MICROWAVE TUBES

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Why conventional Tubes and semiconductor Devices can NOT use at Microwaves

- A wide range of semiconductor devices have been developed for detection, mixing, amplification, attenuation etc.
- Microwave tubes are preferred over vacuum tubes.
- At microwave frequency range, the conventional tubes become less effective when used as an amplifier and oscillator.
- When frequency is raised high enough –**requires greater driving power and O/P drops down**
- **Gain falls to unity or lees.**
- **Output drops down to zero.**

High Frequency Limitations of Conventional Tubes

- The conventional tubes become less effective at microwave frequency range when these are used as an amplifier and oscillator. The limitations of conventional tubes at high frequencies is due to :

  (a) Inter-electrode capacitance effect

  (b) Lead Inductance effect

  (c) Transit Time effect

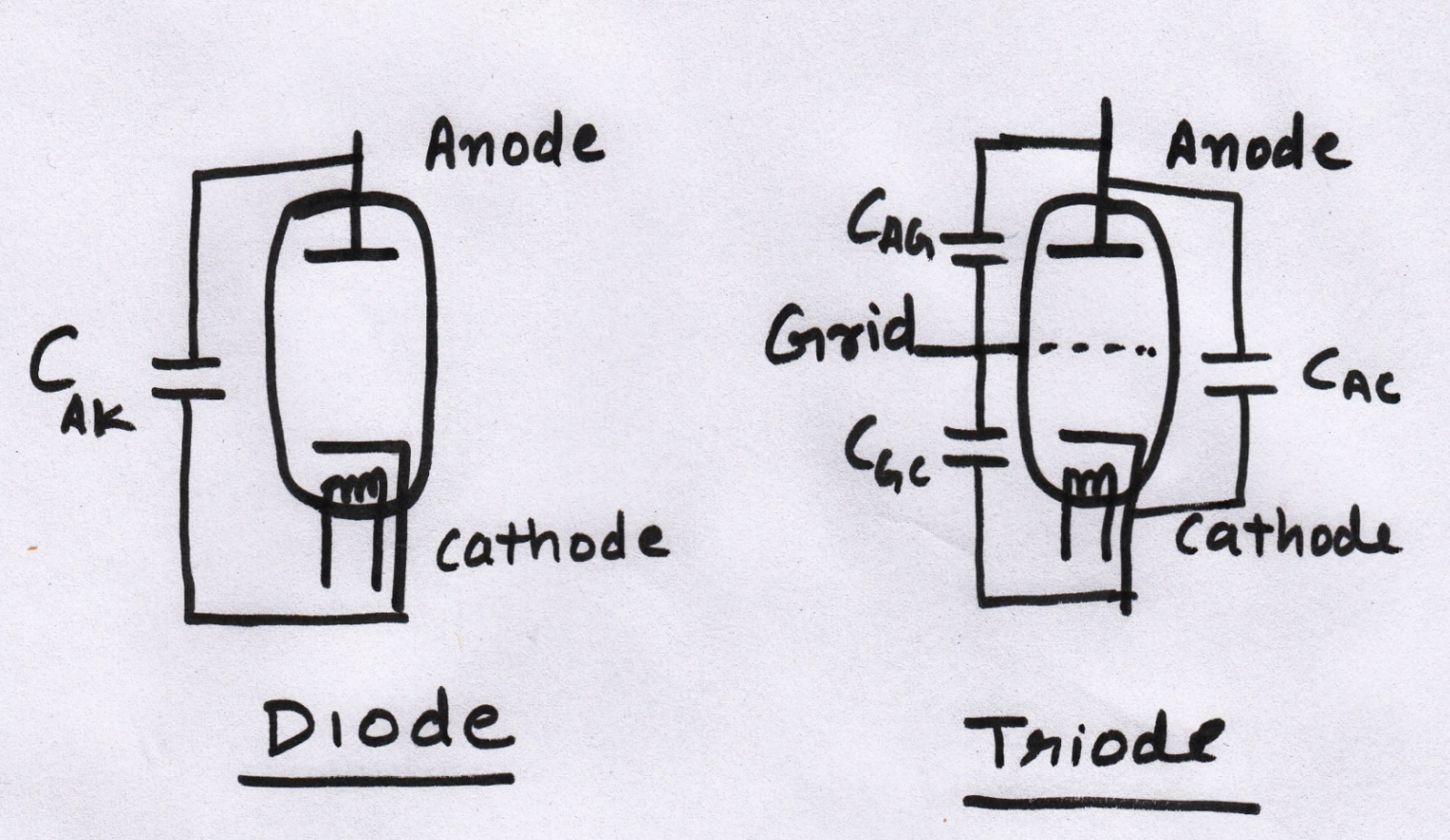
  (d) Cathode emission

  (e) Power loss due to skin effect, Radiation and Dielectric loss

Inter-electrode Capacitance Effect

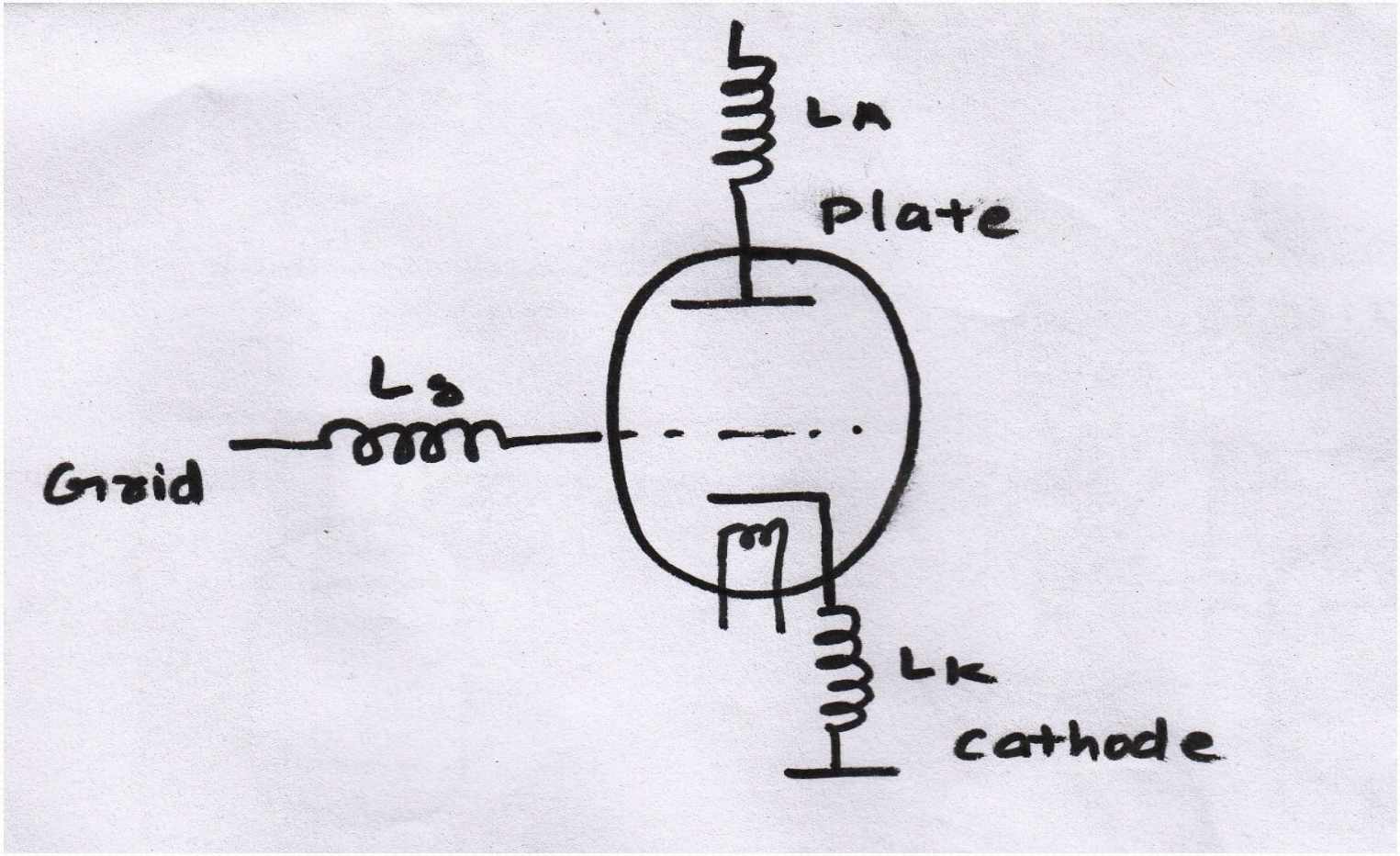
- The capacitance exists when two pieces of metal are separated by a dielectric. Vacuum has a dielectric constant of 1.
- The elements of the triode are made up of metal and are separated by dielectric material .
- So there must exist capacitance between them. This capacitance is called **interelectrode capacitance.**

Inter-electrode Capacitance Effect



Lead Inductance Effect

- The common lead inductance is the inductance associated with the common connection of vacuum triode.
- This effect is more when the frequency of the signal is high.
- As the frequency increases, the inductive reactance increases and due to high inductive reactance there is an input matching problem.

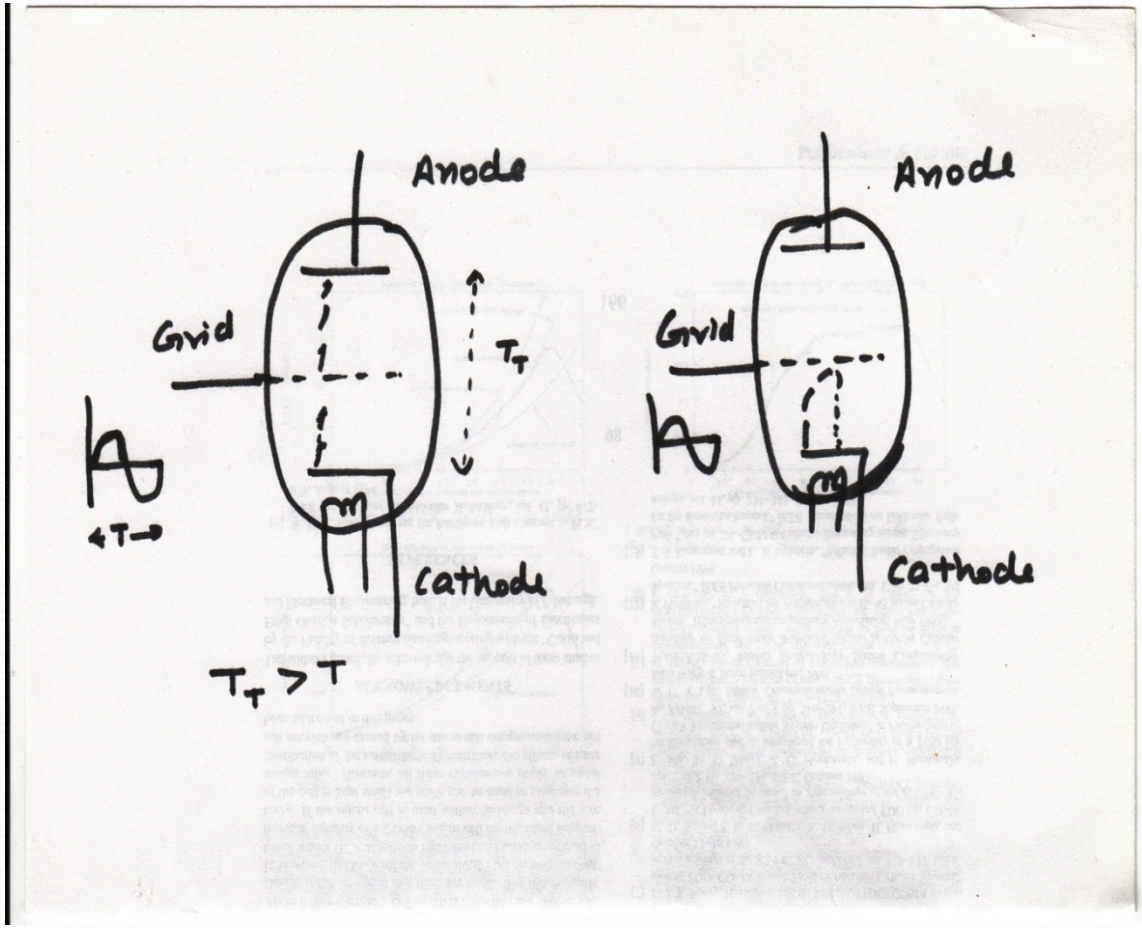

La
Plate
Lg
Grid
M
Lk
cathode

- The lead inductance affects the performance of vacuum triode with most of input voltage lost across inductance and only small fraction of input reach to terminal for amplification.
- These inductances form unwanted tuned circuit with the capacitance and parasitic oscillations are produced. As frequency increases, the reactance increases.

Effect of Transit Time

- The time taken by an electron to travel from cathode to anode is called transit time.
- At low frequencies, the transit time is very small i.e. the electrons reach instantaneously the anode plate from cathode.
- At high frequencies, the transit time becomes large because the source driving the grid becomes loaded and the gain of the vacuum tube becomes less than unity.

Effect of Transit Time



- This loading is due to the dissipation of the power at the grid. The effect of loading is such that the noise in the circuit increases.
- To minimize this effect, the distance between the electrodes is to be reduced and high voltage must be applied.
- This will increase the interelectrode capacitance.

Plate Dissipation Area and Cathode Emission:

- Grater area of cathode emission result into inter electrode capacitance which is undesirable.
- K voltage and temp can not be increased beyond the limit.

Power loss due to skin effect, Radiation and Dielectric loss

- At uw current flows in the thin surface layers due to skin effect, as frequency increases current flow decreases
- Glass and other insulating support have losses due to molecular movements produce by electric filed known as “dielectric losses”
- The exposes pieces of wire i.e. electrode lead radiate appreciable power and hence output reduces and efficiency reduces
- Radiated power increases as the square of frequency