

Klystrons:

Aim: To know the working and construction of klystron tubes and their types.

Objective: To learn the principles of velocity modulation

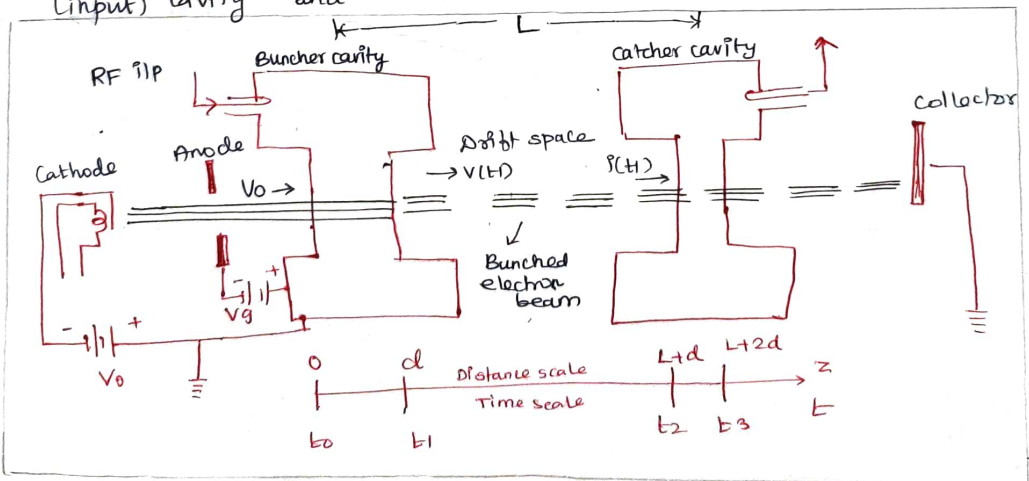
A klystron is a vacuum tube that can be used either as a generator or as an amplifier of power at microwave frequencies operated by the principles of velocity and current modulation.

Two basic configurations:

- i) Two cavity (or) Multicavity klystron - low power microwave amplifier
- ii) Reflex klystron - low power microwave oscillator

① Two cavity klystron Amplifier:

It is a velocity modulated tube in which the velocity modulation process produces density modulated stream of electrons. It consists of two cavities namely, buncher (input) cavity and catcher (output) cavity.



Bunching :

* electrons beam passing thro' the +ve half cycles of the gap voltage undergoes increase in velocity

* those passing thro' the -ve swings of gap voltages undergoes a decrease in velocity.

* As a result, electrons gradually bunch together as they travel down the drift space. This is called **bunching**.

First cavity - bunches and velocity modulates the beam.

Thus electron beam is velocity modulated to form bunches or undergoes density modulation in accordance with input RF signal cycle.

Velocity modulation :

The variation in electron velocity in the drift space is known as velocity modulation.

Equation of velocity modulation

$$v(t) = v_0 \left[1 + \frac{\beta^2 v_1}{2v_0} \sin \left(\omega t - \frac{\theta_0}{2} \right) \right]$$

Bunching Parameters

$$X = \frac{\beta^2 v_1}{2v_0} \theta_0$$

DC transit angle

$$\theta_0 = \frac{\omega L}{v_0} = 2\pi N$$

maximum bunch distance

$$\Delta = L_{opt} = \frac{3.682 V_0 v_0}{\omega \beta^2 v_1}$$

Output power $P_{out} = \frac{P_0 I_2 V_2}{2}$

Max. Efficiency $\eta = 58.2\%$

Characteristics:

Efficiency $\approx 40\%$

Power output: Continuous wave average power ≈ 500 kW

Pulsed Power 30 MW at 10 GHz

Power Gain ≈ 30 dB

Applications:

- i) Troposphere scatter transmitters
- ii) Satellite communication ground stations
- iii) VHF TV transmitters
- iv) Radar transmitters.

Reflex Klystron Oscillator [Single cavity Klystron]

The reflex klystron is an oscillator with a built-in feedback mechanism. It uses the same cavity for both bunching and the output.

The repeller electrode - negative potential sends the bunched electron beam back to the resonator cavity. \Rightarrow Positive feedback mechanism which supports oscillations.

Mechanism of oscillation:

If the power delivered by the bunched electrons to the cavity is greater than the power loss in the cavity, the electromagnetic field amplitude at the resonant freq. of the cavity will increase to produce microwave oscillations.