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HELIUM-NEON LASER

Helium- Neon Laser is a type of gas laser in which a mixture of helium and neon gas is used as a gain medium.

GAS LASER

A gas laser is a type of laser in which a mixture of a gas is used as the active medium or laser medium. Gas lasers are most widely used lasers.

Gas lasers range from the low power helium-neon lasers to the very high power CO_2 lasers. The He-Ne lasers are most commonly used in college laboraties whereas the CO_2 lasers are used in industrial applicatims.

The main advantage of gas lasers over solid state lasers is that they are less prone to damage by overheating so they can be run continuously.

HELIUM-NEON LASER

Helium- Neon laser was the first continuous wave laser ever constructed.

In He-Ne laser, the optical pumping method is not used. Instead an electrical pumping method is used. The excitation of electrons in He-Ne gas active medium is achieved by passing an electric

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current through the gas.

* OPERATING WAVELENGTH

The helium-neon laser operates at a wavelength of 632.8 nm, in the red portion of the visible spectrum.

* HE-NE LASER CONSTRUCTION

The He-Ne laser consists of three essential components:

1. Pump Source (high voltage power supply)
2. Gain medium (laser glass tube or discharge glass tube)
3. Resonating Cavity

1. HIGH VOLTAGE POWER SUPPLY OR PUMP SOURCE

In order to produce the laser beam, it is essential to achieve population inversion. Population inversion is the process of achieving more electrons in the higher energy state as compared to the lower energy state.

In general, the lower energy state has more electrons than the higher energy state. However, after achieving population energy, more electrons will remain in higher energy state than in lower energy state.

In order to achieve population inversion, we need to supply energy to the gain medium or active medium.

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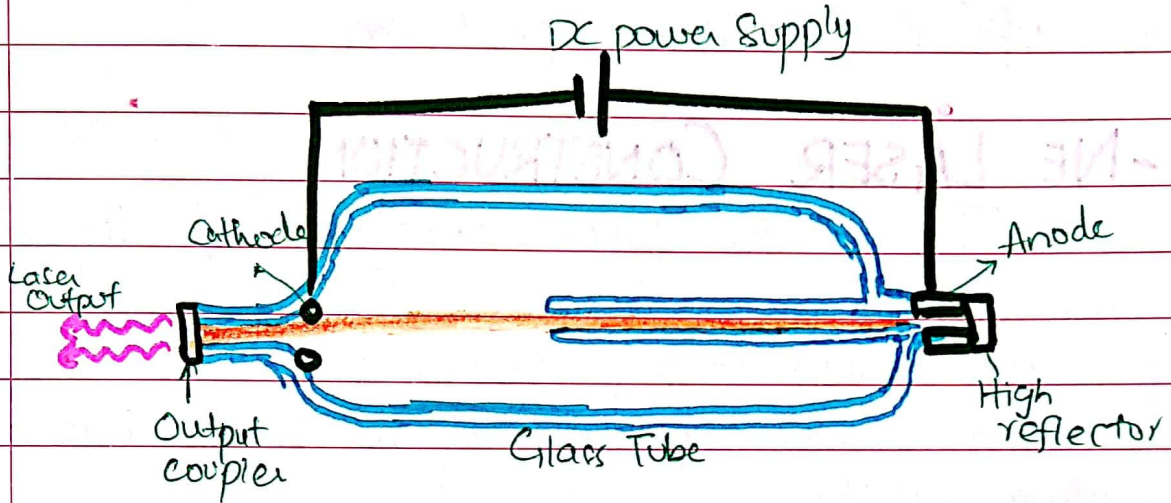
In helium-neon lasers, a high voltage DC ~~source~~ power supply as used as pump source. A high voltage DC supplies electric current through the gas mixture of helium and neon.



2. GAIN MEDIUM

The gain medium of a helium-neon laser is made up of the mixture of helium and neon gas contained in a glass tube at low pressure. The composition of helium is 85% while neon is 15%.

The gas mixture is mostly comprised of helium gas. Therefore, in order to achieve population inversion, we need to excited primarily the lower energy state electrons of the helium atoms.

In He-Ne laser, neon atoms are the active centers and have energy levels suitable for ~~the~~ laser transitions while helium atoms help in exciting neon atoms

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Electrodes are provided in the glass tube to send the electric current through the gas mixture. These electrodes are connected to a DC power supply.

3. RESONATING CAVITY

The glass tube (containing a mixture of helium and neon gas) is placed b·w two parallel mirrors. These two mirrors are silvered or optically coated.

Each mirror is silvered differently. One mirror is partially silvered and is known as output coupler whereas the other is fully silvered and is known as the high reflector or fully reflecting mirror.

The fully silvered mirror will completely reflect the light whereas the partially silvered mirror will reflect most part of the light but allows some part of the light to produce the laser beam.

WORKING OF HELIUM-NEON LASER

In order to achieve population inversion energy is supplied to the gain medium by connecting it with a high voltage DC source. A high voltage DC source produces energetic electrons that travel through the gas mixture.

The gas mixture is mostly comprised of helium atoms. Therefore, helium atoms absorb

most of the energy supplied by the high voltage DC.

In the process of flowing through the gas, the energetic electrons transfer some of their energy to the helium atoms in the gas. As a result, the lower energy state electrons of the helium atoms gain enough energy and jumps into the excited states or metastable state.

The metastable state electrons of the helium atoms cannot return to ground state by spontaneous emission. However, they can return to ground state by transferring their energy to the lower energy state electrons of the neon atoms.

The energy levels of some of the excited states of neon atoms are identical to the energy levels of metastable states of helium atoms.

Unlike the solid, a gas can move or flow between the electrodes. Hence, when the excited electrons of the helium atom collide with the lower energy state electrons of the neon atoms, they transfer their energy to the neon atoms. As a result, the lower energy state electrons of the neon atoms gain enough energy from the helium atoms and jumps into the higher energy states or metastable states, whereas the excited electrons of the helium atoms will fall into the ground state. Thus, helium atoms help neon atoms in achieving population inversion

Likewise, millions of ground state electrons of neon atoms are excited to the metastable state. The metastable states have the longer lifetime. Therefore, a large number of electrons will remain in the metastable states and hence population inversion is achieved.

~~The neon excited electrons~~

After some period, the metastable state electrons of the neon atoms will spontaneously fall into the next lower energy states by releasing photons or red light. This is called spontaneous emission.

The neon excited electrons continue on to the ground state through radiative and non radiative transitions. It is important for the continuous wave operation.

The light or photons emitted from the neon atoms will move back and forth b.w two mirrors until it stimulates other excited electrons of the neon atoms and causes them to emit light. Thus, optical gain is achieved. This process of photon emission is called stimulated emission of radiation.

The light or photons emitted due to stimulated emission will escape through the partially reflecting mirror or output coupler to produce laser light.