

## 6.9 Vortex Tube (Non-Conventional):

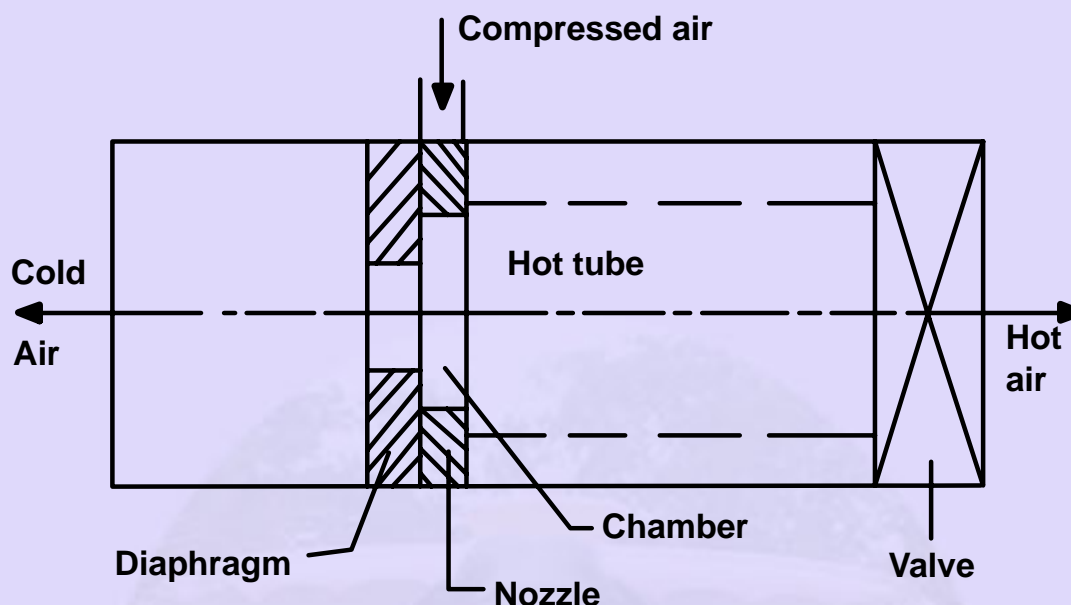


Fig.6.9. Vortex tube

It is one of the non-conventional type refrigerating systems for the production of refrigeration. The schematic diagram of vortex tube is shown in the Fig.6.9. It consists of nozzle, diaphragm, valve, hot-air side, cold-air side. The nozzles are of converging or diverging or converging-diverging type as per the design. An efficient nozzle is designed to have higher velocity, greater mass flow and minimum inlet losses. Chamber is a portion of nozzle and facilitates the tangential entry of high velocity air-stream into hot side. Generally the chambers are not of circular form, but they are gradually converted into spiral form. Hot side is cylindrical in cross section and is of different lengths as per design. Valve obstructs the flow of air through hot side and it also controls the quantity of hot air through vortex tube. Diaphragm is a cylindrical piece of small thickness and having a small hole of specific diameter at the center. Air stream traveling through the core of the hot side is emitted through the diaphragm hole. Cold side is a cylindrical portion through which cold air is passed.

### Working:

Compressed air is passed through the nozzle as shown in Fig.6.9. Here, air expands and acquires high velocity due to particular shape of the nozzle. A vortex flow is created in the chamber and air travels in spiral like motion along the periphery of the hot side. This flow is restricted by the valve. When the pressure of the air near valve is made more than outside by partly closing the valve, a reversed axial flow through the core of the hot side starts from high-pressure region to low-pressure region. During this process, heat transfer takes place between reversed stream and forward stream. Therefore, air stream through the core gets cooled below the inlet temperature of the air in the vortex tube, while air stream in forward direction gets heated up. The cold stream is escaped through the diaphragm hole into the cold side, while hot stream is passed through the opening of the valve. By controlling the opening of the valve, the quantity of the cold air and its temperature can be varied.

### Advantages:

- 1) *It uses air as refrigerant, so there is no leakage problem.*
- 2) *Vortex tube is simple in design and it avoids control systems.*
- 3) *There are no moving parts in vortex tube.*
- 4) *It is light in weight and requires less space.*
- 5) *Initial cost is low and its working expenses are also less, where compressed air is readily available.*
- 6) *Maintenance is simple and no skilled labours are required.*

### Disadvantages:

Its low COP, limited capacity and only small portion of the compressed air appearing as the cold air limits its wide use in practice.

## Applications:

- 1) *Vortex tubes are extremely small and as it produce hot as well as cold air. It may be of use in industries where both are simultaneously required.*
- 2) *Temperature as low as  $-50^{\circ}\text{C}$  can be obtained without any difficulty, so it is very much useful in industries for spot cooling of electronic components.*
- 3) *It is commonly used for body cooling of the workers in mines.*

