Wire cut EDM

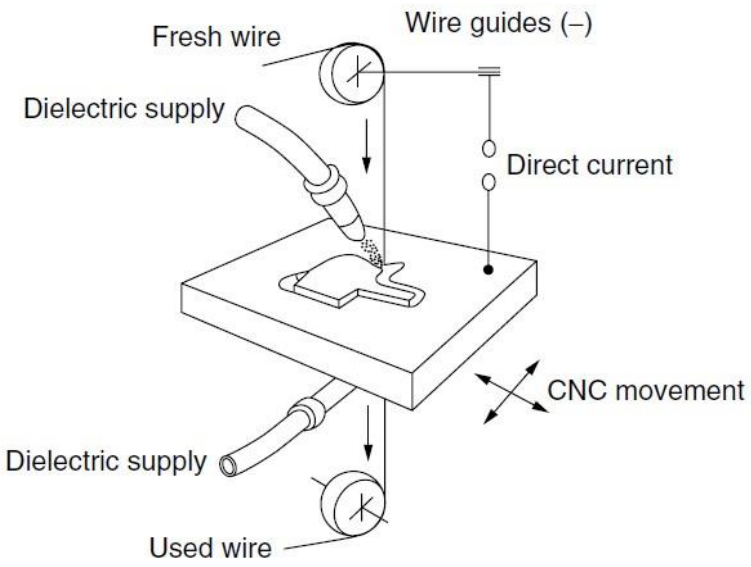
Wire cut EDM equipment, its working and applications

- The Wire Electric Discharge Machining (WEDM) is a variation of EDM and is commonly known as wire-cut EDM or wire cutting. In this process, a thin metallic wireisfed on-to the work piece, which is submerged in a tank of dielectric fluid such as deionized water. This process can also cut plates as thick as 300mm and is used for making punches, tools and dies from hard metals that are difficult to machine with other methods.

- The wire, which is constantly fed from a spool, is held between upper and lower diamond guides. The guides are usually CNC- controlled and move in the x-y plane.
- On most machines, the upper guide can move independently in thez-u-v axis, giving it a flexibility to cut tapered and transitioning shapes (example: square at the bottom and circle on the top). The upper guide can control axis movements in x-y-u-v-i-j-k-l-.Thishelps in programming the wire-cut EDM, for cutting very intricate and delicate shapes.
- In the wire-cut EDM process, water is commonly used as the dielectric fluid. Filters and de-ionizing units are used for controllingthe resistivity and other electrical properties. Wires made of brass

are generally preferred. The water helps in flushing away the debris from the cutting zone. The flushing also helps to determinethe feed rates to be given for different thickness of the materials.

- Wire EDM, involves the use of a continuously moving conductive wire as the tool electrode. The tensioned wire of copper, brass, tungsten, or molybdenum is used only once, travelling from a take-off spool to a take- up spool while being "guided" to produce a straight narrow kerf in plates up to 75 mm thick.
- The wire diameter ranges from 0.05 to 0.25 mm with positioning accuracy up to ± 0.005 mm in machines with NC. The dielectric is usually deionizedwater because of its low viscosity.



- This process is widely used for the manufacture of punches, dies, and stripper plates, with modern machines capable of routinely cutting die relief, intricate openings, tight radius contours, and corners.

Applications of Wire-Cut EDM

- Wire EDM is used for cutting aluminium, brass, copper, carbides, graphite, steels and titanium.
- The wire material varies with the application requirements. Example: for quicker cutting action, zinc-coated brass wires are used while for more accurate applications, molybdenum wires are used.

The process is used in the following areas:

- Aerospace, Medical, Electronics and Semiconductor applications
- Tool & Die making industries.
- For cutting the hard Extrusion Dies
- In making Fixtures, Gauges & Cams
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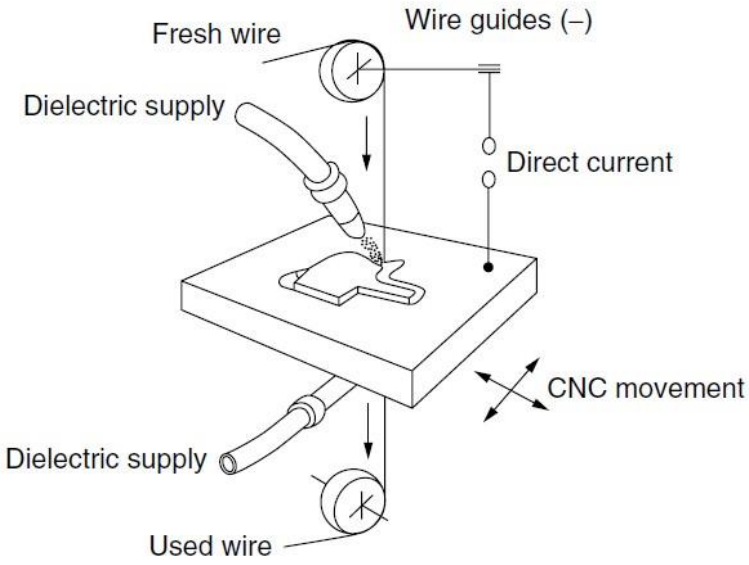

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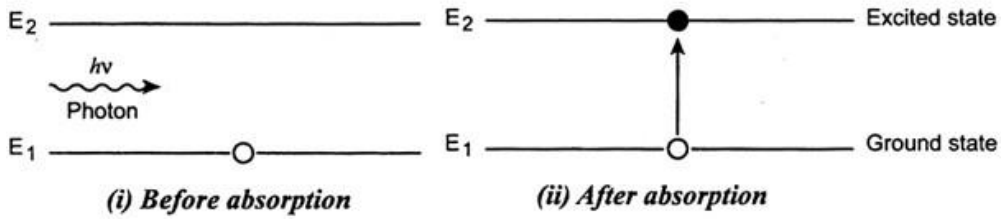
- For cutting the hard Extrusion Dies
- In making Fixtures, Gauges & Cams
- Cutting of Gears, Strippers, Punches and Dies
- Manufacturing hard Electrodes.
- Manufacturing micro-tooling for Micro-EDM, Micro-USM and such other micromachining.

LASER BEAM MACHINING (LBM)

'LASER" which means "Light Amplification by Stimulated Emission of Radiation". It produces a powerful, monochromatic, collimated beam of light in which the waves are coherent.

Laser works on the principle of quantum theory of radiation.

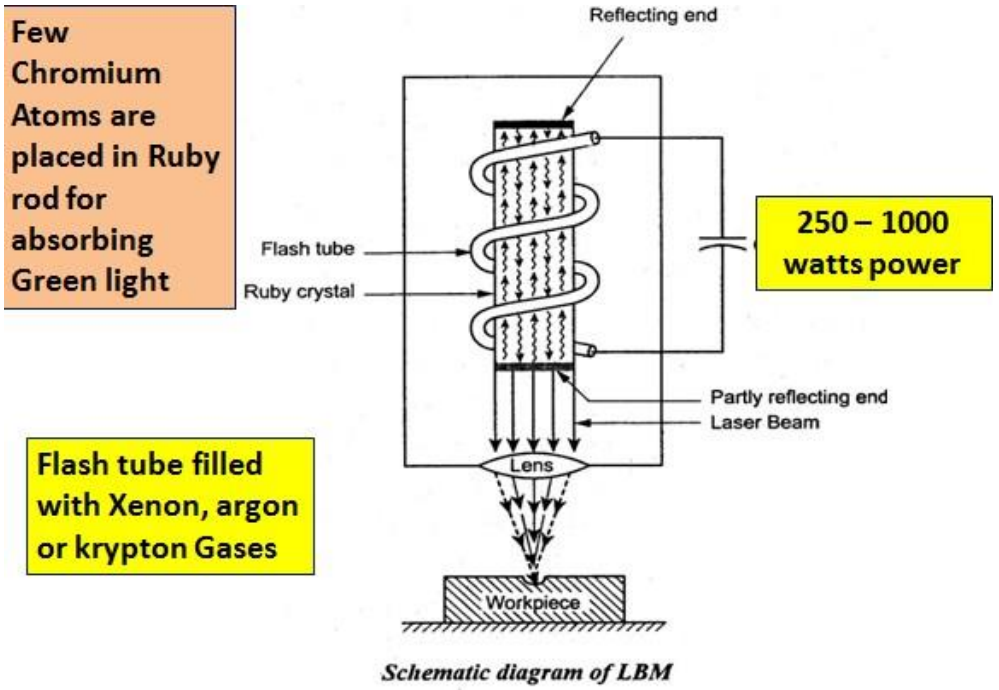
Consider an atom in the ground state or lower energy state (E_1) when the light radiation falls on the atom, it absorbs a photon of energy $h\nu$ and goes to the excited state (E_2).



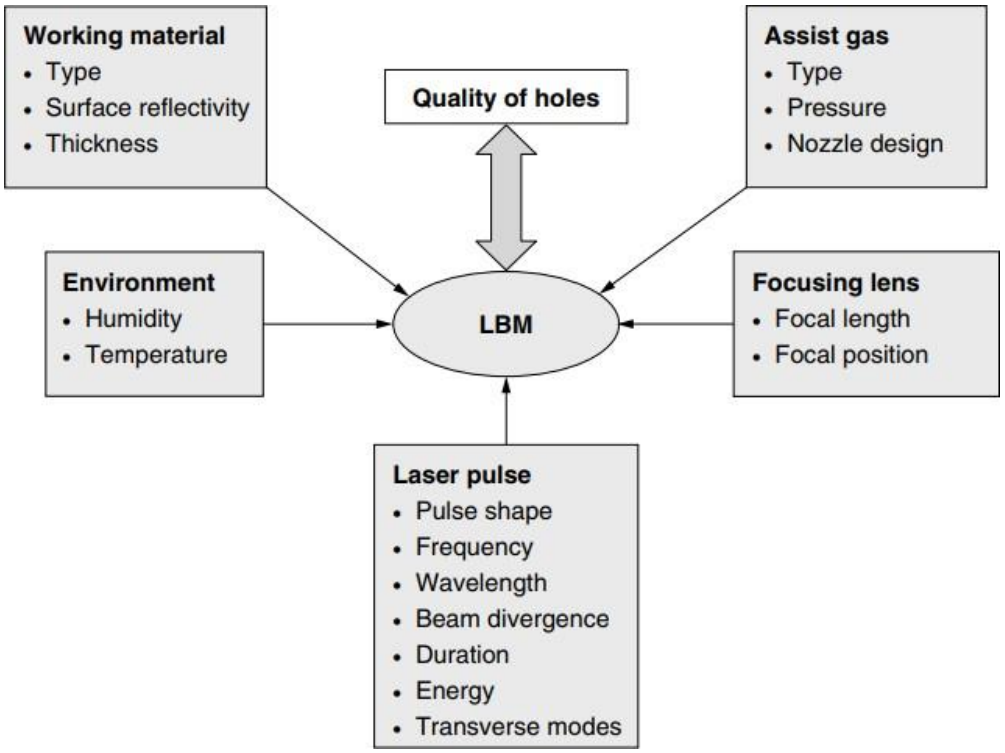
(i) Before absorption *(ii) After absorption*

Normally, the atoms in the excited state will not stay there for a long time. It comes to the ground state by emitting a photon of energy $E = h\nu$. Such an emission takes place by one of the following two methods.

1. Spontaneous Emission
2. Stimulated Emission



Schematic diagram of LBM



Working

A flash light of 1000watts wound around the ruby rod as shown in figure. When a switch is ON the light energy from the flash tube passed into the ruby rod and it triggers the chromium atom in the rod. So theexcited atoms emit photons. These photons are reflected so many times due t the presence of mirror arrangement in the construction. Due to this a powerful coherent beam of red light is obtained. This red light is focused on work piece through converging lenses. So this red light heat and vaporise the pointed metal portion in the work piece. Likewise the machining continued.

TYPES OF LASER

1. Gas lasers
2. Solid lasers
3. Liquid lasers
4. Semi Conductor lasers

SOLID STATE LASER

Ruby laser, the Neodymium doped Yitrium-Aluminium-Garnet (Nd-YAG) laser, and the Neodymium-doped glass laser (Nd-glass) are examples of solid state lasers. The most commonly used solid state laser is ruby laser.

GAS LASER

The main advantage of gas laser is, it can be operated continuously. The gas laser produce exceptionally a high monochromaticity and high stability of frequency. The output of the laser can be changed to a certain available wavelength. So, the gas lasers are widely used in industries.

Examples : Carbon dioxide (CO_2) laser

Helium-Neon (He-Ne) laser

SEMICONDUCTOR LASER

Lasing action can also be produced in semi-conductors. The most compact type of laser is semiconductor laser. It is also known as injection laser. In its simplest form, the diode laser consists of a *p-n* junction doped in a single crystal of a suitable semi-conductor.

Example : Gallium-arsenide.

Applications of Laser

Laser in Metal Cutting

1. Laser in Drilling
2. Laser in Welding
3. Laser in Surface Treatment
4. Trimming
5. Blanking
6. Micromachining applications

Laser in Surface Treatment

- A thin layer of cobalt alloy coating is applied on Turbine blade for heat and Wear Resistance.

- A thin Ceramic coating is applied on metal Surface for heat and Wear Resistance.
- It's also used to seal the micro cracks which are usually present in hard - Chromium electroplates

Advantages of LBM

1. All Kind of metals are machined, Micro holes are possible
2. Soft materials like rubber can be machined
3. No tool wear and contact with w/p
4. Automated process, Controlling of beam is easy

Disadvantages of LBM

1. High initial Cost, Operating cost is high
2. Required skilled labours
3. Rate of production is low
4. Need safety equipments, Life of flash lamp is low
5. The machined holes are not straight and round

PLASMA ARC MACHINING (OR) PLASMA JET MACHINING

Introduction

When a gas is heated to a sufficiently high temperature of the order of 11000 - 28000 degree Celsius, itbecomes partially ionized it's known as PLASMA.

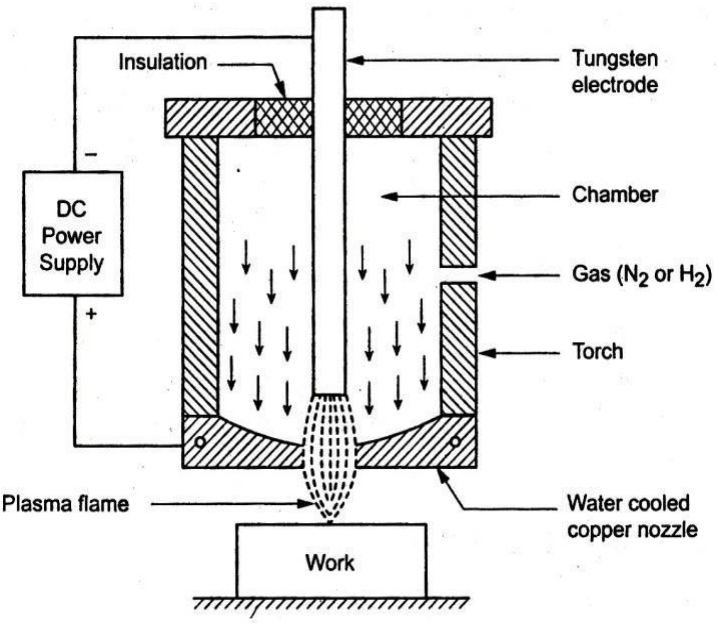
PLASMA

It's a mixture of free electrons + partiallyionized gas and Neutral Atoms

Working Principle

The material is removed by directing a high velocity jet of high temperature (11000°C - 28000°C) ionized gas on the work piece. This hightemperature plasma jet melts the material of the work piece.

In plasma machining a continuous arc is generated between a hot tungsten cathode and the water-cooled copper anode. A gas is introduced around the cathode and flows through the anode.



Schematic arrangement of PAM

The temperature, in the narrow orifice around the cathode, reaches 28,000°C, which is enough to produce a high-temperature plasma arc. Under these conditions, the metal being machined is very rapidly melted and vaporized. The stream of ionized gases flushes away the machining debris as a fine spray creating flow lines on the machined surface.

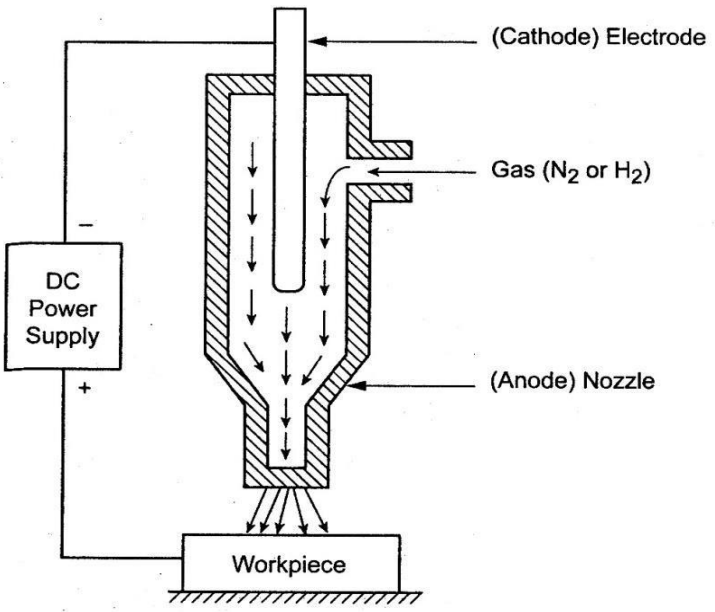
Types of Torches

1. Direct arc plasma torches (or) Transferred arc type.
2. Indirect arc plasma torches (or) Non-transferred arc type.

S.No.	Gas or Gas Mixture	Material to be machined
1.	Nitrogen – Hydrogen, Argon – Hydrogen	Stainless steel and non-ferrous metals.
2.	Nitrogen – Hydrogen, compressed air	Carbon and alloy steels, cast iron.
3.	Nitrogen, Nitrogen – Hydrogen, Argon – Hydrogen	Aluminium, Magnesium

Direct Arc Plasma Torch

- The arc is formed between the electrode(-) and the work piece(+).In other words, arc is transferred from the electrode to the work piece.A transferred arc possesses high energy density and plasma jet velocity. For this reason it is employed to cut and melt metals. Besides carbon steels this process can cut stainless steel and nonferrous metals also where oxyacetylene torch does not succeed. Transferred arc can also be used for welding at high arc travel speeds.



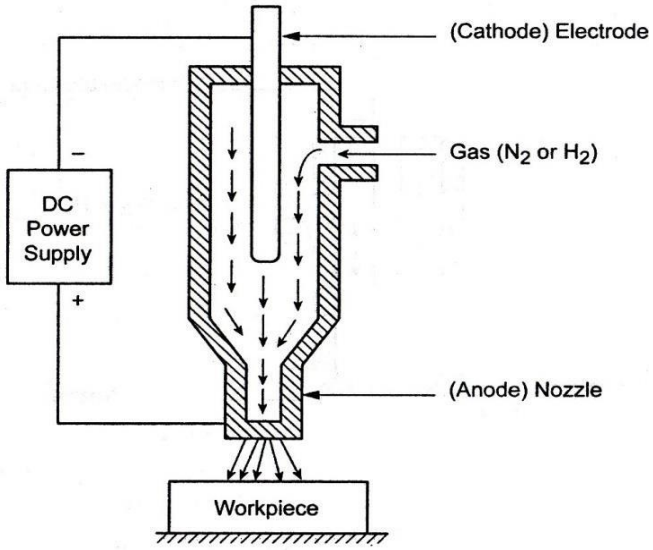
Direct arc plasma torch

A pilot arc is established between the electrode and the nozzle. As the pilot arc touches the job main current starts flowing between electrode and job, thus igniting the transferred arc. The pilot arc

initiating unit gets disconnected and pilot arc extinguishes as soon as the arc between the electrode and the job is started. The temperature of a constricted plasma arc may be of the order of 8000 - 25000^{0}C.

In-Direct Arc Plasma Torch

- The arc is formed between the electrode(-) and the water cooled nozzle(+).
- Arc plasma comes out of the nozzle a
- The arc is independent of the work piece and the work piece does not form a part of the electrical circuit. Just like an arc flame (as in atomic hydrogen welding), it can be moved from one place to another and can be better controlled. The non transferred plasma arc possesses comparatively less energy density as compared to transferred arc plasma and it is



Indirect arc plasma torch

employed for welding and in applications involving ceramics or metal plating (spraying). High density metal coatings can be produced by this process. A non-transferred arc is initiated by using a high frequency unit in the circuit.