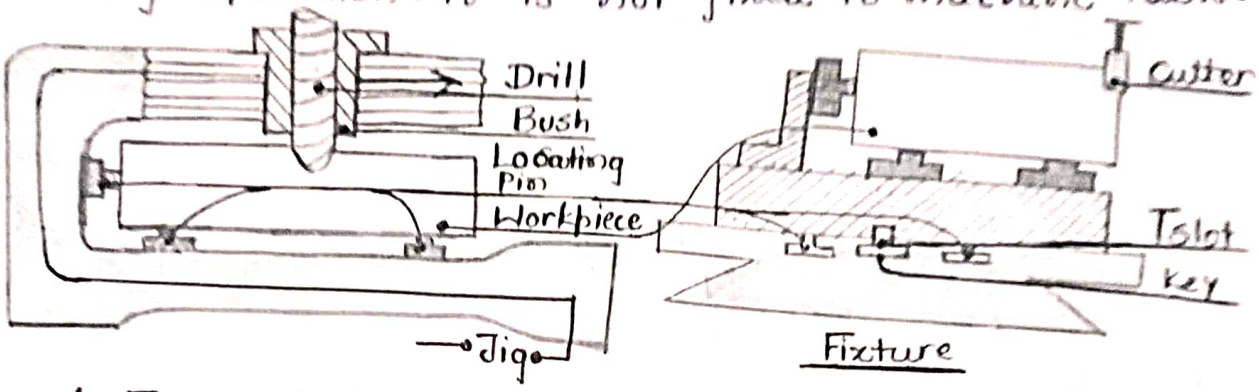
Advance Manufacturing Process (2025603)

UNIT-1 Jigs And Fixtures

Jig: A jig is defined as a device which is used to hold the workpiece as well as guide the cutting tool during machining operation. It is not fixed to machine table.



Fixture: Fixture is a work holding device which only hold the workpiece. It is bolted to the machine table.

Advantages of Jig & Fixture;

1. It eliminate the process of marking and measuring before machining operation.
2. It increases machining accuracy.
3. It enables mass production of similar parts.
4. It reduces operate effort.
5. It reduces cost of manufacturing.
6. It increases production rate.
7. It makes possible to have an unskilled labour perform the operation.

Difference between Jig and Fixture;

Jig	Fixture
1. It hold the workpiece as well as guide cutting tool.	1. It is used to hold workpiece only.
2. Jigs are made lighter for quick handling.	2. Fixture are heavy in construction.

3. Jigs do not needed to clamp the jig on the table.	3. It needed to be clamp on the table.
4. Jigs are commonly used for drilling, boaring reaming and taping operation.	4. Fixtures are commonly used for milling, grinding, planning and turning operation.

Types of Jigs

Depending upon the operation for which a jig is used it is broadly classified as

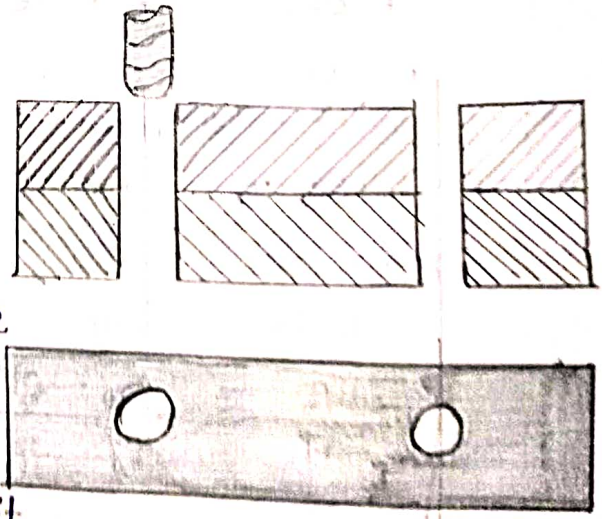
1. Drilling Jig
2. Boring Jig

Drilling Jig

It is used in many operation like drilling, reaming, countersinking, counterboring, tapping etc.
There are many types of drilling jig which are asfollowll;

1. Templet Jig
2. Plate Jig
3. Box & Handle jig
4. Leaf Jig
5. Indexing Jig
6. Universal Jig
7. Vice jig.

Templet Jig

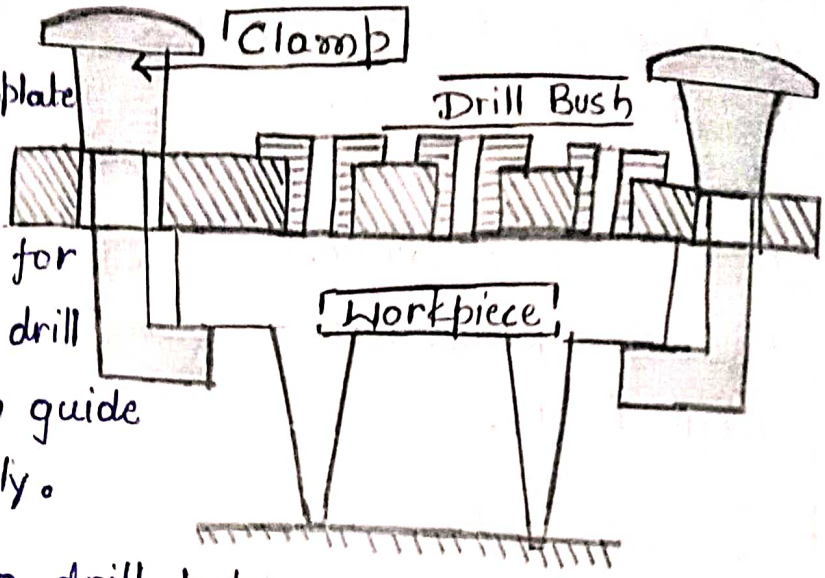


It is a simply a plate of metal made to equal to the shape and size of workpiece and has required number of hole placed accurately in it.

It is simply placed on the component on which whole is to be drilled and the drill (tool) is guided through the template to produce a hole in required location on the workpiece.

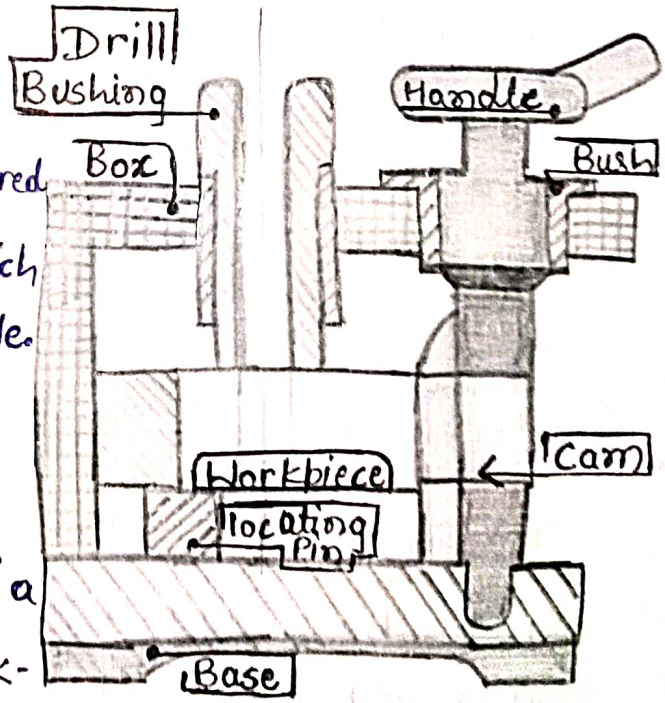
known as "false jig".

Plate Jig



- A plate jig is a template jig with clamping facility provided on it for workpiece. It also has drill bushes which help to guide the drill (tool) properly.
- Plate jig is used to drill holes on larger parts with accurate spacing with each other.
- It is easy to remove chip in plate jig.

Box and Handle Jig

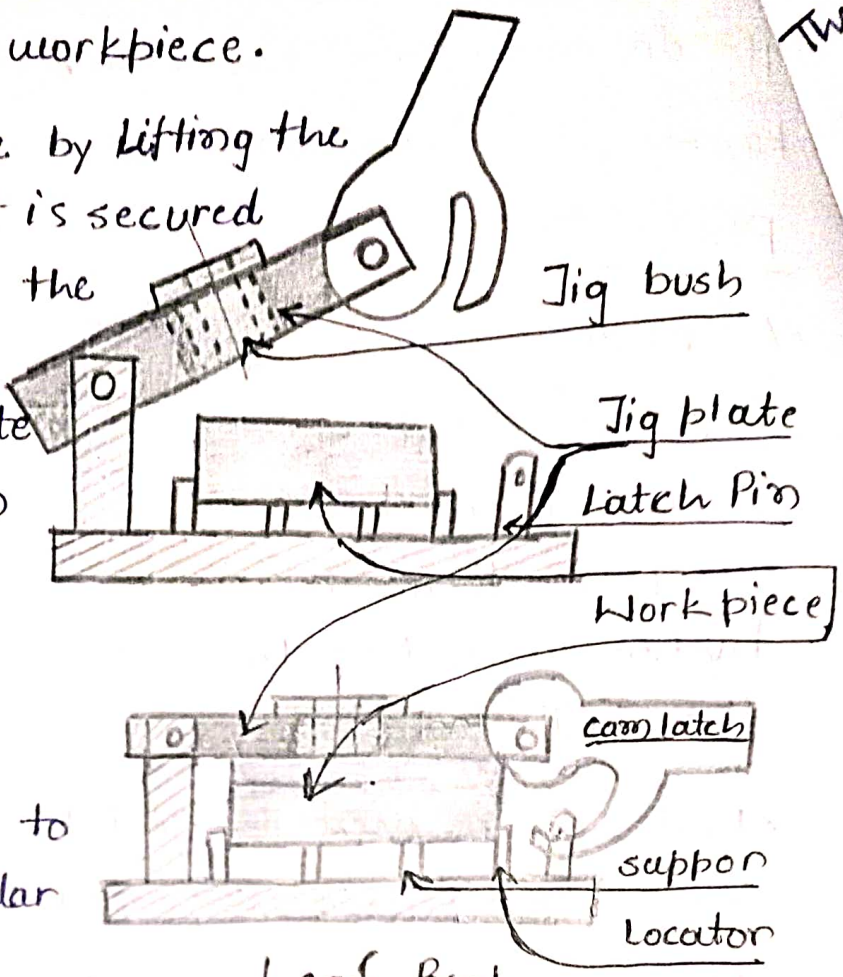


- The box jig is of box like construction inside which the workpiece is located using locating pin/button.
- The hole is present at required location with a drill bush which guide the drill to produce hole.
- The work is clamped using cam handle.
- It is generally used to drill a number of holes on a work-piece from different plane.

Leaf Jig A leaf jig is an open type of jig. It contain a body and a top plate known as jig plate which swing about a pivot point and help in easy loading

and unloading of workpiece.

- The workpiece is place by lifting the jig plate and then it is secured in location by closing the jig plate using latch. The hole at appropiate location is provided on the jig plate with drill bush.

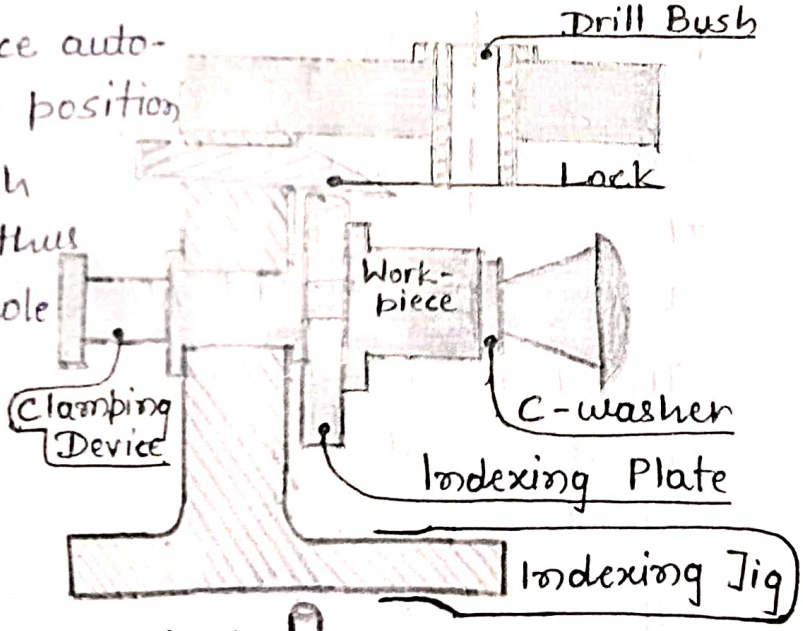


Indexing Jig

Indexing jigs are used to drill hole in a particular pattern.

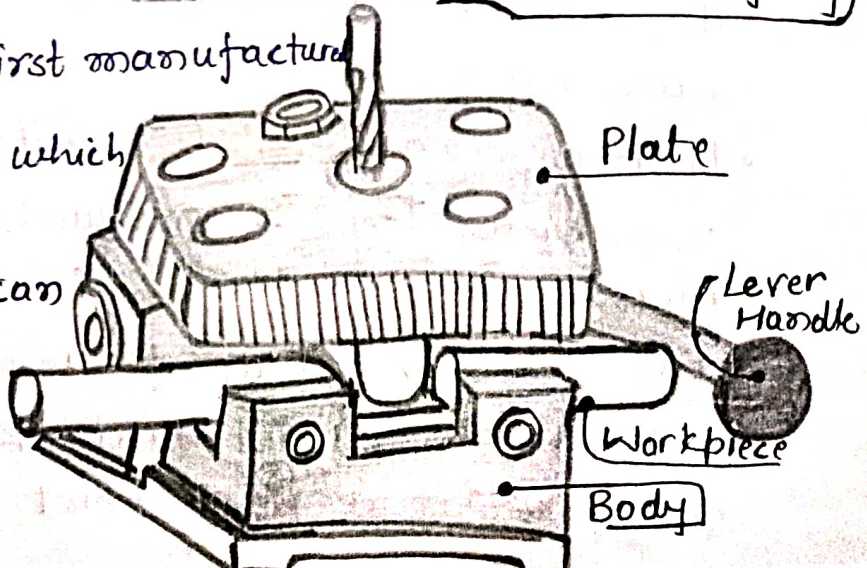
- It contain an indexing mechanism which bring the workpiece automatically to the next position of hole under the bush after a hole is drilled thus a set of equidistance hole can be drilled on the workpiece.

Leaf Bush



Universal Jig

This type of jig is first manufactured as a basic unit into which a number of other elements and parts can be fitted to make it suitable for specific Job.



The same basic unit can be adopted for different workpiece and operations simply by making additions and changes to it, thus it is known as Universal jig.

- It uses a lever-activated plate which makes the jig very fast to load and unload.

Vice Jig

- It is constructed by attaching special insert to the jaws of a bench vice.
- It is generally used for drilling shaft and consist of a pair of specially designed jaws, setting stop and support.
- It is generally used for low volume production.

General consideration for designing a drill jig;

The essential factors which must be considered in designing a jig or fixture are:-

1. A drill jig must be rigid so that it can withstand all forcess applied to it during operation.
2. It should be strong enough that it should resist rough handling.
3. It should be design in such a way that component should not be loaded in wrong way.
4. The component clamping device should be as quick as possible.
5. Complex clamping social should be avoided which may cause excess wear.
6. The process of inserting and removing the workpiece should be as easy as possible.
7. All locating pin should be vissible to the operator so that Workpiece can be seen to be correctly located.

Drill bush

A drill bush is used to position and guide the cutting operation which is fitted on the jig plate.

It is made of hardened steel, carbide, bronze and stainless steel which have sufficient hardness to ensure long life.

Types of Drill bush

There are following types of drill bush;

1. Press Fit Bushes / Fixed Boshes
2. Renewable Bushes
3. Slip Bush
4. Screw Bush
5. Liner Bushing.

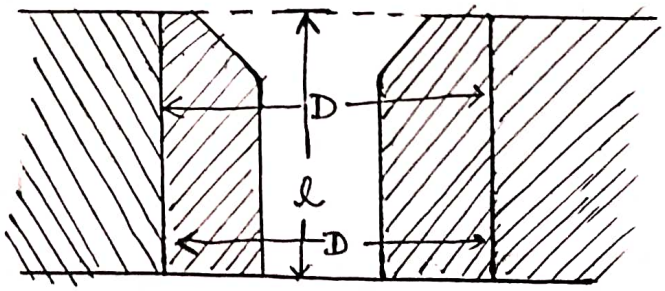
Press Fit Bush / Fixed Bush :-

These types of bush are press fitted directly in the jig body and used to guide the tool. It is used mainly for short production run which do not required bush replacement.

There are two design of press fit bush :-

a. Plain or headless bush

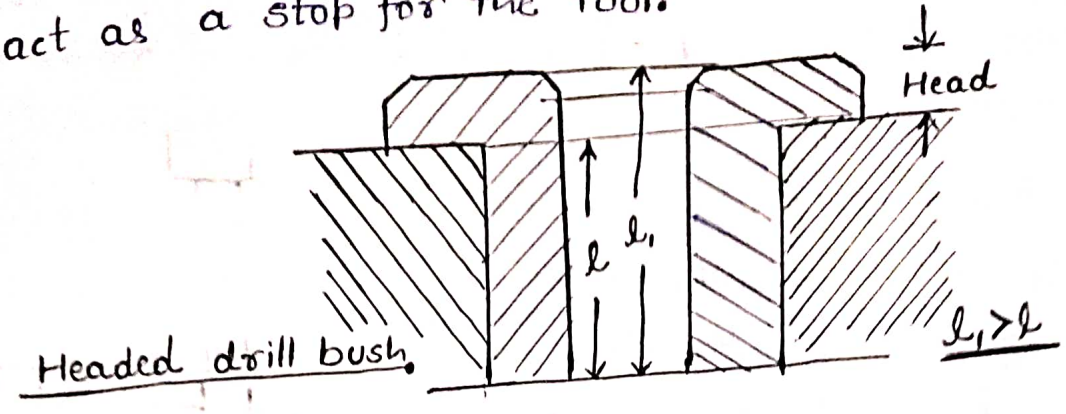
- It is a cheapest type of bush which is greatly used in a thin jig plate.
- Its cross section is uniform along its entire length



b. Flanged or headed bush

- It contain a head which is projected out from the jig surface.

Due to presence of head its length increases which provide longer guiding portion for drill and the head also act as a stop for the tool.



Headed drill bush.

Types of Fixture

There are following types of fixture for specific machine

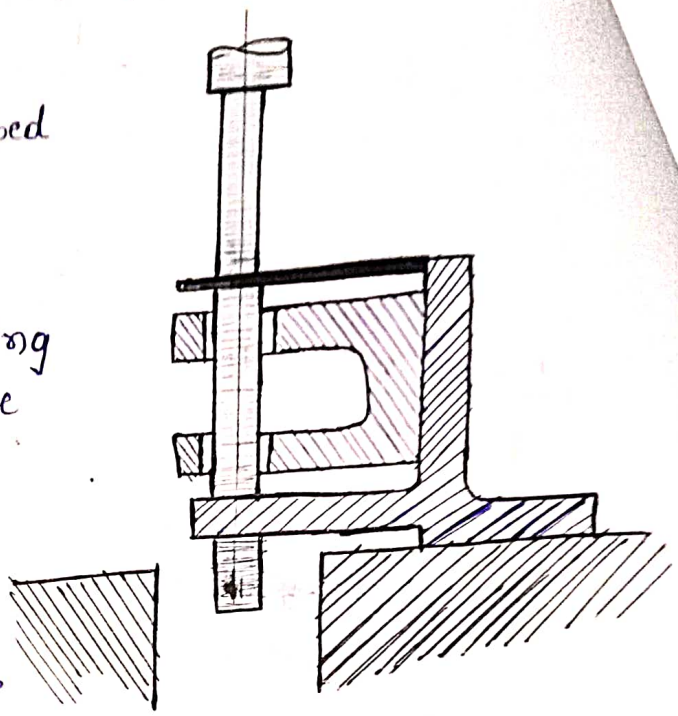
1. Milling Fixture
2. Boring Fixture
3. Grinding Fixture
4. Vice Fixture

Milling Fixture

- A milling fixture is a work holding device which is clamped to the table of the milling machine and hold the workpiece in correct position on the table.
- The essential elements of a milling fixture are:-
  a. Heavy Base
  b. Locating and clamping device
  c. Setting Block.
- A heavy base is most important element and the complete fixture is built on this plate.
- Loacting and clamping elements like locating pin, hinged clamp are provided for holding the workpiece at right place.
- A setting block is also provide on the fixture which is used for setting the correct depth of cut, correct angle of milling.

Boring Fixture

- Boring fixture is designed based on the type of mach on which boring operation is performed and the typ of tool used.
- The fixture consist on a L-shaped plate on which workpiece is holded in correct location in relation to single piloted boring bar and the support to the leading end of the bar is provided on the fixture so that spring of tool can be prevented due to cutting force.



Grinding Fracture

- In grinding operation the fixture used is a magnetic chuck which is fixed on the table of the machine.
- The workpiece is located in desired position with the help of induction block which is seperated from each other using nonferrous spacer.
- The spacer help to distribute the magnetic flux evenly throughout the workpiece and hold it tightly in place

Vice Fixture

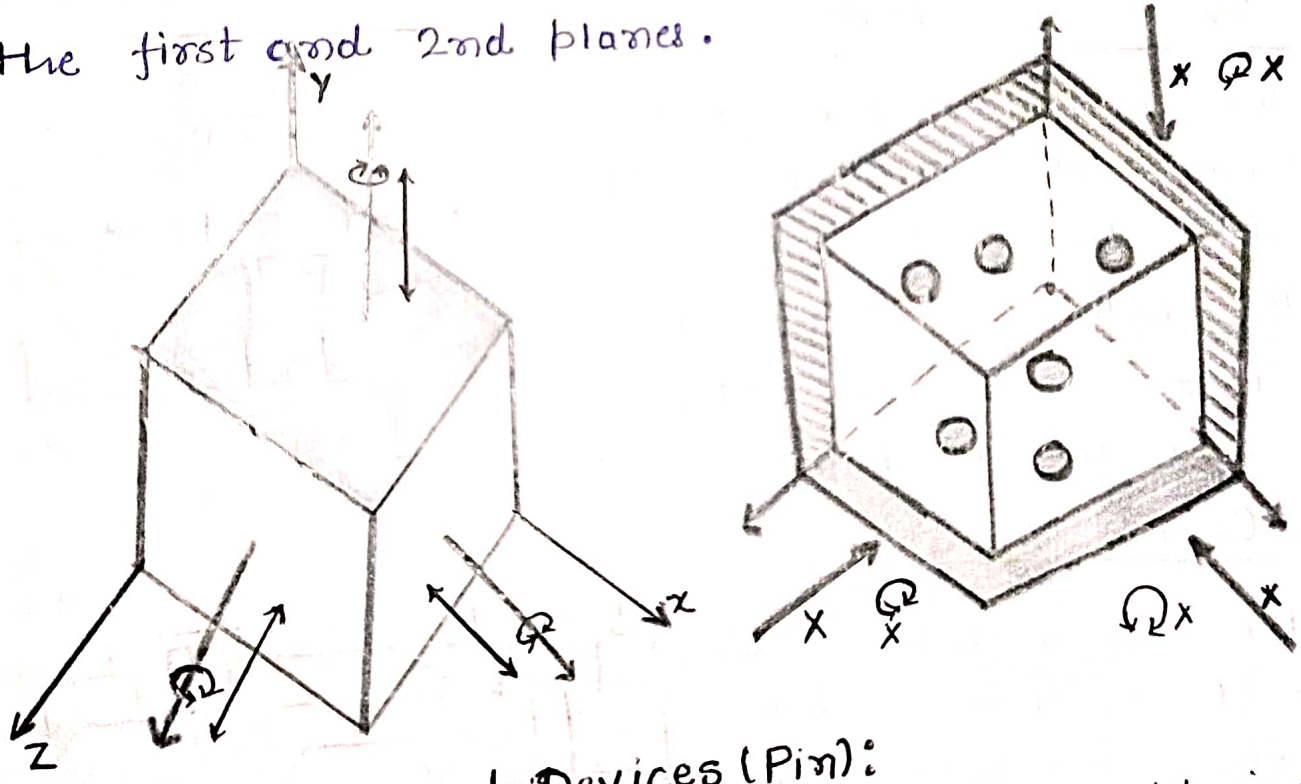
- A machine vice is itself a fixture which is use to hold the work tightly on a machine table.
- When it is required to hold a workpiece which do not have any parallel side then a spacial jaws is used within a vice for such a workpiece which is known as vice fixture
- Special jaws are designed to hold workpiece with irregular surface.

Locating: Locating refers to the dimensional and positional relationship between the workpiece and cutting tool used on the machine.

Basic Principle of Location (3-2-1 Principle),

The basic principle of location is also called 3-2-1 principle which is used to restrict all the six degrees of freedom of a free body to achieve mechanical stability of the component in the jig and fixture

The 3-2-1 principle is a work holding principle where three pins are located on the first plane (XY, YZ, ZX), two pins are located on the second plane which should be perpendicular to the first plane at last, one pin on the plane which is mutually perpendicular to the first and 2nd planes.



Locating Methods and Devices (Pin):

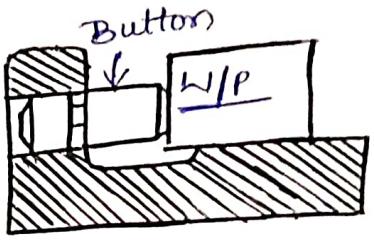
These are different type of locating method which is used in different locating device.

The selection of locating device depends upon the type of workpiece, type of operation, no of pices to be manufactured etc.

The different locating method are as follows;-

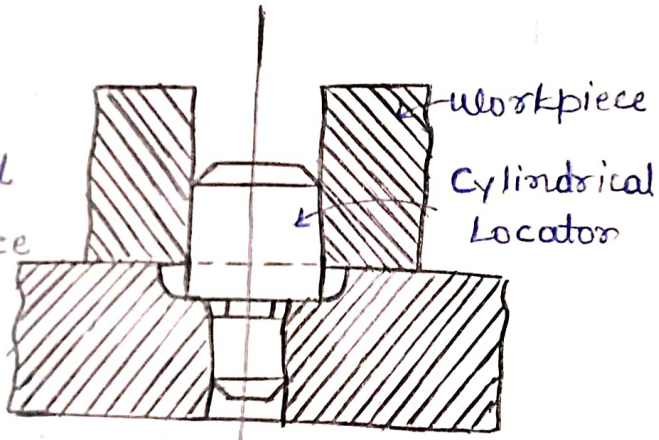
1. Flat Locator
2. Cylindrical Locator
3. Conical Locator
4. Jack Pin Locator
5. Fixed V-locator

1. Flat Locator



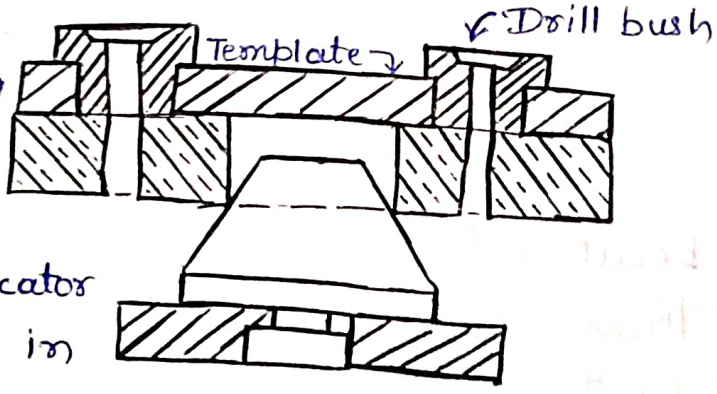
This method of location is used for locating workpiece which has flat machined face.
The workpiece is rested directly on jig body and location button is used to restrict its movement on the jig body.

2. Cylindrical Locator



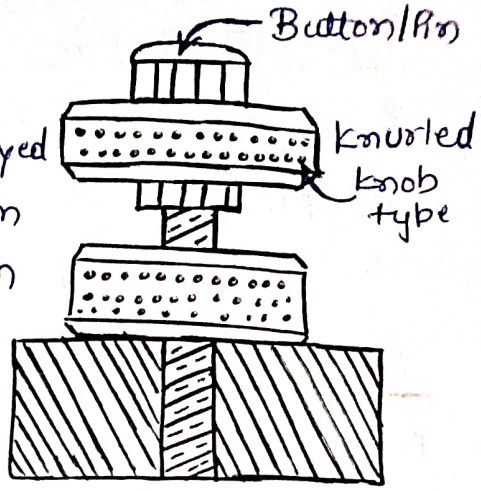
This method uses a cylindrical locator for locating a workpiece which has drilled holes in it.
The cylindrical locator is fitted on jig body which is inserted in the drilled hole of the component to locate its position.

3. Conical Locator



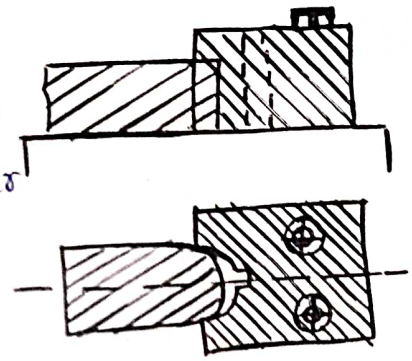
It is also used for locating workpiece having drilled holes.
It is superior to a pin locator due to its capacity to fit in a hole having slight variation in the diameter without affecting the accuracy of the location.

4. Jack Pin and Locator



This type of locator pin is employed for supporting rough workpiece from the button. The height of the pin are adjustable so that the rough and unmachined surface can be easily located.

5. Fixed V-locator



It is used to locate workpiece having circular or semi-circular shape.

After place the workpiece at proper location on the jig surface, the V-block is clamped on the jig surface/body by screw.

Clamping

Clamping is a mechanism of pressing the workpiece against the locating surface and hold it tightly when cutting force is acting upon it.

The mechanisms used for the action is known as clamps.

Basic principles of the clamping refers to the fullfillment of four basic requirements :-

1. The workpiece must be hold rigidly during operation.
2. The time for loading and unloading must be as short as possible.
3. It must be withstand variation.
4. It should not damage the workpiece.

Types of clamps

There are following types of clamp which are in widely us

1. Strap clamp
2. Cam clamp
3. Screw Clamp
4. Toggle clamp
5. Hydraulic and Pneumatic Clamp.

Strap Clamp

It is the simplest type of clamps used in jigs and fixtures. This type of clamps are based upon the lever principles to amplify the clamping force required.

A typical strap clamp which consist of a strap, stud and a heel pin. By tightening the stud, the clamping force is transferred to the part. Heel pin is the ~~function~~ fulcrum about which the lever acts while the clamping force is applied at the stud by tightening the screw.

Cam Clamp

It provide clamping force because of the contour of the cam surface that come in contact with the strap for clamping.

This clamp is extensively used in jig and fixture work due to its rapid and convenient action.

The clamp operates by simply rotating the handle up or down which locks and unlocks the strap with the work.

Screw Clamp

The screw clamp is used to grip the work on its edge. This type of clamping arrangement enables the top surface of the work to be machined without any difficulty.

Toggle Clamps

These are commercially available clamps in various design. A toggle clamp is a quick acting mechanical linkage where two of the elements generate a toggle action. The clamp first move in position, then applies clamping force by streching the linkage elements after contacting the workpiece.

Hydraulic and Pneumatic Clamp

The various types of clamp like strap clamp, cam clamp can be actuated by hydraulic or pneumatic methods when very large quantity of product is need to be manufactured.

It also help in automation of jig and fixtures.

A hydraulic clamp used pressurised oil while pneumatic clamp uses pressurised air for generate clamping force.

UNIT-2 JIG BORING MACHINE

Jig boring machine is used for the production of jigs & fixtures which required a high degree of accuracy. It has highest level of accuracy, low thermal expansion and precise system of measuring distance for locating and spacing holes.

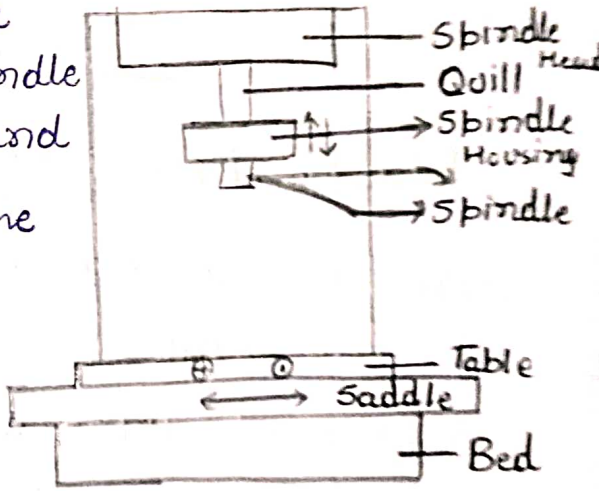
Types of Jig Boring Machine;

There are mainly two types of jig boring machine

1. Vertical milling machine type (Open front type)
2. Planer Type (Cross Rail Type)

1. Vertical Milling Machine Type (Open front Type)

It relates in construction to a vertical milling machine. The spindle rotates on a vertical column and the horizontal table rests on the bed in front of the column.

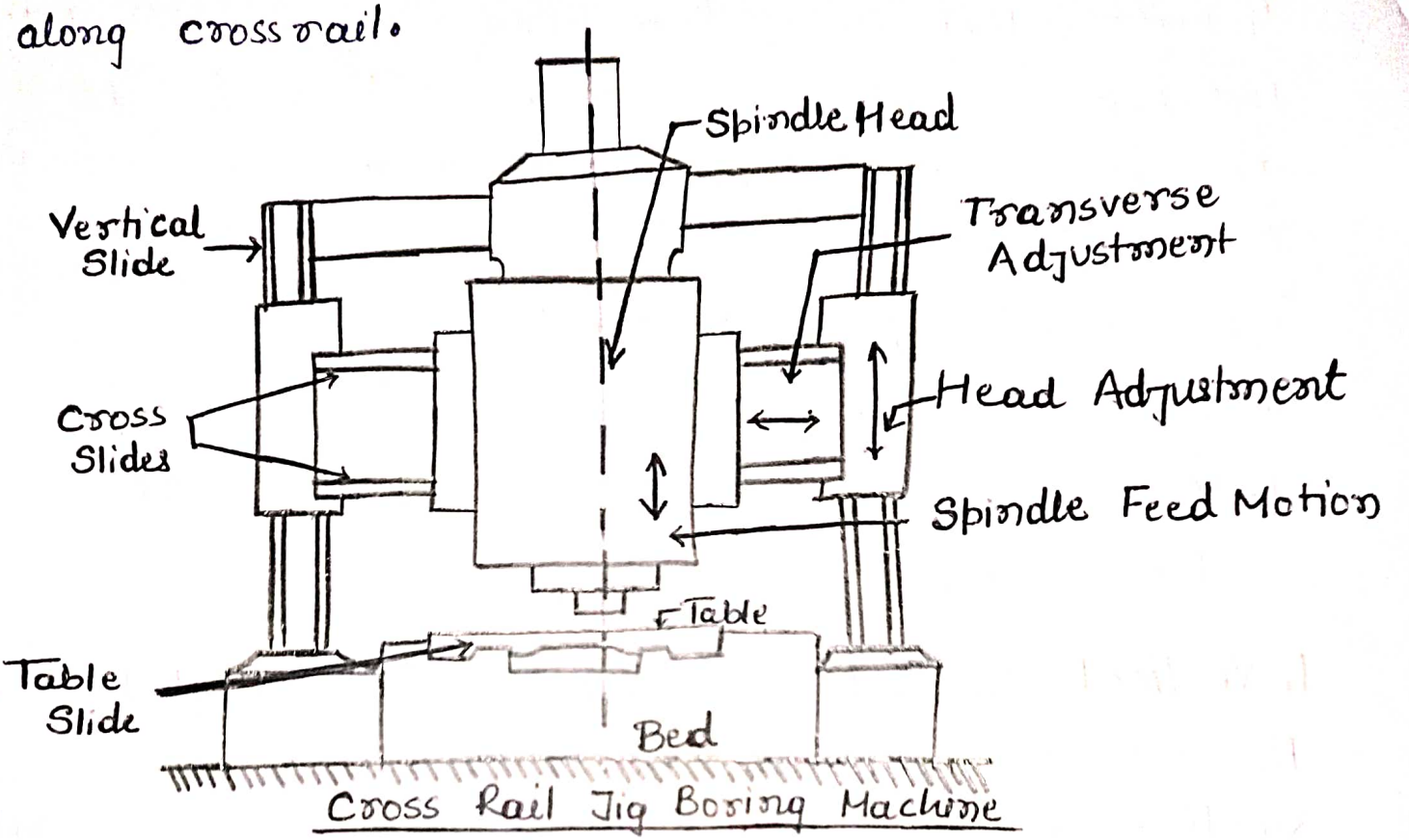


The work mounted on the table which can move perpendicular and parallel to the column face during machining.

2. Planer Type (Cross Rail Type)

It has two vertical columns on the two sides of the table and is fixed on the base. The table has a reciprocating action for adjustment of the work. The spindle is fixed on the cross rail connecting the two vertical columns.

movements for hole location are given. By the longitudi movement of table and the cross movement of spindle along cross rail.



Cross Rail Jig Boring Machine

Plastic Processing or Plastic Manufacturing :

Plastic manufacturing processes are used to convert plastic raw material into finished product.

Different types of plastic manufacturing processes are;-

1. Injection Moulding
2. Compression Moulding
3. Transfer Moulding
4. Extrusion Moulding
5. Calendering
6. Blow Moulding
7. Laminating

Injection Moulding

Injection moulding is the process of manufacturing plastic product by melting (palletizied) plastic material and then injecting this molten plastic inside a mould.

The complete injection molding process is divided into four stages;

1. Clamping
2. Injecting
3. Cooling
4. Ejecting

Clamping:

At first the two halves of the mould is tightly closed before the molten plastic material is injected into it.

The one half of the mould is attached to the injection unit and the other half is allowed to slide on the guide way.

Injection:

At this stage the plastic pallet is melted by the application of heat and then moved forward through the piston towards the nozzle and finally fill the mould.

Cooling:

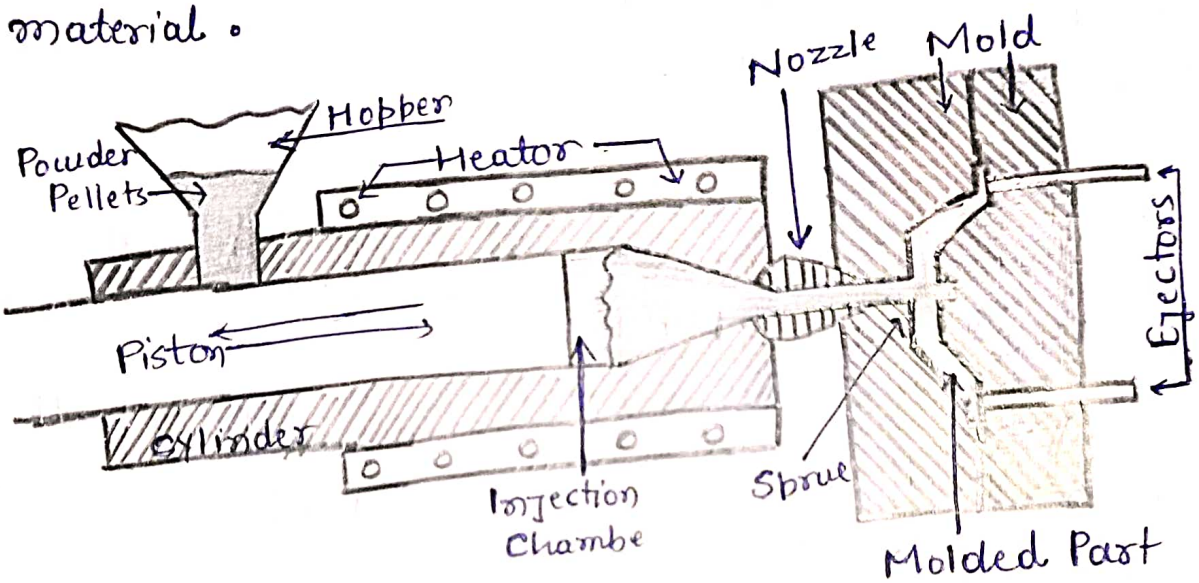
The injection molten plastic begins to cool as soon as it comes in contact with the mould surfaces, extra cooling facility is also provided in the mould for rapid cooling.

After cooing it solidifies into the desired shape of the product.

Ejection:

The molded part, which is attached to the rear half of the mold has to be ejected out from the mold. So to do this an ejector mechanism is used to push the part out of mold.

Sometime a mold release agent should be sprayed on to the mold surfaces prior to injection of the material.



Injection Moulding

Advantages

- Higher production rate.
- Close tolerance on small intricate (complex design) parts.
- Minimum wastage of material
- Complex geometry can be easily produced.

Disadvantages

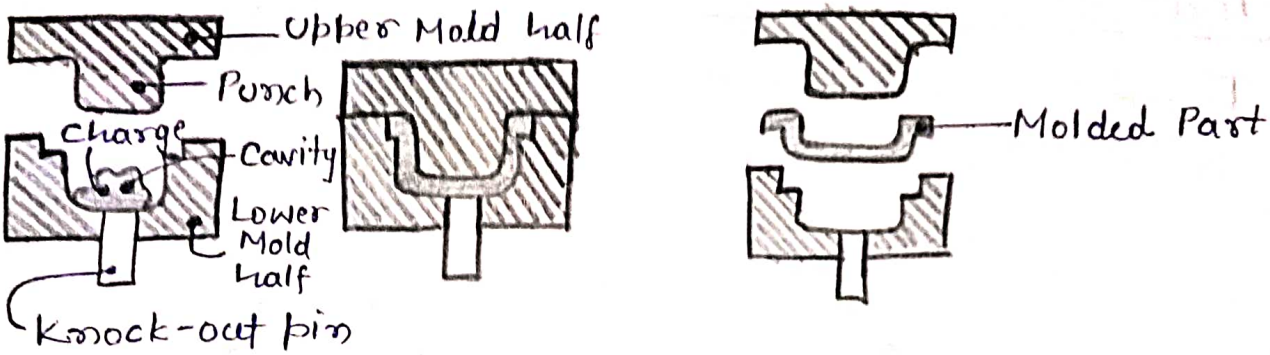
- Higher tool cost
- High setup cost
- Large undercuts can't be formed.

Application

Household appliances, electronics devices and automotive dashboards, buckets etc.

Compression Moulding

Compression moulding is a process which involves pressing or queezing a deformable material charge between two halves of a heated mold.



Compression moulding is carried out as follows :—

1. The raw plastic material (i.e. charge) in the form of solid granules (ballet) is placed in the lower half of the mould which has been preheated to a temperature of 120° to 240°C.
2. The upper half is also heated upto the same temperature and then the two half comes closer to squeezes the material into the mould cavity. thus the plastic material deformed at this temperature and flows into all portions of the mould cavity.
3. The material is kept inside the mould for sometimes to allow it to cure under continued exposure of heat and then removed (with help of ejection pin) to obtain the final product.

Advantages

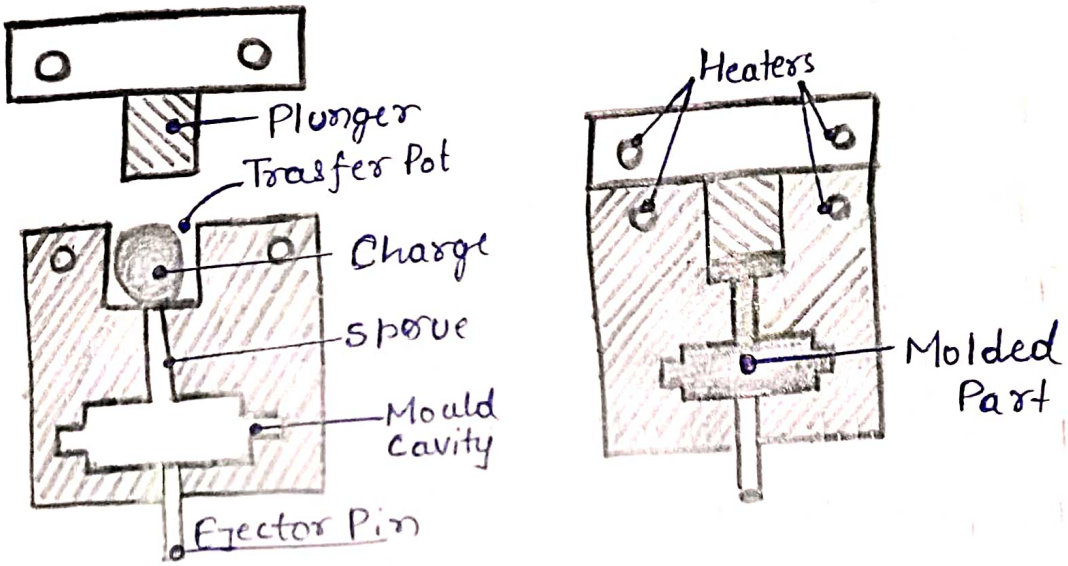
- Heavy plastic part can be manufactured
- Complex shaped part can be easily manufactured.
- Surface finish of the part is good.
- Relatively low wastage of material as compared to other process.
- It is cheaper as compare to injection moulding.

Disadvantages

- Low production rate.
- Parts with undercut is difficult to manufacture.

Transfer moulding (Crate moulding or Extrusion Moulding)

Transfer moulding is modified form of compression moulding.



Transfer Moulding is carried out as follows:—

- The plastic material is preheated and loaded into a holding chamber called transfer port.
- The material is then pushed into a preheated mold cavity using a ram or hydraulic plunger through a channel called sprue.
- The mold remain closed until the material inside is cured or cool.
- Finaly the molded part is removed by using ejector pin.

Advantage

- It has fast setup time.
- Low maintenance cost.
- Plastic parts with metal inserts can be made.
- Dimensional Stability.
- Uniform thickness of the part.

Extrusion Moulding

Extrusion moulding is used to form plastic materials into a pre-defined shape. During the process, the material is melted and pushed through an extrusion die, forming a long, tube-like shape or rod.

Extrusion moulding is carried out as follows

- At first the material is fed through hopper and then it conveyed forward by a feeding screw and then forced through a die, converting to continuous plastic product having uniform cross section.
- Heating is done while it is moving forward by feed screw, which soften or melt the plastic.
- The product going out of the die is cooled by blown air or in water bath.

Advantages

- High production volume.
- Design flexibility.
- Continuous part can be produce.

Dis advantages

- Uniform cross section part can only be manufactured.
- Limited complexity of part.

Application

This process is used for manufacturing rods, plates, and tube, wire and cable coating etc.

Blow Moulding

Blow moulding is a manufacturing process for forming hollow plastic parts. It is also used for forming glass bottles or other hollow shapes.

Blow moulding is carried out as follow

- In blow moulding a hot tube of plastic material is place between two halves of the mould (parison).
- The mould is closed air or non-reactive gas like argon is blown under the pressure of 20-40 MPa which expands the hot tube outwards to fill the mould cavity.
- The mould is then opened and the produce, hollow in shape, is removed from the mould.

Advantages

1. High production rate.
2. Hollow shapes of various sizes with thin wall can be produced.
3. Low cost for making hollow shapes.

Limitation and Disadvantages

1. Limited to production of hollow shapes.

Application

This process used for manufacturing different shape and size of bottles, jars, oil tanks, mug & toys.

Calendaring

- Calendering is the production of sheet of plastic by rolling the heated plastics between multiple rollers.
- In this process a heated paste of plastic is passed through a series of hot rollers, where it is squeezed into the form of thin sheet of uniform thickness.

Laminating

- Laminating is a process where two or more layers of plastic are put together to create multi-layered plastic sheet. Laminatic improves the physical properties of a plastic sheet, such as the impact stregth, stability and sound insulation.
- The most common form of lamination process involves the different layers being saturated with thermosetting resins. These layers are then bonded together and cured under conditions of heat and pressure by passing it through a set of heated roller.

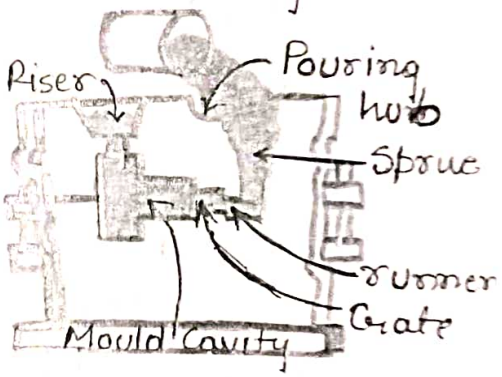
Advantages of Lamination

- Significantly improved impact stregth.
- Improved durability and safety of the material.
- Possibility to turn regular windows into smart glasses.
- Possibility to manufacture bullet proof windows.

Casting

Casting is the process of pouring liquid material into a refractory mould which has the cavity of the shape to be made and then allowing it to solidify to get the final component.

Usually liquid resins such as phenolics, polyster, silicones, acrylics and epoxies which can be consider good for pouring are used for casting. These liquids are poured into the mould which are made of lead, rubber, glass, wood or metal then after hardening, the moulds are open and casting is taken out



Fabrication

Fabrication is the process of constructing products by cutting, bending and assembling.

The different types of plastic fabrication methods are as follows :—

1. Sheet Forming
2. Blow moulding
3. Laminating plastics
4. Rainforcing

Rainforcing / Reinforced / Plastic moulding / :—

In this process low pressure is required to create a plastic with reinforced material like glass, fiber, cotton, asbestos, nylon, hemp paper and other fiber. The fiber is used in the form of cloth or mat.

The commonly used (thermosetting) resins are phenolics, polyters epoxies and silicons for creating reinforced plastics.

Sheet Forming

Plastic sheet forming, also known as thermoforming, is a manufacturing process that uses heat to stretch a plastic sheet over a mould to create a part.

It uses two techniques ;-

1. Vaccum Forming
2. Pressure Forming

Vaccum Forming

In this process a plastic sheet clamped into a frame, then it is heated using electric heater until is begins to sag. Vaccum air is then applied throught small holes in the mould due to which plastic is rapidly pulled tightly into the mould cavity creating the profile of the mould. After cooling the clamp/frame is raised and the part is removed.

Pressure Forming

In this process a plastic sheet is clamped into a frame, then it is heated using an electric heater until is begin to sag. Positive pressure is then applied which force the heated plastic into the mold cavity. After cooling the clamp/frame is raised which removed the part.

Application of Plastics

- Plastics are widly used in trains, planes, automobiles for making bumpers, dashboards, engine components, seating and doors.
- A variety of plastics are used to package, deliver, store, and serve food and beverages.
- Plastics have been widely used in the manufacture of medical tools and devices such as surgical gloves, syringes insulin pens, blood bags, heart valves, artificial limbs etc.
- Plastic is also used as container to preserve something for longer time.

UNIT - 3. Mordern Machining Process

Need of mordern machining procell;

Due to following reason we need mordern machining process;

1. The strength and hardness of material are very high.
2. The material is too brittle to be machined without damage to the workpiece.
3. The material is too flexible to with stand forces in machining or parts are difficult to clamp.
4. Spacial surface finish and dimentional tolerance requirements.
5. The temperature rise during machining which develope residual stress in the workpiece are not desire.

→ Traditional Machining or Conventional Machining

- In this type of machining process their is direct contact between tool and workpiece.
- The cutting tool is always harder than the workpiece.
- Tool life is less due to high wear.
- It uses mechanical energy for material removal.
- Metal remove in the form of chips.
- Example; Lathe, CNC, Drill, milling, shaper, planer.

→ Non-Traditional Maching or Non ~~traditional~~ Conventional Machining

- In this type of machining process there is no contact between tool and workpiece.
- The cutting tool is not harder than workpiece.
- Tool life is more due to very less wear.
- It uses different forms of energy like electrical, sonic, ultrasonic for material removal.
- Metal may or may not be remove in the form of chips.
- Examples; WJM, ECM, LBM, AJM, IBM etc.

Modern Machining Process

— Mechanical

1. Abrasive Jet Machining
2. Ultrasonic Maching
3. Water Jet Machining
4. Abrasive Water Jet Maching
5. Abrasive Flow Machining
6. Magnetic Abrasive Finishing

— Thermo Electrical

1. Plasma Arc Machining
2. Laser beam Machining
3. Electron Beam Machining
4. Electrical Discharge Machining
5. Ion Beam Machining

— Electro-chemical & chemical

1. Electro Chemical Machining
2. Chemical Machining
3. Bio chemical Machining.

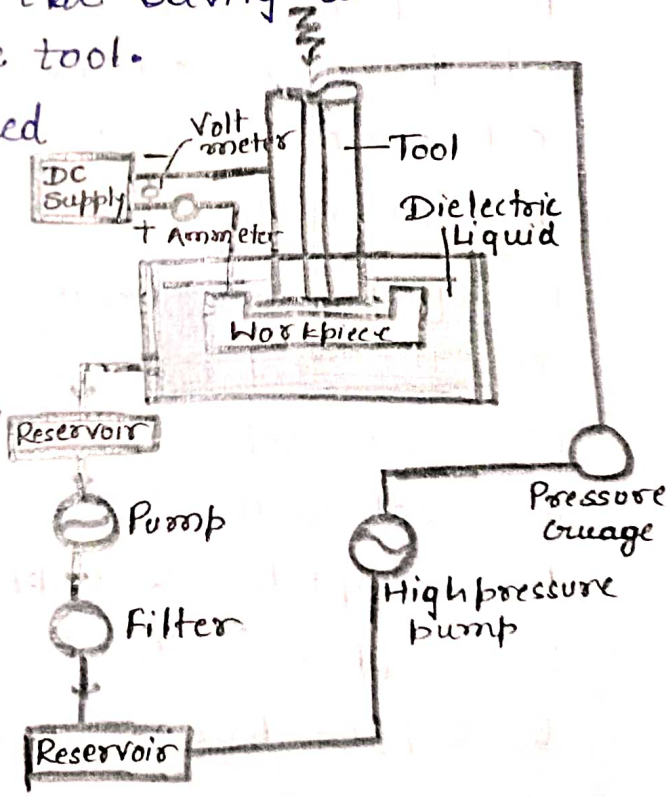
EDM - Electrical Discharge Machining / Spark Erosion Machining or Die sinking process;

Electrical discharge machining is a thermo-electrical process in which heat energy of a spark is used to remove material from the workpiece. The workpiece and tool should be electrically conductive material.

Working of EDM;

The basic EDM system contains a shaped tool and the workpiece, connected to DC Power supply and placed in die electric fluid. When a high voltage is applied between the tool and workpiece and a spark discharge takes place through the fluid thus remove small amount of metal from workpiece surface.

- The material remove to form craters these small craters combined to from the cavity which is in the inverted shape of the tool.
- The partical enrolled/erroded from the electrode known as debries.
- It uses a dielectric fluid to concentrate and control the spark.



Description of equipments;

Any EDM machine tool has for major equipments;

a. Power Supply
b. Dielectric System
c. Tool (Electrode) and Workpiece
d. Servo System

Power Supply

Power supply converts alternating current (AC) into pulsed direct current (DC) which is used to produce sparks between tool and workpiece.

The commonly used principles for supplying the pulsating DC are as follows;

1. Resistance capacitence relaxation circuit with a constant DC source.
2. Rotary Impulse Generator
3. Controlled Pulse circuit.

Dielectric System

It consist of dielectric fluid reservior, filter, pump or delivery devices.

The fluid commonly used as dielectric are transformer oil, paraffin oil, kerosene (widely used in EDM), lubricating oil and deionised water.

Tool (Electrode)

The tool is generally known as electrode and the shape of the tool is same as the final shape required in the workpiece.

The tool materials which are generally used are;

1. Graphite
2. Copper
3. Copper tungsten
4. Brass
5. Cast Aluminium
6. Copper Boron
7. Silver tungsten.

Servo System

A servo system is used to maintain a predetermined gap between tool and workpiece. There is a gap voltage sensor in power supply unit, which sends signal to the servo system according to which the required gap is maintained.

Properties of good dielectric fluid;

A good dielectric fluid should posses certain properties;-

1. It should have high dielectric strength.
2. It should take minimum posible time to breakdown once the breakdown voltage is reached.
3. Deionize the gap immediately after the spark has occured.
4. It should act as an effective cooling medium.
5. It should have high degree of fluidity.

Properties of a tool;

The tool material should have following properties;

a. It should be easily machinable.
b. It should have low wear rate.
c. It should be a good ~~transducer~~ conductor of electricity or heat.
d. It should be cheap or easily accessable.
e. It should be easily available.

Dielectric Flushing;

The concentration of the debries particles in the gap increases as the machining progresses. These particle should be removed from the gap otherwise it may leads to affect the production accuracy of the process. To over come the flushing of dielectric is used to remove by products from the gap.

Flushing techniques used are;-

1. Suction through electrode
2. Pressure through electrode
3. Jet flushing
4. Forced flushing
5. Rotating electroode flushing.

EDM Process parameter ;

The process parameter of EDM which effect the performance of maching processes are as follows;

a. Capacitance and resistance
b. Spark frequency
c. Break down voltage
d. Inter electrode gap.

→ Capacitance is directly proportional to MRR while resistance is inversly proportional to MRR.

→ An increased in spark frequency results in improved surface finish.

→ The voltage at which dielectric breakdown is known as break down voltage which is directly proportional to spark energy.

→ As the gap (Inter-electrode) increases the MRR rate firstly increased but after attaining a maximum value it start decreasing rapidly.

Output characteristics of EDM;

The different characteristics of EDM are

1. Material Removal Rate :- MRR is directly proportional to the current density and it is very low as compare to conventional machining. (5-10 mm of volume per second)

2. Tool Wear :- Tool wear can not be eliminated and it is inversly perportional to pulse duration.

3. Surface Finish :- Surface finish is inversely proportional to MRR and directly proportional to spark frequency. For rough cut heavy current is used and for finer cut less current is prefered.

Advantages of EDM;

→ It can be used for extremly hardened workpiece.
→ Creating small hole can be easily possible.
→ Brittle workpiece can also be easily machined.
→ No burrs is present in finished product.
→ Little or no polishing is required after the completion of the process.
→ No mechanical stress is developed due to no physical contact between work and tool.

Dis-advantages;

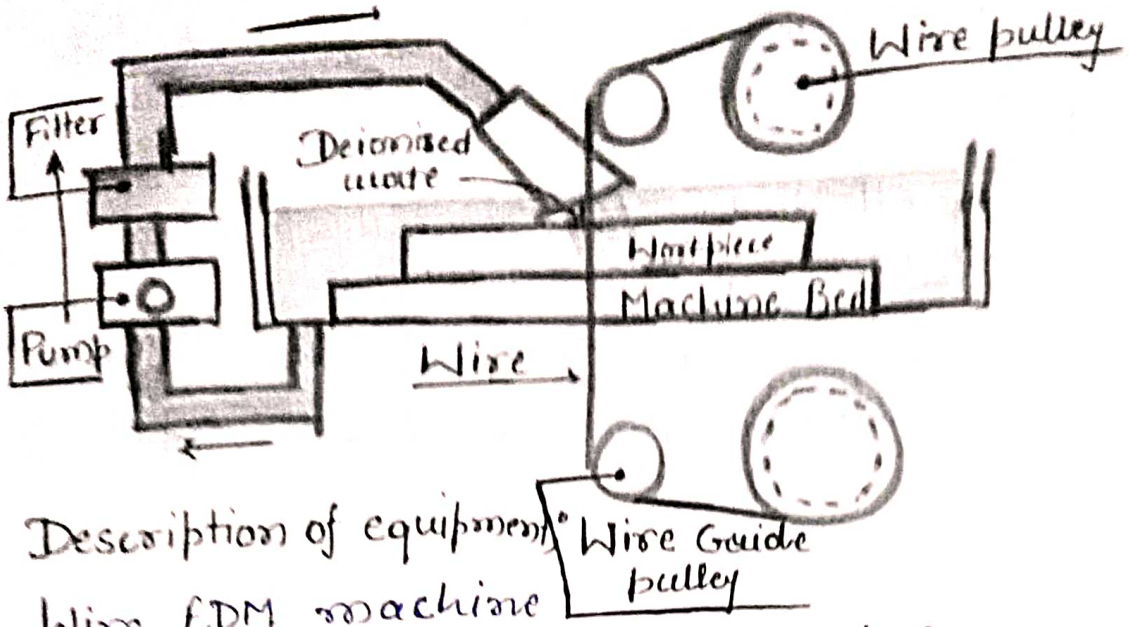
→ Machining time is too long.
→ High energy is required for machining.
→ The metal removal rate is low.
→ It can machine only those material which is electrically conducting in nature.

Wire EDM - Wire cut Electro Discharge Machining;

Wire cut electric discharge machining (WEDM) uses a metallic wire to cut or shape a workpiece with a thin electrode wire that follows precisely programmed path.

Working Principle;

→ It is a special form of electric discharge machining that uses a small diameter wire to cut through the workpiece. The cut is known as kerf.
→ The cutting action is achieved by thermal energy from electric discharge between the tool & workpiece.
→ The workpiece is fed against the wire to get required cutting path which is controlled by a numerical control system.
→ While cutting the wire continuously move downward so a fresh wire(electrode) of constant diameter is available for cutting and maintain a constant cut size.



Description of equipment:

Wire EDM machine tool has four major equipments;

1. Power Supply System

It is different as compare to conventional EDM power supply system. It is basically provide a pulse frequency which is about to 1MHz. It helps in reducing crater size and improve better surface finish.

2. Dielectric System

→ It consist of dielectric fluid reservoir, filter, pump and delivery devices.

→ Deionized water is commonly used as dielectric fluid because it has low viscosity, high cooling rate and high MRR.

3. Positioning System

→ A positioning system is a computerized numerical control (CNC), two axes table which operates in such a way that a proper cutting gap and maintained it.

→ It is able to sense the gap.

4. Wire Drive System

→ This system is used for following purpose;

a. It continuously supply the fresh wire for cutting condition gap is maintained between the work and the tool, so that a constant ~~gap~~ cut is maintained.

b. It is able to sence the gap;
It keeps the wire in proper tension are required for machining.

→ The wire is guided by wire guides and takes up by spool on both sides which help to maintain proper tension.

→ Material used for wires are brass, copper, tungston molybdenum etc.

Advantages of wire EDM;

1. A surface finish of the order of 0.1 micrometer can be achieved.
2. The material loss is negligible as compare to other process due to very thin cut.
3. It is possible to control tolerance very effectively
4. It save time required to prepare the tool in conventional EDM.

Disadvantages;

1. It cannot handle large current.
2. The process take lots of time due to limitation of current i.e. heat is limited.
3. The wire may break so required proper care while machining.
4. The wire can be reused.

Ultrasonic Machining

Ultrasonic machining is a mechanical metal remova process for brittle materials by using high freque oscillation of a shaped tool using abrasive slurry.

Working principle;

→ In USM a transducer converts the electrical energy into a high frequency linear motion. These high frequency linear motion are transmitted to the tool via tool holder.

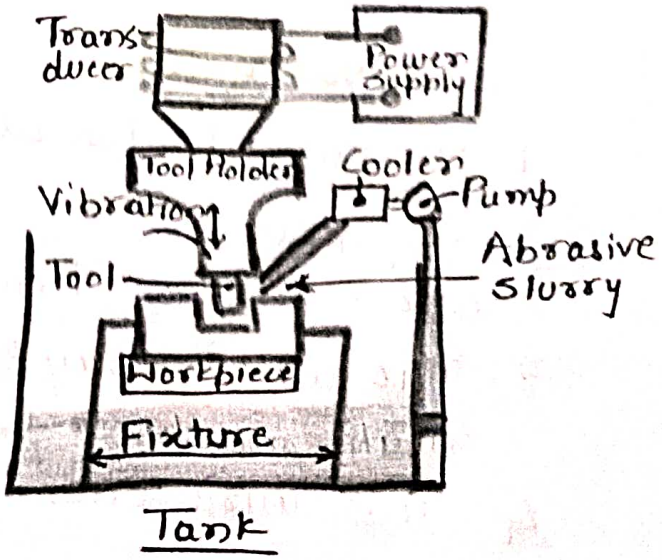
→ The tool shape is made complimentary shape of the final cavity to be made. The tool is placed very near to the work surface and the gap between the vibrating tool and workpiece is filled with abrasive slurry.

→ As the tool vibrates, in the downward stroke it strike the abrasive particle against the workpiece thus remove material from the brittle workpiece and form a small crater. A very large number of such small crater remove large amount of material from the workpiece and finally the shape of the tool is impressed into the workpiece.

Description of equipment

Ultrasonic machine tool has four major equipments.

1. Power supply system
2. Transducer
3. Tool Holder (Horn)
4. Abrasive slurry



Power supply system

A power supply unit contains a high power sine wave generator which converts low frequency (60 Hz) electrical power into high frequency (20kHz) electrical power.

Transducer

→ It helps to converts electrical energy into vibratory motion. It uses pizoelectric effector principle.

→ A piezoelectric is a material which cange in size when an electric current is applied and return to normal size when the current is removed.

→ Piezoelectric material generaly used are Quartz, lead zironate, titanate etc.

Tool Holder

→ Tool holder (Horn) amplifies the mechanical energy produced by the transducer.

→ The horn act as a resonator to amplify the signal.

→ It is made of titanium, monel and stainless steel.

→ The tool tip is attached to the horn by means of silver brazing or by screw.

Abrasive Slurry

→ The abrasive used are aluminium oxide, silicon carbide, boron carbide.

→ The abrasive is mixed with a liquid which act as acoustic bond and give efficient transfer of energy between the tool and workpiece. It also act as coolant.

→ Water, Benzene and glycerol are used as liquid for abrasive.

Advantages of USM

1. It is not effect by chemical or electrical characteristics of work material.
2. Hole of any shape can be produced.
3. It has no high speed moving parts.
4. It generate smooth surface and do not requir special treatment.

Limitations of USM

→ Low MRR.
→ Depth of hole produce is limited.
→ Sharp corner is difficult to produce.
→ Tool wear is high.

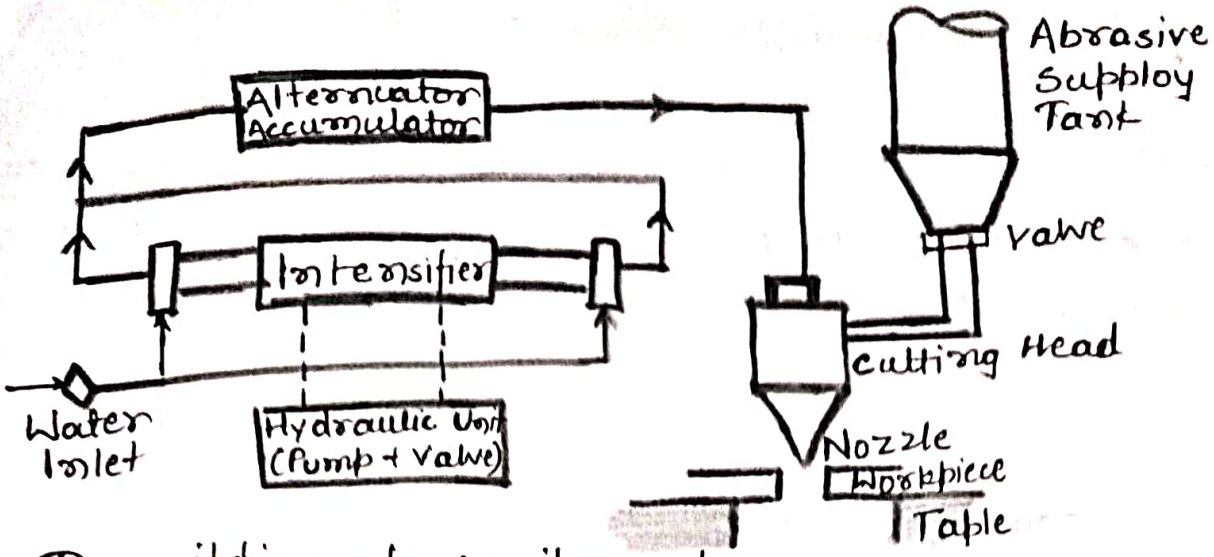
Abrasive Jet Machining (Water Jet)

Abrasive water jet machining is a process that uses a very high speed water jet mixed with abrasives to cut any type of material.

Working Principle;

→ The inlet water pressure is raised between 1300 to 4000 bar which is forced through a tiny hole which has a typical 0.18 to 0.4 mm diameter, creating a very high velocity beam of water.

→ The abrasive particle is introduce with gain the momentum from the water jet, as a result velocity of abrasive rises rapidly and thus a high velocity stream of mixture of abrasives and water falls on the workpiece and remove material.



Description of equipments;

1. Pump system;

→ A pumping system in AJM consist of a hydraulic unit, an intensifier and an accumulator or attenuator which combinely help to get a high pressure water for cutting.

→ The hydraulic unit help to drive to an intensifier which convert a low pressure fluid into very high pressure upto 20 times

2. Abrasive feed system and cutting head

→ Abrasive feed system helps to deliver a stream of dry abrasive to the cutting head.

→ It contains an abrasive supply tank which constantly supply the cutting head. A control valve is present at the present at the bottom of the tank which help to control the flow rate of the abrasive.

→ The cutting head converts the pressurised water into a cutting stream. The abrasive particle enters into the water jet in the mixing chamber, where it get accelerated by the incoming water jet.

3. Computer controlled cutting head

→ The cutting head is controlled by computer control system which guides the head for the proper cutting of material. It helps to travel the head in the desired path.

4. Catcher

→ Catcher is simply a tank which is placed just below the table which catches the water and abrasive after they completed the cutting action.

→ A lot of energy is still left in the jet stream and thus a catcher is needed to supress this energy. It is filled with water at depth of 0.6m and with steel pellets, ceramic pellets etc.

Advantages;

1. Any material of any hardness level can be cut by this process.
2. Low cost as compare to another machining method.
3. The surface finish is very good & no addition finishing is required.
4. It is a faster cutting process as compare to other.

Disadvantage;

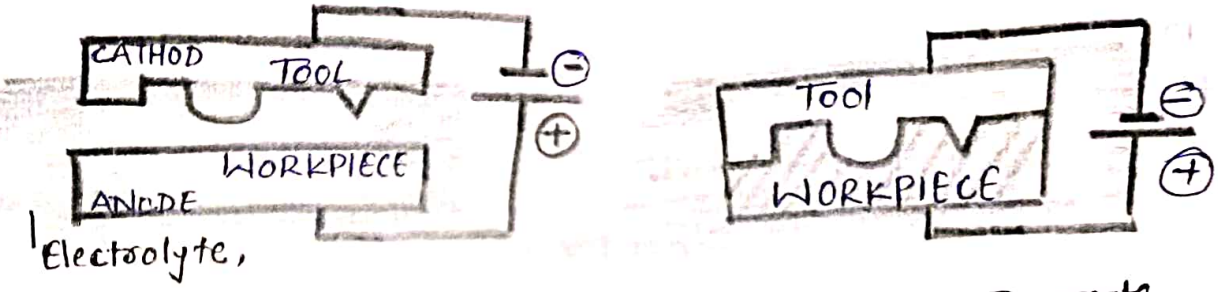
1. Difficult to cut thick material.
2. The material which react with water cannot be cut.
8. Low MRR.

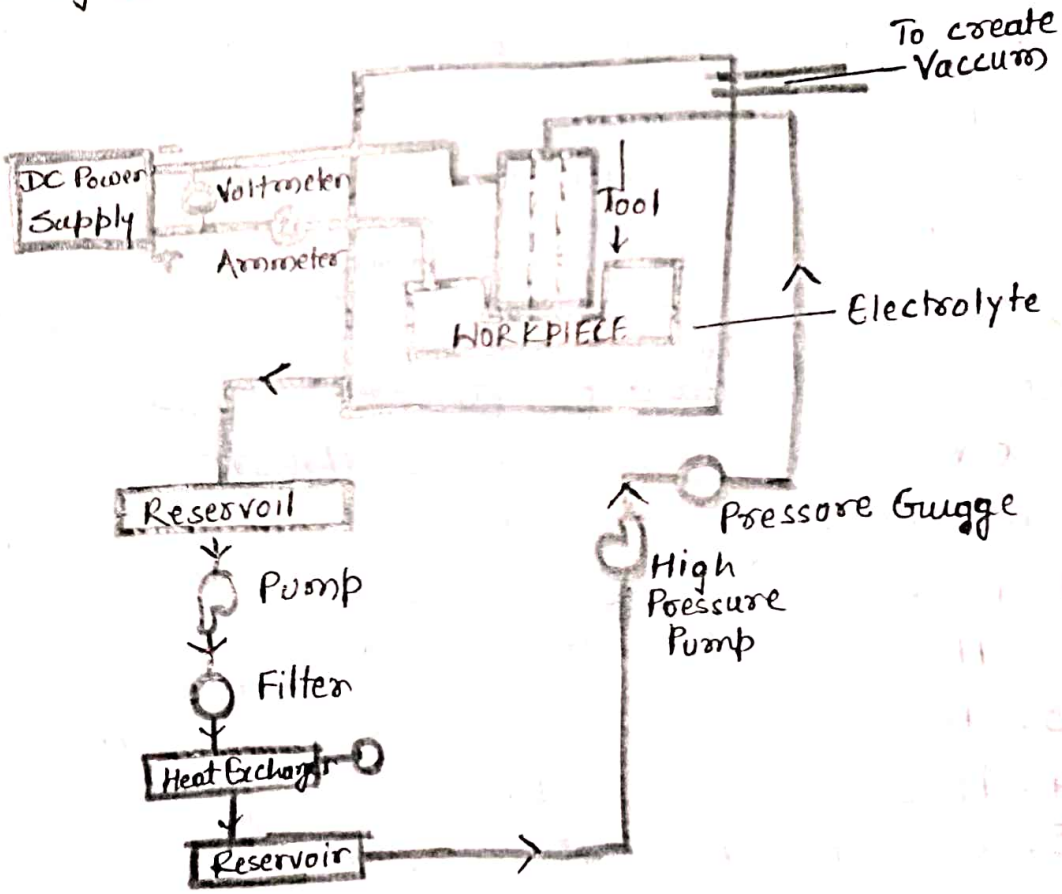
Electro-Chemical Machining

Electro-chemical machining is a process which uses electrical current to remove the metal. It uses the principle of electro-ly sis for material removal.

Working principle ;

This process involves a tool cathode, which has the shape of part to be produced and an anode (w/p) saperated by a small gap which is filled with suitable electrolyte at high pressure and when electric current is applied then the anode erroded and form the shape of cathode on machining is achieved.





Description of equipments;

ECM machine tool consist of mainly four sub-system

1. Power supply:

During ECM process a high value of DC and low value of voltage across the gap is desired. To attain this the power source helps to convert a three phase AC into loco voltage and high current DC.

2. Electrolyte supply and cleaning system:

It consist of a pump, filter, cooling coil, pressure gauge and reservoir. Electrolyte supply port is made in the tool or work holding device depending upon the requirement of electrolyte flow.

3. Tool and tool feed system;

The tool is continuously feed into the work so that a constant gap is maintained. The rate at which tool is feed is equal to the rate at which the work is dissolved into electrolyte.

4. Work holding devices;

The workpiece must be conductor of electricity and the work holding device must be a non conductor of electricity as well good thermal stability.

The electrolyte must posses following properties;

1. It must be electrically conductive.
2. It must allow the reaction to take place.
3. It must provide cooling during the operation.
4. It should have low viscosity.
5. It must be chemically stable.
6. It must be none-corrosive and non-toxic in nature.

The electrolytic fluid generally used are

1. Salt solution with water
2. Sodium chloride or potassium chloride with water
3. Sodium nitrate with water

The tool must posses the following properties;-

1. It should have high electric conductivity.
2. It should have high thermal conductivity.
3. It should have high corrosive resistance.
4. It should be easily machinable.
5. It should have good stiffness.

The material commonly used for tool are;

1. Aluminum
2. Brass
3. Bronze
4. Copper
5. Carbon
6. Monel steel
7. Stainless steel.

Advantages of ECM;

1. The ECM does not cause heating of workpiece.
2. The tool wear does not occur in ECM.
3. The surface finish will be higher because material remove atoms by atoms.
4. A complex 3D surface can be machined accurately

Disadvantage;

1. Due to corrosive nature of electrolyte, it is difficult to handle.
2. Sharp corner and difficult to produce.
3. It is very expensive machine.

LASER - Light amplification by stimulated emition of rad

A laser is defiend as light amplification by stimulate emission of radiation. It is a device which produce higuly intensified monochromatic light beam which help in melting and vaporising the metal for machining process.

Production of Laser :

→ According to Bohr's atomic model an atom consist of proton and neutron which is inside the nucleus and electron revolve arround this nucleus in an orbit which has its own energy level.

→ An electron will stay in its lowest energy level (ground state) unless it absorbe the required amount of energy (photon) to move it to one of its higher orbital level. When this occur, the atom is said to be in an excited state. This process is called absorption or excitation.

→ The atom stays in this excited state only momentarly and releases an identical photon (energy) equal to the one it absorbed, which returns it to a ground state. This process is called spontaneous emission.

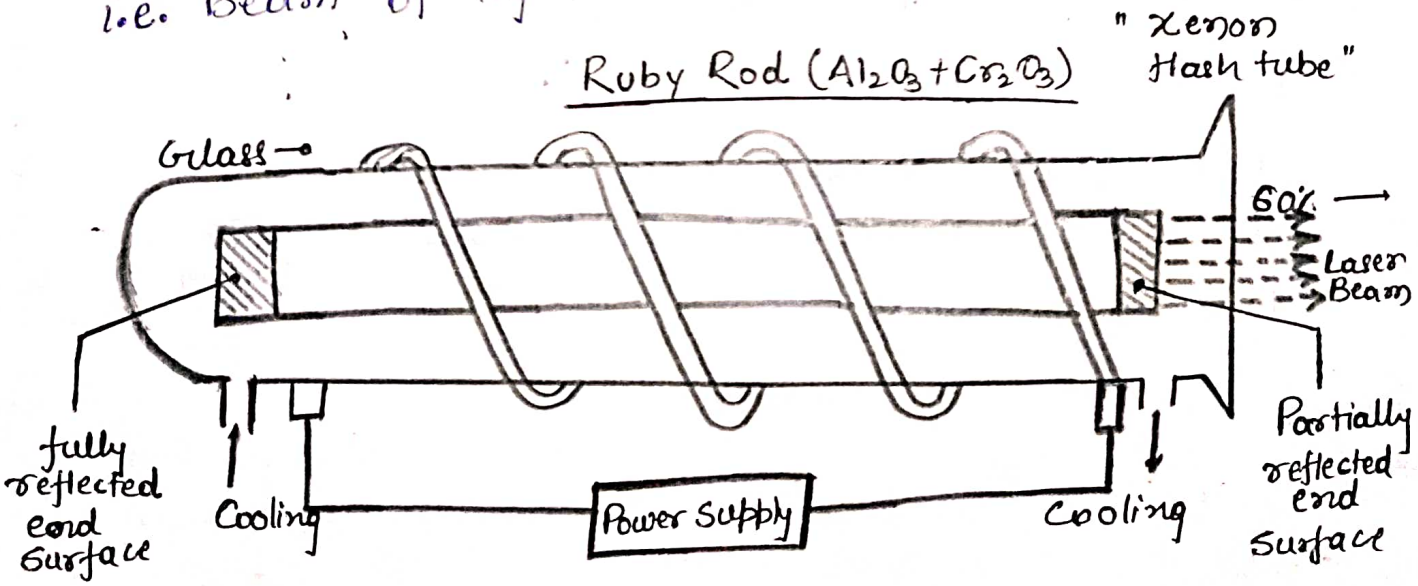
→ When this released or emitted photon collides with another atom is an excited state causing it to emit another photon.

→ The result (end) is the emission of two identical photons and the return of the electron back to the lower energy state. These two photon will promote the release of additional identical photons as long as other excited atoms present. This process is called stimulated emission.

→ This occurs when having an environment with ultimate excited atoms which is termed population inversion.
→ This is the principle of operation of laser.

Ruby Laser

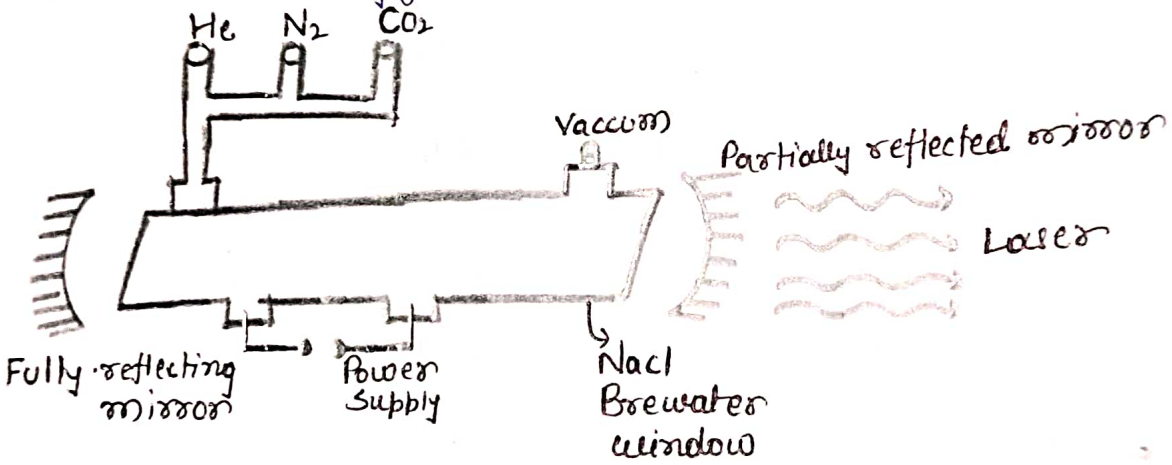
→ The ruby laser consist of a coiled xenon flash tube which is placed around the ruby rod and the internal surface of container wall is made highly reflective so that maximum light falls on ruby rod for the pumping operation.
→ The capacitor is charged and very high voltage is applied to trigger the electrode for initiation of the flash.
→ The ruby rod contain $Al_2O_3 + Cr_2O_3$ in which 0.05% of Al ion are replaced by Cr ion which is act as active medium.
→ After receiving energy from xenon flash the chromium ion absorbe the energy and move from ground state to excited state where it say for 10^{-8} sec. After that it losses its energy very rapidly and move to meta-stable state where it say for 10^{-3} sec and then while falling back to ground state it emitted photons i.e. beam of light known as laser beam.



Carbon Dioxide Laser

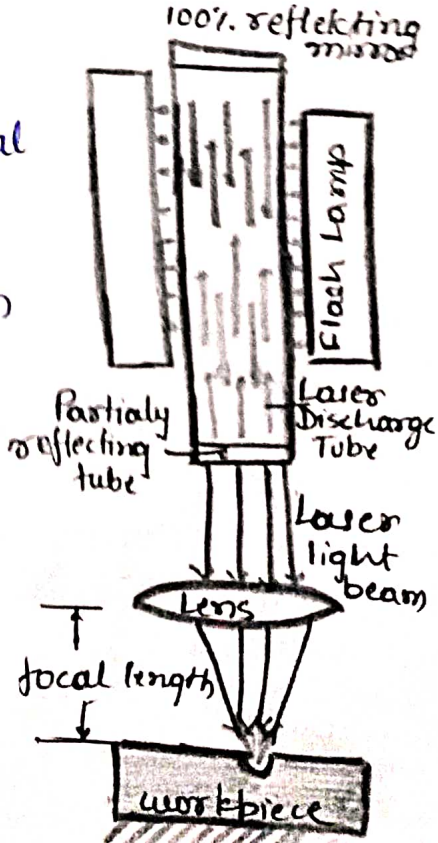
→ It is molecular gas laser which uses a gas mixture of CO_2, N_2 and He as an active medium. Electrical discharge method is used for pumping action.

→ When an electric discharge occurs in the gas, the electrons collides with nitrogen molecules and they are raised to excited states. Since the excited level of nitrogen is very close to E5 level of CO_2 atom, population in E5 level increases. As soon as population inversion is reached, any of the spontaneously emitted photon will trigger laser action in the tube.



Laser Beam Machining (LBM):

Laser beam machining uses the light energy from a laser to remove material by vaporization and melting. The types of laser used in LBM are carbon dioxide gas lasers and solid state lasers (ruby laser).



Working Principle

The types of laser used in LBM are carbon dioxide gas laser or solid-state laser (ruby laser). In laser beam machining, the energy of the coherent light beam is concentrated used a converging lense that produces a combination of evaporation and melting, with the melted material leaving the surface at high velocity. LBM is used to perform various type of drilling, slitting, slotting, scribing, marking operations. LB M is not considered as mass production process, and it is generally used on thin stock.

Description of equipment;

The laser beam machining consist of four elements;

1. Laser

A laser is a device which produce highly intensified monochromatic light beam which help in melting and vaporising the metal for machining process.

2. Laser Power Source

A laser power source consist of a capacitor which give high voltage disaster for a short time to xenon lamp (in case of ruby laser) which help to achieve population inversion so that lasing action can be started.

3. Focusing System

It consist of converging lense which help to direct the beam to a concentrated point on the workpiece to do machining. The work must be kept at the focus of the lense.

4. Cooling System

It keep the ruby rod cool during the process so that due to intense amount of heat it should not melt.

Advantages of LBM

- It can be used to cut any material.
- No tool cost is required.
- It can be easily automated due to less or no moving part
- It give excellent surface finish.

Disadvantages;

- It required very high capital and maintenance cost.
- It required proper safety during machining.
- It can not be used to cut deep holes due to taper wall created during deep hole production.

UNIT - 4 CNC Milling Machines

Introduction to NC machine ;

These automatic machine in which all the operation which is performed by operator in conventional machine are controlled by alpha numeric codes are called NC machine. If all the operations are translated into alpha numeric codes and feed and stored in a control unit known as nemeric control and the machine which is having numeric control and machine which is having numeric control is called NC machine.

NC Program

→ NC program is also known as part program
→ In drawing of finished product what operation is to be performed, with parameter and with what sequence is decided is known as instruction.
→ Now these instruction are translated into alpha code or alpha numeric form known as part program or NC program.
→ Through NC program machine is instructed what do to (operation), when to do (sequence) and how to do (parameter).

Tape Punch

Once the programming is prepared and checked a punching machine known as flexo writer is to punch the program on a tape.

Punched Tape

→ Punched tape is generally a paper tape of 1 inch width.

→ Those are made up of special material known as mylor material.

→ In this part program is punched in form of hole.

Tape recorder

It reads the part program punched in form of hole on the tape and transfer this information to machine control unit.

Machine control unit (MCU)

It is the brain of computer in which all alpha numeric code with their operation are stored. According to information receives from tape recorder it generates signal and direct it to the processor.

Processor

According to signal from M.C.U. the processor generates electric power to the corresponding element of the machine such as tool, spindle to perform the desired operation.

CNC

CNC stands for computerized numeric control machine. Entire part programming, ie all numeric control function is directly feed to C.P.U. of computer. It simply eliminates tape punch, punch tape, tape recorder, M.C.U as used in N.C. machine.

Features of CNC;

1. The part programming feed in computer is through keybbard.
2. The programming once prepared and entered can be edited and used again and again as it is a software based system.
3. CNC machine has simulation facility where the part programming can be checked for its accuracy without running the machine.
4. Some common operation like turning, threading, knurling, drilling etc to be performed on workpiece for these operation subprogram is created and stored.

Comparison between NC and CNC

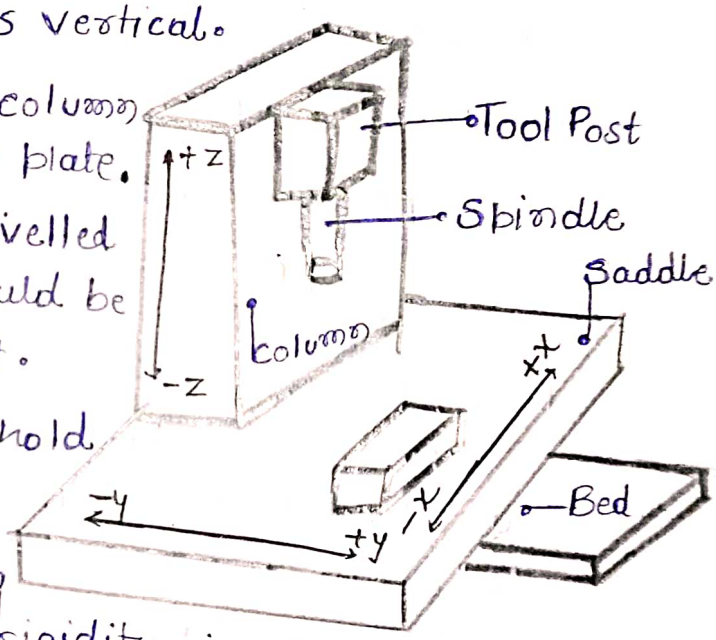
NC	CNC
1. In NC machine all the numeric control function are feed to M.C.U. through tape punch, punched tape, tape recorder.	1. In CNC machine the numeric control function are feed to computer through keyboard.
2. It is the hardware based system once the program is prepared it can't be edited.	2. It is the software based program is prepared it can be edited.
3. In N.C. machine during some course of time the tape become distorted and it can't used again.	3. In CNC machine program can be used again and again.
4. In this machine no simulation facility	4. Simulation facility available.
5. Less accurate, low productivit	5. More accurate, high productivity

CNC Milling

→ The word CNC means computerized numeric contro
→ CNC milling are those milling machine in which various milling operations are obtained by computerized numerical control.
→ On the basis of milling machine tool spindle axis position there are two types of CNC milling machine.
  a) Vertical CNC milling machine centre
  b) Horizontal CNC milling machine centre.

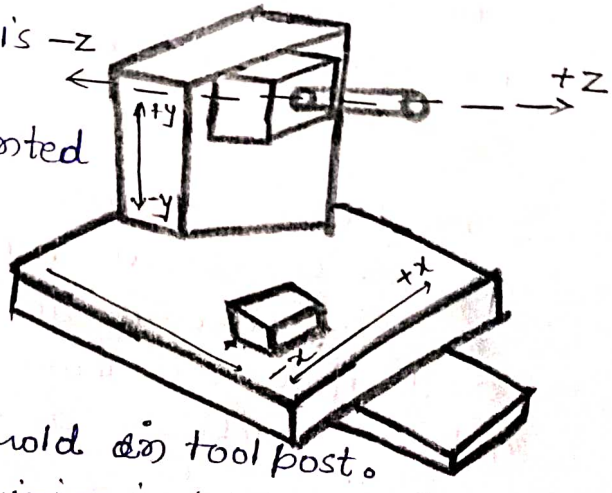
Vertical CNC Milling Machine Centre :

→ In this axis of spindle is vertical.
→ Tool post is mounted on column with the help of swiveling plate.
→ Tool post has to be swivelled at any angle hence it should be small and light in weight.
→ Less no of tool can be hold in tool post.
→ Vibration produced during machining is low hence rigidity in structure is not much required.



Horizontal Milling machine centre :

→ In this the axis of arbor is Horizontal.
→ Tool post is directly mounted on column.
→ Tool post need not to be swivelled hence it is heavy and large.
→ More no of tools can be hold on tool post.
→ Vibration produced in machining is high, structure berigid.



Axis Identification

According to axis identification in CNC machine three types of axis are defined a) Linear axis, b) Parallel axis c) Rotational axis.

Linear axis : It is defined for three principle-axis in which the motion of either workpiece or milling cutter and linear. It is of three types x-axis, y-axis and z-axis is the axis of spindle.

The axis identification for CNC machine follows a simple rule of right hand thumb rule in which the middle finger is the Z axis, the thumb the X-axis, and index finger the Y axis. The fingers point towards the plus directions.

for Horizontal Milling Machine

Away column - +Z
Toward column - -Z
Rightward - +x
Leftward - -x
Upward - +y
Downward - -y

for Vertical Milling Machine

Upward - +Z
Downward - -Z
Rightward - +x
Leftward - -x
Toward column - +y
Away column - -y

Parallel Axis : There are three parallel axis which are parallel to principle axis

1. U-axis - Those axis which are parallel to x-axis.
2. V-axis - Those axis which are parallel to y-axis.
3. W-axis - Those axis which are parallel to Z-axis.

Rotational Axis;

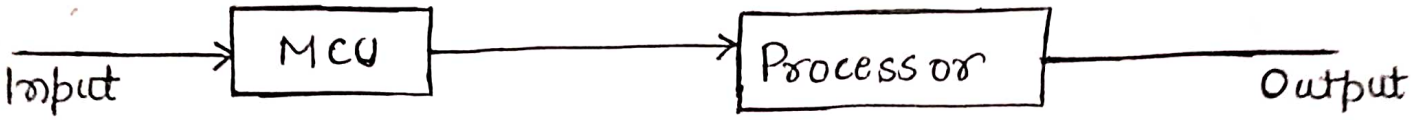
- A-axis: Rotation in clockwise direction about x-axis.
- (ii) B-axis: Rotation in clockwise direction about Y-axis
- (iii) C-axis: Rotation in clockwise direction about Z-axis

Control System Used In CNC Milling Machine

There are two types of control system used in CNC mill

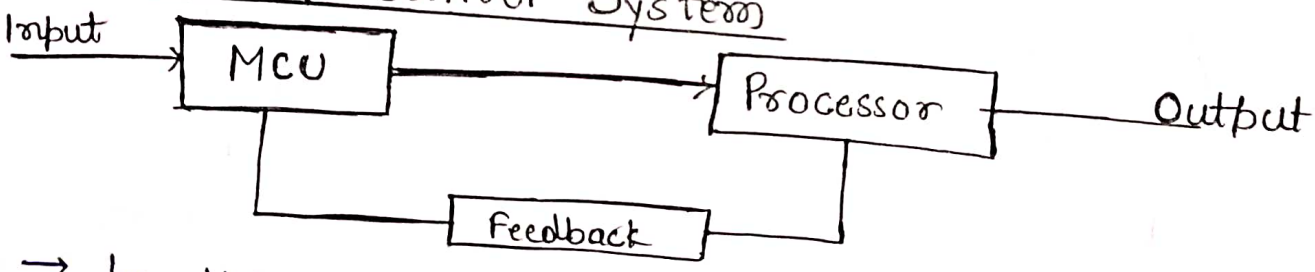
a) Open loop control system
b) Closed loop control system

Open loop control system



→ In this system there is no feedback of output from given input.
→ The accuracy of machine depends upon response of processor.
→ The loop is open between output and input.
→ Due to absence of feedback element it has less electronic component hence less expensive.

Closed Loop Control System



→ In this system here is a feedback system which Sense the deviation of output from its accurat value and by changing the input parameter desired output can be obtained.
→ The loop beetween output and input is closed.
→ It has feedback elements has expensive.
→ It is more accurate.

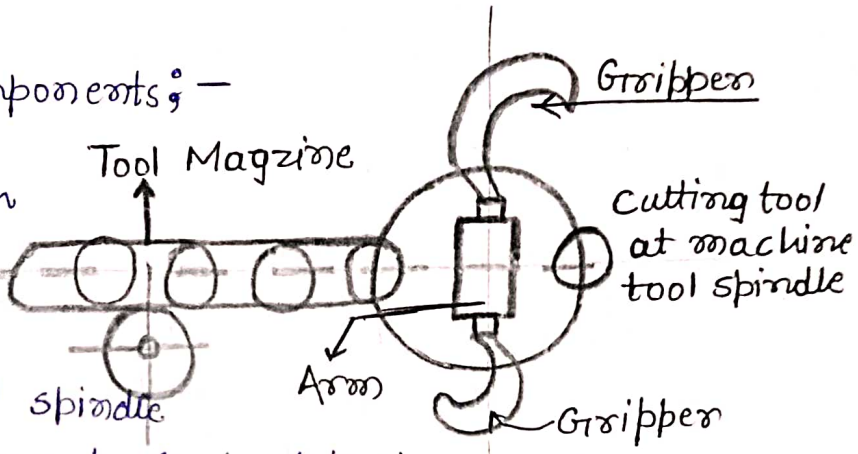
Automatic Tool Exchanger

→ Automatic tool exchanger used in CNC machine to improve the rate of production and tool carrying capacity of machine.

→ Automatic tool exchanger the tool very quickly and reduces the production time hence increase productivity.

→ It gives the machine to carry large no of tool with various type.

→ It has three main components;-



Arm: Arm rotates such that its one end with the gripper attached with it reaches tool spindle while other end reduces to tool at tool magzine.

Gripper: Gripper attached with arm grip and hold cutting tool in spindle and in magzine and exchange them by rotating the arm.

Tool Magazine: Tool magzine carry various types of tool in larger no with the help of conveyor required tool moves towards the arm.

→ Conveyor is moved by rollers.

Tool Positioning

There are two type of tool positioning system used in CNC machine.

a) Absolute coordinate system
b) Incremental coordinate system

Absolute coordinate system :-
All the position of tool are given from fixed origin. It is also known as fixed origin system.

Incremental coordinate system :-
In this system cordinate of tool is not defined from fixed origin. It is defined from its preceding origin. Since origin of tool always change hence it is known as floating origin system.

Machine Tool Automation

Every industry has to improve the productivity and quality of finished product. This objective have forced their industry to convert the manual operation into mechanical activity ie replace human by machine.

Mechanisation

→ The term mechanisation means that the operation are called machine instead of being performed by humans.

→ In this all the operation of tool performed on workpiece one automatic but the operation like movement of tool from one workstation to another workstation, loading and unloading of workpiece on the workstation, checking the workpiece are done manually.

→ In mechanisation there is no prevision of feed back system hence it is open loop system.

Automation

→ The term automation means high degree of mechanisation.

→ In this all process and operation ie even material handling and checking of workpiece are done automatic.

→ In this operator is only for supervision and one machine can attain no of machine at one time.

→ Thus automation can be defined as technology concerned with application of mechanical, electronic, computer based system to operate and control the production.

Benefits of machine tool automation;

1. Increase the productivity.
2. Human fatigue is greatly minimised.
3. Good quality product is obtained.
4. Single operator can operate more than one machine at a time.

Single spindle automates:

Those machine which have spindle and used for operating single component at a time are known as single spindle automates.

Based on single spindle automates the automatic machine are classified in three ways:-

1. Automatic Cutting Machine:- These machine used for producing small length shaft from a long bar shaft. They are used for cutting operation of any bar or rod to reduce its length. The spindle moves workpiece towards the tool.

Swiss-type Automatic Machine :- In this the tool p
carrying the turning tool is fixed and the headst
carrying the workpiece is moved toward the turni
tool.

Turret-type Automatic Machin :- In this headstock carrying the rotation workpiece is fixed at its position and tool is moved towards the workpiece. It has special design tool post in which upto 6 Nos tool can be mounted.

Transfer Line

Transfer line is a automatic flow line to transfer the workpiece to different workpiece, ie from one workstation to another workstation in a particular direction so that sequence of operation can be performed on workpiece.

It is combination of material processing unit and material holding unit.

Each machining in this area in series called machining station and perform operation simultaneously on workpiece.

Requirement of Transfer line;

→ Correct starting up and finishing up time ie time of operation at each workstation must be Sychronized.

→ Accurate transfer of workpiece at each workstation.

→ The fixture carrying the workpiece must be rigidly clamped to transfer line.

Advantages of transfer line;

1. Material handling is fast and automatic.
2. Faster machining thereby reducing cycle time and increasing production rate.
3. Since material handling is automatic hence greater accuracy is achieved.
4. Less no of operator are required.

Disadvantages of transfer line;

1. A very high initial investment is required.
2. Failure of one machining station will temporarily stop production.
3. High maintenance is to be required.
4. The whole set up is to be changed if design of product changes.

Types of Transfer; 1. Inline transfer line,

In this type of transfer line the machining station attached to transfer line are arranged in straight line.

But if floor space is less the machining station can be arranged in various geometrical space.

It is of two type :-

a) Pallet Type;

→ The workpiece is clamped in a holding fixture called pallet.

→ In this the pallet carrying the workpiece moves from one transfer line to another.

b). Plain Type;

→ In this type of transfer line the workpiece is moved itself to workstation through the help of crane.

→ In this fixture remain at its position on machining station. It is used for light jobs.

Rotary-type Transfer line

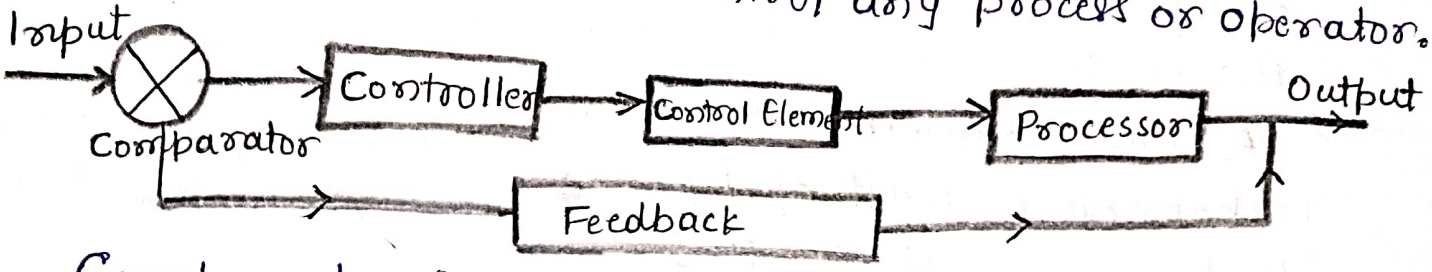
→ In rotary transfer line workpiece is moved or transfered from one machining station to another maching station in a circular path.
→ It consist of arotary table which rotates to transfer the workpiece to different workstation
→ The machining station is so arranged that if must be equally spaced in the rotary table
→ The main advantage of this transfer line is that loading and unloading takes place at some work-station and it occupy very less floor area.

Drum-type Transfer line

→ In drum type transfer line the workpiece are transfered along circular path similar to the rotary transfer line.
→ Instead of rotary table it carries a heavy drum of cost from which is mounted between tri-union
→ The workpiece are located radially on the front and rear side of the drum.
→ The workpiece are loaded and unloaded at same work staion ie at top of drum.
→ The work-station at bottom of drum is called Idle station in this no operation is performed.
→ It is used for heavy workpiece but it has a limitation that only two machining operation can be performed on workpiece.

Control System

Control system is defined as an arrangement of electrical, electronic and mechanical equipment in such a manner so that these combination will regulate and control any process or operator.



Comparator: It is also known as error detector. A standard of any process is initially set within it and this value or standard is called set point valve.

Controller: The controller examine and analysis the detected error and then determine the action to be taken. To make the measured value equal to set point valve

Control Element: It is known as brain of control system it recieves singal given by controller and translate it into part programming which is further send to processor.

Processor: It is an electromechanical device it perform operation as instructed in the part programming given by control element.

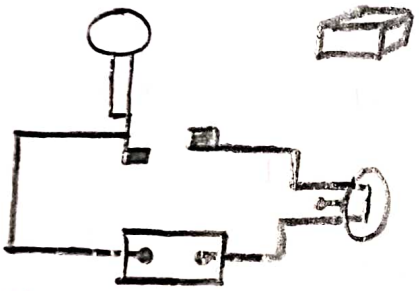
Feedback sensor: The main function of feedback sensor is to sense the output value andsend to the siggnal to comparator.

Limit and Proximity Switches

Limit switch :- Limit switch is an electromechanical electromechanical device which have contact actuator. When any object comes in contact with switch the contact actuator comes in contact and this cause the electric circuit to complete.

A limit switch is so configured that the switch is boundary limit of object, so when object crosses its boundary limit it make contact with switch which will close the electric circuit.

The limit switch sense the object when the object make physical contact with switch.



Proximity switch :- In this the presence of object can be detected without the establishment of physical contact between object and switch.

Proximity switches closes the electric circuit when any object comes in the domain of switch.

Therefore proximity switches can be defined as electronic switch which detect the presence of any object without touching it.

Limit switches

1. They require physical contact between switch and object.
2. They are completely slow in operation
3. They are less sensitive.
4. It is electro mechanical device.
5. It respond when object crosses its boundary limit
6. Contact part may get wear out.

Proximity Switch

1. They don't require physical contact between switch and object.
2. They are quick in operatio
3. They are highly sensitive.
4. It is electronic device.
5. It respond when object comes in domain of switch.
6. No such problem of wearing takes place.

Types of Proximity switctches :- Infrared Proximity Switch

→ They work by sending out infrared light beam.
→ A photodetector is installed with the proximity switch having infrared light become emitter.
→ When the light beam emitter emits the light beam and if any object comes infront of light beam the light beam gets reflected back which is sensed by photo-detector, and thus presence of object can be detected.

Accoustic Proximity Switches :-

→ They are similar in operation and in operation as that of infrared switches. But they uses sound waves instead of light beam.
→ They uses two transducer one emit the sound wave and other recieve the sound waves.

Jig: A jig is ... well ...

the

→ When the emitted sound waves strickes the object it gets reflected back which is sensed by another transducer hence the presence of object can be felt.

Object

Capacitive Proximity Switches:

When any object comes near by capacitor its dielectric strength charges which changes the value of capacitance. Thus when change in value of capacitance takes place circuit closer and object presence detected.

Inductive Proximity Switches:

It is used for detection of magnetic oscillator change change and this change in flux is opposed by trigger level signal converter and thus induce an emf across itself which is having very low, magnitude which is further amplified by the output amplifier. In this way presence of object can be felt.

Servo control System

→ It is a type of control system which is used for the process and control of process for servo-motor.

→ A servomotor is an electromechanical devices which produce large output mechanical energy by the means of small input electrical energy

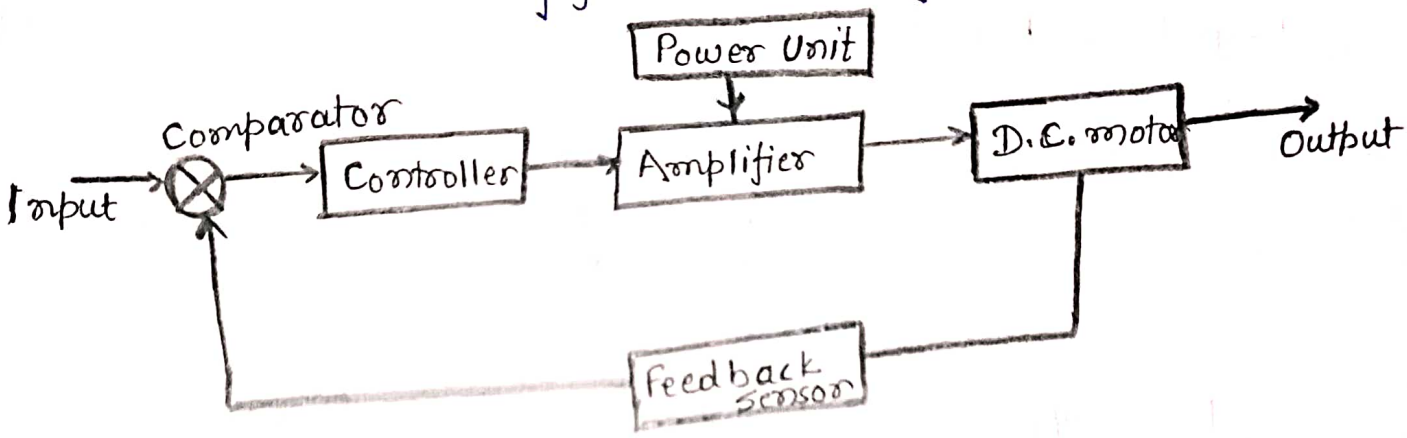
→ It is a closed loop system as it uses feedback system.

Objective;

→ Accurate and automatic control of operation without need of human operator

→ Production and control of high power output from low power input.

→ Operation is very fast with very less error.



Controller: It is a computer based system which recieves signals from comparator and it is so programmed to send the signal to the amplifier to activate the motor so that desired output can be produced.

Servo-Amplifier: The signal from comparator is then passed into amplifier which amplify the signal upto appropriate level as required to operate the servo-motor.

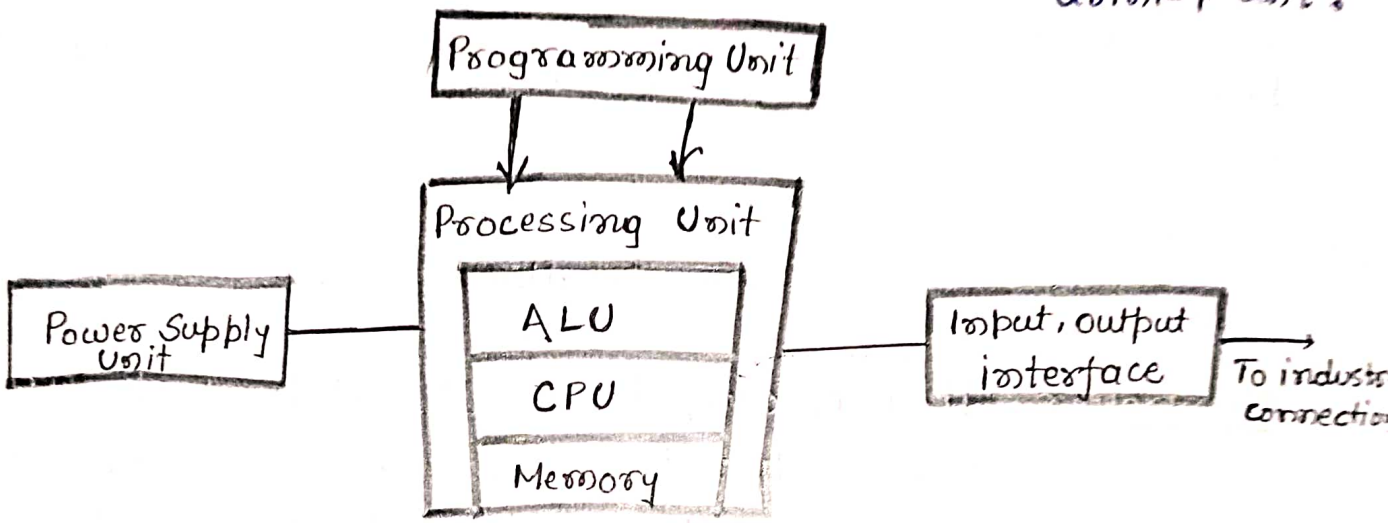
Servo-motor: The motor is basically a D.C. motor which generates very high mechanical output to generate very high force to provide high torque with high speed.

Sensor: It is a feedback element which send signal to comparator whether the output is desirable or not.

Programmable logic control;

A programmable logic controller is an industrial computer control system that continously monitors the state of input devices and make decision base on custom program to control the state of output devices.

Examples; 1. ATM machine, 2. Petrol supply unit, 3. Cold drink plant.



1. Power supply unit; It provide voltage necessary to operate the circuit of PLC. Some circuit of PLC required low D.C voltage. Requirement of voltage is fulfilled by voltage.
2. Programming unit; It is an external device that is connected to PLC. It allows the user to enter the data. It also monitor the programming stored in memory of processing unit.

The most important part of the programming unit is the processing unit which has three components;-

a). ALU :- The unit performs mathematical calculation and make logical decisions.

b). CPU :- It is the brain of PLC, a microprocessor which work according to the logical decision made by ALU.

c) Memory: Programme and other data can stroore in memory.

3. Input Output Interface; It is an interface where the PLC is connected with industrial connection. The output signal generated by C.P.U. is input signal for industrial connection.

UNIT-5

SPACIAL PURPOSE MACHINE

Spacial Purpose Machine is that machine which is made to do or perform specific or dedicated operation. It is design to operate continuously for 24 hours a day with minimum supervision.

General elements of spacial Purpose Machine:

The construction of every spacial purpose machine is different and depends on the component needed to be manufactured on it, but in general they carry the following unit :—

1. Mechanical Components
2. Actuators
3. Tooling and workholding devices
4. Control System
5. Sensor and feedback mechanism
6. Saftey Feature
7. Human machine interface (HMI)

Mechanical Component :— It include the structural elements, such as the frame, base and moving parts like slides, guides and linkage mechanical components provide the support and mechanisms necessary for the machine to do its required functions accurately and effectently.

Actuation System :— Actuators generate motion or force to complete the required tasks. Depending on the requirement, actuators can be hydraulic cylinders, pneumatic cylinders, electric motors which is capable of precise and controlled movement.

Tooling and Workholding :- Tooling refers to the specific clamps attached to the machine for holding different types of tools while workholding refers to the devices required to hold the workpiece of different sizes during the manufacturing process.

Control System :— The control system regulates and coordinates the operation of various machine components to ensure smooth and accurate execution of process. This system includes programmable logic controllers (PLCs) computer numerical control (CNC) systems which is responsible for sequencing, timing and monitoring machine actions.

Sensors and Feedback Mechanisms :- Sensors help in providing feedback to the control system, allowing the machine to operate or adjust its operation based on machining requirement, workpiece characteristics or process variables.

Safety Features :— Safety elements are provided protecting operators, preventing accidents and help in fullfilling the safety regulations. Safety features may include guards, emergency stop buttons, curtains etc to minimize risks related with machine operation.

Human Machine Interface (HMI) :— The HMI help operators to interact with machine, monitor its operation and input commands for performing the operation. It may include interfaces such as touchscreens, buttons, switches or graphical user interfaces (GUIs).

Principle of spacial purpose machine design

The basic principle of spacial purpose machine design involves following factors to be consider while design :-

1. The types of operation for which spacial purpose machine is to design like manufacturing assembly, inspection etc.
2. The different steps which is required to perform to complete the operation.
3. The types of forces which will act on the machine while performing operation.
4. The operation cost of the machine.
5. The machine should be design for minimum supervision.

Maintenance

It is the act of keeping equipment in good condition by making repairs correcting problems and replacing worn out components if needed from time to time so that the service life of the machine will increas and the efficiency will not be affected.

Objective of maintenance :-

- To minimize machine breakdown during operation.
- To maintain machinery in perfect working condition at lowest cost possible.
- To keep machinery in such a condition that it can operate at their maximum capacity.
- To assist the management in decision making in respect of replacement and purchase of new machinery.
- To standardize the spare and consumable material in according with the machine requirement.

Importance of maintenance;

- Due to lack of maintenance the machine may breakdown during manufacturing which result in loss of production and money.
- If the machinery is poorly maintained or totally negelected it may breakdown in such a form that it may required to purchase a new machine which result in heavy loss of time production and money.
- Due to abrupt stoppage of production at one station in a transfer line machine the in-process material at other stations also damage and result in material loss.
- In case of temporary work stoppage, the workemen will need alternative arrangement which lead to loss of production rate.
- Due to sudden work stoppage, we have to pay worker for no work which increase the production cost.

Types of Maintenance;

1. Unplanned Maintenance

These types of maintenance is not sheduled or planned but executed when requirement arises.

a). Breakdown Maintenance

- In this type of maintenace some minor adjustment and lubrication are done at proper interval but major repair of parts or replacement of parts and other maintenance work are carried out only after the equipment had become totally non-operational.

In this type of maintenance after breakdown of machine the production department informed the maintenance is suited department about breakdown and request to rectify the detect.

- This type of maintenance is suited in following conditions;
  i). If the sudden failure of a machine did not bring big financial losses.
  ii). If sudden failure of one machine did not bring lead to the damage of other machine.
  iii). If about failure of machine did not lead to damage result in safety hazard.
  iv). If the cost of scheduling practice of maintenance did not justify it.
  v). It is best suited for small size plant.

b. Opportunistic Maintenance;

- It is the method of utilizing at opportunity which is not schedule but may arise due to total breakdown of a machine or due to pause in production or due to breakdown of other machine in line.
- This method enhance the running life of equipment and prevents frequent shutdown failure.

C. Corrective Maintenance;

In this type of maintenance the maintenace work are taken to restore such equipment which likely to fail or has already failed. It include works from small jobs like some adjustment to major maintenance work and redesign of the machine.

2. Planned Maintence

It is also known as schedule maintenance in which a proper schedule of mantenance for equipment is made by the maintenance department and time to time maintence is done.

a. Routine Maintenance:

- It is most simple type of planned maintenance in which small work like cleaning, inspecton lubrication adjustment of belt and chain, electrical things etc, are done at scheduled interval.
- Small defects detected during rutine inspection is correct immediately but if larger defect are detected which involves too much time and work then there correction is schedule for the period of next shutdown.

b. Preventive Maintenance:

It is a well planned schedule maintenance which is considered in advance before the need for maintenance arises. This type of maintenance is done to minimize the chance of sudden failure of machine element and to minimize unanticipated interruption in production work.

~~c. Predictive Maintenance:~~

- It contains several different types of maintenance activities like :—

1. Routine inspection, cleaning, lubrication.
2. Internal cleaning of components and equipment, replacement of worn out parts like belt and chain etc.

Main objective of preventive maintenance:

- To keep the equipment and machinery of the plant at its maximum productive capacity.
- To enable maximum production at lowest possible cost of repair
- To have availability of equipment and machinery in operational condition at all times.
- To ensure safety of workers.
- To minimize likelihood of breakdown and production stoppage.

Advantages of preventive maintenance;

The following are the main advantages of preventive maintenance

1. The number of repeated repair is reduce.
2. The number of breakdown reduce thus less production loss.
3. The life of the equipment increase.
4. The quality of product increase and less defective product will produce.
5. They results in better safety of workers.

Predictive Maintenance:

→ It is the most advance form of maintenance, it predict the failure of any component in the machine before it occurs.

→ It basically involves recognizing the change in physical condition of an equipment or parts of machine with the help of various sensing and monitoring devices such as amplitude sensor, strain gauge, vibration analysis, ultrasonic sensor etc, such devices indicate the significant change in physical condition which may result in failure of parts or equipments.

Preventive Maintenance	Predictive Maintenance
→ It is carried out at fixed time of interval.	→ It is decided on the basis of monitored condition as & when needed.
→ Frequency of maintenance are scheduled in advance.	→ The decision is based on condition monitoring an maintenance will be done just before the failure.
→ Decision of maintenance and repair is made on past experience judgement and recommendation of the manufacturer.	→ The condition monitoring device used regularity and monitor the condition.
→ It is more respectitive and require normal tools.	→ It is less respetitive and required special tool & skill.
→ It is suitable for those machine which mass produce single type of product.	→ It is suitable for those machine which produce variety of highly sophisticated parts.

Design out maintenance:

Some times some defects are frequently occur in the machine due to faulty design of machine tool or parts due to following reasons;-

1. Improper knowledge of operation conditions.
2. Low factor safety.
3. Deviation from close tolerances for making the product cheaper.
4. Uses of inferior material for cost cutting.

If the defect is detected during maintenance the design section is advice by maintenance people to change the design.

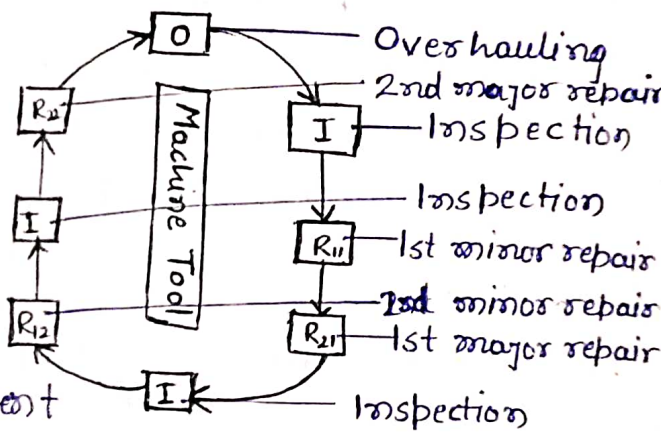
Repair Cycle Analysis

The maintenance schedule generally include inspection, repair and overhauling. The repair may be minor like adjustment of belt tension, replacement of bearing or major like replacement of sliding guide, repairing of bearing seats etc, so while formulating a schedule the maintenace work may be classify into these works;-

- Inspection → 1. Inspection [I]
- Repair → 2. Minor Repair [R_1]
- Repair → 3. Medium or Major Repair [R_2]
- Overhauling → 4. Overhauling [O].

Now, the repetitive performance of all the maintenance activity in between two overhauling is termed as "Repair Cycle".

So, a typical repair cycle contains three inspection and two major and two minor repair in between the time span of two consecutive overhauling.



The above cycle may be represent as $O_1 \rightarrow I_1 \rightarrow R_{11} \rightarrow R_{21} \rightarrow I_2 \rightarrow R_{12} \rightarrow I_3 \rightarrow R_{22} \rightarrow O_2$.

Advantages of Repair Cycle Analysis;

A repair cycle analysis is done for the following purpose:-

a. It helps to decide the schedule time of maintenance.
b. It helps to decide the skill set of the maintenance staff required.
c. It help to avoid repetition of same maintenance procedure twice.
d. It help to decide the tool and equipment required for maintenance.
e. It help to prepare the schedule of different maintenance staff required.

Repair Complexity

→ A repair complexity tells that how complex a maintenance procedure or repair work of a machine is form other machine.

→ It is used for comparision of maintenance task of two different machine. It is denoted by a index technically known as repair complexity number.

→ The index is decided by taking into account the power transmission devices, hydraulic units and complex mechanisms associated with the function of machine. High the repair complexity number more complex will be maintenance and repair work and require higher activity of repair.

→ For example the repair complexity number for boiler may be 12, for an air compressor it may be 8 but for a turbine it may be 14.

Advantages of Repair Complexity;

A repair complexity number is needed for following purpose;—

1. It help to decide the size of maintenance staff needed.
2. It helps to decide the inventory (Spare parts of tools) required to do the maintenance work.
3. It help to decide maintenance cost of a machine tool.
4. It help to decide the time for maintenance required.

Housekeeping

Housekeeping is an activity defined as "a provision of clean, comfortable and safe environment", and one who does so is commonly known as housekeeper. In industry the housekeeping work may be done by maintenance department or a seperate department is estabilished for this purpose known as housekeeping department.

A housekeeping involves following work to keep the work place/ machine area clean to avoid any hazard:-

1. Keeping all the work related tools in proper place after work has been done.
2. Proper disposal of scrap should be done regularly to keep the machine clean.
3. Lubrication system should be inspect regularly so that any leakage if occur should be correct.
4. All the electrical connection should be checked regularly.
5. After every shift of work before leaving the workplace machine tool must be cleaned.

Maintenance Manual

→ A maintenance manual is a technical document which provide recommendation and information necessary to maintain the system effectively.

→ It is created on the basis of experiment past experience and previous record of maintenance work of the machine tool.

→ It contain the step-by-step instruction related to maintenance work of each and every part of the machine tool element.

→ It uses part drawing as well assembly drawing to provide instruction for the maintenance work.

→ It contain a basic schedule recommended by the manufacturer for the maintenance of every element of machine tool.

→ It contain a list of common problems which may arise in the machine tool with their trouble shooting.

→ It mention all the type of tools required for the maintenance work.

Index of a Maintenance Manual;

An index of a maintenance manual shows all the information it contain with reference to the page on which they are mention.

A common index of a maintenance manual contains the following;

1. General Information
   a. Technical specification
   b. Warranty terms
   c. General Instruction
   d. Tool required for maintenance
2. Periodic Maintenance
3. Servicing of Machine tool
4. Services Information
   a. Service data
   b. Trouble shooting

Maintenance Records

A maintenance records also known as a maintenance log or service history, is detailed document that records all the maintenance activities performed on machinary over time. This record is essential for tracking the performance while minimizing the risk of unexpected breakdowns

Importance of Maintenance Records

→ Operational Efficiency : Regular updates helps in ensuring that machinary operates at optimal efficiency.

→ Safety : Maintenance records are important to maintain safety standards and regulatory requirements.

→ Asset Management : They help to check into the health and lifecycle of the equipment.

→ Predictive Maintenance : Analysis of these records can help in predicting when a piece of equipment might fail, allowing earlier action to be taken.

→ Financial Planning : Detailed records of maintenance expenses help in financial planning for future maintenance needs.

Total Productive Maintenance (TPM)

→ It is the new concept of maintenance developed in order to maximize the utilisation of the plant and its equipment.

→ In this maintenance concept the operator themselve take care of the routine maintenance work and maintenance staff is invited only when there is some major problem or a breakdown occurs.

→ It can be considered as the medical science of machine

Advantages of TPM;

1. The requirement of manpower reduce
2. Idle time is reduced
3. Smaller problem is solved immediately.
4. No waiting time for smaller problem.
5. Production get stabilised, the rate of production is constant.

Total productive maintenace concept consist of 8 pillars and 5S foundation.

1. Autonomous Maintenance
2. Planned Maintenance
3. Quality integration
4. Focused improvement
5. New equipment management
6. Training and education
7. Safety, health and environment.
8. TPM in administration.

1. Short: Eliminate anything that is not truely needed in the work area.
2. Straighten : Organize the remaining item.
3. Shine : Clean and inspect the work area.
4. Standardize : Create standards for performing the above three activities.
5. Sustain : Ensure the standards are regularly applied.

The principles of TPM revolve around the following key components :

→ Minimize effectiveness : — TPM aims to ensure equipment performs it intended functions without interruptions, defects or accidents.

→ Involve all employees : — It involve all employee from management to floor operators, in maintenance activities. The collaborative approach helps in developing a sense of ownership among employees, encourag them to take part in maintaining their equipment.

→ Implement preventive maintenance : Regular maintenance tasks are scheduled failures before they occur. This includes cleaning, lubrication, adjustments, and parts replacement at scheduled.

→ Focus on continuous Improvement : TPM encourage continuous improvement in production and maintenance processes through systematic problem-solveing techniques.

→ Training : Ongoing draining and education for all employees · so that they understand the operational process and are capable in using and maintening the equipment.

→ Safety, Health and Environment : TPM programs include safety, health and environmental concerns into the maintenance process. The goal is to create a safe workplace with no accidents and minimal impact on the environment.

→ Eliminate Waste : A key goal of TPM is the eliminate of all forms of waste, including waste time, material, and labour. This includes focusing on reducing small stops and defects that disturb effective operations.