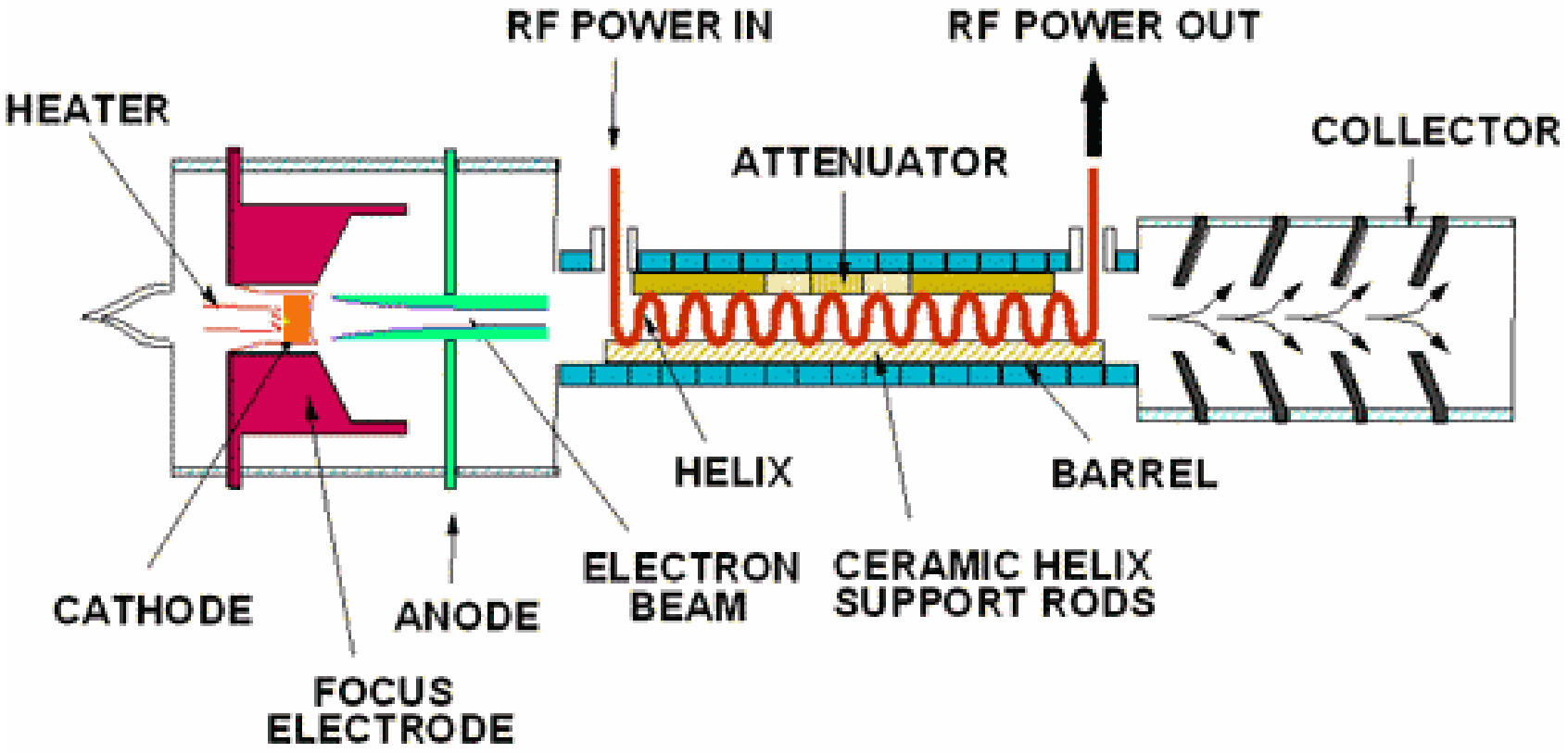
TWT

TRAVELLING WAVE TUBE

BASICS of Traveling Wave Tube (TWT) Amplifier



Reference: http://www.twtas.com/pictures/factorywalk/faccathode.html

Key Notes of TWTA:

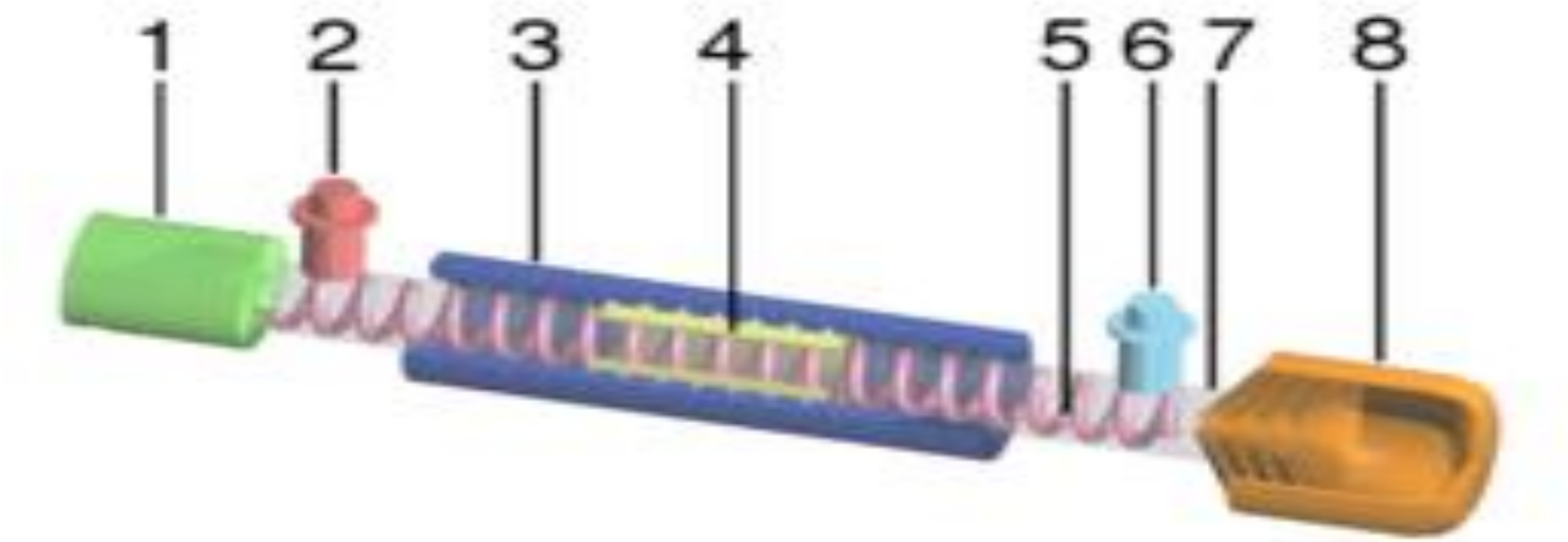
- Heater/Filament is closest to Cathode Voltage.
- Heater and Cathode act as electron gun, and they are on the side RF Input.
- Collectors sits on RF output.
- Electrons are fired from Cathode and received from Collectors.
- RF signal is amplified through bunching effect after traveling along the path of Helix coil.*
- Higher Cathode voltage → Higher RF Power *
- Advantage of TWTA (over solid state amplification) is the linearity and output power*
- TWTA Efficiency: 50% to 60% vs. Solid State: 25% to 30%
- Ranges of Frequency for TWTA: 1Ghz – 40 Ghz
- *Additional Information:
  - http://www.djmelectronics.com/articles/twt-vs-solid-state.html

TWT

- Broad band devices
- Rf and electron beam travel in same direction
- Same velocity
- Electron beam travel with velocity governed by anode voltage typically(0.1 vc)
- RF field propagate with the velocity of light in vacuum
- The interaction between the RF field and electron beam takes place only when RF field is retarded

Slow wave structures

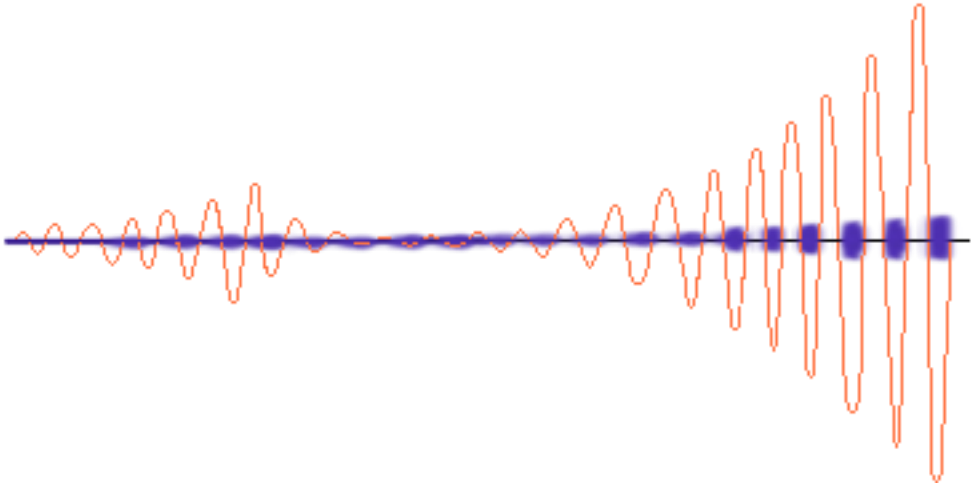
- Reduce the velocity in certain structures
- Electron beam and signal can interact
- Phase velocity of wave in ordinary wave guide is greater than the velocity of light in vacuum
- Effective interaction



Cutaway view of a helix TWT. (1) Electron gun; (2) RF input; (3) Magnets; (4) Attenuator; (5) Helix coil; (6) RF output; (7) Vacuum tube; (8) Collector

Construction features of TWT

- Narrow constant voltage
- Center of the long axial helix1
- RF electric field , propagates with velocity of light
- Axial phase velocity
- $V_p = v_c(\text{pitch}/2\pi r)$



Performance characteristics

- Frequency operation ;0.5 Ghz to 95 Ghz
- Efficiency : 5to 20%
- Power output

  5mw at(10-40GHz) low power twt

  250 kw at 3Ghz (high power TWT)

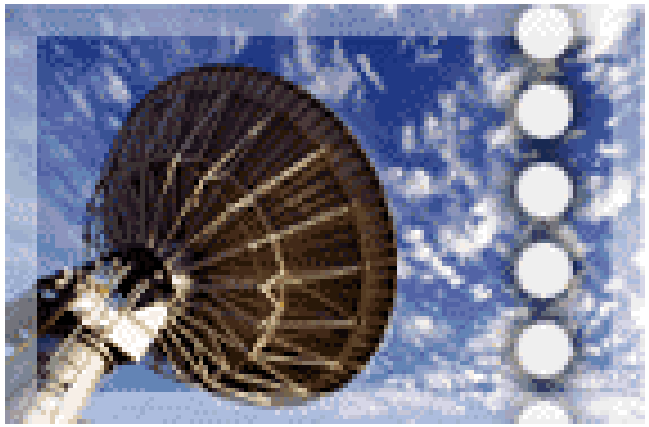
  10 MW (pulsed) at #GHZ

Application

- Low power RF amplifier in broad band microwave receiver
- Repeater amplifier in wide band communication links
- TWT used as power out put tube in communication satellites
- Air bone and ship bone pulsed high power radars

Application of TWTA

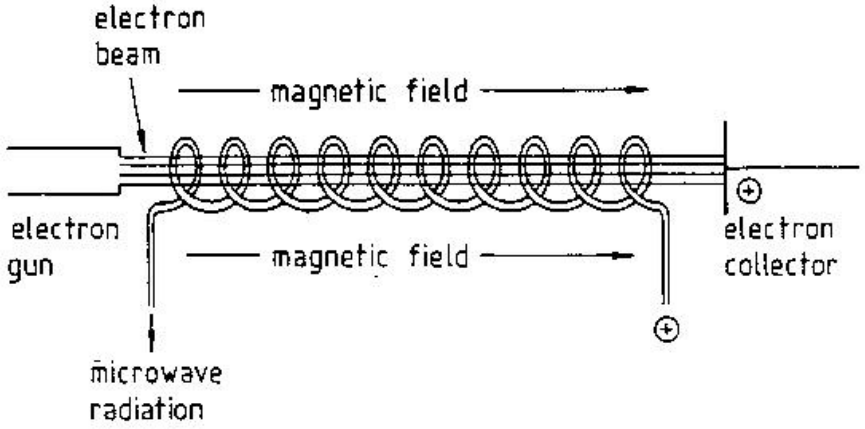
- Point to Point Communication
- Satellite communication and Rader Appz
- Missile tracking application for military
- Television live broadcasting
  - LIVE news vans with satellite dishes on the roof carry TWTA inside



Microwave Sources

- **The Backward Wave Oscillator (BWO)**

  The electron beam (from an electron gun) passes through a wire helix and generates an electric field that induces voltage with the helix wire. The resonating electric fields (in and out) produce microwaves in the direction opposite to the electron beam.



Microwave Sources

- **The Backward Wave Oscillator (BWO)**

  The BWO method is more convenient and can cover a complete MW band, unlike the klystron.

  The frequency of the radiation is varied by controlling the beam velocity and the helix potential.

Magnetron

- Invented by Hull in 1921
- Improved high power magnetron was developed by RANDALL AND BOOT AROUND 1939
- MICROWAVE OSCILLATION FOR very high peak power

Types of magnetron

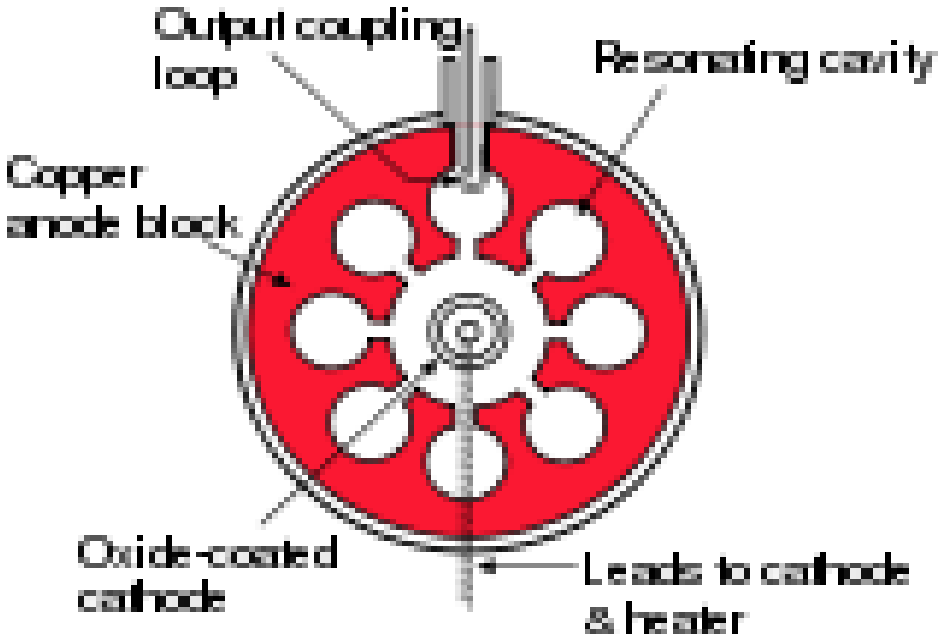
- Negative resistance type
- Cyclotron frequency type
- Travelling wave or cavity type

Negative

- Negative resistance between two anodes segment ,low efficiency – low frequencies(,500Mhz)

Cyclotron frequency

- Synchronism between an alternating component of electric field and periodic oscillation of electron parallel to this field
- |



Resonant cavity magnetron high-power high-frequency oscillator

- Microwave Applications

1. Radar
   a. Aircraft and marine navigation
   b. Military threat detection
   c. Altimeters
   d. Weather plotting
   e. Traffic speed enforcement
   f. Automotive collision avoidance and speed control
2. Satellite
   a. Telephone communication
   b. TV transmission (cable, short-range, direct broadcast)
   c. Surveillance
   d. Weather plotting
   e. Navigation (GPS, etc.)
3. Wireless local-area and personal-area networks

a. IEEE 802.11b/g	Ethernet, 2.4 GHz, rates of 11 to 54 Mbps
b. IEEE 802.11a	Ethernet, 5 GHz, rate of 54 Mbps
c. 802.11n	Ethernet, 2.4 GHz, rate to 250 Mbps
d. Bluetooth	2.4 GHz, rate to 3 Mbps
e. HomeRF	2.4 GHz, rate to 10 Mbps
f. Ultrawideband	Rate to 1 Gbps

4. Wireless broadband access to the Internet
   a. MMDS
   b. LMDS
   c. WiMAX
5. Cell phones (allocations in the 1.8-, 1.9-, and 2.3-GHz ranges)
6. Heating
   a. Microwave ovens (domestic)
   b. Microwave heating (industrial)
7. Radio telescopes