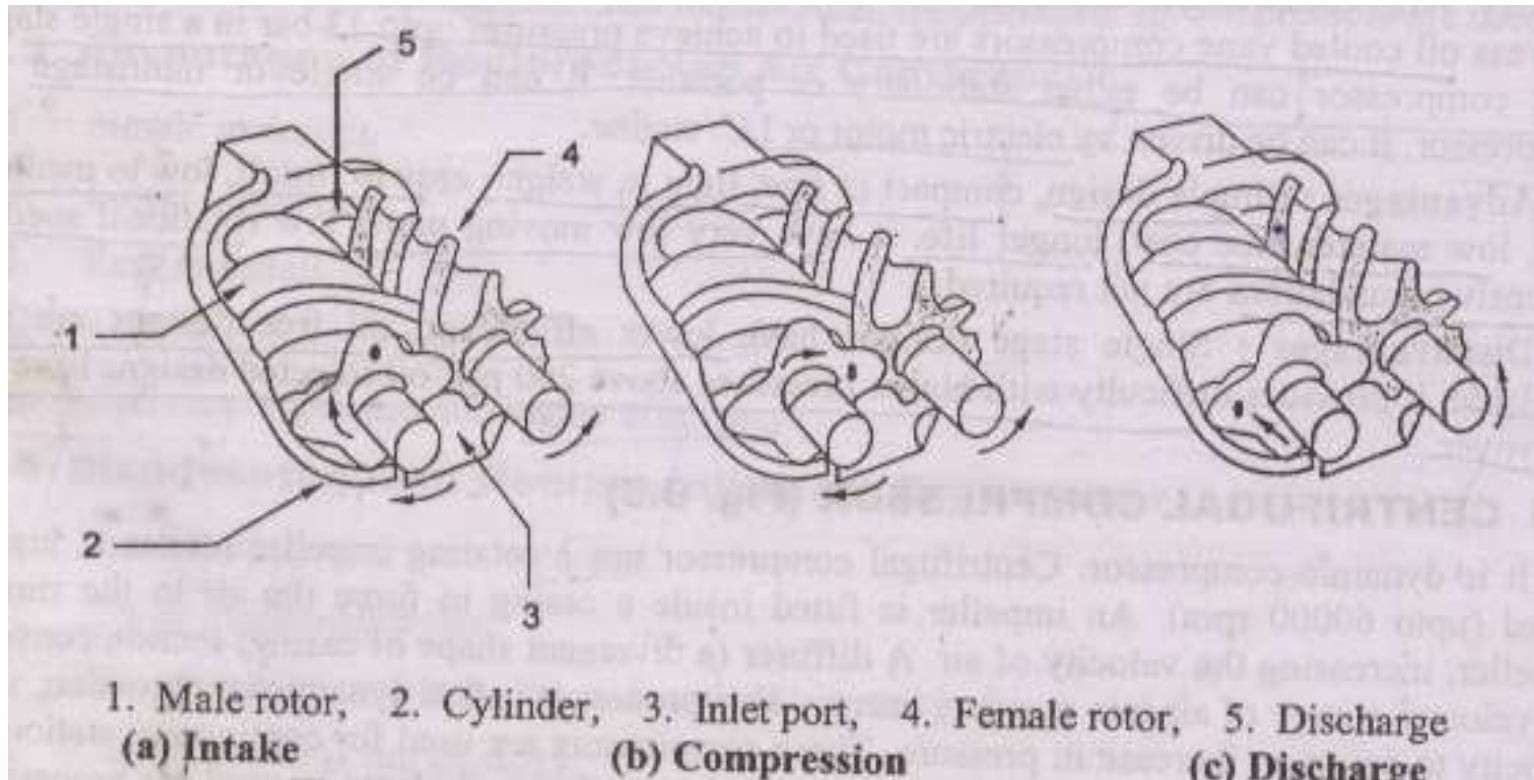


## DETAILS OF SCREW COMPRESSOR

- Thus compression begins and air is discharged at the end of other side.
- There is no contact between male and female rotors and casing. Hence no lubrication require but oil may injected for the purpose of cooling.



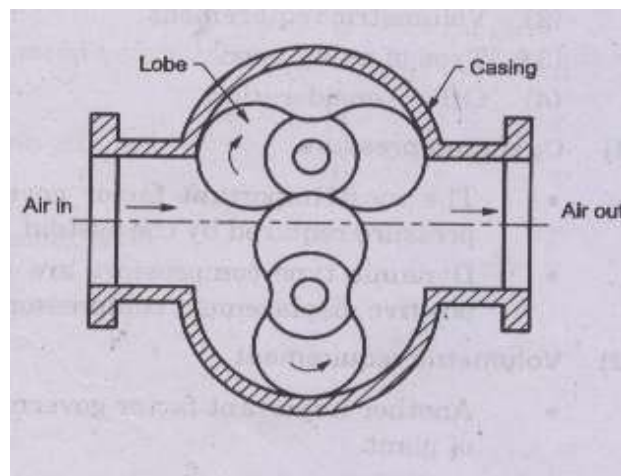
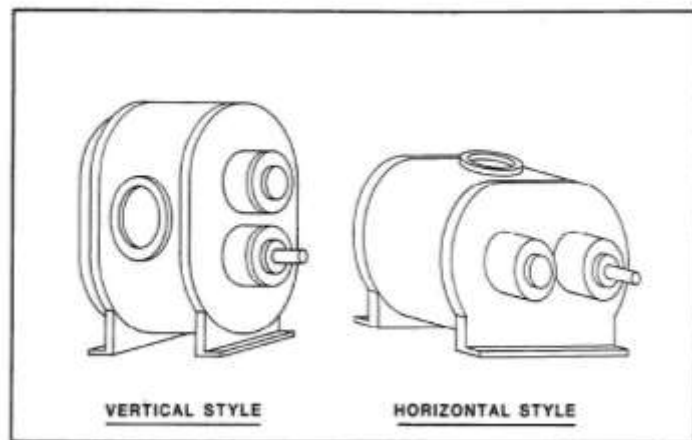
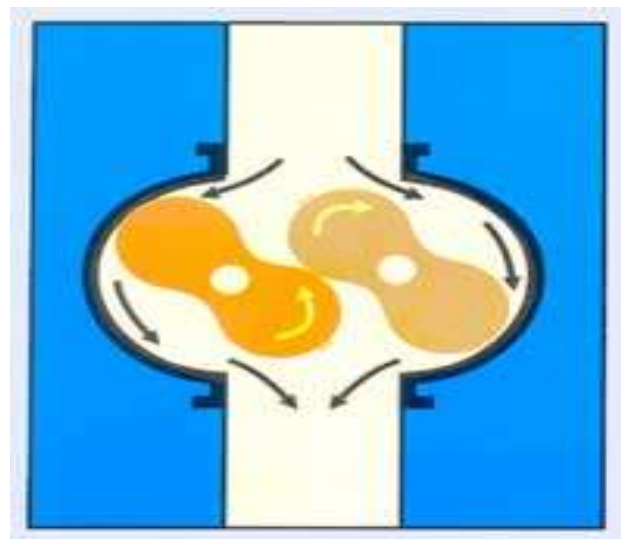
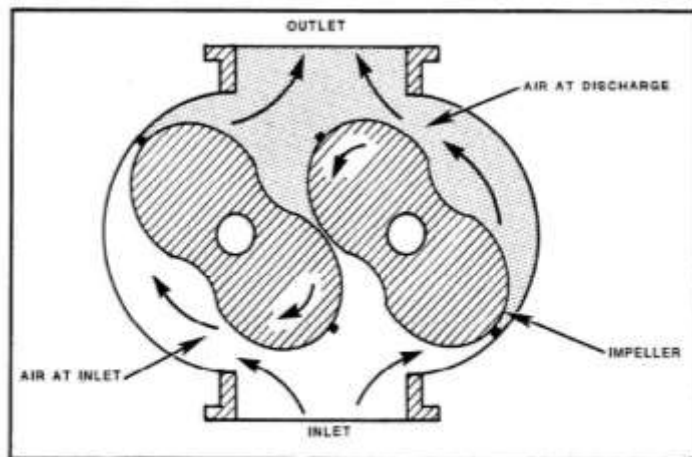
# DETAILS OF SCREW COMPRESSOR





## TWIN LOBE COMPRESSOR

- It is used in applications where higher flow at comparatively low pressure is required.
- Here two lobes are placed in a casing
- The air is transferred from suction side to the delivery side with continuous rotation of two lobes
- The lobes are precisely maintained and the casing also maintained to close tolerances
- It has limited compression ratio @ 1.7



## MULTISTAGE COMPRESSOR

- ▶ Multi stage compressor is use to develop pressures more than  $35 \text{ kg/cm}^2$ .
- ▶ For preparation of mineral water bottle, air pressure more than  $40 \text{ kg/cm}^2$  is required to produce desired shape of bottle at bottom side.
- ▶ Here two stage compressor is not used as it produces pressure up to  $35 \text{ kg/cm}^2$  .
- ▶ Three stage compressor is use as it produces pressure up to  $85 \text{ kg/cm}^2$  .
- ▶ Above four stage compressor is used.
- ▶ The working is same as that of double stage compressor.
- ▶ In three stage compressor fresh air from atmosphere enters first stage cylinder through air cleaner.

- Here it is compressed by piston to 4 kg/cm<sup>2</sup> and then delivered to second stage cylinder through intercooler for further compression.
- In second stage cylinder low pressure air is compressed up to 14 kg/cm<sup>2</sup> and discharge to third stage cylinder through second intercooler to increase air pressure up to desired delivery pressure i.e. 35 to 85 kg/cm<sup>2</sup>

## SELECTION OF COMPRESSORS

### PRESSURE :

- The discharge pressure from the compressor should be decided first considering the needs of the cylinder, air motor & pressure drop in the circuit.
- Most of pneumatic systems and tools are designed for pressure of 6 – 7 bar.
- A compressor used should meet the requirement.

- Pneumatic circuit requiring air at high pressure can be supplied with air by a separate high pressure compressor
- While any low pressure can be met by availing a reducing valve.
- For huge air flow rates at pressures below 2 bar, a turbo-blower or low pressure rotary compressor may be used.
- **FLOW RATES OR CAPACITY:**
- Volume of air required per minute is also an important factor for selection.
- The capacity should be adequate enough to supply air to all devices operating simultaneously.
- In many plants where pneumatic tools are operated intermittently, in such cases maximum instantaneous demand of the compressed air has to be find first.

## GEOMETRY OF CYLINDER:

- *For single cylinder geometric fashion :-*
  - vertical-single acting or double acting
  - horizontal- single or double acting
- *For two cylinders geometric fashion:-*
  - vertical inline, single or double acting
  - V-type, single or double acting
  - horizontal duplex, double acting

## SPEED OF PISTON:

- ▶ The speed of piston inside the cylinder must also be considered.
- ▶ For small capacity compressor, the piston speed 300 m/min, whereas for large capacity compressor piston speed 250 m/min.
- ▶ The layout of pipe line, system requirement and the distance of user machine from compressor plant

ANY QUESTIONS?