Unit 4:- Active Microwave Components.

- Limitations of Conventional Tubes.
- O and M type classification of Microwave tubes
- Re-entrant Cavity.
- Velocity Modulation.
- Construction, operation, performance analysis and applications - Single Cavity and two cavity klystron, Cylindrical wave magnetron and Helix travelling wave.

* Conventional Tubes:-

- Tubes which operates at frequency range of 300 MHz to 3000 MHz.
- In Vaccum tubes, electrons flow from one electrode to another electrode.
- Vaccum Tubes contain one or more grids, cathode and anode.
- These grids are used for controlling action.
- For high frequency applications, conventional tubes cannot be used. Due to following effects:-

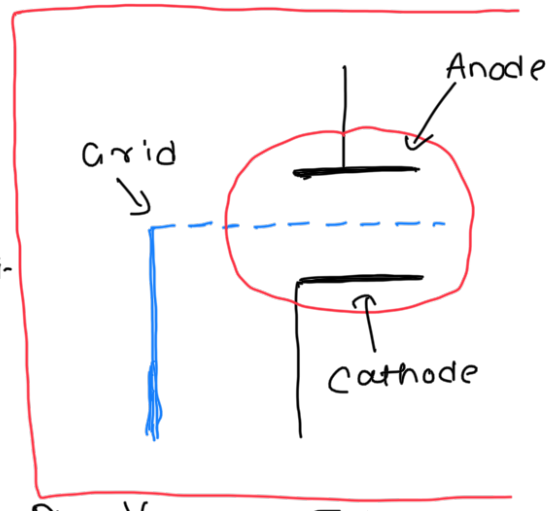


Fig. Vaccum Tube

1. Lead Inductance Effect.
2. Inter electrode capacitance effect.
3. Transit Time effect
4. RF losses.

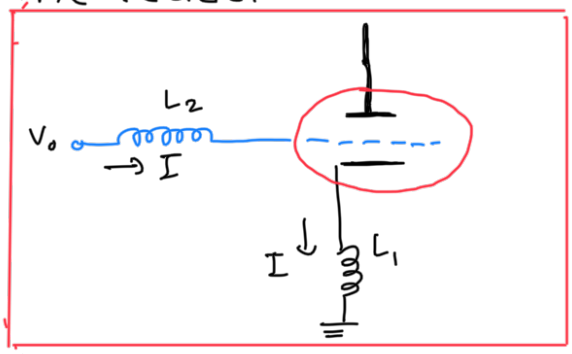
5. Main Bandwidth Limitation.

1. Lead Inductance Effect :-

- Lead Inductance is due to active parts of tube structure i.e. between the leads.

- As frequency increases, reactance X_L increases.

$$\because X_L = 2\pi f_L$$



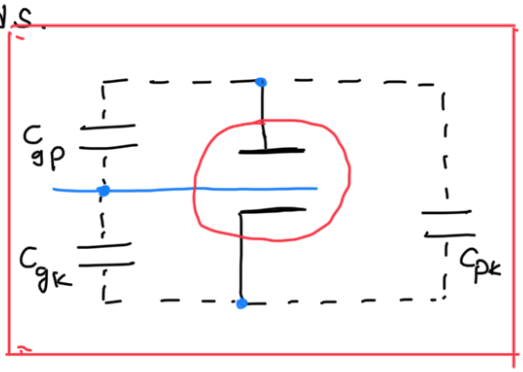
- L_p, L_g and L_k decreases and begins to short circuit the input and output voltages.

2. Inter-Electrode Capacitance Effect (IEC) :-

- IEC effect is due to the active parts of tube structure i.e. between the leads.

- As frequency increases, reactance X_c decreases.

$$X_c = \frac{1}{2\pi f_c}$$



- C_{gp}, C_{gk}, C_{pk} decreases and begins to short circuit the input and output voltages.

3. Transit Time Effect :-

- Transit time is the time taken for the electron to travel from cathode to anode.

- At low frequencies, transit time is negligible, but at higher frequencies, the transit time 'T' is appreciable which reduces the output.

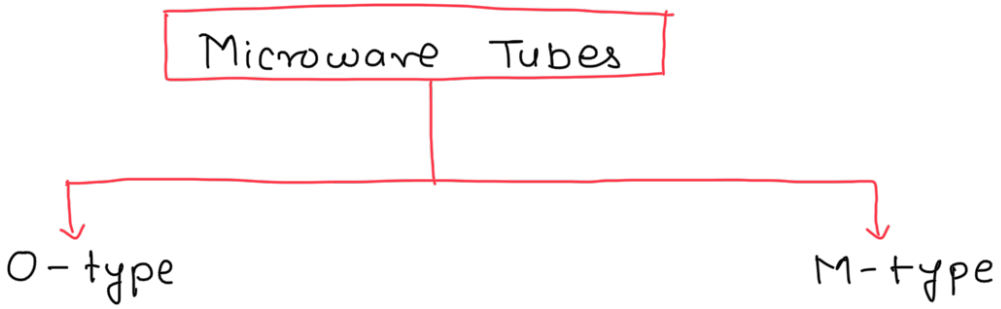
4. Gain Bandwidth Limitation:-

- Gain Bandwidth product is given by :- $A_{max} \times B.W$

- At higher freq. for a particular circuit or tube, higher gain can be achieved by decreasing the bandwidth.

- It can be overcome by use of Re-entrant Cavities.

* Microwave Tubes :-



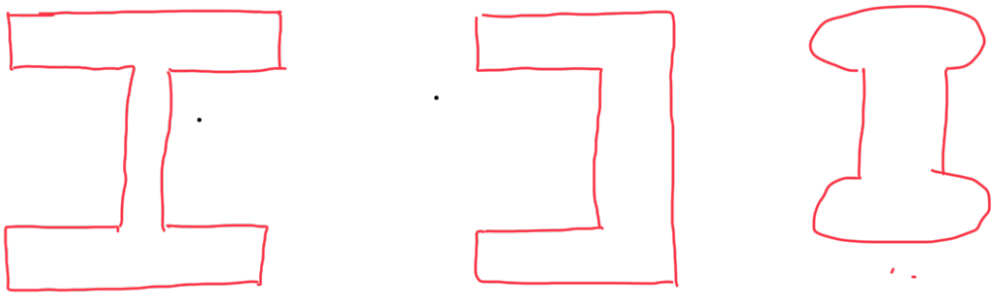
'O' type	'M'-type
- 'O'-type tubes are also called linear beam tube.	- 'M'-type of tubes are called cross field devices.
- Electric field is in direction as the static magnetic field.	- Static Magnetic field is perpendicular to electric field.
- Example: Klystron Tube, Travelling Wave Tube	- Example; Magnetron.

* Re-entrant Cavity :-

- The heart of any vaccum tube is its resonating circuit. At low frequencies they are designed using Resonant Circuit.

- But at microwave frequencies, the resonant circuit is replaced with re-entrant cavities.

- A re-entrant cavity is a metallic tube of any shape which is shorted on both ends. Structure is shorted at its both ends, it can be termed as cavity.
- Various shapes of re-entrant cavities :-



- The cavity dimensions are freq. dependent.

- It supports infinite number of frequencies.

* Velocity Modulation :-

- When electron move inside the microwave tube, their velocity varies.
- The process of the variation in the velocity of electrons is known as velocity modulation

* Formula for velocity modulation :-

- We assume that the velocity