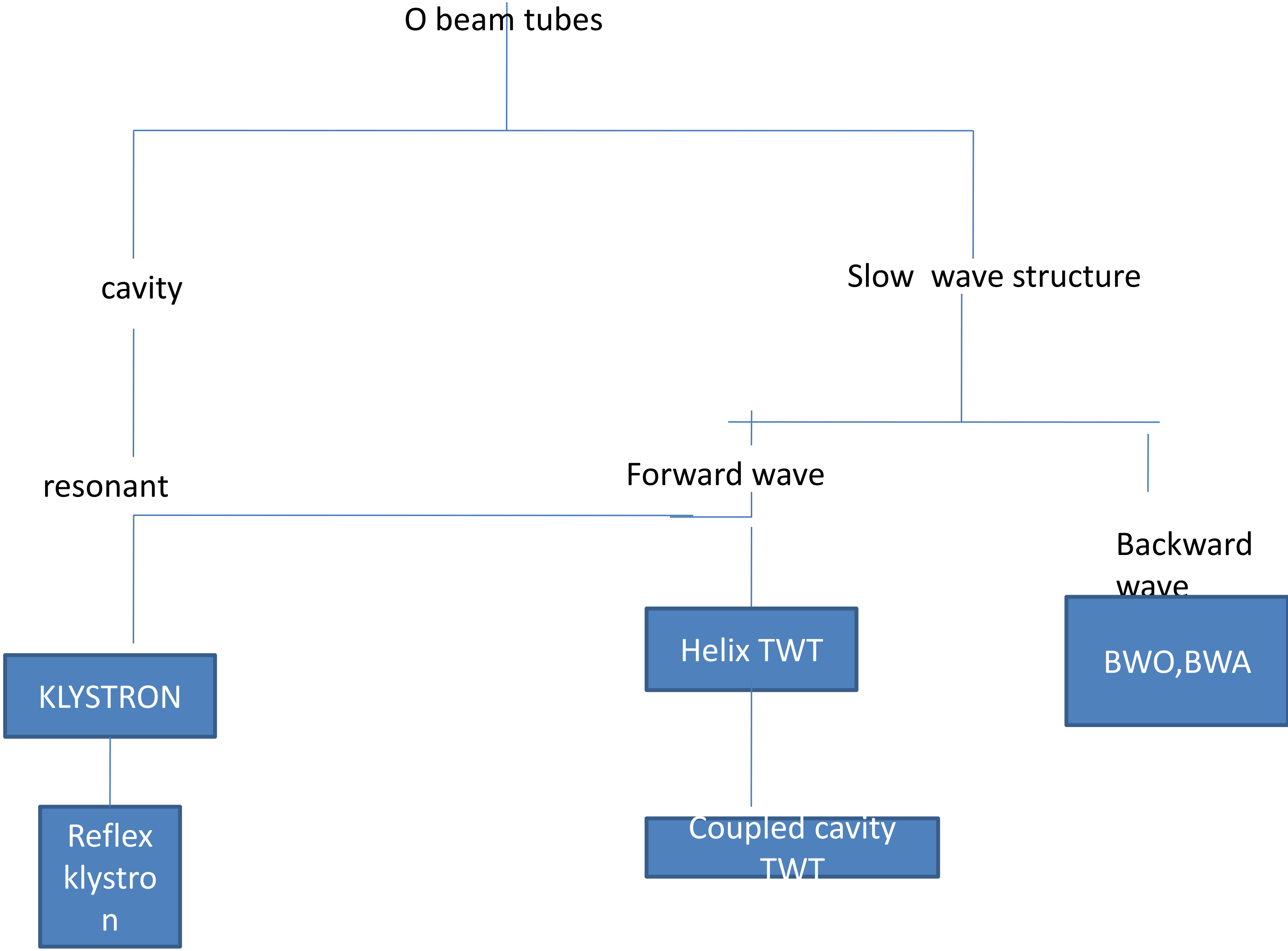
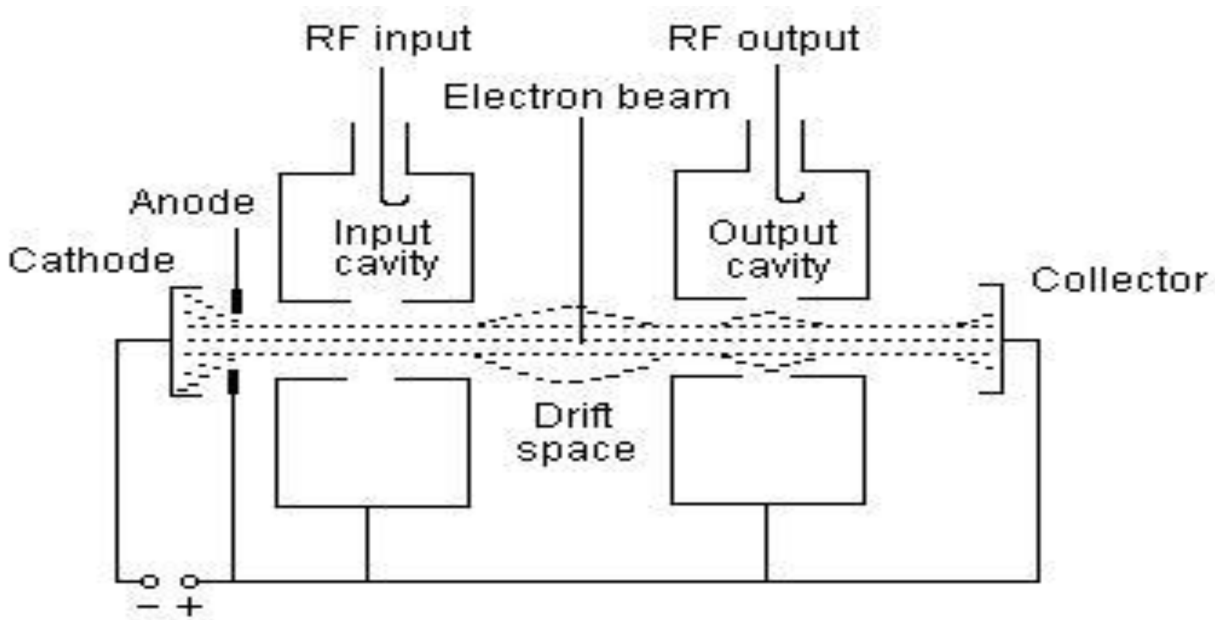
- LINEAR BEAM TUBES (o) type


O beam tubes
cavity
Slow wave structure
resonant
Forward wave
Backward wave
KLYSTRON
Helix TWT
BWO,BWA
Reflex klystron
Coupled cavity TWT

TWO CAVITY KLYSTRON

- Vacuum tube either as generator or amplifier
- RUSSEL H VARIAN



Two cavity klystron amplifier

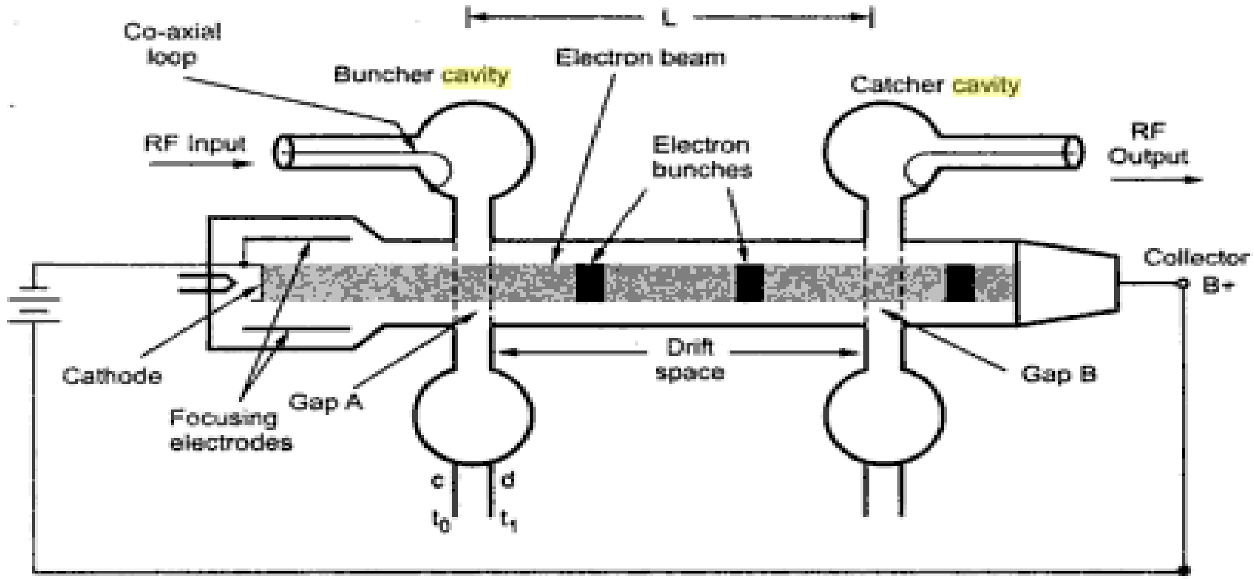
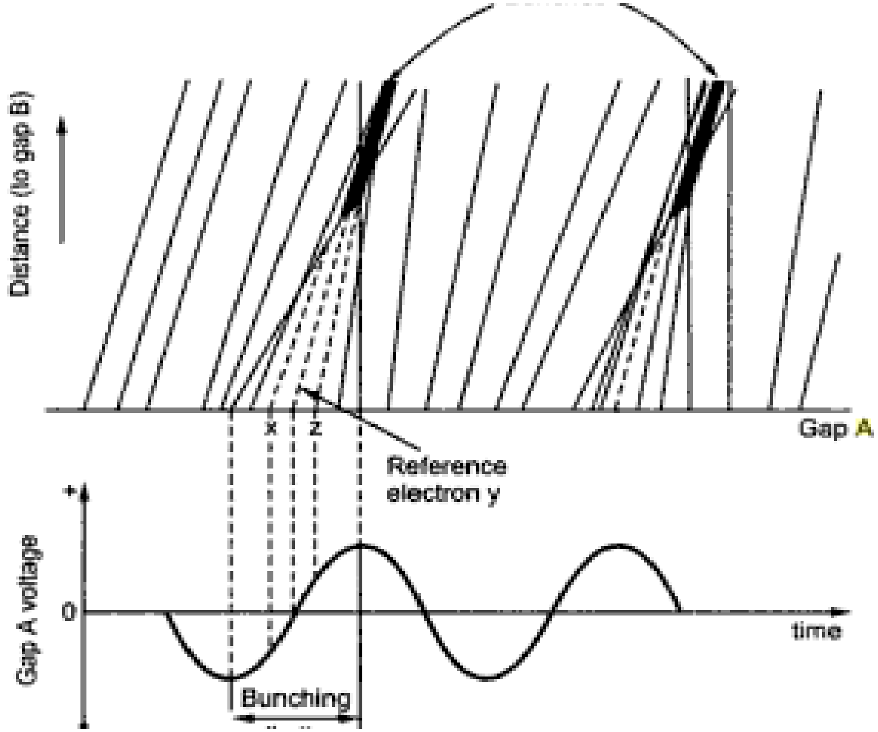
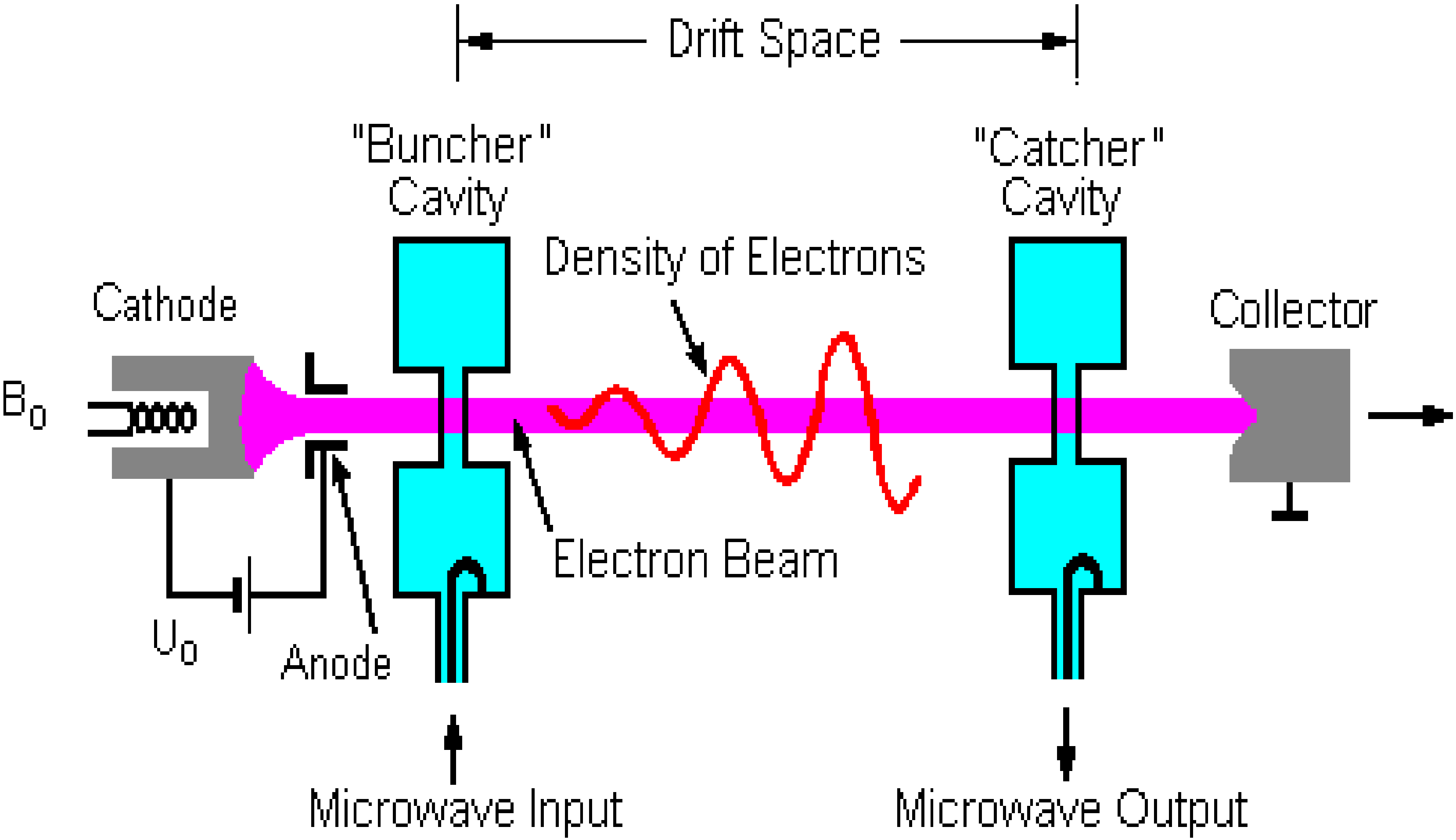


Fig. 4.4.1 Klystron amplifier schematic diagram

Apple gate diagram



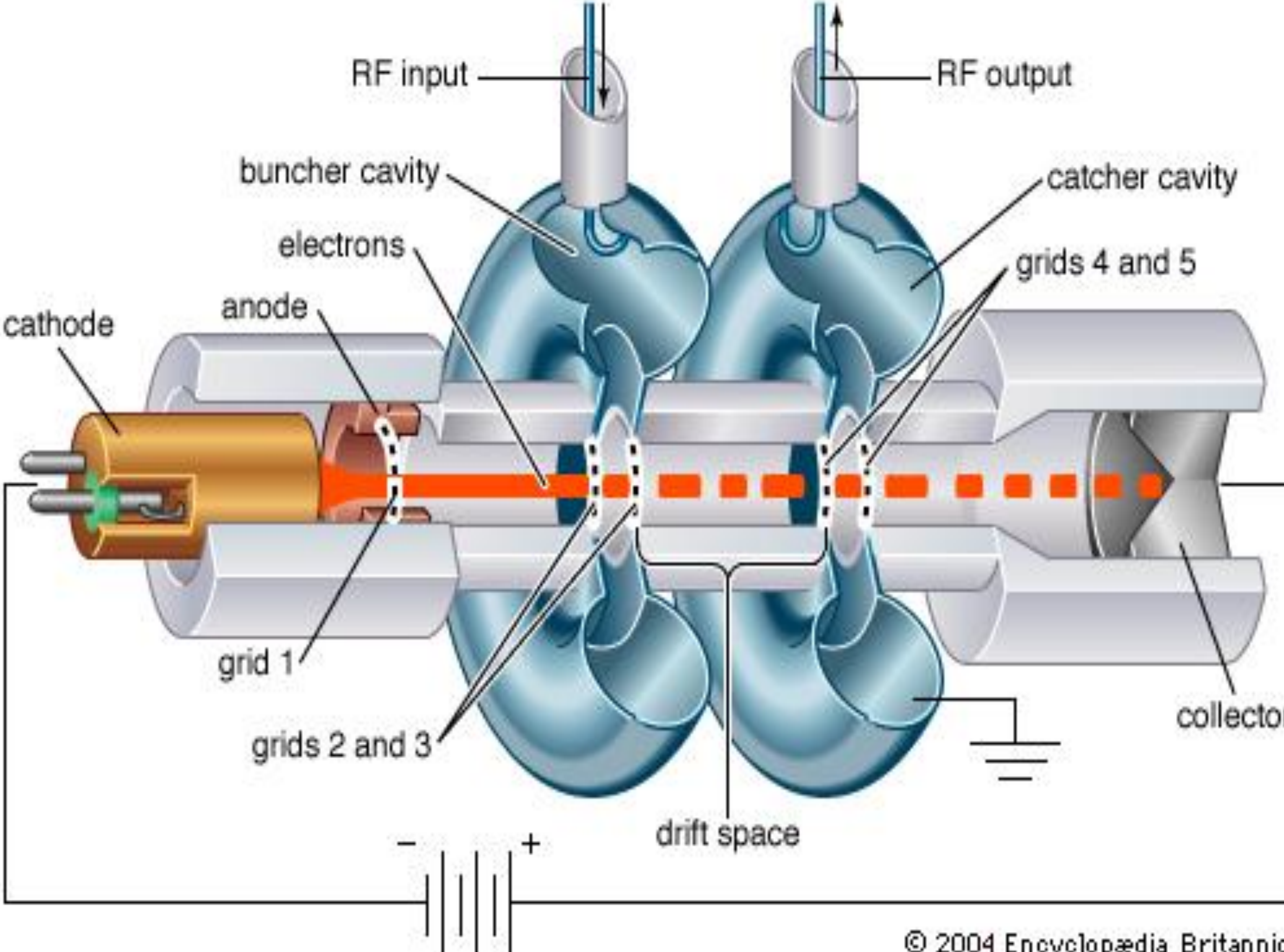
Two Cavity Klystron Amplifier



Principle

- Velocity modulated tube
- High velocity electron beam is generated by an electron gun and sent down along a gas tube through an input cavity (BUNCHER), drift space (FIELD FREE) and an output cavity (CATCHER) to a collector electrode anode.
- The anode is kept positive to receive the electrons, while the output is taken from the tube via resonant cavities with the aid of coupling loops

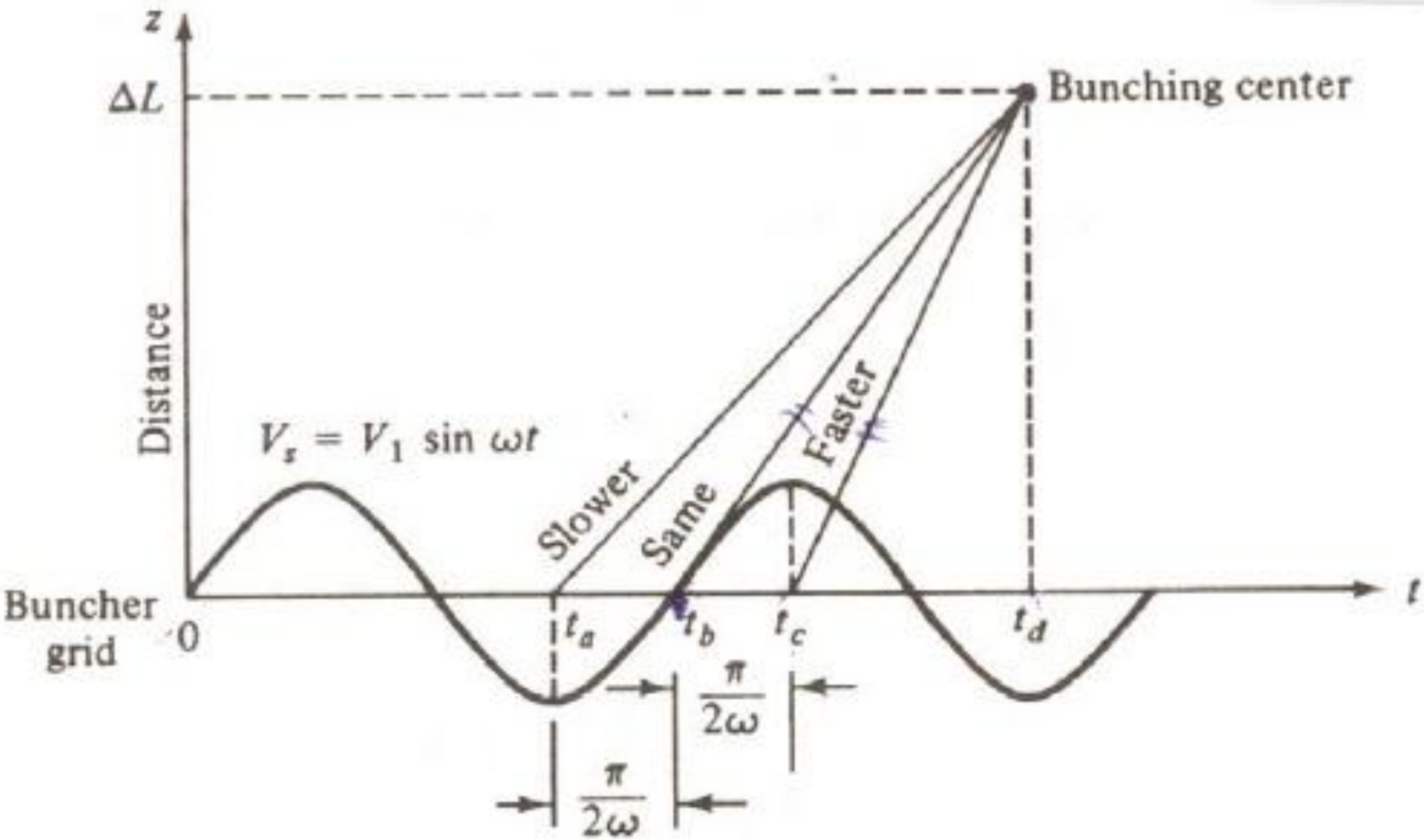
- Two grids of the buncher cavity are separated by a small gap A while the two grids of the catcher cavity are separated by a small gap B.


RF input
RF output
buncher cavity
catcher cavity
electrons
grids 4 and 5
anode
cathode
grid 1
collecto
grids 2 and 3
drift space
−
+

OPERATION

- The input buncher cavity is exited by the RF signal, (the signal to be amplified) which will produce an alternating voltage of signal frequency across the gap A.
- This voltage generated at the gap A is responsible to produce bunching of electrons or velocity modulation of the electron beam.

Applegate Diagram



Performance Characteristics

- Frequency 250Mhz-100 GHz
- Power -10kw -500 Kw
- Power gain 15 db-70 db
- Bandwidth – limited 10-60 Mhzfixed application
- Noise figure -15-20 db
- Efficiency -58%

Application

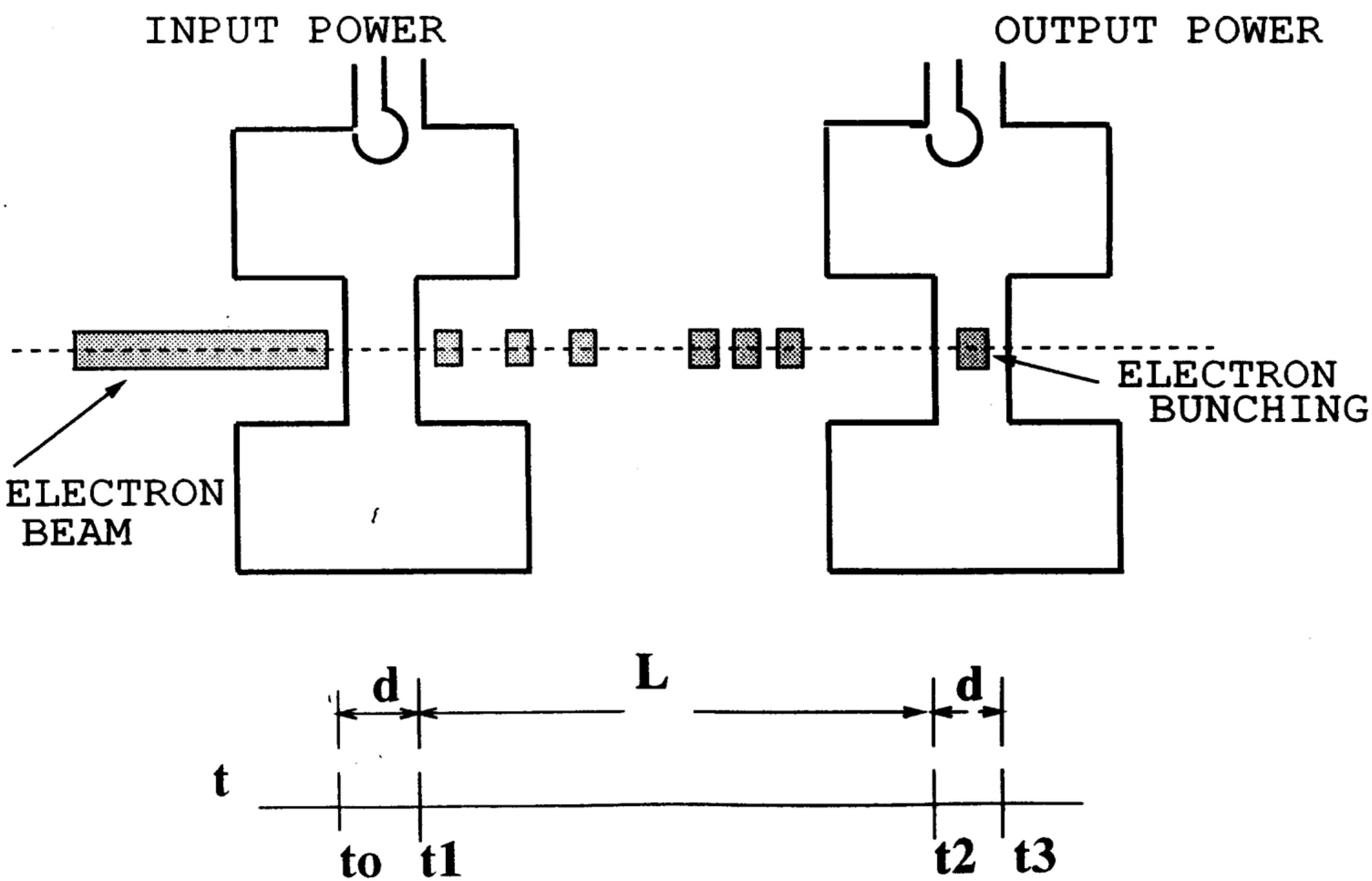
1) As power o/p tubes

- In UHF TV transmitter
- In troposphere scatter Transmitter
- Satellite Communication Ground station
- Radar transmitter

2) As power oscillator (5-50 Ghz) is used as Klystron amplifier

KLYSTRON

SIMPLIFIED SCHEMATIC



Mathematical analysis

$$v_0 = \sqrt{\frac{2eV_0}{m}} = 0.593*10^6\sqrt{v_0}\,m/s$$

$$V_s = V_1 \sin wt_1$$

$$\frac{1}{2}mv_1{}^2 = e(V_o + V_1 Sinwt_1)$$

$$v_1 = \sqrt{\frac{2e(V_o + V_1 Sinwt_1)}{m}}$$

$$v_1 = v_0\left(1 + \frac{V_1}{V_0}\sin wt_1\right)^{1/2}$$

$$v_1 = v_0\left(1 + \frac{V_1}{2V_0}\sin wt_1\right)$$

$$wt_1 = wt_o + \frac{\theta_g}{2}$$

θ_g *is the* phase angle of RF input *voltage*

$$wt_1 = wt_o + \frac{\theta_g}{2}$$

θ_g *is the* phase angle of RF input *voltage*

$$\theta_g = \omega t = \omega(t_1 - t_0) = \frac{\omega d}{v_0}$$

Bunching process of Electron Beam

$$v_{1(\max)} = v_0\left(1 + \frac{V_1}{2V_0}\right) \text{ at } \pi/2$$

$$v_{1(\min)} = v_0\left(1 - \frac{V_1}{2V_0}\right) \text{ at - } \pi/2$$

$$L_1 = v_0(t_1 - t_0)$$

Bunching process of Electron Beam

$$L(t_{-\pi/2}) = v_{\min}(t_1 - t_{-\pi/2})$$

$$L(t_{\pi/2}) = v_{\max}(t_1 - t_{+\pi/2})$$

$$t_{-\pi/2} = (t_0 - \pi/2\omega)$$

$$t_{\pi/2} = (t_0 + \pi/2\omega)$$

$$L_1 \text{ at } \mathrm{t}_{-\lambda/2} = vo\left(1 + \frac{V_1}{2V_0}\right)(t_1 - t_0 + \pi/2\omega)$$

$$L_1 \text{ at } \mathrm{t}_{+\lambda/2} = vo\left(1 + \frac{V_1}{2V_0}\right)(t_1 - t_0 - \pi/2\omega)$$

$$\therefore \mathrm{L}_1 = v_0(t_1 - t_0) + v_o\left[\frac{\pi}{2\omega} - \frac{V_1}{2V_{0\ 1}}\left(t_1 - t_0\right) - \frac{V_1}{2V_0}\pi / 2\omega\right]$$

$$\left[\frac{\pi}{2\omega} - \frac{V_1}{2V_{0\ 1}}\left(t_1 - t_0\right) - \frac{V_1}{2V_0}\pi / 2\omega\right] = 0$$

$$-\left(t_1 - t_0\right) = \frac{\pi}{2\omega}\left[\frac{V_1}{2V_{0\ 1}} - 1\right]\frac{2V_0}{V_1}$$

$$= \frac{\pi}{2\omega} - \frac{\pi}{\omega}\frac{V_0}{V_1}$$

$$t_1 - t_0 \approx \frac{\pi}{\omega}\frac{V_0}{V_1}$$

$$L_1 = v_0\left(\frac{\pi}{\omega}\frac{V_0}{V_1}\right)$$