He-Ne LASER

Introduction:

- The He-Ne Laser is a gaseous state 4-level laser and was fabricated by Javan, Bennett & Herriot in 1961.
- It is a continuous wave laser, which consists of a mixture of He & Ne in a 10:1 ratio.

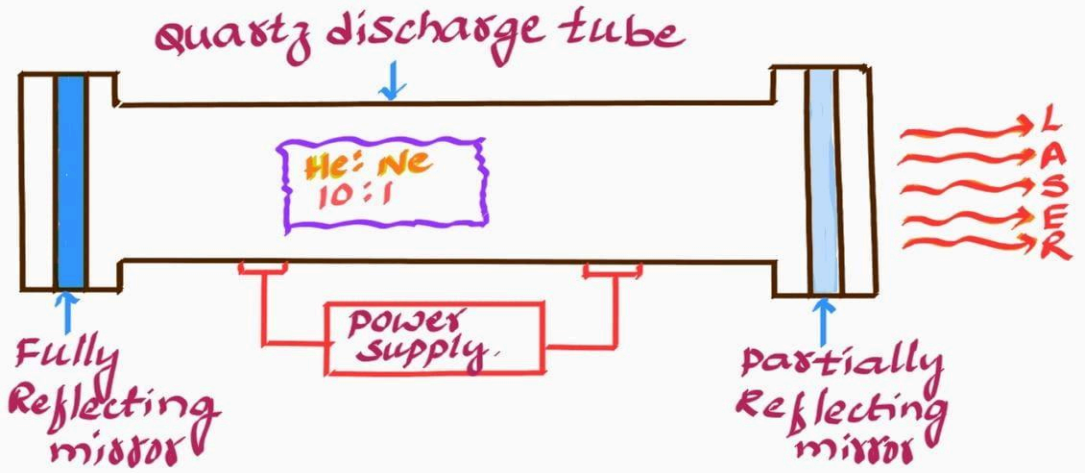
Principle:

- The principle of operation for the He-Ne laser is an electric discharge excited Helium atoms, which then transfer energy to Neon atoms through collisions, leading to population inversion and the emission of laser light at specific wavelengths

Main components:

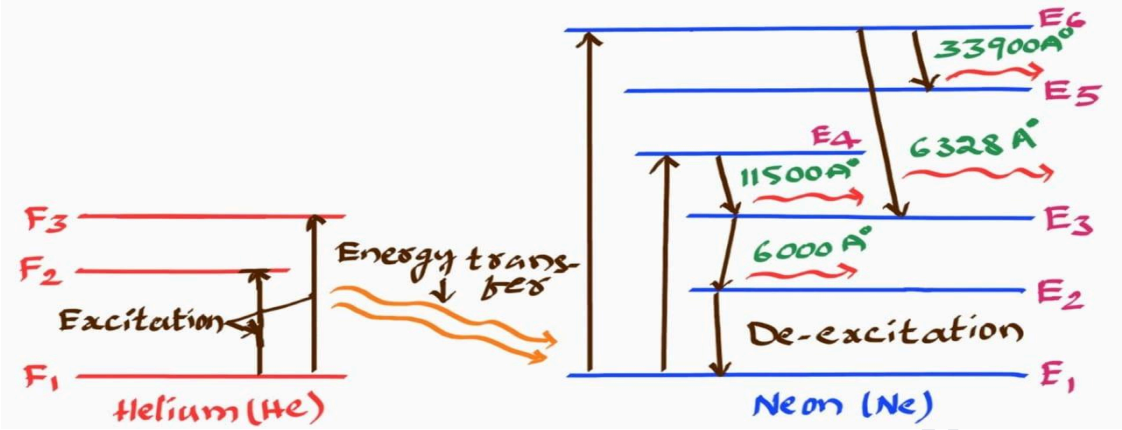
- **Active medium:** He & Ne gas mixtures.
- **Pumping source:** Power supply (1000V) or R.F. Generator.
- **Optical cavity**: Arrangement of Reflector
- **Pumping mechanism:** Electrical discharge.

Construction:



- The He-Ne Laser consists of a Quartz discharge tube with a length of 80cm and diameter of 1.5 cm.
- This tube is filled with a He-Ne gas mixture of 10:1 ratio and maintains low pressure of 0.1 mm of Hg for He and 1 mm of Hg for Ne.
- Energy source of a laser is provided by an electrical discharge of around 1000V through an anode and cathode at each end of the quartz discharge tube to excite the active medium.
- Two reflecting mirrors are fixed on either ends of the discharge tube, in that, one is partially reflecting, and the other is fully reflecting.
- The output of the laser depends upon the length of the discharge tube and the pressure of the gas mixture.

Working:



- When an electrical discharge of approximately 1000V is applied across the tube via electrodes to energize the gas mixture, the electrons accelerate towards the positive electrode.
- During their passage, accelerated electrons collide with He atoms, exciting them to higher energy levels F_2 and F_3 from F_1,where the lifetime of He atoms is longer (So there is a maximum possibility of energy transfer between He and Ne atoms through atomic collisions).
- When He atoms present in the levels F_2 & F_3 collide with Ne atoms present in the ground state (E_1), the Ne atoms get excited into higher levels E_4 and E_6.
- This continuous excitation of Ne atoms leads to population inversion between the higher levels (E_4 & E_6) and lower levels (E_3 & E_5).
- The transitions from E_6 to E_5 and E_4 to E_3 in Ne atoms result in the emission of infrared radiation with wavelengths 33900 Å and 11500 Å, respectively.
- While the transition from E_6 to E_3 in Ne atoms produces visible light with a wavelength of 6328 Å and the Ne atoms in the E_3 level can spontaneously emit photons of wavelength 6000 Å and transition to the E_2 level..
- Finally, the Ne atoms present in the E_2 collide with the walls of the discharge tube and get de-excited to ground state E_1.

Advantages/Merits:

- Operates without damage at high temperature.
- Highly stable characteristics.
- Economic) Cheaper & No cooling required.
- Light emission in visible regions.

Disadvantages/De-merits:

- Low efficiency
- Low gain
- Limited to low power tasks.
- Mirrors are eroded by the gas discharge.

Applications/Uses:

- Used to demonstrate optical experiments in laboratories.
- Most commonly used in Holography, surveying & alignments in metrology.
- Used to read barcodes and used in scanners for optical character recognition.
- Used in medical - dermatology.
- Used in Laser gyroscopes.
- Used in nano positioning of Semiconductor fabrication.
- Used in manufacturing of glass, plastic, microchips & printed circuit boards