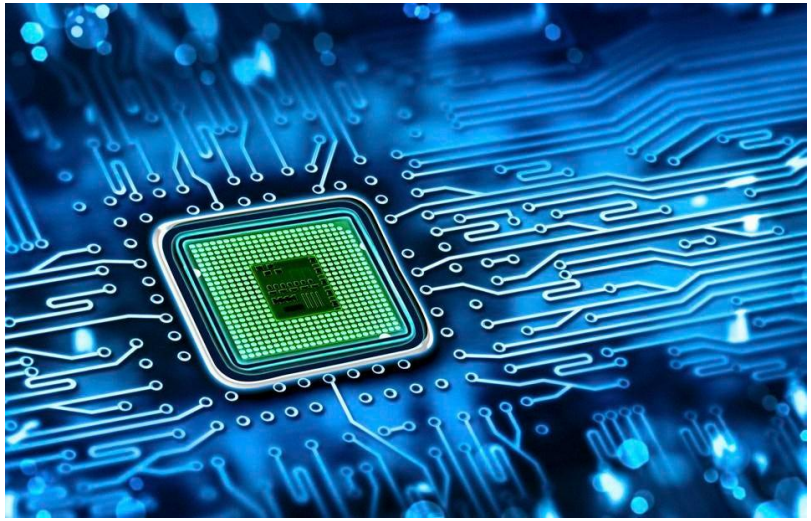
Travelling Wave Tube (TWT)



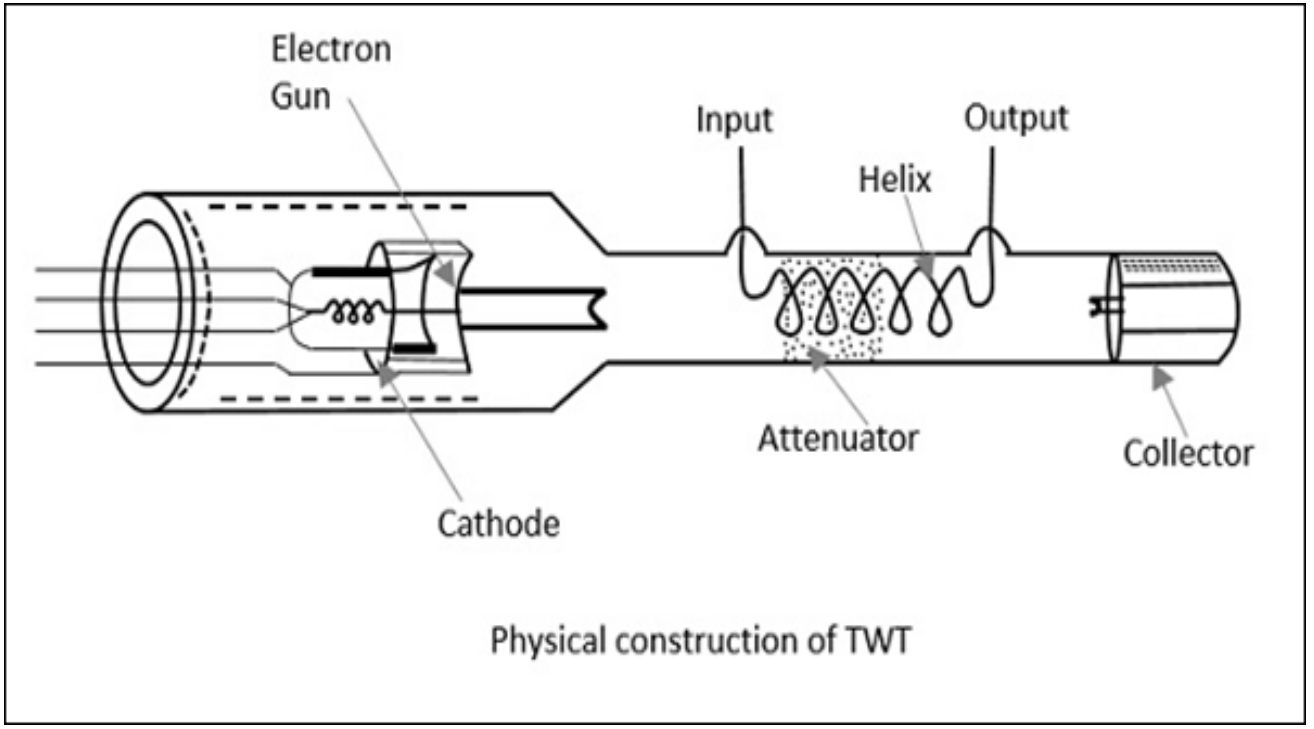
Travelling Wave Tube (TWT)

Travelling wave tubes are broadband microwave devices which have no cavity resonators like Klystrons. Amplification is done through the prolonged interaction between an electron beam and Radio Frequency RF field.

Travelling Wave Tube (TWT)

Construction of Travelling Wave Tube:

The following figure explains the constructional features of a travelling wave tube.



Physical construction of TWT

Travelling Wave Tube (TWT)

Travelling wave tube is a cylindrical structure which contains an electron gun from a cathode tube. It has anode plates, helix and a collector. RF input is sent to one end of the helix and the output is drawn from the other end of the helix.

Travelling Wave Tube (TWT)

An electron gun focusses an electron beam with the velocity of light. A magnetic field guides the beam to focus, without scattering. The RF field also propagates with the velocity of light which is retarded by a helix. Helix acts as a slow wave structure. Applied RF field propagated in helix, produces an electric field at the center of the helix.

Travelling Wave Tube (TWT)

The resultant electric field due to applied RF signal, travels with the velocity of light multiplied by the ratio of helix pitch to helix circumference. The velocity of electron beam, travelling through the helix, induces energy to the RF waves on the helix.

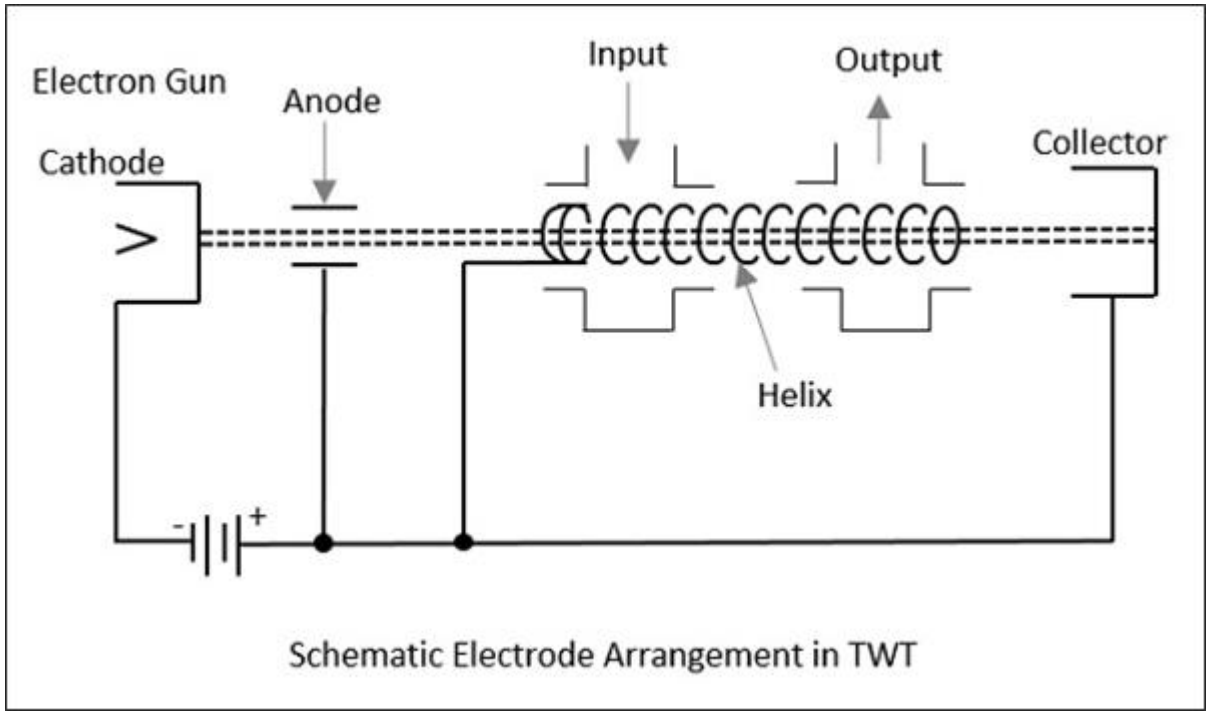
Thus, the amplified output is obtained at the output of TWT. The axial phase velocity Vp is represented as

$$Vp=Vc(Pitch/2\pi r)$$

Where r is the radius of the helix. As the helix provides least change in Vp phase velocity, it is preferred over other slow wave structures for TWT.

Travelling Wave Tube (TWT)

In TWT, the electron gun focuses the electron beam, in the gap between the anode plates, to the helix, which is then collected at the collector. The following figure explains the electrode arrangements in a travelling wave tube.



Schematic Electrode Arrangement in TWT

Travelling Wave Tube (TWT)

Operation of Travelling Wave Tube

The anode plates, when at zero potential, which means when the axial electric field is at a node, the electron beam velocity remains unaffected. When the wave on the axial electric field is at positive anti node, the electron from the electron beam moves in the opposite direction. This electron being accelerated, tries to catch up with the late electron, which encounters the node of the RF axial field.

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At the point, where the RF axial field is at negative anti node, the electron referred earlier, tries to overtake due to the negative field effect. The electrons receive modulated velocity. As a cumulative result, a second wave is induced in the helix. The output becomes larger than the input and results in amplification.

Travelling Wave Tube (TWT)

Applications of Travelling Wave Tube:

There are many applications of a travelling wave tube.

1. TWT is used in microwave receivers as a low noise RF amplifier.
2. TWTs are also used in wide-band communication links and co-axial cables as repeater amplifiers or intermediate amplifiers to amplify low signals.
3. TWTs have a long tube life, due to which they are used as power output tubes in communication satellites.
4. Continuous wave high power TWTs are used in Troposcatter links, because of large power and large bandwidths, to scatter to large distances.
5. TWTs are used in high power pulsed radars and ground based radars.


Thank
you