



# **SNS COLLEGE OF TECHNOLOGY**

**Coimbatore-35**  
**An Autonomous Institution**



Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A++' Grade  
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

## **DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING**

### **19ECB311 -OPTICAL AND MICROWAVE ENGINEERING**

**TOPIC– REFLEX KLYSTRON**



# Reflex Klystron



- A Reflex Klystron is a type of vacuum tube used in electronics for generating and amplifying microwave signals, typically in the range of 1 GHz to 40 GHz.
- It operates based on the principle of velocity modulation of an electron beam passing through a resonant cavity.
- The name "reflex" comes from the fact that a portion of the energy from the output signal is reflected back into the tube and used to modulate the electron beam, resulting in higher efficiency and improved performance.
- Reflex Klystrons are used in various applications such as microwave ovens, radar systems, communication systems and particle accelerators.



## Characteristics



- Resonant cavity: A Reflex Klystron consists of a resonant cavity that is made up of two cylindrical cavities. The cavities are separated by a small gap called the drift space.
- Electron beam: An electron gun is used to produce a narrow, high-velocity electron beam that is directed towards the resonant cavity. The electrons are focused by magnetic fields and are made to pass through the drift space.
- Bunching: As the electrons pass through the drift space, they are affected by the alternating electric field produced by the resonant cavity. This causes the electrons to bunch together, forming groups or bunches.



## Characteristics



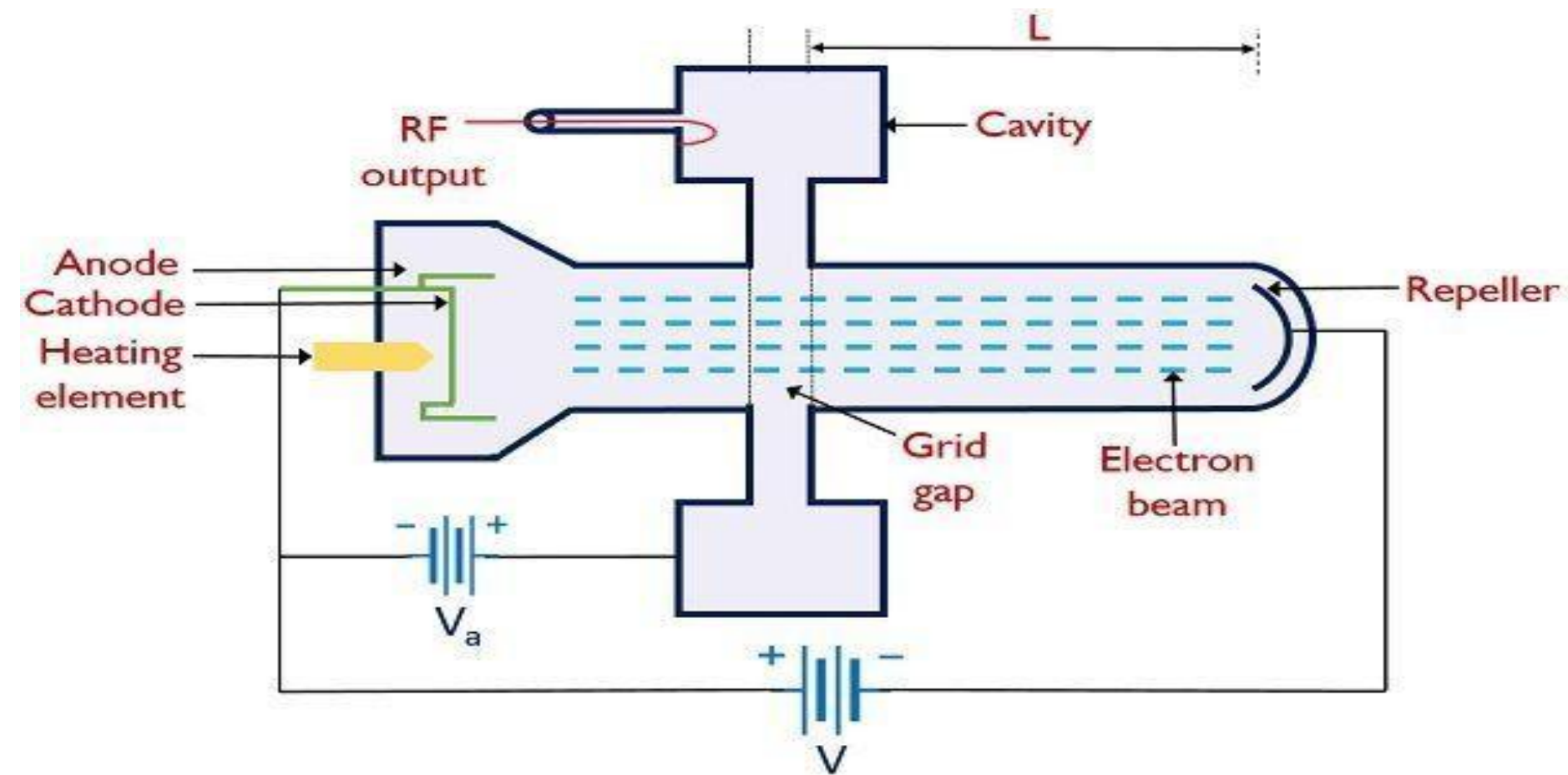
- **Amplification:** The bunches of electrons that pass through the resonant cavity interact with the electric field, causing the field to be amplified. The amplified field then interacts with the next bunch of electrons, resulting in further amplification.
- **Oscillation:** The interaction between the electron beam and the resonant cavity can cause the cavity to oscillate at a frequency determined by the dimensions of the cavity. This produces a microwave signal that can be used for various applications, such as in radar and communication systems.





# Working Principle

- The working principle of a Reflex Klystron involves the interaction of an electron beam with a resonant cavity to generate and amplify microwave signals.



Structure of Reflex Klystron

Electronics Desk





## Working Principle Cont...



- Electron beam formation: The electron beam is produced by an electron gun and is directed towards the resonant cavity.
- Bunching of electrons: As the electrons pass through the drift space between the electron gun and the resonant cavity, voltage generated at the gap A is responsible to produce bunching of electrons or velocity modulation of the electron beam.
- The repeller distance  $L$  and the repeller voltage can be adjusted to receive all the electrons at a same time on the positive peak of the cavity RF cycle.
- Thus the velocity modulated electrons are bunched together and lose their kinetic energy when they encounter the positive peak of the cavity RF field.
- When power delivered by the electrons is equal to the power loss in the cavity- Microwave oscillation is started



## Working Principle Cont...



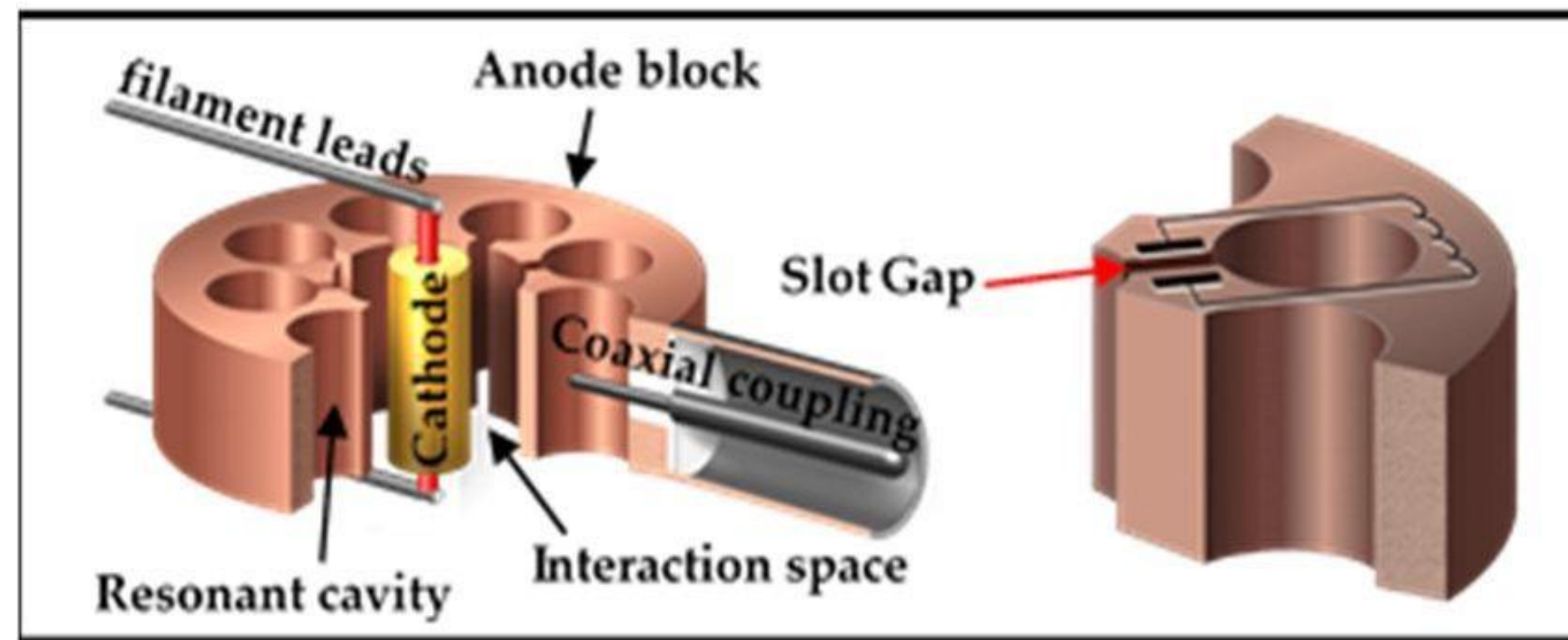
- Amplification and oscillation: The interaction between the electron beam and the resonant cavity can cause the cavity to oscillate at a frequency determined by the dimensions of the cavity.
- This produces a microwave signal that can be amplified by the interaction between the cavity and the electron beam. The amplified signal is then output through a waveguide or other output device.
- Reflected energy: A portion of the energy from the output signal is reflected back into the tube and is used to modulate the electron beam. This results in higher efficiency and improved performance.
- The overall effect of this process is to produce a stable, high-frequency microwave signal that can be used for various applications, such as in radar and communication systems.



## Working Principle Cont...



- Interaction with the resonant cavity: When the bunches of electrons pass through the resonant cavity, they interact with the alternating electric field of the cavity. This interaction causes the electrons to gain energy, which results in an increase in the velocity of the electrons.







## Advantages



- High frequency stability: Reflex Klystrons can operate at high frequencies with excellent stability, which makes them useful in applications that require precise and stable signals.
- High power output: Reflex Klystrons can generate high power microwave signals, which makes them suitable for use in applications that require high power output, such as in radar and communication systems.
- Compact size: Reflex Klystrons are relatively small in size compared to other microwave tubes, which makes them ideal for use in applications where space is limited.



## Advantages



- **Low noise:** Reflex Klystrons generate very low noise levels, which makes them suitable for use in applications that require high signal-to-noise ratios, such as in communication systems.
- **Long lifespan:** Reflex Klystrons have a long lifespan and can operate for many thousands of hours without requiring maintenance, which makes them a cost-effective choice for many applications.
- **Overall,** the Reflex Klystron's high frequency stability, high power output, compact size, low noise, and long lifespan make it a versatile and reliable option for a wide range of microwave applications.



## Disadvantages



- High voltage requirement: Reflex Klystrons require a high voltage power supply to operate, which can be expensive and pose a safety risk.
- Limited frequency range
- Limited power control: Reflex Klystrons have limited power control capabilities and are typically operated at a fixed power output. This can be a disadvantage in applications where variable power output is required.
- Sensitivity to temperature changes: The performance of Reflex Klystrons can be affected by changes in temperature, which can limit their stability and reliability in some applications.
- Complexity: Reflex Klystrons are relatively complex devices compared to some other types of microwave tubes, which can make them more difficult to design, manufacture, and maintain.



## APPLICATIONS



The reflex klystrons are used in

- Radar receivers
- Local oscillator in microwave receivers
- Portable microwave links
- Pump oscillator in parametric amplifier

Performance Characteristics

- Frequency: 2– 200 GHz
- Power: 10 mW – 2.5 W
- Theoretical efficiency : 22.78 %
- Practical efficiency : 10 % - 20 %
- Tuning range : 5 GHz at 2 W – 30 GHz at 10 mW





## ASSESSMENT



1. The klystron tube used in a klystron amplifier belong to
  - a) Linear beam
  - b) Crossed field
  - c) Parallel field
  - d) None of the mentioned

**Answer: a**

2. Which is a single cavity klystron tube that operates as on oscillator by using a reflector electrode after the cavity.
  - a) Backward wave oscillator
  - b) Reflex klystron
  - c) Travelling wave tube
  - d) Magnetrons

**Answer: b**



THANK YOU