UNIT - I

THEORY OF METAL CUTTING

Introduction

* In any engineering industry, Components are made into Various Shapes and Sizes by using metals.

* These Shapes and Sizes are formed by using Suitable tools depending on the type of operations what we Choose to obtain our requirements.

* So, the required Shape is Obtained by a Suitable metal removing Process.

Metal Removing Processes

Generally, The metals are removed from the Workpiece to obtain the required Shape and Size by Various Processes.

They are classified into two types Such as

1, Non - Cutting Process or Chipless Process.
2, Cutting Process or Chip Process.

1, Non - Cutting Process (or) chipless process

* In the former type, the metal is Shaped under the action of forces or heat or Combination of both force and heat.

* Since there is no Cutting of metal, the chip formation will not be there.

The Various non - Cutting Process are * forging.

1. Drawing
2. Spinning
3. rolling
4. Extruding.

2, Cutting Process (or) chip Process:

* The required Shape of metal is obtained by removing the unwanted material from the Workpiece in the form of Chips.

* The Various Cutting Processes are

1. Turning.
2. Drilling
3. Milling
4. Boring
5. Shaping
6. Broaching

Mechanism of Metal Cutting:

* During machining, the Cutting tool exerts a Compressive force on the workpiece.

* The material of the Workpiece is stressed beyond its yield Point under this Compressive force.

* It Causes the material to deform Plastic flow takes Place in a localized region Called Shear Plane.

* The Sheared material begins to flow along the Cutting tool face in the form of Small Pieces Called Chips. The Compressive force applied to form the Chip is Called force.

The following Points are Worth to be noted:

* The Shear Plane is actually a narrow Zone of the order of about 0·025mm.

* The Cutting edge of the tool is formed by two intersecting Surfaces.

* The Surface along which the chip moves upwards is called rake Surface.

* The Surface which is relieved to avoid rubbing with the machined Surface is Called flank.

Properties of During Cutting Process:

1, Hardness
2, Abrasive Qualities
3, Toughness
4, Tendency to weld
5, Inherent hard Spots and Surface inclusions.

Mechanism of metal Cutting:

1, Hardness
2, Abrasive Qualities
3, Thoughness
4, Tendency to weld
5, Inherent hard Sports and Surface inclusions.

Mechanics of Chip Formation:

* The mechanism that involves during formation of Chip is explained in mechanism of metal Cutting itself.
* The Various types of Chips are formed during metal Cutting.
* The type of chip formed during metal Cutting depends upon the machining Condition and material to be Cut.

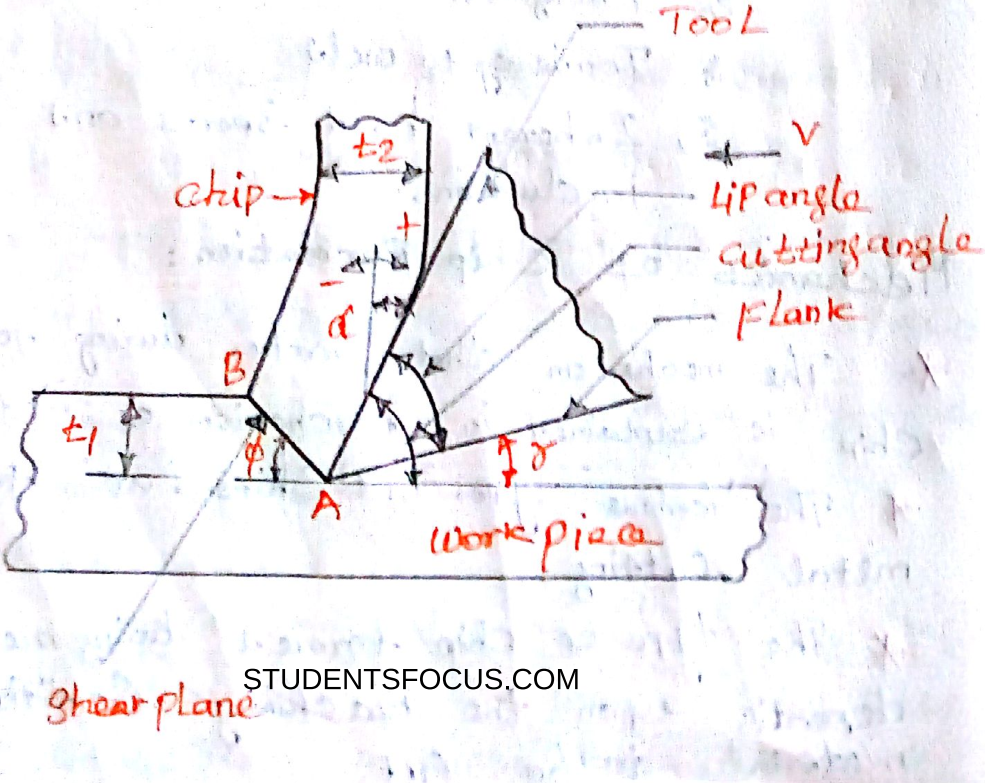
Mechanics of Chip Formation:

The mechanism that involves during formation of chip is explained in mechanics of metal cutting Its self

Type of chip variables are influencing in Producing.

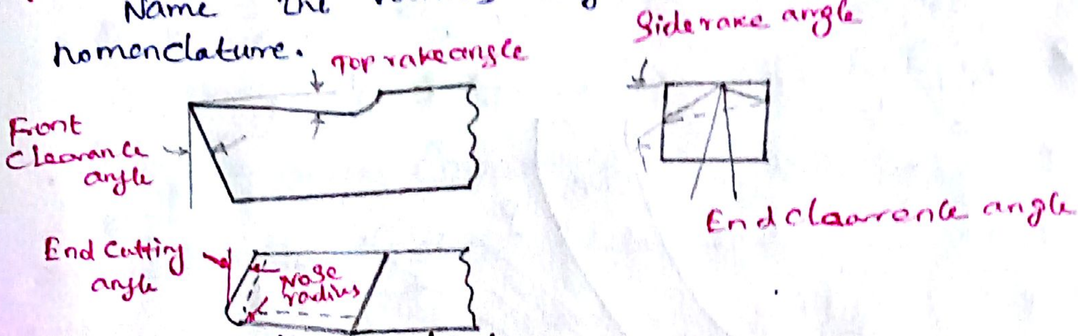
1. Mechanical Properties of material to be cut in Particular ductility and brittleness.
2. Depth of cut
3. Various angles of tool especially rake angle.
4. Cutting Speed.
5. Feed rake
6. Type of Cutting fluid.
7. Machining temperature of Cutting region.
8. Surface finish required on Workpiece.
9. Co-efficient of friction b/w chip and tool interface.

Mechanism of metal Cutting:



Single Point Cutting Tool:

Name the Various angles and Parts is known as nomenclature.



Forcess in Machining:

For designing of Cutting tool, It is necessary that the Various forces acting on a tool are Very Important.

During the Cutting Process, the following Three Components of Cutting forces are mutually acting right angles.

i) Feed forces F_x acts in a horizontal plane but in the direction opposite to feed.

ii) Thrust force F_y acts in the direction Perpendicular to the generated Surface.

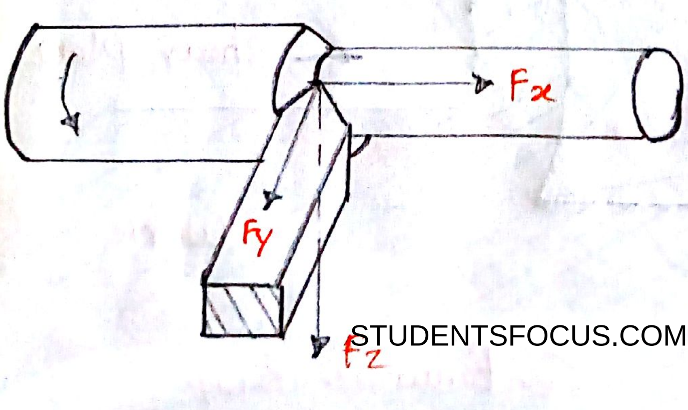
iii) Cutting force F_z acts in the direction of the main Cutting motion.

The resultant force, $R = \sqrt{F_x^2 + F_y^2 + F_z^2}$

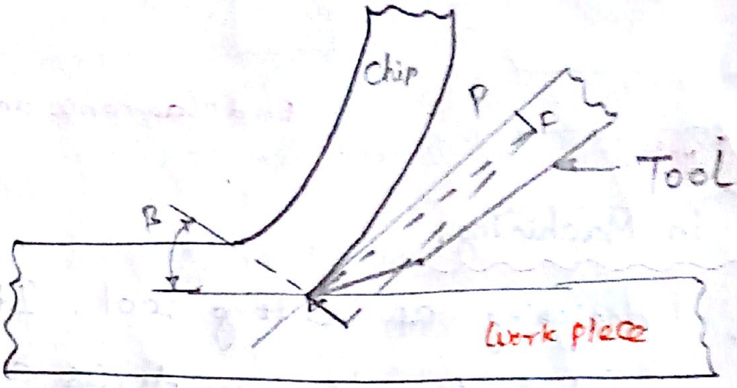
$$R = \sqrt{F_z^2 + F_{xy}^2}$$

$$F_{xy} = \sqrt{F_x^2 + F_y^2}$$

Cutting forces:



Cutting forces on chip :



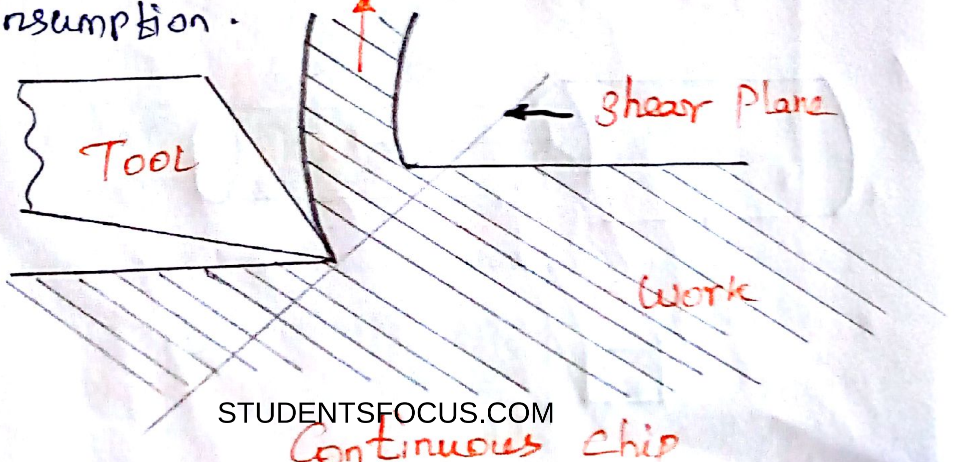
Types of chips :

* 1, Continuous chip
* 2, DisContinuous chip
* 3, Continuous chip with build-up edge.

1, Continuous chip :

→ During cutting of ductil material, a Continuous ribbon such as chips is produced due to the Pressure of the tool cutting edge in Compression and shear.

→ This type of chip is most required, since it gives the advantage of good surface finish, Improving the tool life and less power consumption.



Continuous chip

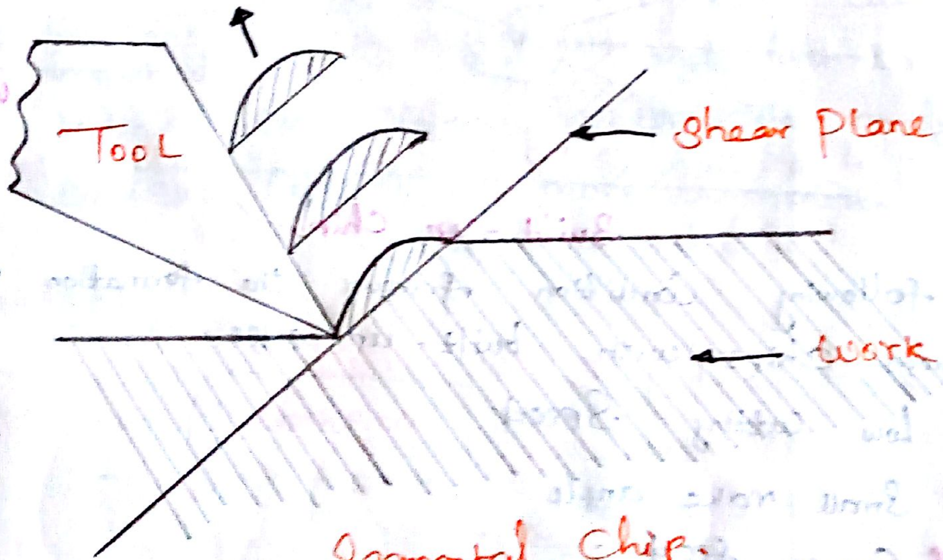
The following Condition favours the formation of Continuous Chips.

* Ductile material Such as Low Carbon Steel, aluminium, Copper etc.
* Smaller depth of cut
* High Cutting Speed.
* Large rake angle
* Sharp Cutting edge
* Proper cutting fluid
* Low friction b/w tool face and chip interface.

Discontinuous or Segmental chip:

Discontinuous chips are produced while maching brittle material Such as Gray Cast iron, bronze. high Carbon steel at low cutting Speed without fluids when the friction exists b/w tool and chip interface.

During machining, the brittle material lacks its ductility which is necessary for Plastic chip formation



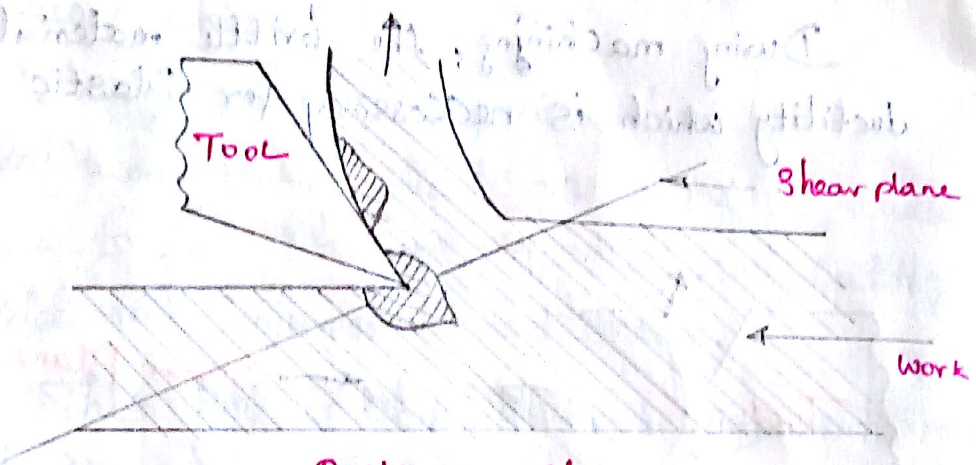
Segmental Chip.

The following conditions favours the formation of discontinuous chips

* Machining of brittle Material
* Small rake angle
* Higher depth of cut
* Low Cutting Speeds
* Excess Cutting fluid
* Cutting ductile material at very low feeds
* With Small rake angle of the tool.

Continuous Chip with Built-up Edge:

During Cutting Process, the interface temperature and Pressure are quite high and also high friction b/w tool-chip interface.



Build-up Chip.

The following Condition favour the formation of Condinuous Chips with built-up edge

* Low cutting Speed
* Small rake angle
* Coarse feed
* Insufficient Cutting fluid.
* Large uncut thickness

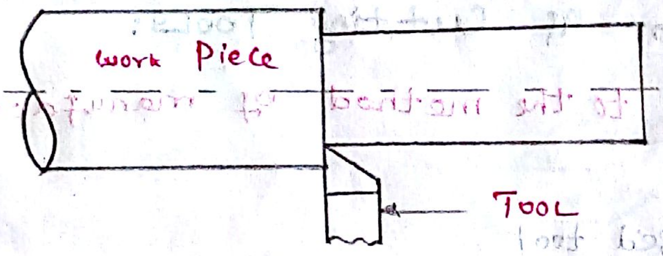
Types of Metal Cutting Process:

i) orthogonal Cutting Process - (Two - dimensional Cutting)

ii) oblique Cutting Process - (Three - dimenensional Cutting).

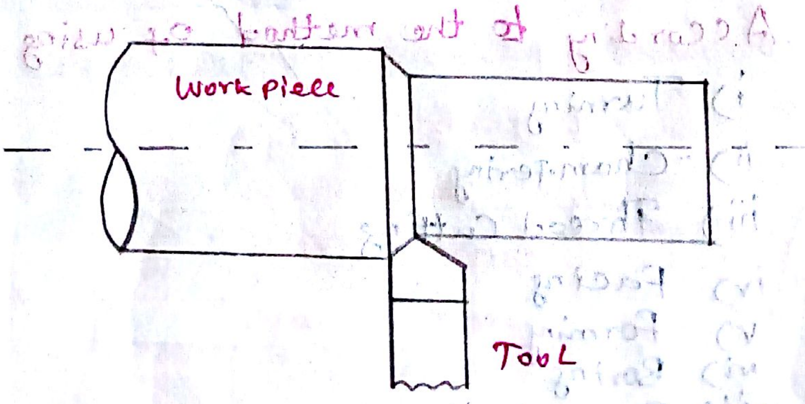
(i) orthogonal cutting Process:

In orthogonal Cutting, the Cutting edge of the tool is Perpendicular to the Cutting Velocity Vector. Orthogonal Cutting involves only two forces and it makes the analysis Simpler.



(ii) oblique Cutting Process:

In oblique Cutting, The Cutting edge is inclined at an acute angle with the normal to the Cutting Velocity vector. The analysis of the oblique Cutting is more Complex.



Cutting TOOLS:

1, Single Point Cutting tool
2, Multi Point Cutting tool.

1, Single Point Cutting tool:

Single Point Cutting tools are used for turning, facing, Chamfering, thread Cutting and Parting off operations.

2, Multi Point Cutting tool:

Multipoint Cutting tools are used for knurling, drilling and milling operations

Classification of Cutting TOOLS:

1, According to the method of manufacturing the tool

i) Forged tool
ii) Tipped tool brazed to the Carbon Steel Shank.
iii) Tipped tool fastened machanically to the Carbon Steel Shank.

2, According to the method of holding the tool:

i) Solid tool
ii) Tool bit inserted in the tool holder

3, According to the method of using the tool:

i) Turning
ii) Chamfering
iii) Thread Cutting
iv) Facing
v) Forming
vi) Boring
vii) Internal threading
viii) Grooving
ix) Parting - off

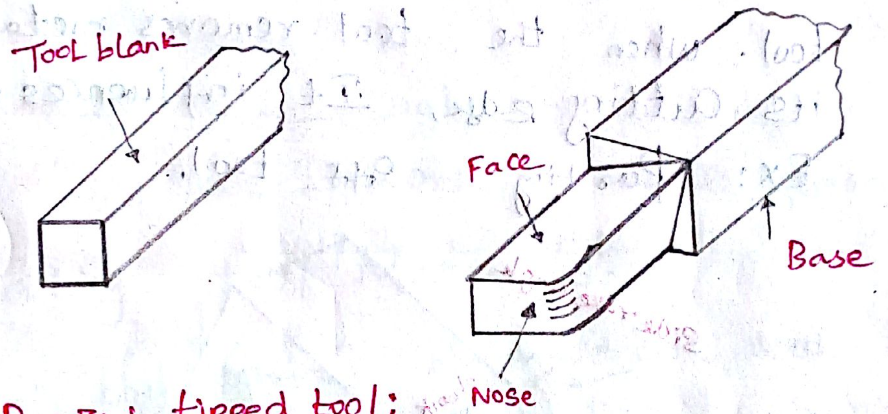
4) According to the method of applying feed:

i) Right hand tool
ii) Left hand tool
iii) Round nose tool

According to the Method of Manufacturing the TOOL:

(1) Forged tool:

* This type of tool is manufactured from high Carbon Steel or high speed steel.
* The Solid Shank of the tool is formed to the required shape by forging Process



(2) Brazed tipped tool:

These types of tools ared made from Cemented Carbide tool materials. It has high brittleness and Low tensile Strength. But, its Cost is high.

a) Torch brazing
b) Furnace brazing
c) High frequency induction brazing.
d) Dip brazing.
e) Resistance brazing
f) Laser brazing and electron beam brazing.

Influence of Tool Angles:

It is defined as the slope given on the tool. Usually, the rake angles are provided for the following functions.

1, To allow the chip flow in any convenient direction

2, To reduce the required cutting force

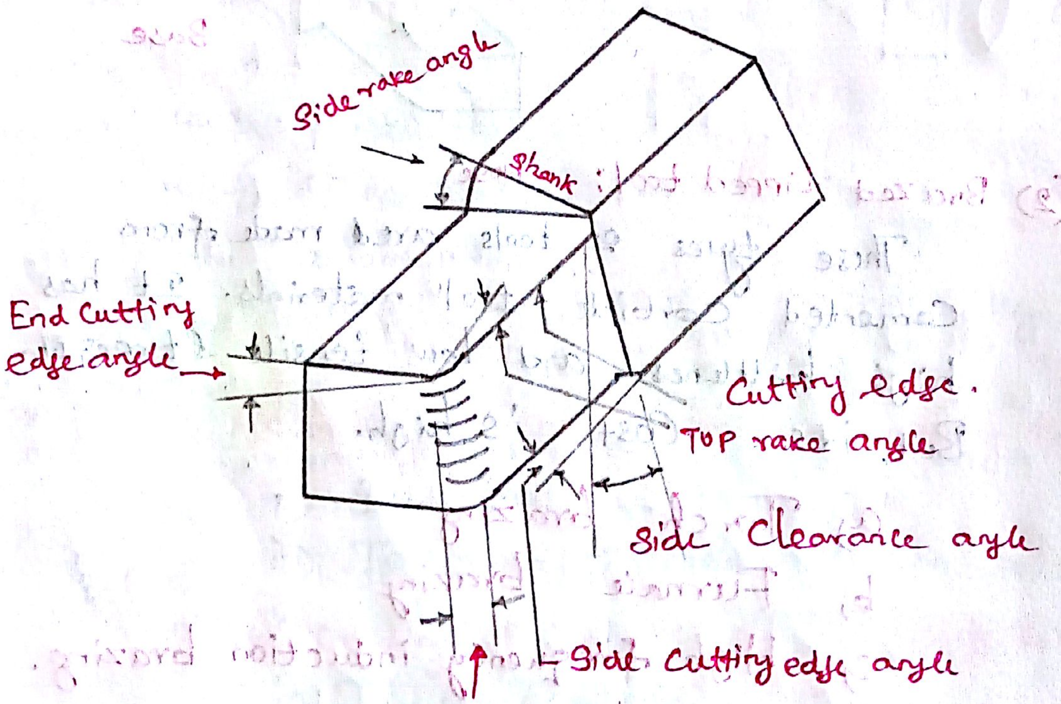
3 To provide keenness to the cutting edge

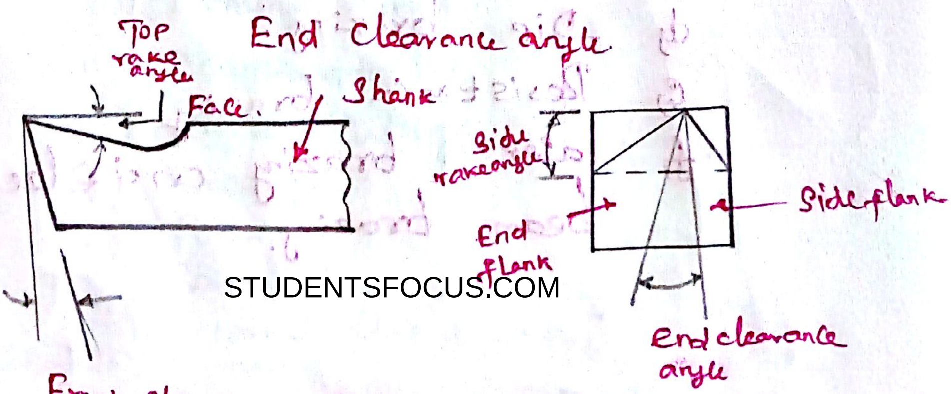
4, To improve the surface finish.

(i) Front rake:

It is given on front portion of the tool. when the tool removes metal from its cutting edge, It influences machining

Ex: Parting off tool.





Types of Turning Tools:

(i) Rough turning tool
(ii) Finish turning tool

Thermal Aspects:

In metal Cutting Process, the energy dissipated at the Cutting edge is Converted into heat. This heat influences a tool and its develops friction b/w the Cutting edge of the tool and Chip interface.

* 1, Shear Zone
* 2, Chip - tool interface region
* 3, Tool - Work interface region.

Cutting tool Materials:

The Various materials are used to removed the metal from work Piece. The tool must be harder than the material which is to be Cut.

Factors: * Volume of Production
* Tool design.
* Type of M/c Process.
* Physical and Chemical Properties of work material
* regidity and Condition of M/c

Properties/characteristics of cutting tool Material:

1, Hot Hardness
2, Wear resistance
3, Thoughness
4, Low friction
5, Cost of tool.

Tool Wear:

During machining process, the tool is subjected to three important factors such as forces, temp and sliding action due to relative motion b/w tool and work piece.

Mechanism / Forms of Tool Wear:

1, Attrition
2, Diffusion

Classification of tool wear:

1, Flank wear or Creater wear.
2, Face wear
3, Nose wear.

Tool Life:

Tool life is defined as the cutting time required a tool life criterion or time elapsed b/w two consecutive tool resharpenings.

Factors Affecting Tool Life:

1, Cutting Speed.
2, Feed and depth of cut
3, Tool geometry
4, Tool material
5, Cutting fluid
6, Work material
7, Regidity of work.

Surface finish:

Factors:

1) Cutting Speed
2) Feed
3) Depth of cut.

Cutting fluids:

During metal cutting, heat is generated due to plastic deformation of metal, friction of the tool workpiece interface.

* 1) Function of Cutting fluids
* 2) Properties of Cutting fluids

Types of Cutting fluids

a) Water based Cutting fluids
b) Straight or heat oil based Cutting fluids.

Machinability:

Machinability is defined as the ease with which a material can be satisfactorily machined

* The life of tool before tool failure or resharpening
* The quality of the machined surface.
* The power Consumption per unit Volume of material removed.

UNIT - II

TURNING MACHINES

CENTRE LATHE :

A Lathe is a father of all machine tool. It is the most Important machine used in any workshop.

The main function of a Lathe is to remove the metal from a piece of work to obtain the required shape and size.

The parts to be machined can be held b/w two rigid supports called live and dead centres.

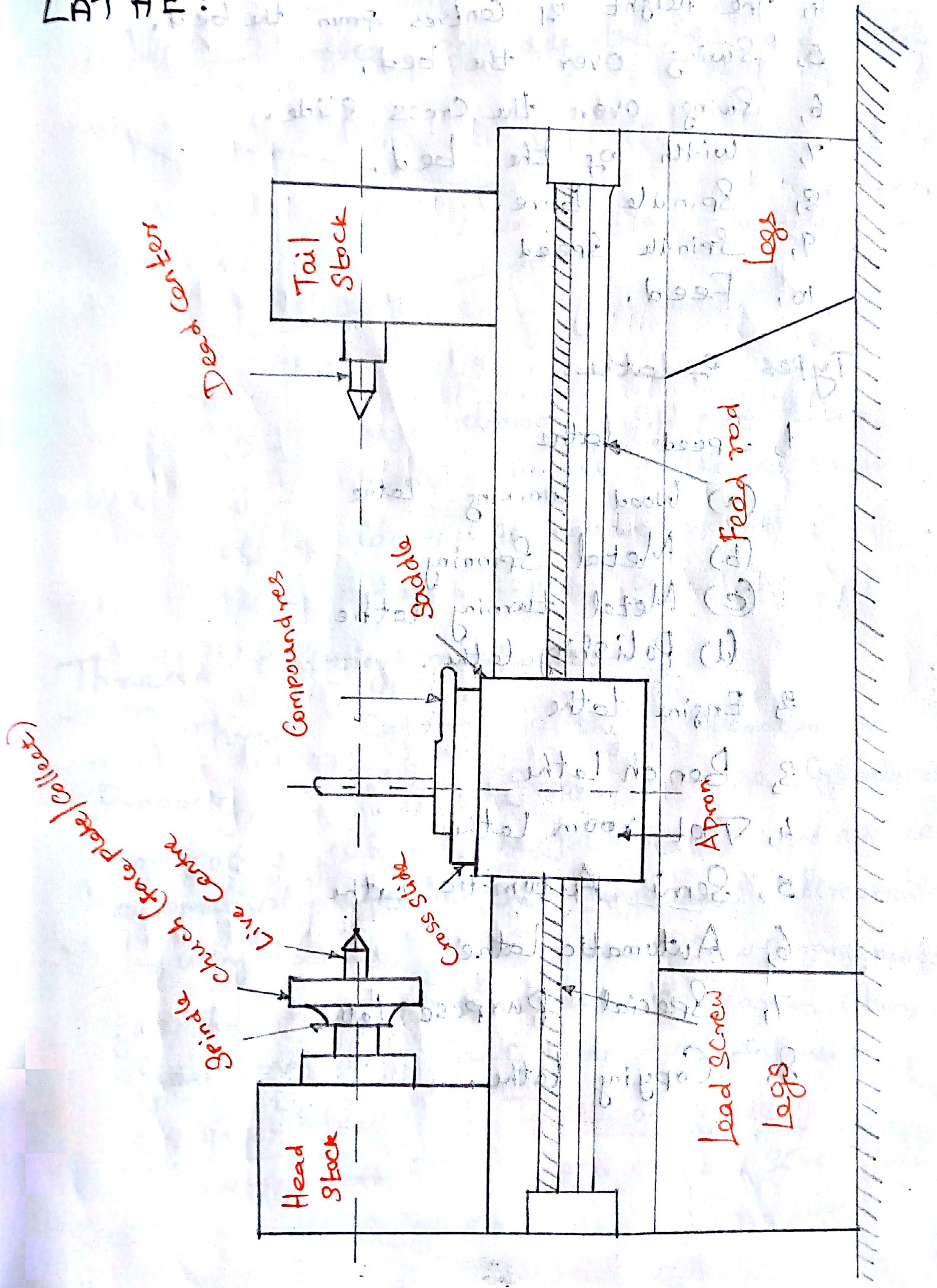
The following operations can be done by using Lathe.

* 1, Turning.
* 2, Taper Turning
* 3, Eccentric turning
* 4, Chamfering
* 5, Facing
* 6, Drilling
* 7, Boring
* 8, Reaming
* 9, tapping
* 10, knurling
* 11, forming
* 12, Grooving
* 13, Polishing
* 14, Spinning and Thread Cutting.

Parts of the Lathe:

(i) Bed
(ii) Head Stock
(iii) Tail Stock
(iv) Carriage
(V) Feed Mechanism.

LATHE:



Specification of a Lathe:

1, The length of bed.

2, Maximum distance b/w dead live Centres.

3, Type of bed, i.e. straight, Semi gap or gap type

4, The height of Centres from the bed.

5, Swing over the bed.

6, Swing over the Cross Slide.

7, Width of the bed.

8, Spindle bore.

9, Spindle Speed

10, Feed.

Types of Lathe,

1, Speed lathe

(a) Wood working Lathe

(b.) Metal Spinning

(c) Metal turning lathe

(d) Polishing lathe.

2, Engine lathe

3, Bench lathe

4, Tool room lathe

5, Semi Automatic Lathe

6, Automatic Lathe

7, Special Purpose Lathe

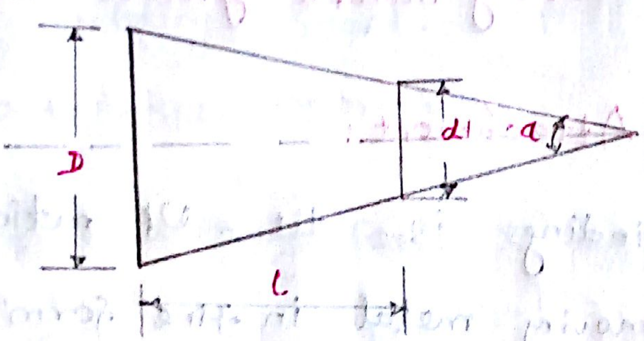
8, Copying lathe.

Taper Turning:

A taper is defined as the uniform change in the diameter of a workpiece measured along its length. Taper may be expressed in two ways.

(i) The ratio of difference in diameter to the length

(ii) In degrees of half the included angle.



D – Large diameter of the taper.

d – Small diameter of the taper

L – Length of tapered part

α – Half taper angle.

Thread Cutting methods:

Thread Cutting is the Operation of Producing a helical groove on the cylindrical workpiece. When the Job rotates, the tool is automatically fed in the longitudinal direction by using Locknut and Lead Screw arrangements.

The number of teeth on Various Change gears may be Calculated as follows.

$$\frac{\text{Driver teeth}}{\text{Driven teeth}} = \frac{\text{Teeth on Spindle gear}}{\text{Teeth on Lead Screw gear}}$$

Special Attachments:

Milling Attachment:

Milling in the Process of removing metal by moving the work against a rotating Cutter is mounted on the tool holder Called arbor. Milling Cutters have multipoint Cutting edges

1) For Cutting grooves on keyways.
2) For Cutting multiple grooves and gear wheel.

Grinding Attachment:

* Grinding is the Operation of removing metal in fine form of chips. It is done by moving the work against a rotating abrasive wheel.

* This abrasive wheel is known as grinding wheel. Both external and internal grinding Can be Cut by using Special attachments on a lathe.

* The work is held b/w centres or on a Chuck and rotated for grinding external Surfaces.

Power Estimation:

Power is the product of cutting force and velocity. In machining process, the force component is the force in the direction of cutting speed.

Force involved in orthogonal cutting is the force component in the direction of cutting speed. Ex: Turning, facing, Parting-off operations.

W_c = Cutting force × Velocity of cutting or cutting speed.

$$W_c = F_c \times V$$

W_c = Force in the direction of cutting speed.

F_c = Cutting force.

V = Velocity or cutting speed.

Due to shear and friction,

* 1) Power due to shear
* 2) Power due to friction.

Total power = Power due to shear + Power due to friction

$$W_c = W_s + W_f$$

$$F_c \cdot V = F_s \times V_s + F_f \times V_f$$

Capstan and Turret Lathes:

The main parts of Capstan and turret lathes are as follows.

1, bed
2, Head Stock
3, Turret head and Saddle
4, Cross Slide.

1, Bed:

Bed is the base part of the lathe. It is a box type which is made of Cast iron.

2, Cross Slide

1, Reach over type
2, Side hung type.

3, Head stock:

A Headstock of Capstan and turret Lathe is similar to a head in ordinary Centes lathes but larger and behavier in Construction to house the Spindle and driving mechanism.

Pre-Selective head stock

4, Saddle
5, Turret head.

Automatic Lathes:

* Automatic Lathes or simply automats are machines tools in which all operations required to finish off the workpiece are automatically done without the attention of an operator.

* These m/c are meant for producing identical parts without the participation of an operator.

Advantages of Automatic Lathes:

1, Mass production of identical parts is highly achieved.
2, High accuracy is maintained.
3, Time of production is minimized.
4, Less floor space is required
5, Constant flow of production occurs.

Classification of Automatic Lathes:

1, Classification according to the type of work material used:
   a, Bar stock mechanism
   b, Chucking machines.
2, Classification according to the number of spindles:
   a, Single spindle automates
   b, Multi spindle automates
3, Classification according to the arrangement of spindles:
   a, Horizontal spindle type
   b, Vertical spindle type.

Single Spindle Automatic lathes:

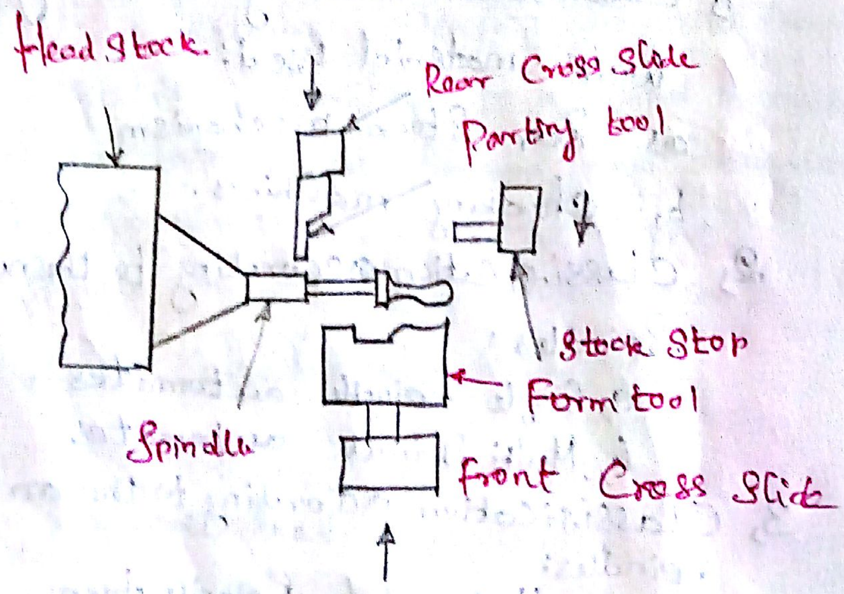
A Single Spindle automatic Lathe is a modified from of turret lathe. These machines have an addition to a 6-Station or 8-Station turret, a maximum of 4 Cross Slides.

The following types of Single Spindle automatic Lathe are mostly used

1. Automatic Cutting off M/c
2. Automatic Screw cutting M/c
3. Swiss type automatic Screw M/c.

1. Automatic Cutting off Machine:

These machines are Simple in design and they are used for Producing large quantities of Parts of Smaller diameter and Shorter lengths.



Swiss Type Automatic Lathes:

This type of automatic Lathe is Suitable for Small Parts, but they Should be long and Slender Parts Such as Parts of Wriswatches.

There is a distinct difference b/w Conventional automatic Lathes and Swiss type Automatic lathes.

Parts:

1, Sliding Head Stock
2, Tool bracket
3, Feed Base
4, Cam Shaft

Advantages of Swiss type screw machine:

1, It is used to manufacture Precision turning of Small Parts.
2, It has five tool Slides
3, wide range of Speeds is available
4, It is rigid in Construction
5, Micrometer tool Setting is possible
6, Simple design of Cams is enough
7, Tolerance of 0.005 to 0.0125mm is obtained.

Single Spindle Automatic Screw Cutting M/c

* These machines are essentially automatic bar type turret lathes.
* They are widely used for Production Of all Sorts of Small turned Part
* It mainly Consists Of a Cross slide and turret.
* Two Cross Slides, one front Cross Slide and another rear Cross Slide are Provided for Cross feeding tools.
* The turret Slide is Placed at the right end of the bed.
* It Carries the turret having Six tool holes.
* The Various tools used in the machine are mounted arround the turret in a Vertical Plane in line with the Spindle.

Applications:

1, Producing Small Jobs.
2, Screws
3, Stepped Pins
4, Tapper bins
5, Bolts.

Multiple Spindle Automatic Lathes

Multiple Spindle automatic Lathes are machines which Can produce larger workpieces than Single Spindle automats.

The Principle advantages of Multi Spindle automat is that it has a tool Slide working Simultaneously on the Jobs on all Spindles and hence, the time for producing a Piece is the time for the Longest Cut.

Classification of Multispindle Automatic Lathes:

1. According to the type of workpiece (stock) used:
   a. Bar type machine
   b. Chucking type m/c
2. According to the type of arrangment Spindle
   a. Horizontal Spindle type
   b. Vertical Spindle type.
3. According to the Principle of operation.
   a. Parallel action type
   b. Progressive action type.

Unit - III

SHAPER, MILLING AND GEAR CUTTING MACHINES

SHAPER :

* The one and only basic machine is lathe. Except this lathe; other basic machines are shaper, planer, slotter, drilling, grinding, boring, milling and broaching machines.

Shaper, planer and slotter are used for machining flat surface which may be horizontal, vertical or inclined surfaces.

* Drilling, grinding, boring, milling and broaching machines are not used for m/c flat surfaces but they are performing specific operations by using a multi point cutting tool.

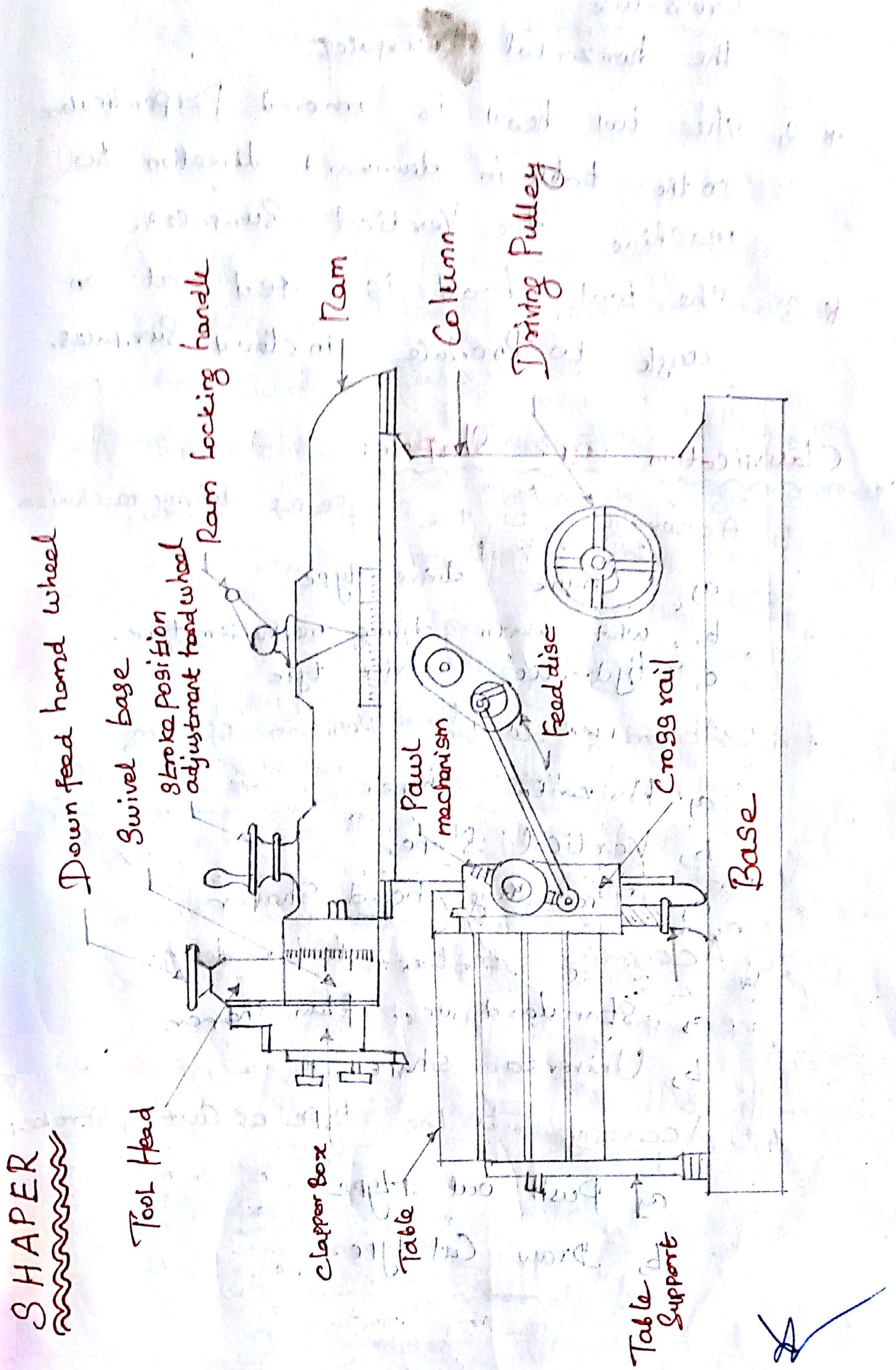
Principle of operation:

The shaper having a reciprocating type of machine tool with single point cutting tool is used to produce flat surfaces. The flat may be horizontal, vertical or inclined surfaces. It has the three important parts such as

1. Table
2. Tool head
3. Ram

The tool head is fitted on the front end of the ram while the job is rigidly fixed on the table. The tool is mounted on the tool post or head.

The ram reciprocates along with the tool to remove the metal during forward stroke called as Cutting stroke.



Machining Various Types of Flat Surfaces:

* 1, The table is moved in a Cross-wise direction to machine the horizontal Surfaces.
* 2, The tool head is moved Perpendicular to the table in downward direction to machine the Vertical Surfaces.
* 3, the tool head is fed at an angle to Produce inclined Surfaces.

Classification of Shaper:

1, According to the type of driving mechanism

a, Crank drive type

b, whit worth driving mechanism type.

c, Hydraulic drive type

2, According to the Position of ram

a, Horizontal Shaper

b, Vertical Shaper

c, Travelling head Shaper

3, According to the table design

a, Standard or Plan Shaper

b, Universal Shaper.

4, According to the type of Cutting Stroke

a, Push out type

b, Draw Cut type.

Types of Quick Return Mechanism:

* 1, Hydraulic drive
* 2, Crank and Slotted Link mechanism.
* 3, Whitworth quick return mechanism.

Drilling:

* Drilling is the process of producing hole on the work piece by using a rotating cutter called drill.
* The machine on which the drilling is carried out is called drilling machine.
* The drilling machine sometimes is called as drillpress as the m/c exerts the vertical pressure to originate a hole.

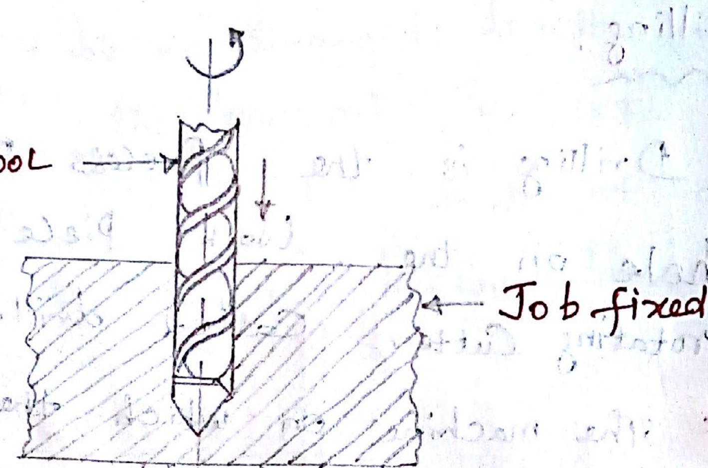
Classification of Drilling machine:

* 1, Portable drilling M/c
* 2, Sensitive drilling m/c
  - a, Bench type
  - b, Floor type.
* 3, Upright drilling M/c
  - a, Round coloumn type or pillar type.
  - b, Box coloumn type.
* 4, Radial drilling m/c
  - a, Plain type
  - b, Semi-universal type
  - c, Universal type.

* 5, Glary drilling M/C
* 6, Multiple Spindle drilling m/c
* 7, Automatic drilling m/c
* 8, Deep hole Drilling M/c.

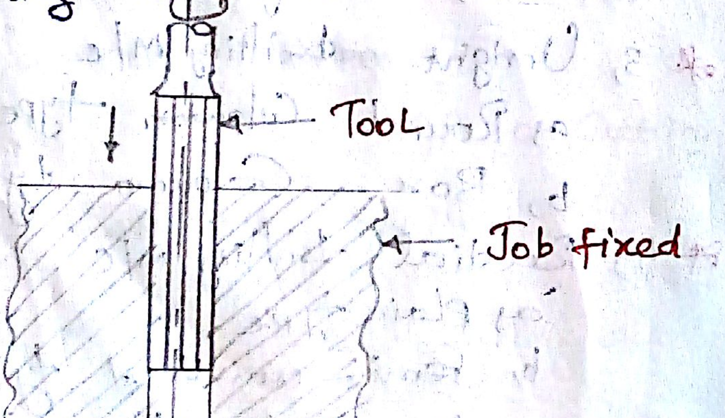
→ Mechanism is Feed mechanism.

Drilling :



Reaming :

Reaming is the Process of sizing and finishing the already drilled hole. The tool used for reaming is known as a reamer, Reamer is a cylindrical tool having many cutting edges. The reamer Cannot Produce a hole. The amount of metal removed in remaining is about 0.375 mm.

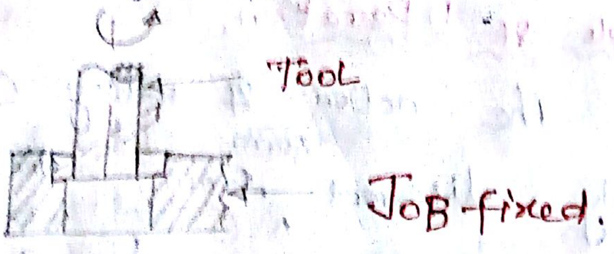


Boring:

Boring is an operation of enlarging a hole by a single point cutting tool.
Boring is done where the suitable size drill is not available. If the hole size is very large, it cannot be drilled.

Types of Boring Machine:

1. Horizontal boring m/c
   - a) Table type
   - b) Floor type
   - c) Planer type
   - d) Multiple head type.
2. Veritical boring machine
3. Precision boring machine
4. Jig boring m/c



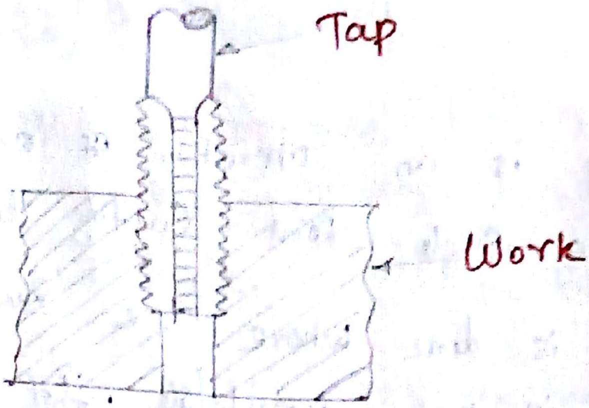
Boaring

Tapping:

The operation of producing or cutting internal threads in a hole by using a cutting tool called tab. A tap has cutting edges in the shape of threads.
The drilled hole will be smaller than the tap size.

Tap drill size = 0.8 × outside diameter of the thread.

Tapping:



~~MILLING~~:

MILLING:

Milling is the Process of removing metal by feeding the work past against a rotating multipoint cutter. The metal is removed in the form of small chips.

In milling operation, the ratio of metal removal is rapid as the cutter rotates at a high speed and has many cutting edges.

Principle of Operation:

The action of milling cutter is vastly different form from drill or lathe tool.

The milling m/c has a rotating cutter. The multi point cutter is mounted on a rotating spindle or arbor.

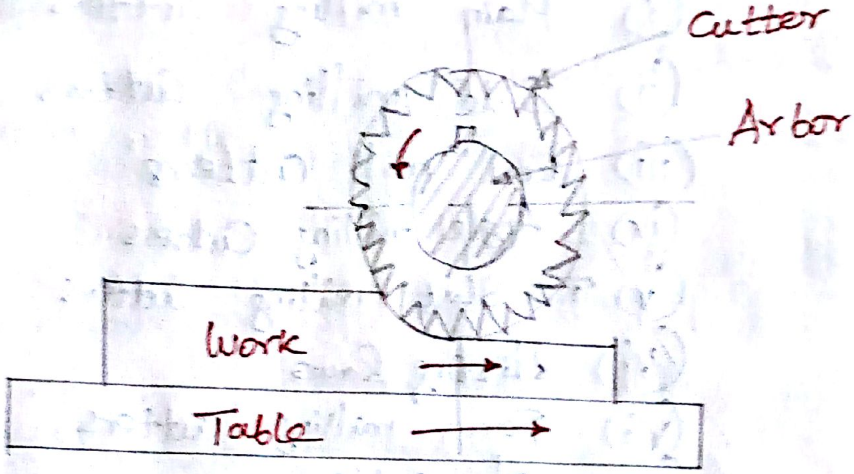
The cutter rotates at the required cutting speed.

The work piece is slowly fed past the cutter. As the work advances, the metal is removed by cutting edges in the form of chips.

Specifications of milling machine:

1, The table length and width
2, Number of Spindle Speeds and feeds
3, Power of driving motor
4, Floor Space and net weight
5, Spindle nose taper size.

MILLING:



Classification of Milling Machine:

1, Column and knee types:
  a, Plain milling machine
  b, Vertical milling machine
  c, Universal milling m/c
  d, Ram type milling m/c
  e, Omniversal milling m/c
3 Bed - Type milling M/c
  a, Simplex milling M/c
  b, Duplex milling m/c
  c, Triplex milling m/c
3, Plano - type milling m/c
4, Special Purpose milling m/c
  a, Rotary table milling m/c
  b, Drum milling m/c

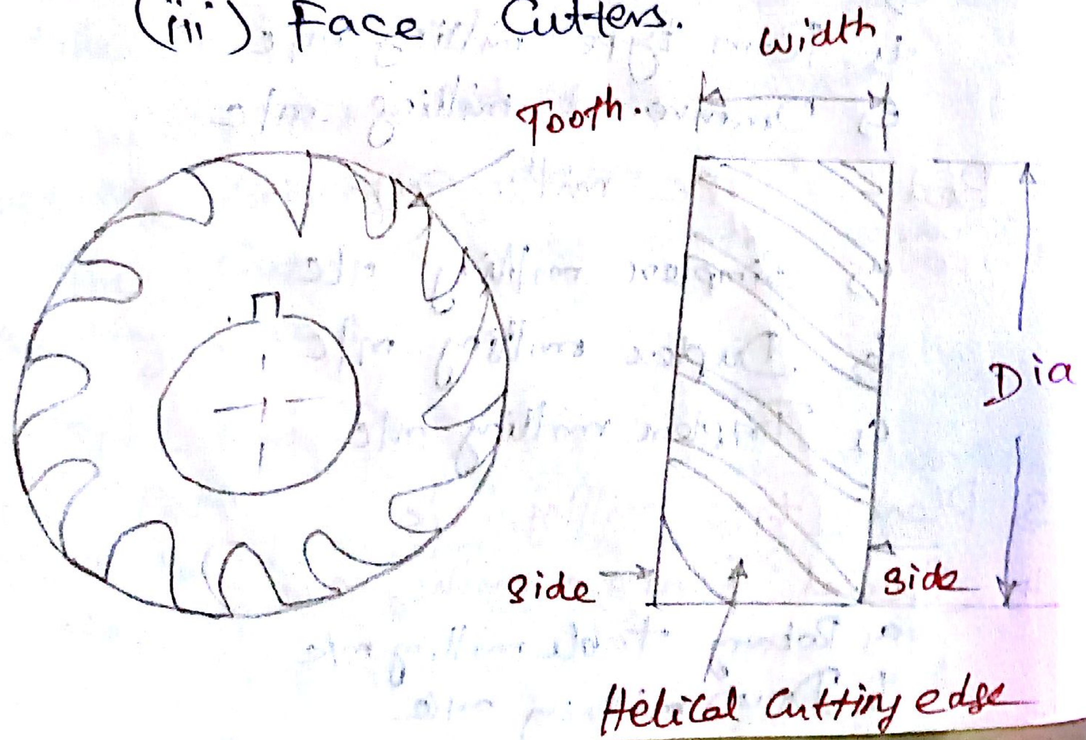
Milling Cutters:

Types of Cutters:

a) Shape of the tooth, milling cutters
  i) milled tooth cutters
  ii) Form relieved cutters

b) According to the type of operation.
  (i) Plain milling cutters
  (ii) Side milling cutters
  (iii) End mill cutters
  (iv) Angle milling cutters
  (v) T- slot milling cutters
  (vi) Slitting saws
  (vii) Form milling cutters
  (viii) Fly cutters.
  (ix) Wood ruff key. slot milling cutter.

c) According to the way of mounting on the machine.
  (i) Arbor cutters.
  (ii) Shank cutters
  (iii) Face cutters.



Gear Cutting:

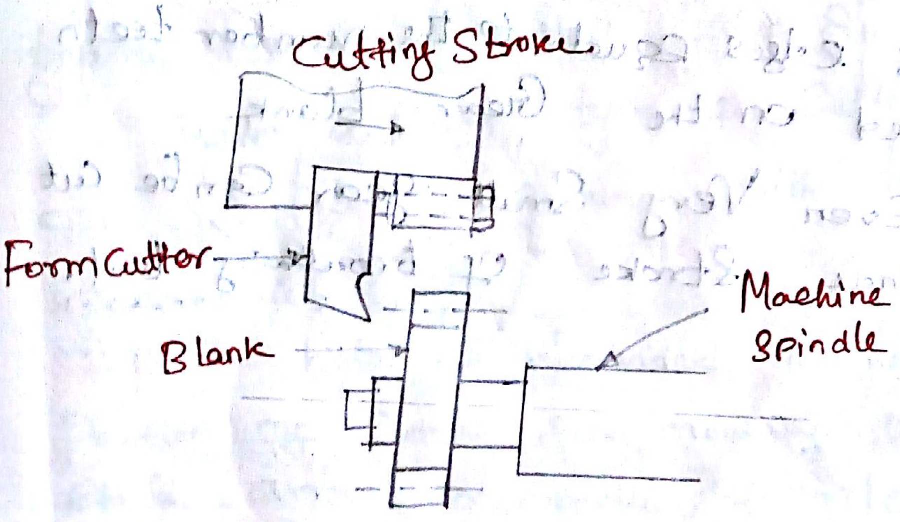
The Gear Cutting Operation involves in Cutting different types of gears on a milling machine. It is performed by using a form releived cutter which is having the Profile Corresponding to the required tooth Space of the gear.

Gear Cutting:

1, Gear Cutting by single point form tool.
2, Gear Cutting by Shear Speed Shapping Process
3, Gear milling using a formed end mill.
4, Gear broching
5, Template method.

1, Gear Cutting by a Single Point Formed tool:

In this Case, a Single Point Cutting tool is used for Cutting the gear in a Shaping m/c or Planning m/c. The Cutting edge of the tool is made to the Shape of gear tooth.



Gear Cutting by Speed Shaping Process:

* In this type, the form tools are radially arranged in the cutter head.

* The number of form tools is equal to the number teeth required on blank.

Gear Milling Using a formed End mill:

* In this type, the Cutting edges are formed to the shape of the gear tooth space.

* The formed end mill cutter is held on the spindle of a Vertical milling m/c. The blank is held in a dividing head and fed against the rotating Cutter.

* $\text{Crank movement} = \frac{40}{N} = \frac{40}{Z}$

where

Z - be the number of teeth to be cut (assuming N=Z)

Gear Broaching:

* This method is mainly used for making internal Gears with accurate shape. Here also, the broaching tool has a number of Cutting edges equal to the number teeth required on the Gear blank.

* Even Very Small gear Can be cut in Single Stroke of broaching tool.

Gear Generation Principle And Construction Of Gear Milling:

* Gear generation is based on the fact that any two involute gears of the same module will mesh together. Here, one of the meshing Gears is made as the Cutter.
* Due to relative rolling motion of Cutter and the blank, gear teeth are generated on the Gear blank.
* Generally, Gears may be generated by a rack Cutter or by a Pinion Cutter or a hob.

The Common gear generating Processes are given below:

* 1, Gear Shaping Process
* 2, Gear Planning Process
* 3, Gear hobbing Process.

Gear Shaping:

* Gear Shaping is done on a Special type of machine called Gear Shaper.
* Here, a pinion type of Cutter is used. The Cutter has ground with top rake and clearance.
* The hole is Provided in the Centre Portion of Cutter for mounting on a Stub arbor or Spindle of m/c.

The Various movements obtained from gear Shaper are given below:

1, Rotary motion of the cutter and blank.
2, Radial feed of the cutter towards the blank.
3, Vertical reciprocating motion of cutter.
4, Withdrawal motion of the blank away from the cutter during return stroke.

Gear Hobbing:

* The Process of generating a gear by means of a rotating cutter called hob is known hobbing. The hob has helical threads. Cutter having grooves is also made with proper rake angle and clearance angle. The hobs may be either a single threaded or multi threaded part.

Finishing of Gears:

* Generally, the Gear teeth are Produced by any one of the generating Processes. But, the gear does not be more accurate with good quality surface.
* The rough surface gear teeth occur due to vibrations causing noise, excessive wear, Play and backlash b/w meshing pair of gears.

So, the Gear Produced by generation Process leads Low Power transmission and produces incorrect Velocity ratio because Poor surface finish gears get hardened due to dimensional inaccuracies.

UNIT - IV

ABRASIVE PROCESS AND BROACHING

ABRASIVE PROCESSES:

* Grinding is one of the Abrasive Processes.
Grinding is a metal removing Process in which the metal is removed with the help of rotating grinding wheel.

* Such wheels are made of fine grains of abrasive materials held together by a bonding material called a bond.

* Therefore, it is used as a finishing operation. This Process removes Comparatively little material usually from 0.25mm to 0.5mm.

* The abrasive grains which Project on the Surface of the grinding wheel moving with high Velocity and shear off small metal Particle from the work piece.

* In their Place, new abrasive grains project from the Surface of the wheel. This Process is Called Self Sharpening of Grinding wheel.

Grinding is mainly used for following Purposes:

(i) To remove small amount of metal from work pieces and finish them to close tolerances.
(ii) To obtain a better Surface finish.
(iii) To machine hard surfaces which cannot be machined by high-Speed steels.
(iv) Sharpening of cutting tools.
(v) Grinding of threads.

Grinding wheel:

Grinding wheels are made up of small abrasive particles held together by bonding materials. Thus, it forms a multi-edge cutter.

Grinding wheel Abrasives:

Abrasive is a hard material. It can be used to cut or wear away other material.

Small sizes of abrasive particles are used in grinding wheels

Types:

1) Natural abrasives
2) Artificials abrasives
   (a) Aluminium oxide
   (b) Silicon Carbide
   (c) Artificial Diamond
   (d) Boron Carbide
   (e) Cubic boron nitride.

Specification of Grinding wheel:

1) Grit or Grain size:

It refers to the actual size of the abrasive particles. The grain size is denoted by the number. This number is equal to the number of meshes in 254 cm of a sieve through which the grains can pass through.

2, Grade

3, Structure of wheels

Designation of Grinding wheel:

1, Type of abrasives

2, Grain size or grit number

3, Grade of the wheel

4, Structure

5, Type of bond

6, Manufacture's Code.

Selection of Grinding wheel:

The selection of a proper grinding wheel is very Important for getting the best results in grinding work, A wheel may be required to perform various functions such as quick removal of stock material give a high - Class surface finish and maintain close dimensional tolarance.

1, Constant factors

2, Variable factors.

1, Constant factors

1, Physical properties of material to be ground.

2, Amount and rate of stock to be removed.

3, Area of Contact

4, Type of machine.

2, Variable factors:

1, Work Speed
2, Wheel Speed
3, Condition of the grinding m/c
4, Personal factor.

Types of Grinding Machines:

1, According to the type of operation
   a, Tool Grinders
   b, Cut-off grinders.
2, According to the quality of surface finish.
   a, Precision grinders
   b, Rough grinders
3, According to the type of surface generated.
   a, Cylindrical grinders
   b, Internal grinders
   c, Surface grinders
   d, Tool grinders
   e, Special purpose grinding m/c
   f, Surface finishing grinders.

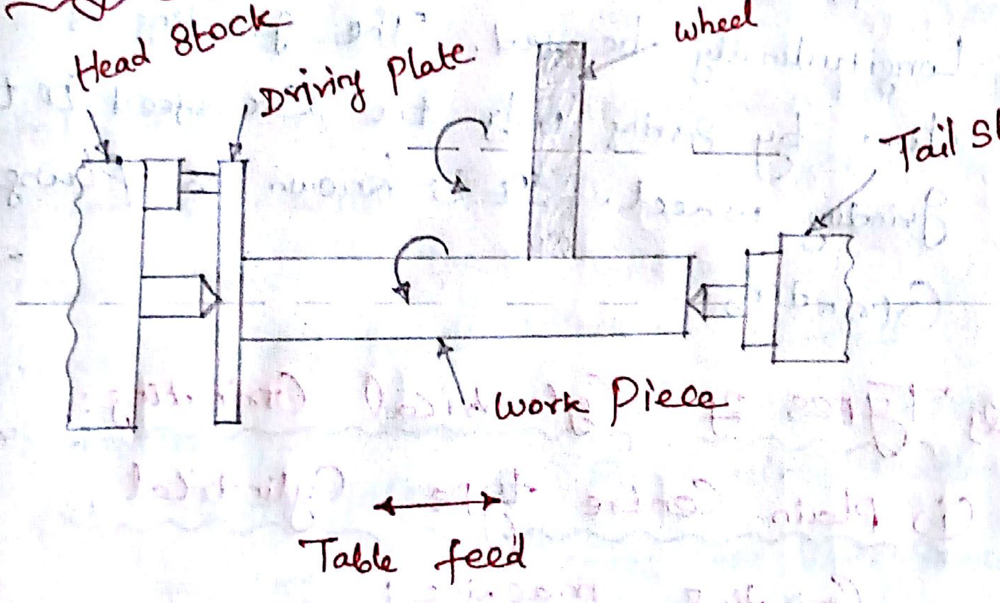
Cylindrical Grinders:

The Principle of Cylindrical grinder is illustrated, The work piece is held b/w Centers. It is rotated by a dog and a face plate.

There are four movement in a Cylindrical Centre type grinding.

1, Rotation of Cylindrical workpiece about its axis
2, Rotation of the grinding wheel about its axis.
3, Longitudinal feed movement of the work past the wheel face.

Cylindrical Grinders:



1, Types of operations in Cylindrical grinding:

(i) Transverse grinding
(ii) Plunge grinding.

(i) Transverse grinding:

This method is used when the Job length is more than the width of the grinding wheel. The Job is hold b/w two centers. The grinding wheel is made to rotate in a fixed position.

(ii) Plunge grinding:

This method is used when the length of the work piece is less or than the width of grinding wheel.

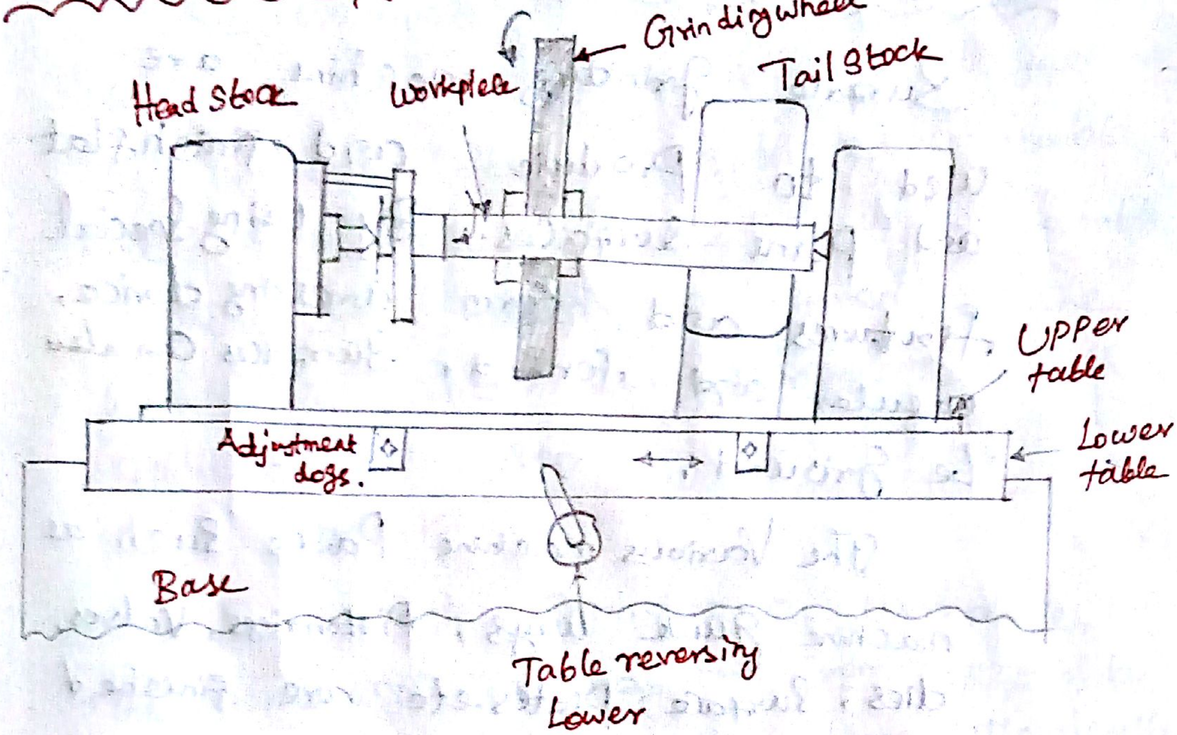
Here, the work piece need not Longitudinally be fed. The grinding is done by giving only the Crossfeed to the grinding wheel. It is known as Plunge Grinding.

2) Types of Cylindrical Grinding:

(i) Plain Centre type Cylindrical Grinding machine:

A plain Centre type Cylindrical grinding machine is shown in fig. These grinding machines are used for grinding mainly Cylindrical Parts.

Plain Centre type Cylindrical Grinding M/c.



Working Principle:

The work piece is held b/w Centres. It is rotated by a dog or faceplate. The grinding wheel also rotates about its own axis in the Opposite direction of work. The grinding wheel is fed by either hand or automatic mechanism towards the workpiece for Successive cuts.

It most of the cases, the work Speed is selected b/w 20 and 30 Surface Speed meters per minute. (smpm).

Wheel Speed is usally Selected b/w 1500 and 2000 smpm. The depth of cut at each reversal is from 0.025mm to 0.125mm for rough grinding.

For finishing Process, it Should be from 0.0125mm to 0.0625mm.

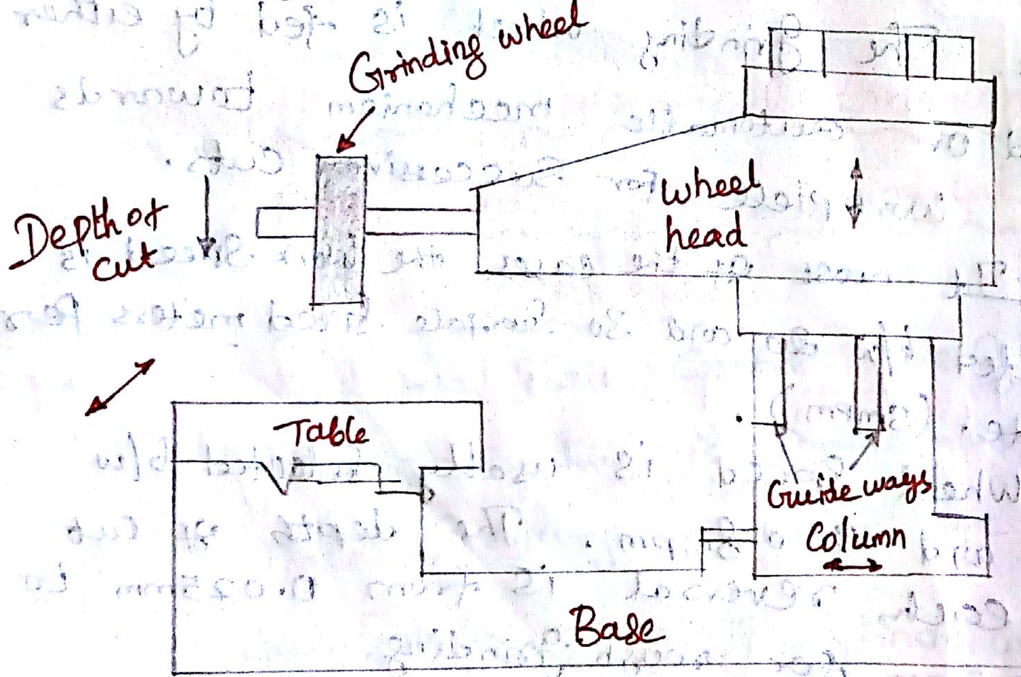
Surface Grinders:

Surface grinding machine are used to produce and finish flat and plane surfaces. By using special fixtures and form dressing device, angular and formed. Surfaces can also be ground.

The various machine parts such as machine guide ways, piston rings, valves, dies, surface plates etc are finished by surface grinding.

Horizontal Spindle Reciprocating Table Surface Grinder:

It consists of a horizontal spindle carrying the grinding wheel and rectangular worktable.



Working:

The workpiece is clamped on the table. The trip dogs are suitably adjusted to get the correct stroke length of the table. The work piece reciprocates under the table.

The cross feed is given to the work piece after every stroke. The depth of cut is given by lowering the wheel head.

For rough grinding of workpiece, the depth of cut may be from 0.02mm to 0.06mm. For finishing operations, the depth of cut may be from 0.005mm to 0.01mm.

Centreless Grinders:

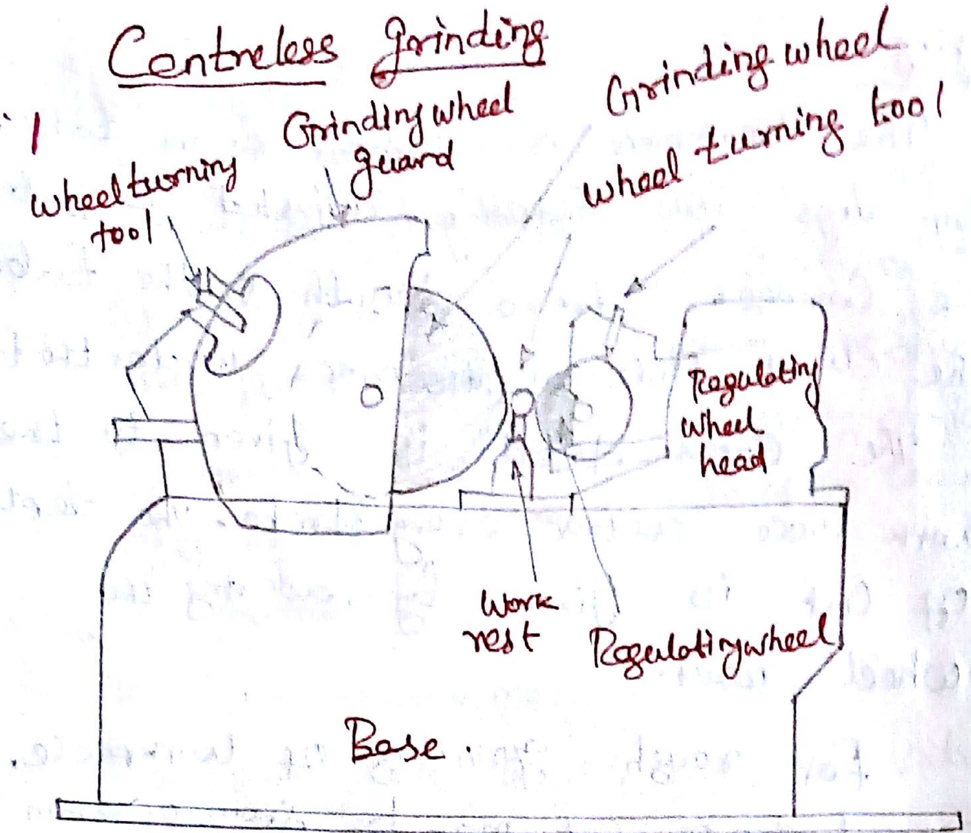
Centreless grinding is performed on work pieces which do not have centres, such as pistons, valves, rings, tubs, balls, wrist pins, drills, bushings, shafts etc. Centreless grinding can be done on both external and internal cylindrical surfaces.

The work rests is located b/w wheels. The work is placed on the work rest.

The grinding wheel is driven by an electric motor and it rotates at a maximum surface speed of about 1850mpm.

The regulating wheel speed ranges from 33 to 130 mpm.

Centreless Grinding



Internal Grinders:

Internal grinders are used to finish straight, tapered of formed holes to the correct size, shape and finish.

There are three types of Internal grinders

(a) Chucking type
(b) Planetary type
(c) Centreless type.

(a) Chucking type Internal Grinders:

In this the work piece is chucked and rotated about its axis. The work head is mounted at the left side of the machine. The wheel head is mounted at the right end of the machine.

These machines are used for grinding work piece which can easily be held in a chuck.

(b) Planetary type Internal Grinders:

The work remains stationary and the rotation of wheel spindle gives an eccentric motion according to the diameter of the hole to be ground. A such type of operation is used where the work is difficult to be rotated. There fore, in this operation, the motion of grinding wheel is in the form of planet and hence, It is called Planetary grinding.

(c) Centreless grinding:

The external centreless grinding principle is also applied to internal grinding. In internal centreless grinding, the work is supported by three rolls.

One is the regualating wheel, the second one is a supporting roll and the last one is pressure roll to hold the workpiece against the supporting and regulating rolls.

The grinding wheel directly contacts the inside diameter of the workpiece and it reciprocates about its axis for giving the feed. The depth of cut is given by moving the grinding wheel in a crosswise direction.

Typical Applications of Grinding machines:

Some Grinding machines are designed for highly Specialised works Such as forming, Gear teeth Grinding, thread grinding, Cam grinding tool/Cutter grinding etc. These Grinders are Called as Special Purpose grinders. Some of these types are explained below.

Form Grinders:

The grinding wheel for form grinding is so shaped such that the form ~~grinding is so shaped~~ &. of the surface is to obtained. The grinding operation of dovetail guide ways and machining of Complex Cross section.

Thread Grinding:

This is also one type of forming method by which the thread is ground on a Cylinderical Surface.

These machines differ from Conventional Cylindrical Surface m/c only.

In this, the grinding wheel is either single or multiple rib wheels. The work is mounted b/w Centres and it is rotated definite Speed.

Cam Grinders:

These machines are basically Cylindrical grinding machines with additonal feeding and withdrawl mechanisms for the work piece. An arrangement for grinding Cams of a Camshaft. The grinding wheel is arranged so that it Can radially be moved towards or away from the work piece in Co-ordination with the rotation of the work piece.

Tool post Grinder:

It is used for miscellaneous and small Grinding works on a Lathe. The grinding wheel is held on the tool post of a Lathe and fed across the work, the regular Longitudinal or Compound rest feed being used. A Common application of tool post grinder is the turning of lathe Centres.

Disc Grinder:

These grinders rapidly remove the stock and finish the flat surfaces by the sides of disc wheels. A single horizontal or vertical spindle disc grinder is used for repetitive work by hand operation or with simple fixture.

The work up to 350mm in length Can be ground in opposed wheel grinders with wheels up to 750mm.

Broaching :

* Broaching is a Process of machining a Surface with a Special multi... Cutting tool Called broach which has Successively higher. Cutting edges in a fixed Path. Each tooth removes a predetermined amount material.

* It is a faster and cheaper method of machining but the depth of removed material is limited to 6mm or less.

* Broaching Process is used for machining through holes of any Cross-Sectional Shape, Straight and helical slots, external surfaces of Various Shapes, external and internal toothed gears. Broaching the inside Surfaces is Called "internal or hole broaching" and the outside surface is known as surface is known as Surface broaching.

Specification of a Broaching Machine :

Main Specifications of a broaching machine are:

1, Maximum length of stroke in "mm".

2, Maximum force developed by the slide in Tonners.

The subsidary Specification are:

1, Power rating of electrical motor

2, Speed and feed ranges.

Types of Broaching machine:

(a) According to the nature and direction of Primary cutting motion.

(i) Horizontal broaching machine.
(ii) Vertical broaching machine.
(iii) Continuous broachining machine.

(b) According to the Purpose

(i) Internal broaching machine.
(ii) External Surface broaching m/c.

(c) According to method Operation.

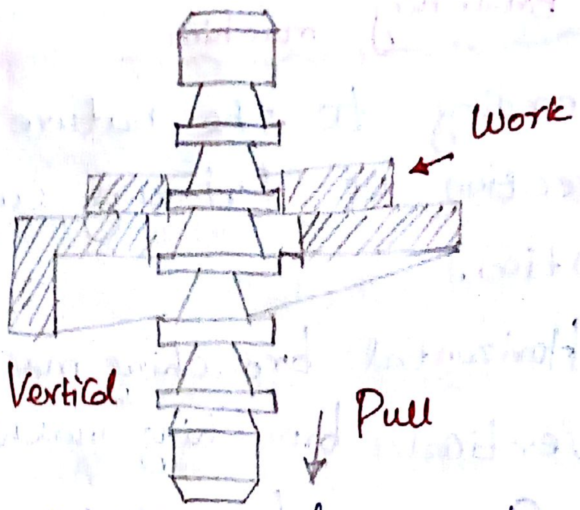
(i) Pull broaching m/c
(ii) Push broaching m/c.
(iii) Solid broaching m/c
(iv) Build-up broaching m/c
(v) Single broaching M/C.

Vertical Broaching Machine:

1) Pull up type
2) Pull down type
3) Push down type.

1) Pull Down Type Vertical broaching M/c.

These machines are mostly used for internal broaching operations. Instead of being pushed the broach, it is pulled through the job.



The pulling mechanism is enclosed in the base of the machine. The workpiece is mounted on the table by means of fixture. The tail end of the broach is gripped in the elevator.

Push down Type Vertical Broaching M/c:

The Push type Vertical broaching machine is used in Surface broaching operation. It Consists of a box shape Column, Slide and drive mechanism.

Broaching tools are mounted on Slide which is hydraulically operated and accurately guided on Coloumn ways.

Its Stroke is adjusted to Suit the broaching operation to be Performed.

The Slide is Provided with quick return mechanism.

Continuous Broaching Machine:

Continuous broaching machines are used for high Production rates of Small parts

Types of broaching Machines:

(1) Horizontal
(2) Vertical
(3) Rotary type.

(1) Horizontal type Continuous Broaching Machine:

This is one type of Surface broaching Machine. The broaching machine has a driving unit which Consists of two Sprockets.

They are Connected by an endless chain.

Fixtures are mounted at intervals on the Chain for locating and holding Workpiece.

(2) Vertical Continuous Broaching machine:

When the axes of two Sprockets are Vertical, it is Called as Vertical broaching Machining.

The fixtures are mounted on the Chain according to its movement.

The operating Principle is Similar to Previous Case. Here the broach is Vertically Placed on the frame of the machine

Rotary Type Continuous Broaching Machine:

The machine has a rotary table and a vertical column. In the vertical column the broach is horizontally fitted. A series of fixtures are mounted on the rotary table for locating and holding work pieces.

They move past the stationary broaches.

The rotary broaching machines are limited to small parts.

— x — x —

UNIT - V

CNC MACHINING

Introduction:

* In the late 1940's, J. Parsons formulated a method of using Punched Cards Containing Co-ordinate Position data to Control a machine tool.
* The machine was directed to move in Small increments to generate the desired Surface of an airfoil.
* In 1948 Persons demonstrated his Concept to the US Airforce. Then it was taken as a Series of research Projects at Servo mechanisms Laboratory of the massachutters Institute of Technology. (MIT)
* They developed Part Programming language which Could be used for NC machines which resulted the Automatically Programmed TOOLS (APT) language. APT is utilized in many industries and most other Languages are based on APT language.
* There are numbers of Problems in Conventional NC machines which have motivated the machine tool builders to seek improvements in basic NC Systems.

Some of the problems are given below:

i) Part Programming mistakes.
ii) Non optimal speeds and feeds
iii) Punched tape wear and tear.
iv) Least reliable tape reader.
v) Less management information.

NUMERICAL CONTROL SYSTEM:

Numerical Control (NC) refers to the automation of machine tools operated by programmed commands encoded on a storage medium against to manual control through hand wheels or levers, or mechanically automated through cams alone.

Controlling a machine tool by means of a prepared programme is known as Numerical Control or NC.

NC machines are method of automation where the automation of medium production and small volume production is done through the use of some controls under the instruction of a programe. The various definitions of NC are given below.

Definition of NC System.

A System in which actions are Controlled by the direct insertion of numerical data at some point is known as NC System. In other words, It is defined as a form of Software Controlled automation in which the process is Controlled by alphanumatic Characters or Symbols.

The numerical data which are required for producing a part is maintained on a punched tape called as Part Program.

Types of NC Systems:

NC Systems are classified on the basis of machine.

(a) Traditional numerical Control (NC)
(b) Computer numerical Control (CNC)
(c) Distributed numerical Control (DNC)

(a) Traditional numerical Control (NC)

The original numerical Control machine is referred as a NC machine tool. It has a hardwired Control where the Control is proficient through the use of Punched paper tapes or Cards. Tapes tend to whear and become dirty.

(b) Computer Numerical Control (CNC)

CNC refers to a System which has locally linked with a Computer to store all necessary numerical data. To enhance the Performance of tapes, CNC was used due to the Compatibility of incorporating other storage media such as magnetic tapes and hard disks.

(c) Distributed Numerical Control (DNC)

The further development of CNC Systems over many years with the used of Local area networking has changed in the modern Concept updating fields.

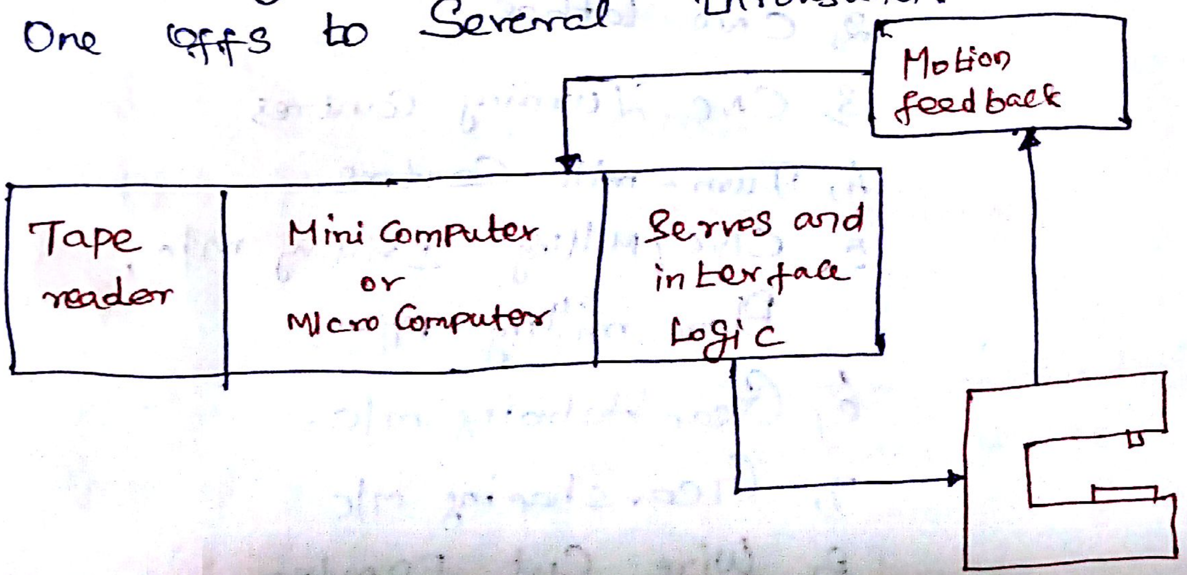
Therefore, it led to develop a modern numerical Control System called Distributed Numerical Control (DNC). DNC System is almost similar to CNC except an isolated Computer used to Control a number of m/c.

COMPUTER NUMERICAL CONTROL SYSTEM (CNC)

Computer Numerical Control is a NC System that utilizes a Stored programme to perform the basic numerical Control functions. A mini or micro Computer based Controller unit is used.

CNC is a microprocessor based Control System which accepts a set of Programme instructions, Processes and feeds the output Control information to a machine tool, accepts the feed back information acquired from a transducer placed on the machine tool and assures the proper motion, Speed to Perform the operation.

Otherwise, CNC machines are Programmed and Controlled by a Computer so it Can Offer Very Short set up time and the flexibility is more to run batches from One offs to Several throusand.



* The external appearance of CNC is very similar to NC.
* The part programmes are entered in similar manner.
* The punched tape readers are common devices for both CNC and NC systems.
* In CNC, the programme is entered once and then it is stored in the computer memory whereas in conventional NC machines for every workpiece, the punched tape is cycled through the tape reader.

The types of CNC used in these above-said field are given below:

1. Machining Centre
   a. Horizontal.
   b. Vertical
   c. Universal.
2. CNC lathes
3. CNC Turning Centres
4. Turn-mill Centres.
5. CNC/Milling Drilling m/c, Plane milling m/c
6. Gear Hobbing m/c.
7. Gearshaping m/c
8. Wire Cut EDM/LEDM
9. Tube Bending
10. Electron Beam welding.

11. Laser/Arc/Plasma Cutting
12. Co-ordinate Measuring M/c
13. Grinding Machines.
   a, Surface Grinder
   b, Cylindrical Grinder
   c, Centreless Grinder.
14, Tool and Cutter Grinder.
15, CNC Boaring and Jig Boaring M/c
16, PCB Drilling M/c
17, Press Brakes
18, CNC Guillotines.
19, CNC Transfer Lines, SPM's
20, Electrochemical Milling M/c.

Types of CNC:

There are two types of CNC used according to the Controller design. They are given below.

1, Hybrid CNC
2, Straight CNC

Major Elements of CNC Systems:

1) Hardware:

It includes a microprocessor, machine tools, actuators and other peripheral devices.

2) Software:

CNC Software includes Various instructions, Programming Languages, Input/output Control and Graphics.

3, Information :

Information is the data required for Cutter Location, Programming, Machining Process.

CNC Machine Constructional Details:

Production equipment with Computer numerical Control is a major Component of CAD/CAM technology. For flexible Automation on the Shop floor, CNC Machines Play a major role. This technology is applied for large Scale Industries of material processing equipment.

For manufacturing a Component, CAD/CAM Process generates a NC Programme which Can run the CNC machines.

The integration of CNC machines technology is the today Concept of many Industries.

Some of the Important parts of CNC machines are machine Structure, Guide ways, feed drives, Spindle and Spindle bearings, measuring System, Controls, Software and operator Interface, gauging, tool monitoring.

Special features of CNC Machines:

CNC Drive Systems:

1) Cutting Spindles:

A Spindle drive is a primitive type of transmission. A rod, referred to a Spindle, is attached to the output of an engine.

A Spindle tooling provides an objective connection b/w cutting tool and Spindle of the machine tool.

Requirements of Spindles for CNC Machines:

(i) High Stiffness - both Static and dynamic.
(ii) Running accuracy
(iii) Axial Load Carrying Capacity
(iv) Thermal Stability
(v) Axis freedom for thermal expansion.
(vi) High Speeds of Operation.

The following are typical Spindle tooling for various machining requirements.

(i) Drill chuck adaptors
(ii) Collet Chucks
(iii) Morse taper adaptors.
(iv) Shell mill adaptors
(v) Face mill adaptors.
(vi) Screwed Shank end mill adaptors.

Advantages:

1. A Spindle driven transmission is simple
2. Spindle drives do not require lubrication.
3. It needs minimal maintenance.

Dis advantages:

1. Spindles cause excessive wear on the tire So, it needs readjustment in order to maintain an optimal pressure on a tire's surface.

2. Spindle heads:

(i) Inclinable head
(ii) Robot - head.
(iii) Horizontal Spindle head.
(iv) Vertical Spindle head.
(v) Universal head.

Feed Drive:

1. Constant torque for overcoming frictional and working force.
2. Infinitely variable drive speed with a speed range of at least 1: 20000
3. Maximum speed up to 3000 rpm.
4. Permanent magnet construction.
5. Low armature or rotor inertia.
6. Low electrical and mechanical time constants.

Types of CNC Machines:

1. CNC Machining Centre
2. CNC Turning Centre
3. CNC Lathes
4. CNC/Milling /drilling machines
5. CNC Special Purpose machines

Machining Centres:

Machining Centres are one of the important types of CNC machine tools. Automatic Tool Charger (ATC) is used here. The following Operations Can be Carried out here.

1. Milling
2. Drilling
3. Reaming
4. Boring
5. Tapping.

Indexable tool magazine is an important Character for machining Center Carrying (16-100) tools.

The machining Centre has two or more table named as pallets. An Automatic Pallet Charger (APC) Centre is used and time will be reduced.

It means, Work - In - Process (WIP) will be reduced.

Classification of machining Centres:

1, Horizontal Spindle machining Centre
2, Vertical Spindle machining Centre
3, Universal machining Centre.

1, Horizontal Spindle Machining Centre:

A typical horizontal Spindle machining Centre Configuration. The features of horizontal Spindle machine.

(i) Single Spindle m/c
(ii) Automatic tool charger
(iii) Bed type m/c
(iv) Axis X ⇒ Table or Column
Y ⇒ Spindle head.
Z ⇒ Saddle
(v) Rotary indexing table.

2, Vertical Spindle machining Centre:

The features of the Vertical Spindle machining are:

1, Single or Multi Spindle
2, ATC or Turret head.
3, Axis X ⇒ Table or Column.
4, Y = Saddle
5, head Stock.

Universal Machining Centre:

1, It has single spindle.
2, Spindle is capable of fitting horizontal to vertical.
3, It has five axis of machine
4, Table also can be fitted
5, Tool breakage detection is possible.

Part Programming fundamentals:

The conversion of engineering blue print to a part programme can manually be performed or with the assitance of high level computer language.

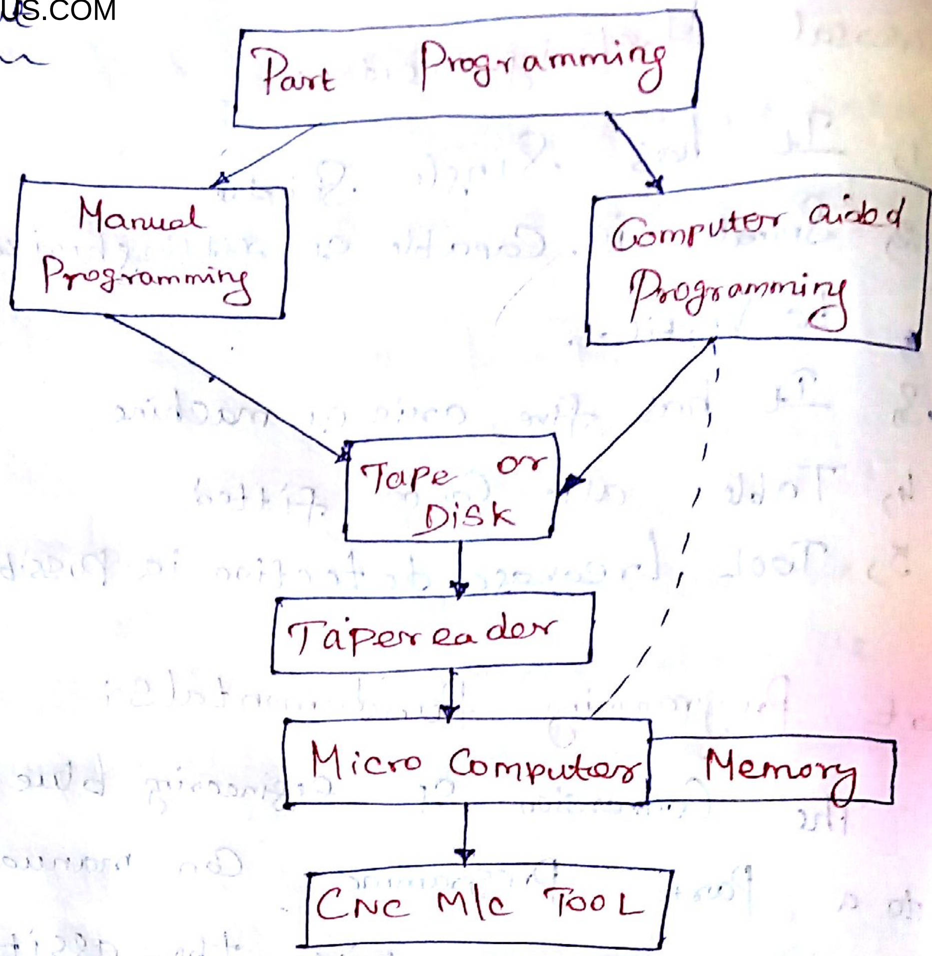
In both part programmers determine the cutting parameters, spindle speed and feed, based upon characteristics of the work piece, tool material and limitations of the machine tool.

Part Program:

The part programme is a set of instructions proposed to set the machined part starting with the desired blank and NC machine tool.

Each line of instruction is capable of specifying dimensional and non-dimensional data and it is written in a specific format. This format is known as NC block.

Layout



Methods of Creating Part Programming

1. Manual Part Programming.
2. Computer - assisted Part Programming (CAD / CAM based Programming System)
3. Manual data input
4. Computer automated Part Programming.

The manual Programming Jobs can be divided into two Categories:

1. Point to Point Jobs
2. Contouring Jobs

Data Required for Part Programming:

1. Job Dimension / workpiece.
2. Work holding.
3. Feed / cutting Speed.
4. Finished dimension with tolerance.
5. Sequence of Operation
6. Types of tools
7. Mounting of tools

Preparatory function Codes and their function:

Function Codes	Meaning
G00	Point to point Positioning
G01	Linear Interpolation
G02	Circular Interpolation, clock wise
G03	Circular Interpolation, anticlockwise
G04	Dwell
G06	Parabolic Interpolation
G08	Acceleration
G09	Decèleration
G17	XY Plane Selection
G18	XZ Plane Selection
G19	YZ Plane Selection
G41, G42	Tool off set
G54, G59	Linear Shift
G71	Metric Programming
G63	Tapping

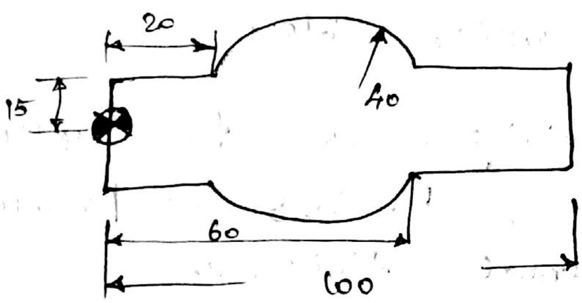
G97	Spindle Speed
G95	Feed /revolution
G94	Feed /minute
G93	Inverse time, feedrate

Miscellaneous function Codes and their function of FANUC System:

Function Codes	Meaning
M00	Programmed Stop
M01	Optional Stop
M02	End of Programme without skip back
M03	Spindle clockwise
M04	Spindle anticlockwise
M05	Spindle Stop
M06	Tool change.
M07	High Pressure Coolant on
M08	Low " " "
M09	Coolant off
M10	Clamp workpiece.
M11	Release workpiece.
M12	Hydraulic power rotary table ON
M13	Last replacement tool
M14	oil hole drill Collant ON

M16	Heavy tool change.
M19	Spindle orientation
M20	Coolant nozzle up
M21	Coolant nozzle middle
M22	Coolant nozzle down
M23	Detection of Contact in -X
M24	" " +X
M25	Detection of Contact in -Y
M26	" " +Y
M28	Quill forward
M29	Quill back
M30	End of Programme with skip back.

Problem on milling.



N01	M03				
N02	X0	Y0	F1500	Z3	F1500
N03	G41				
N04	X0	Y0			
N05	Z-3	F100	(Z - refers to the depth of cut)		
N06	Y15	F100			
N07	X20				
N08	G02	Y28.544	XC50	YC -11.56	
N09	G02	X80	Y15	XC50 YC-11.456	
N10	X100				
N11	Y0				

N12	Z3	
N13	G40	
N14	G54	X108
N15	G110	
N16	G12	
N17	G81	
N18	Z10	
N19	M05	
N20	G13	
N21	G10	
N22	X-50	Y0
N23	M02	

MICROMACHINING:

Micromachining refers a technique for the fabrication of 3D Structures on the micrometer Scale.

Micromachining refers the Superfinishing a metal working Process for Producing Very fine Surface finishes.

Types:

1) Bulk micromachining
2) Surface micromachining.

Micromachining Process;

1) Photolithography Process
2) Etching - (i) Wet, (ii) Dry

3, Lithographic, Galvanoformung, Abformung (LIGA)

(a) Resist development
(b) X-ray radiation and masking.
(c) Electroforming
(d) Resist removal.
(e) Plastic molding

(4) Laser Ablation Process

(5) Mechanical micromachining.

(1) Bulk micromachining:

It is the Process used to Produce micromachinary or micro electro mechanical Systems (MEMS). It uses a Series of thin film deposition and Selective etching. The Process is defined as Structures by Selectively etching inside a Substrate.

Usually, Silicon wafers are used as Substrates for bulk micromachining as they can anisotropically be wet etched to form highly regular Structures.

Bulk micromachining transfers a Pattern from a mask to the Surface.

WAFER MACHINING:

* For larger Sapphire wafer sizes and the continued growth in demand for higher quality LED, the conventional methods of batch lapping and planetary polishing will not be more efficient.

* For over ten years, Strabaugh has been developing a single-wafer sapphire grinding and polishing process.

* It closely works with alliance partners to develop the diamond wheel technology in such a way to achive our performance goals.

* The single-wafer surface machining solution is still emerging in LED industry to improve thickness control, TTV, surface finish, processing times and yield.

* The preparation of part to be machined is almost similar to micromachining.