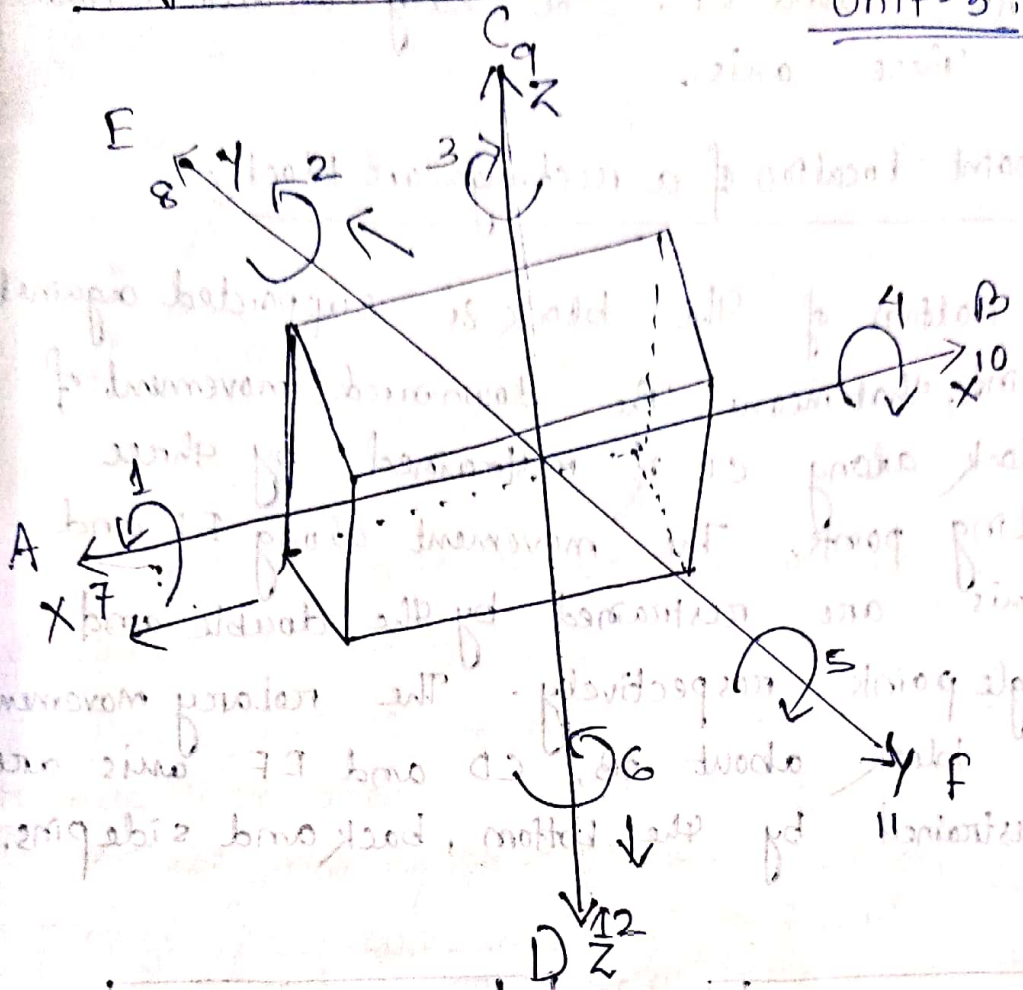
Degrees of freedom:-



An unrestricted object is free to move in any of twelve possible directions and have twelve degrees of freedom.

Principle of Location:-

The term location refers to establish a definite relationship between the workpiece and the cutting tool or jig or fixture.

→ The function of location is done by locators and the movement of part is restricted by clamps.

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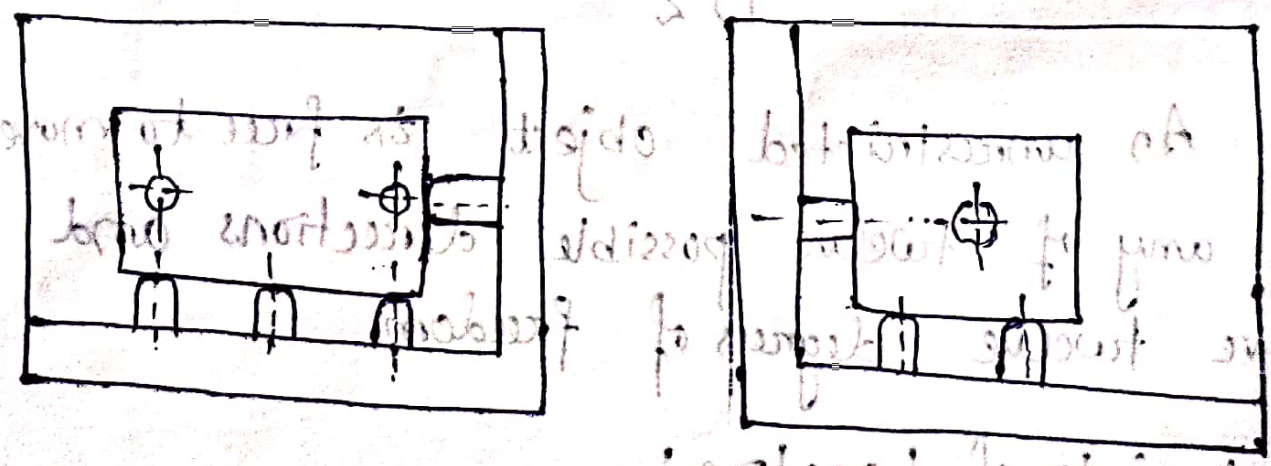
A rectangular block is free to move along the axis AB, CD and EF. The body can also rotate about these axis.

Six point location of a rectangular block:-

The bottom of the block is supported against three points, that means the downward movement of the block along CD is restrained by three supporting points. The movement along EF and AB axis are restrained by the double and the single points respectively. The rotary movement of the block about AB, CD and EF axis are also restrained by the bottom, back and side pins.



The six points thus serve to locate a block correctly while restraining all its movement.

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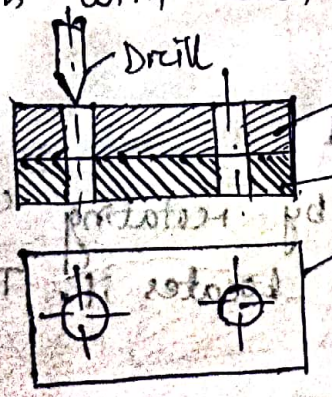
Types of Jigs:-

(i) Template Jig
(ii) Plate Jig
(iii) Diameter jig
(iv) Box jig.

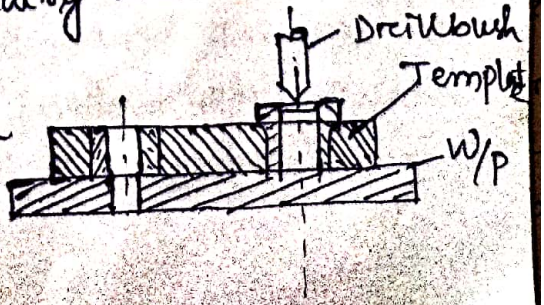
(i) Template Jig:-

→ Template jig is the least expensive and simplest type of jig to use.
→ This type of jig is normally used for accuracy rather than speed.
→ A plate having holes at the desired positions serves as template which is fixed on the component to be drilled. The drill is guided through these holes of the template and the required holes are drilled on the workpiece at the relative positions with each other as on the template.



(ii) Plate jig:-

A plate jig is an improvement of the template jig by incorporating drill bushes on the template.
→ The plate jigs are employed to drill holes on large parts maintaining accurate spacing with each other.



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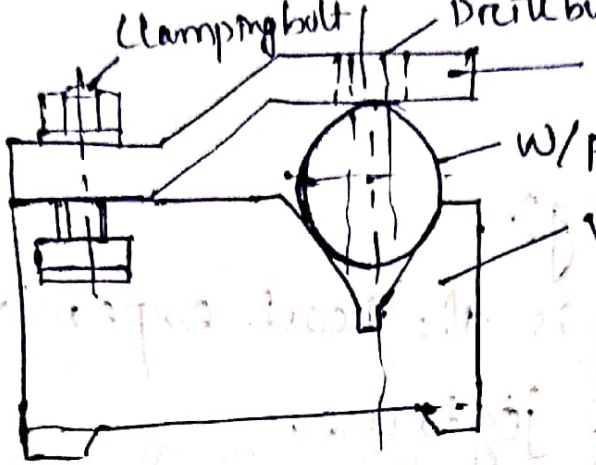
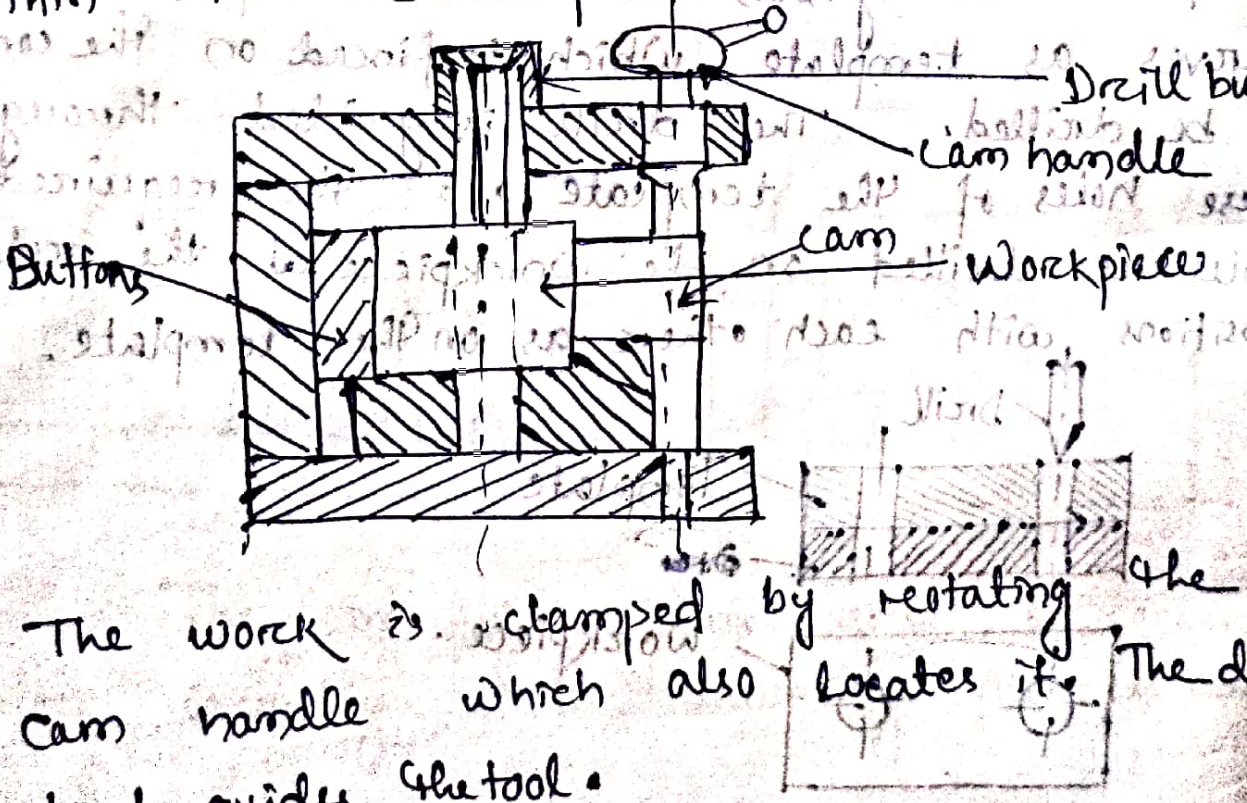
(iii) Diameter Jig:- The diameter jig is used to drill radial holes on a cylindrical or spherical work-pieces. The work is placed on the fixed V-block and then clamped by the clamping plate which also locates the work. The tool is guided through the drill bush which is said radially with the work.



(iv) Box jig:- It is a box like construction within which the components is located & the buttons.



The work is clamped by rotating the cam handle which also locates it. The drill bush guides the tool.

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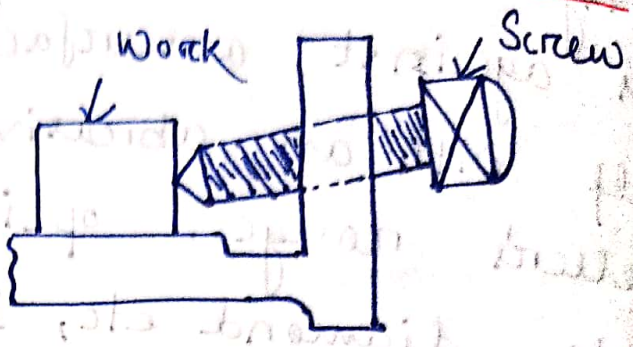
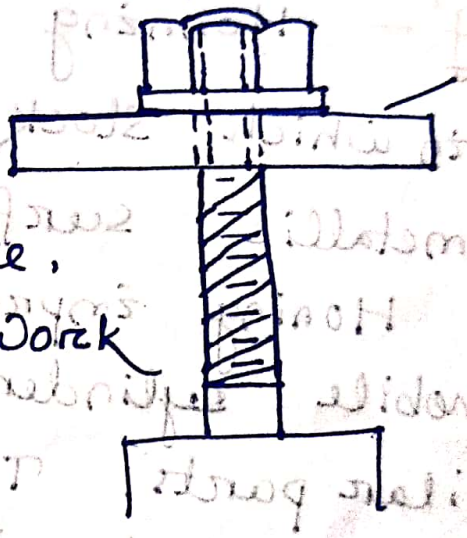
Different types of clamps & clamping devices :-

1. Screw clamp :-



The screw clamp is used to grip the work on its edges. This type of clamp is not able to restrict the workpiece from the top surface

2. Flat clamp :-



The flat clamp supports the work by the clamp face, which is pressed against the work by tightening the nut.

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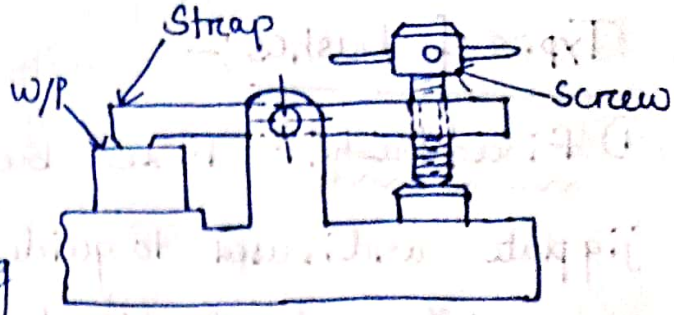
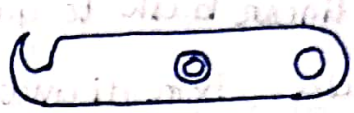
3. Pivoted clamp:-



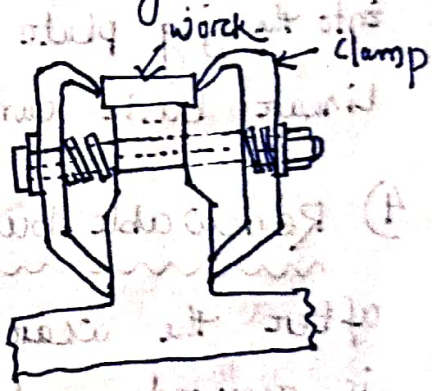
The pivoted clamp eliminated the use of spanner for clamping purposes. The work can be gripped quickly by rotating the screw, which actuates a pivoted clamp on the face of the work.

4. Swing plate clamp:-



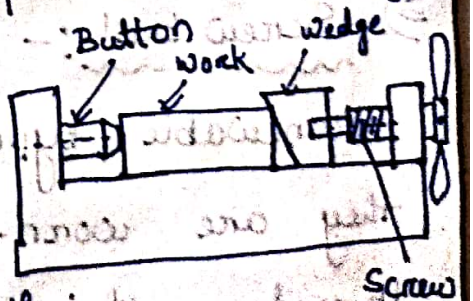
The swing plate clamps are employed for quick loading and unloading purposes for light jobs. The clamp is operated by swining the plate in position and locking it by turning screw which passes through its centre.

5. Double acting clamp:-



The double acting clamp is employed to grip the work by rotating the central screw, which actuates the two clamps placed at the two sides of the work to operate simultaneously.

6. Wedge clamp:- The wedge clamp is employed to grip the work by wedge block which is made to slide by rotating the screw. The wedge block grips the work against the fixed button fitted on the other end of the jig body.



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Types of bushes :-

1) Fixed bush :- Fixed bush directly fits into the jig plate and is used to guide the tool. The bush can guide only one tool and the life of the jig and the life of the bush is estimated to be same.

2) Slip bush :- Slip bush is commonly used in conjuction with linear bush to guide the tool. The slip bushes having variable bore diameters are fitted on a linear bush to receive two or more tools through the same hole of the jig body.

3) Linear bush :- The linear bush fits permanently into the jig plate and receives the slip bush. The Linear bush can also guide a tool independently.

4) Renewable bush :- These type of bushes are replaced after the wear due to usage. A retaining screw is removed and the worn-out bush is taken out.

5) Screw bush :- These type of bushes are also renewable type. They are replaced as and when they are worn-out. This type of buses contain threads on their outer diameter and can be easily removed and replaced.

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9.0-Information of Non Conventional Machining

Chemical Etching:-

Chemical etching is a high precision subtractive manufacturing process that uses baths of temperature regulated etching chemicals to selectively remove material to produce high precision metal parts in any desired shape.

Compared to other micro manufacturing techniques ~~techinig~~ techniques such as Stamping, EDM, CNC, LBM, Chemical Etching is more cost efficient with shorter lead time, more design flexibility, and no need for deburring.

Chemical etching materials:-

- Stainlesssteel
- Mild steel, Carbonsteel, Tool steel, Springsteel
- Aluminium.
- Molybedenum.
- Nickel Alloys
- Copper
- Brass etc.

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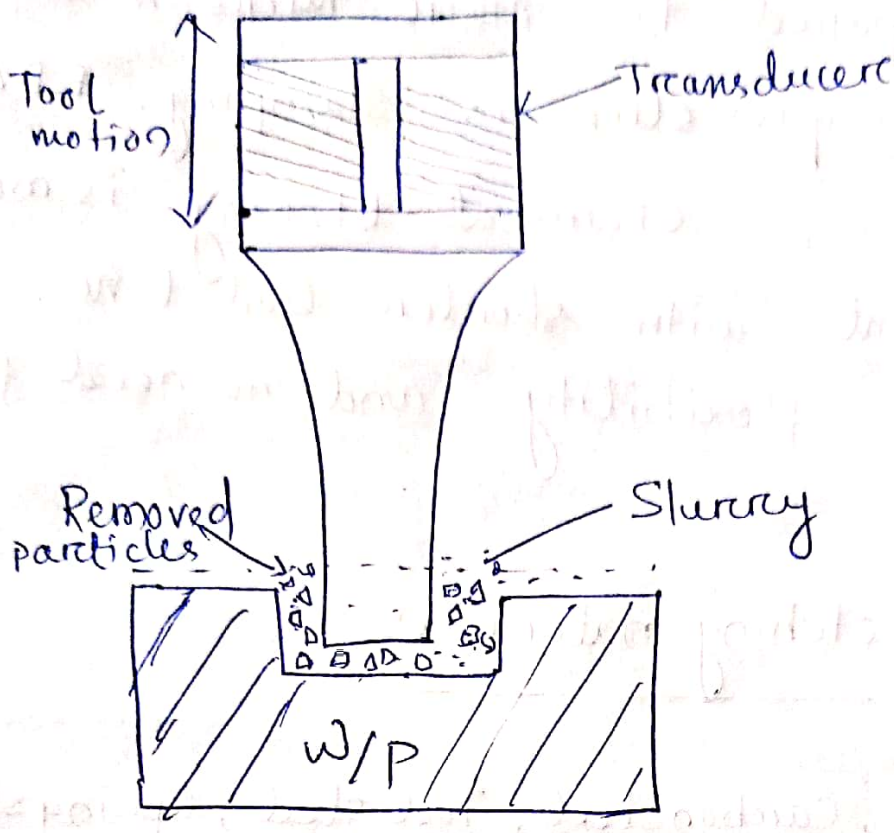
Ultrasonic Machining:—



Ultrasonic machining is a manufacturing process that removes material from the surface of a part through high frequency, low amplitude vibrations of a tool against the material surface in the presence of fine abrasive particles. The tool travels vertically or orthogonal to the surface of the part at amplitudes of 0.05 to 0.125mm. The fine abrasive grains are mixed with water to form a slurry. It is used on brittle materials as well as materials with a high hardness due to the microcracking mechanics.

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Electro discharge machining (EDM)

Electro discharge machining is also known as spark erosion, electro-erosion machining process.

Equipment required for EDM Process

1. DC Power supply (0.5 - 400 Amp current, 40 - 300 Volt. Voltage)

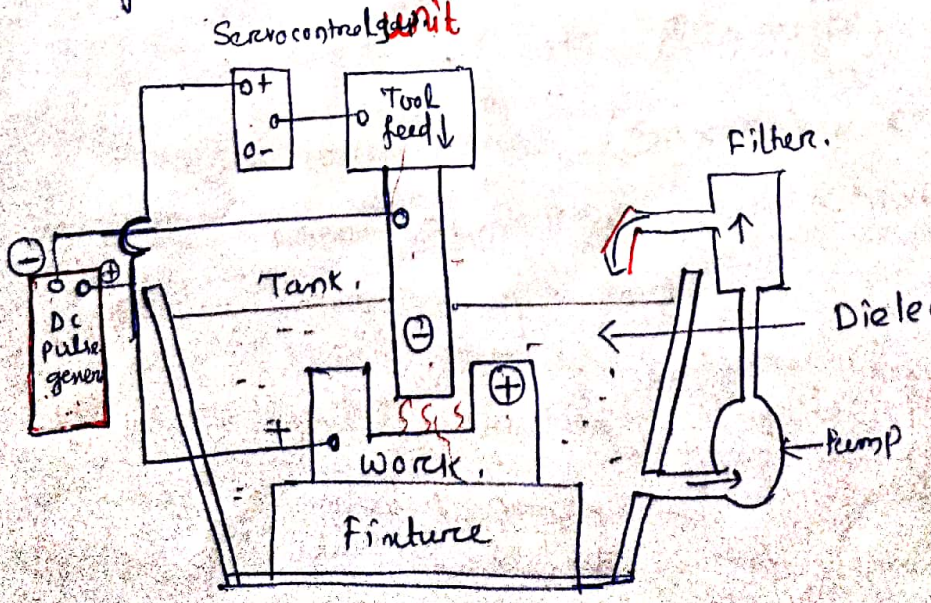
2. Tool holding electrode.

Normally made up copper, tungsten & graphite alloy. The shape of the electrode or tool is the same as that of the part desired.

3. A servomechanism (Drive unit) :- To control the movement of the electrode to maintain the correct distance ~~between~~ between the w/p & the tool.

4. A coolent :- a light mineral oil, that forms a dielectric (non-conducting) barrier between the electrode and the work gap.

The gap is about (0.025mm).



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When the voltage across the gap reaches a point sufficient to cause the dielectric to break down, a spark occurs. Temperatures around 10,000°C and pressures many thousand times greater than atmospheric are created, all in less than one microsecond for each spark. Each spark erases a minute piece of metal from the workpiece, but as the sparking occurs 20,000 to 30,000 times per second, appreciable quantities of metals are removed.

Advantages

1. Hard & tough metals can be machined with better surface finish.
2. Complex and Internal shapes can be machined.
3. No cutting force between metal w/p & tool.
4. Tolerance upto 0.4 micrometer is achieved.

Disadvantages

1. Low MRR
2. The w/p must be electric conductor.
3. Machining time is too long.
4. Specific power conjumption is too high.

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Plasma Arc Machining (PAM)

Plasma arc machining is done with a high velocity jet of high temp. ionized gas known as plasma.

→ Plasma is the fourth state of matter. When heated at temperatures above about 5500°c, gases are partially ionized and exist as plasma. A plasma is a mixture of free electrons, positively charged ions and highly ~~exic~~ excited neutral atoms of the gas.

→ As the plasma temp is extreamly high so it does not depend on chemical reaction.

→ It is used for profile cutting of stainless steel and aluminium alloys. Also used in magnesium, titanium, copper, nickel and alloys of copper and nickel.

Plasma Cutting Equipment

1) A Cutting torch :- It may be manually operated or M/c operated. It consists of electrode holder & the tip of the electrode is located within a nozzle. Plasma gas is injected into the torch around the electrode and exists through the nozzle orifice. The electrode & nozzle are water-cooled

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2) Gas cylinders, regulators, flow-meters & gas supply hoses.

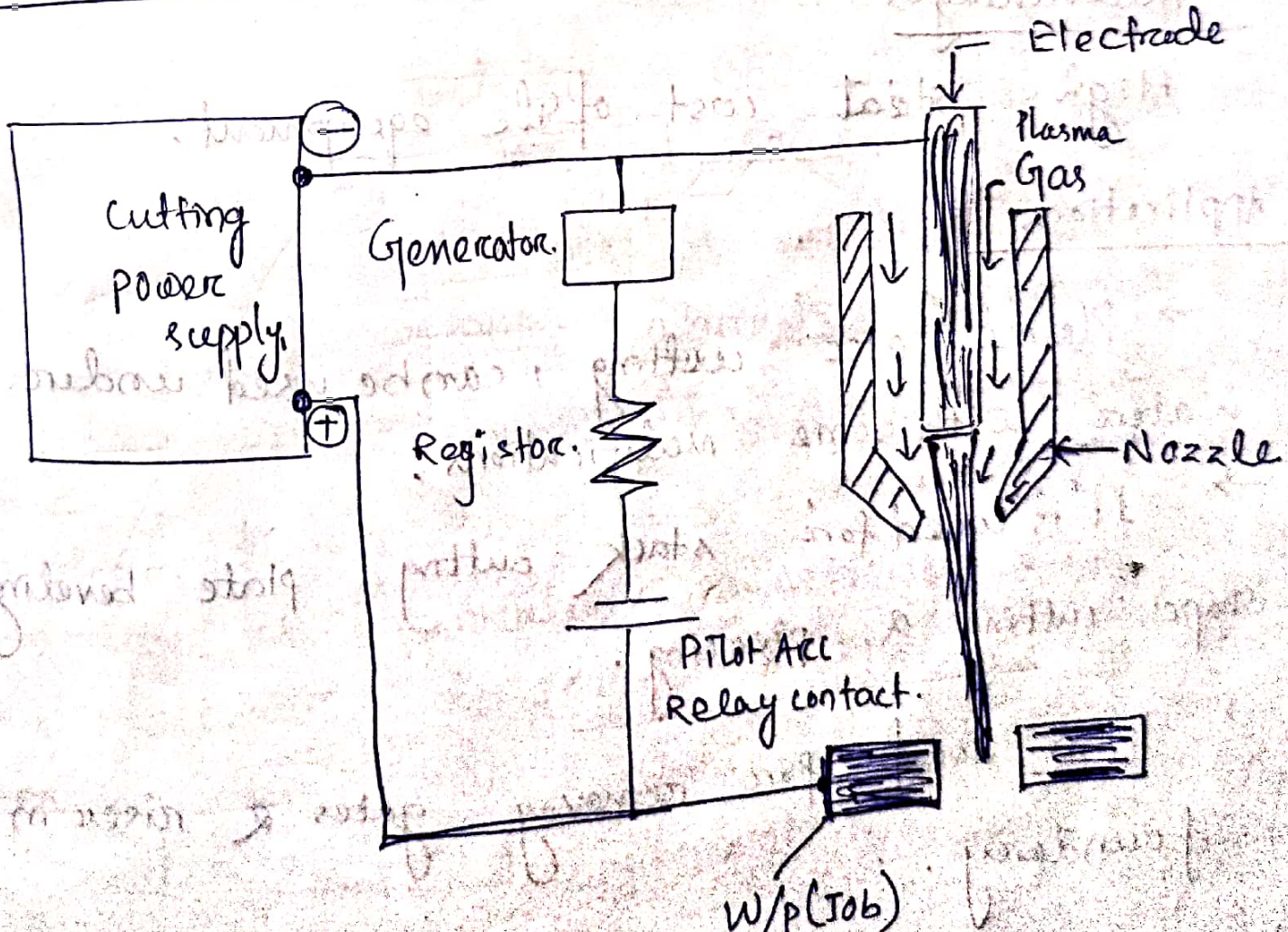
3) Power source – voltage 100 to 400 volts
current 250 to 1000 Amps

4) Pilot arc and high frequency power source circuit.

5) A system to circulate cooling water.

6) Controls

Principle of operation



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Advantages

(i) It cuts carbon steel up to 10 times faster than oxy-fuel cutting.

(ii) It leaves a narrower kerf.

(iii) Plasma cutting being primarily a melting process, can cut any metal.

~~(iv)~~

Disadvantages

High initial cost of the equipment.

Applications:

→ Plasma arc cutting, can be used under water with some modifications,

→ It is used for stack cutting, plate beveling, shape cutting & piercing.

→ It is used for removing gates & risers in foundary.

→ It cuts hot extrusions to desired lengths.

→ It is used to cut any desired pipe contour.

→ It is also employed for gauging application

→ It is used in industries such as shipyard, chemical, nuclear & pressure vessel.

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LASER BEAM MACHINING (LBM)

LASER – "Light Amplification by Stimulated Emission of Radiation".

The energy of the laser beam is concentrated onto a small area, causing the material to vapourise.

Principle of operations :-

Two types of lasers are commonly use
→ Solid laser
→ Gas laser

Solid lasers are only capable of providing short bursts of power; where as gas lasers produce a continuous laser beam.

Solid lasers suitable to production work. A neodiymium doped glass rod used as the lasing medium. The rod ends are finished as optical surfaces with reflective coatings. One end has a partially reflective coating to permit escape of the laser beam when it has reached the required intensity.

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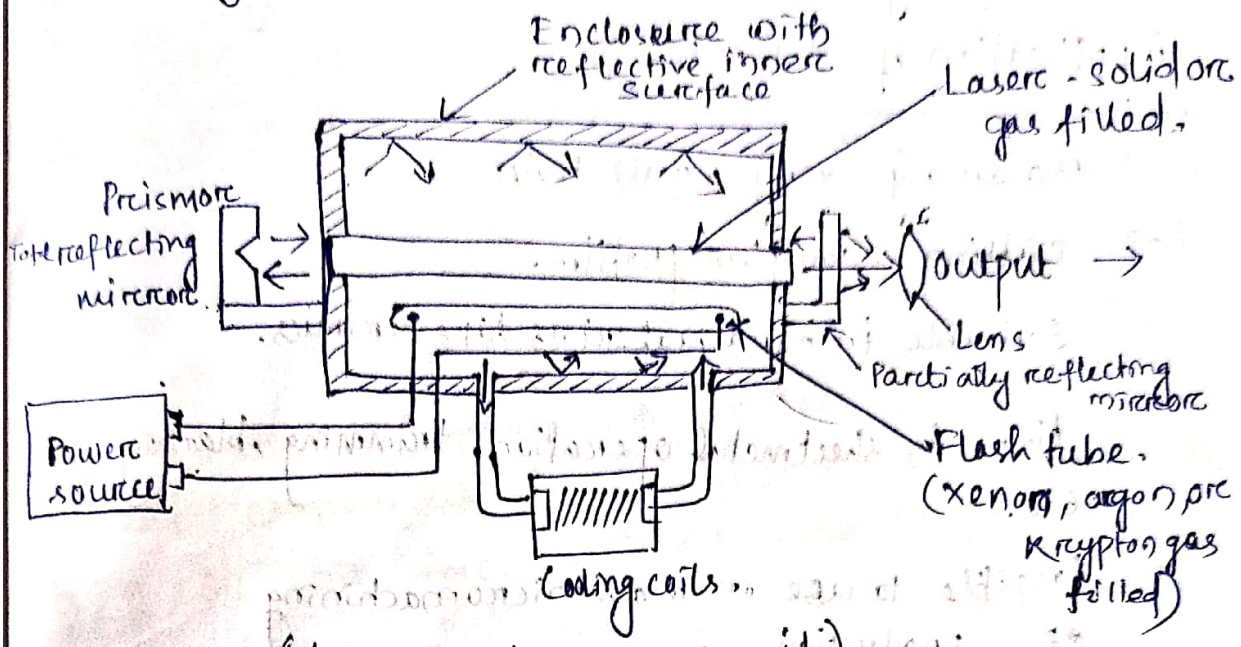
The Laser rod is initially excited by a high intensity flash lamp.



(A basic Laser circuit)

A basic laser circuit consists of three parts:

(1) a pair of mirrors;

(2) a source of energy

(3) an optical amplifier. (Laser) (Increases the light intensity)

These basic parts must be added a control system and a cooling system.

When lamp gives light to the crystal rod, it amplify and highly reflecting inside the cylinder. Flash lamp give maximum light to the rod so that as much energy as possible can be absorbed by the laser material. The chromium atoms in the ruby are excited to high energy levels. This excited atoms emits energy (Photons) when they return to the normal state. In this way very high energy is obtained in short pulses. This light passes through the partial reflecting mirror and focused in a small spot of light by the help of focusing lens.

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This spot provide enough heat to melt and vaporize any of the known material.

Application of LBM:-

→ Machining very small holes
→ cutting complex profiles.
→ Suitable in hard materials like ceramics.
→ Also in sheetmetal operation, trimming, blanking etc.
→ Possible to use in mass micromachining of production.

Advantages

→ No direct contact between tool & w/p.
→ Machining of any material including non metals also.
→ Heat affected zone is small.
→ Extremely small holes can be machined.
→ Soft materials like rubber & plastics can be machined.

Limitations

→ Overall efficiency is extremely low.
→ Process is limited to thin sheets.
→ Low material removal rate.
→ Cost is high.
→ Machined holes are not round & straight

Abrasive Jet Machining (AJM)

Abrasive jet machining is a process that removes material by directing a high velocity stream of abrasive particles on to a workpiece. AJM cuts materials, uses smaller size abrasive particles. AJM is used chiefly to cut materials that are sensitive to heat damage and thin sections of hard materials.

Principle of Operation :—

Abrasive particles are feed from the hopper into the mixing chamber. High pressure air or gas under pressure is supplied to the mixing Chamber containg the abrasive powder and Vibrating at 50 c/s. The abrasive stream is directed to the workpiece locations by a nozzle, which may be manually positioned or mounted in a specially designed fixture for automatic operation. Since the abrasive particles are very small, material removal is very slow.

Elements of Abrasive Jet Machining :—

There are three ~~element~~ elements of AJM

(1) Nozzle :
- Geometry
- Material
- Distance from workpiece
- Inclination to work surface

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2) Abrasive
- Type
- Size
- Shape
- Flowrate

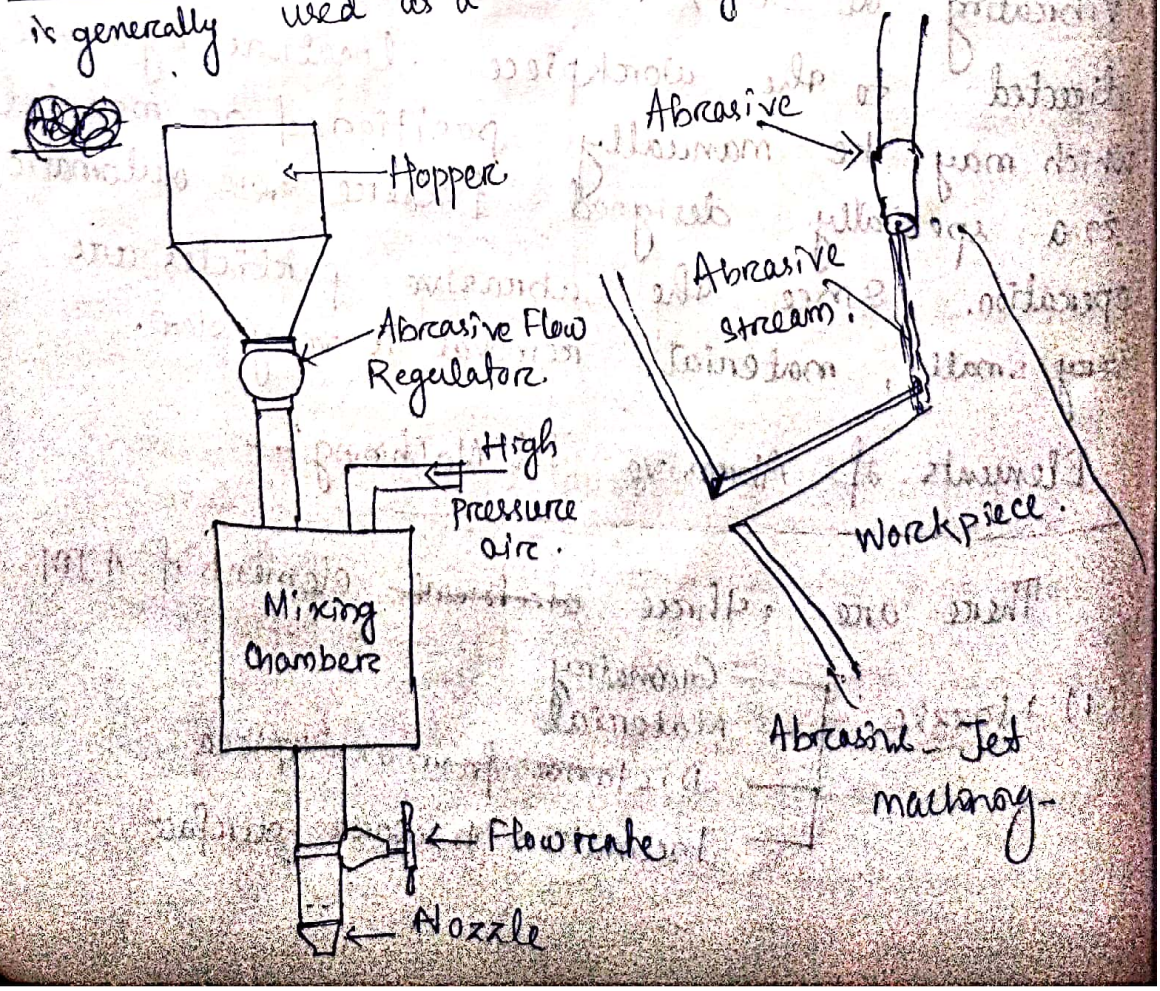
3) Carrier gas
- Type
- Pressure
- velocity.

The above mentioned three elements of AJM influence
a) Material removal rate in AJM
b) Geometry of cut
c) Surface roughness, and
d) Nozzle wear rate.

Nozzle - (i) Tungsten carbide or
(ii) Synthetic sapphire

Abrasive:- Aluminium oxide, silicon carbide, Dolomite, glass beads, sodium bicarbonate

carriergas:- Air, nitrogen or carbon-di-oxide is generally used as a carrier gas.



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Applications of AJM

(i) Abrading and frosting glass.

(ii) Cleaning

(iii) Cutting fine lines

(iv) Machining semiconductors such as germanium, gallium etc.

(v) Cutting and etching quartz, sapphire, etc.

(vi) Drilling and cutting thin sections of hardened metal.

(vii) Removing plating, anodic or thermal oxide coatings.

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