S. No.	Date	Title	Page No.	Teacher's Sign

Drilling

Process of generating circular hole on w/p. Also existing holes can be enlarged ranging from 1mm to 40mm of varying length depending on requirement and on different materials ranging from hard metals to soft materials like rubber, polythene etc.

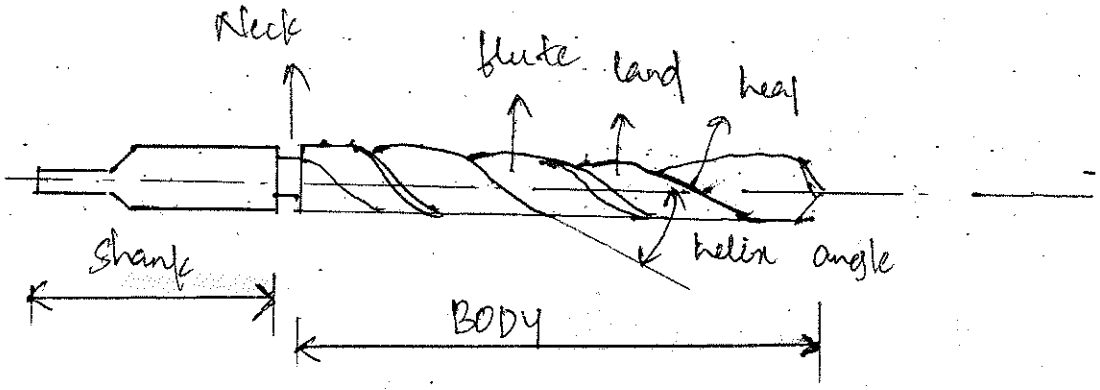
Drilling machines

* Portable drilling m/c - known as hand drill, used for small job to drill holes on brick walls, soft materials like plywood.
* Table top small Sensible - drilling m/cs for drilling small holes - less than 10mm dia on thin metal sheets.
* Round or box column drilling m/c - high power drilling
* Radial drilling m/c - drilling medium to large holes on heavy work plate.
* Gang drilling m/c - capable of drilling two to six holes either progressively or simultaneously.

* Radial drilling m/c - to drill medium to large holes on heavy work parts.

* Turret drilling m/c - has indexable turret to hold multiple drill bits of different specifications.

DRILLING MACHINE TOOL



A drill is a fluted - cutting tool used to bore or enlarge a hole in a solid material.

Most common type of drill in use is the twist drill which have spiral flutes or grooves that run lengthwise around

the body of the drill. Except separates body from shank.

shank portion is fixed to the spindle with the help of chuck.

Boring

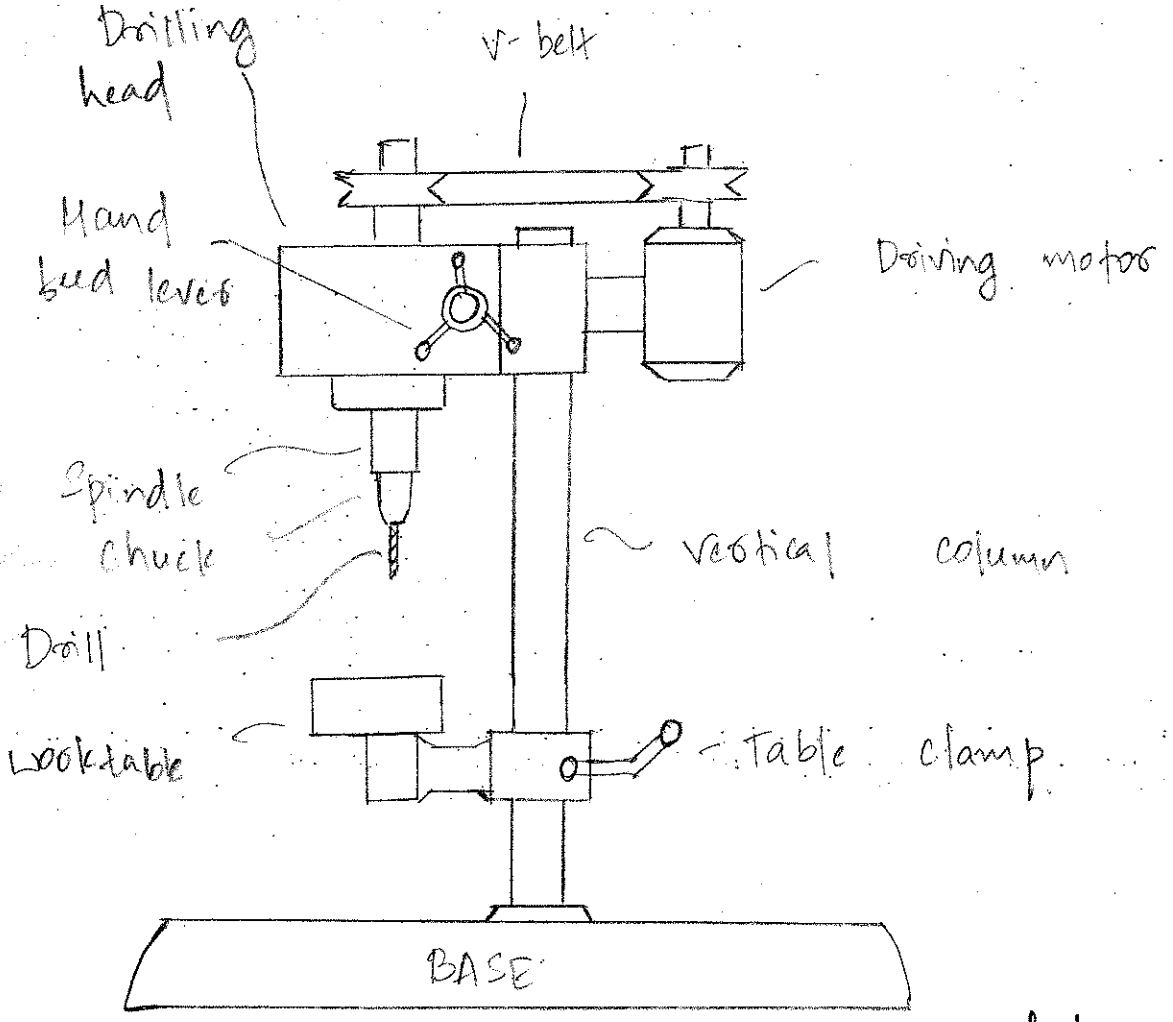
Drilling machine

Specifications of drilling machine

1) Capacity
   - Drilling (dia in mm)
   - Tapping
   - Boring
2) Drill head
   - Spindle travel (mm)
   - No: of Spindle speeds ~~(numbers)~~
   - Range of Spindle speeds (rpm)
3) Column Sleeve diameter (mm)
4) Worktable Size (mm x mm x mm)
5) Net volume (mm x mm x mm)
6) Power (in kW)
7) Net weight (in kgs)

BENCH DRILLING MACHINE

(Sensible drilling m/c)



It is used for drilling small holes at high speeds in small jobs. the diameter of the hole ranges from 1.5 mm to 15.5 mm.

Construction:-

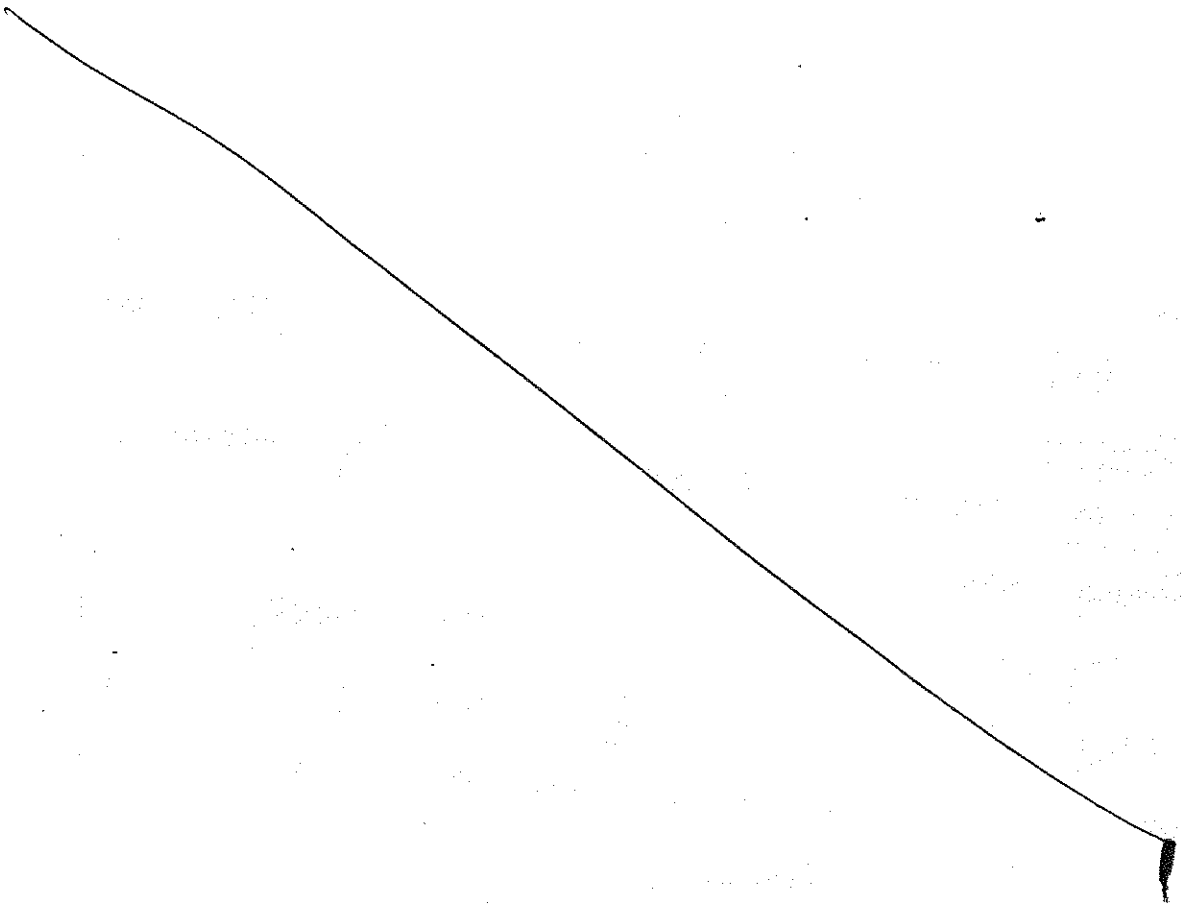
a) vertical column:- Made of Steel & mounted over a strong base.

b) work table: It supports the workpiece. It is provided with T- Slots. It can be moved up and down and held at any desired position with vertical column.

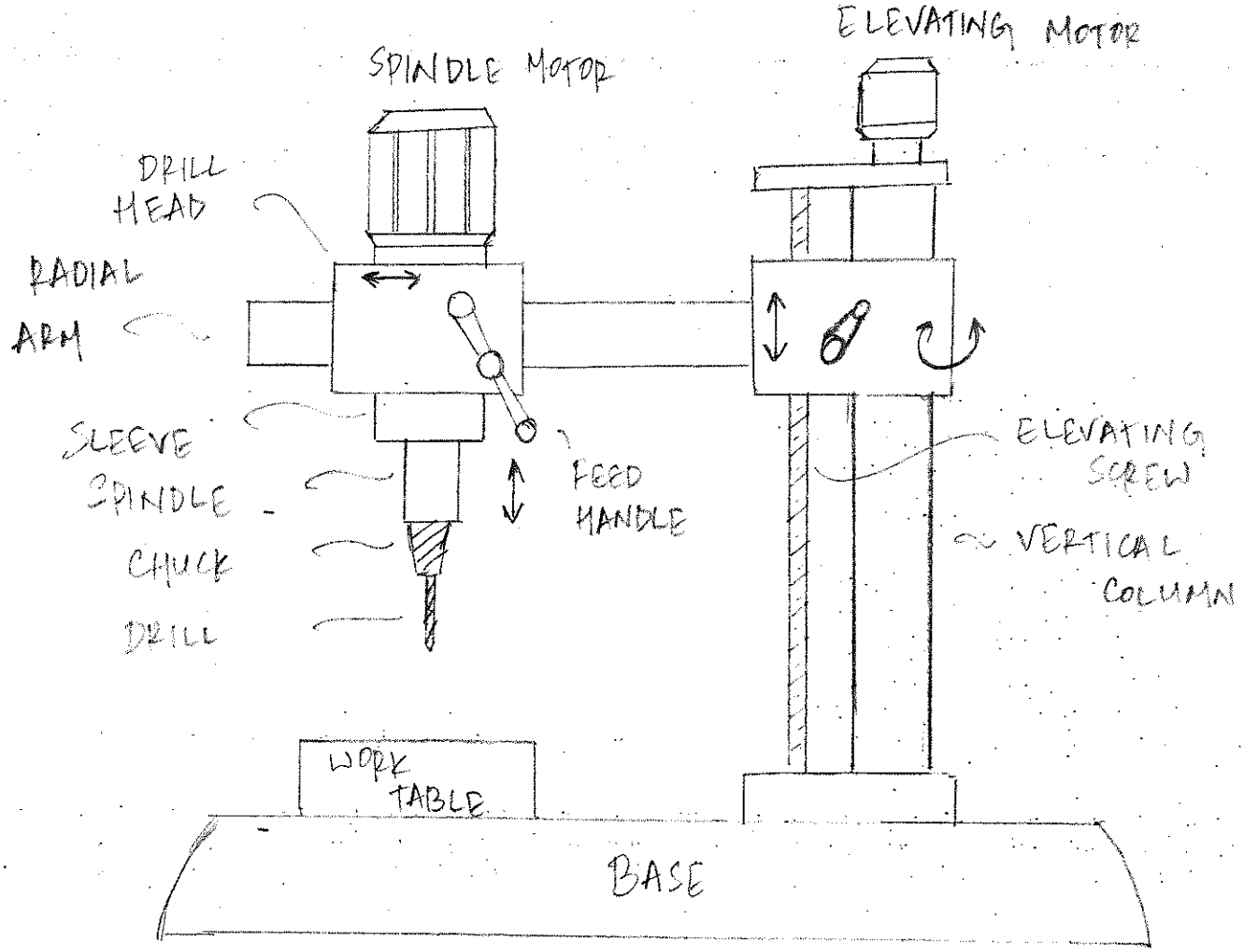
driving motor and driving mechanism. Driving mechanism contains drill spindle which can rotate as well as slide up and down. Power is transmitted from the motor to the spindle through belt drive arrangement. The lower end of the spindle accommodates a drill chuck used for holding drill bit rigidly.

OPERATION:

After clamping the workpiece the machine is started and with the help of hand feed lever, the drill bit is slowly fed into the workpiece so as to produce the hole. When the hole is completed, the drill bit is withdrawn slowly by rotating the hand feed lever in the reverse direction.



Radial drilling machine



- used to drill medium/large diameter holes in a heavy workpiece at different locations.

Machine consists of:

a) <u>vertical column</u>:

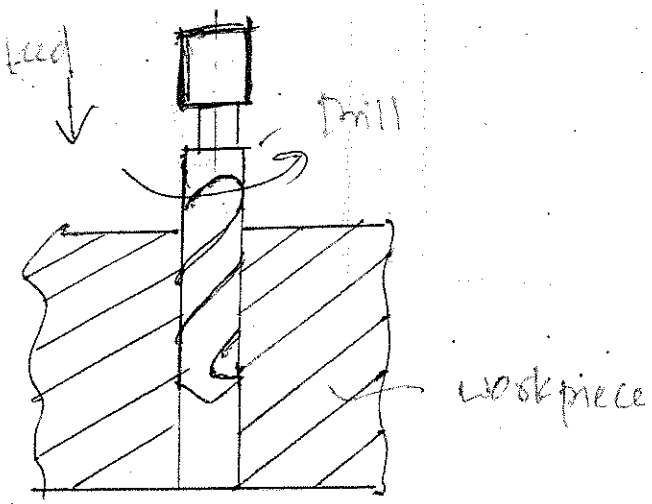
It is mounted on a large base and supports a radial arm that can be raised or lowered in order to accommodate workpiece of different heights. Radial arm can also be rotated in complete circle around the column.

b) Drill [illegible]

The drill head mounted on a radial arm carries a driving motor and a mechanism for revolving and feeding the drill bit into the workpiece. The drill head can be ~~clamped at any desired~~ moved horizontally on the guide ways provided in the radial arm and can be clamped at any desired position. With the combination of the movements of radial arm and the drill head, it is possible to move the drill bit to any desired position on the workpiece.

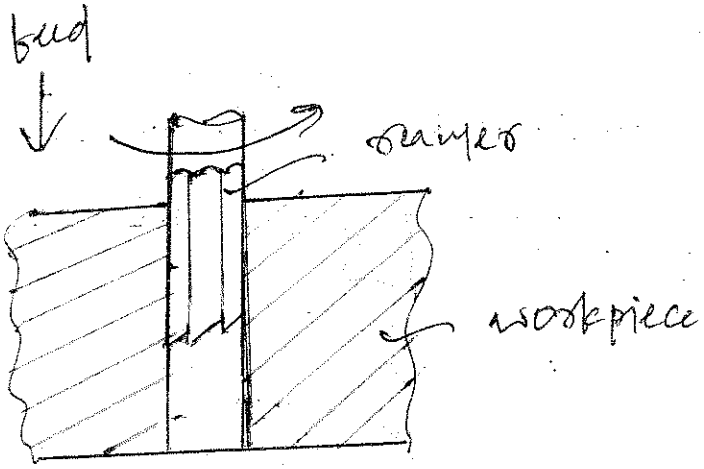
Different operations performed on drilling machine

Drilling



- It is a process of producing a cylindrical hole by removing material (chip) from the workpiece by the rotating edge of a cutting tool called twist drill.
- Based on the diameter of the hole to be drilled, a suitable drill bit is clamped in the chuck of drilling machine and given a rotary motion.
- Rotating drill is made to approach the workpiece and penetrate it gradually upto the required depth of the hole.
- the chips (excess material removed) gets curled and escapes through the helical grooves provided in the drill bit.
- In drilling, lot of heat is generated and coolants are used to carry away the heat to minimize damage to the workpiece and tool.

Reaming



It is an accurate way of sizing and finishing a hole which has been previously drilled.

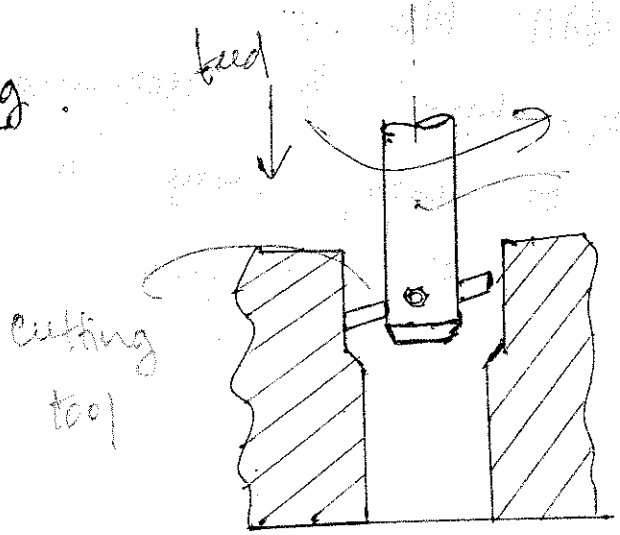
Reamer tool has flutes parallel to its axis.

It is multipoint cutting tool.

The speed of spindle is half that of drilling. Reamer is held in the drill Chuck and fed in the path of drilled hole.

Since it is a finishing operation, material removal rate is less than drilling.

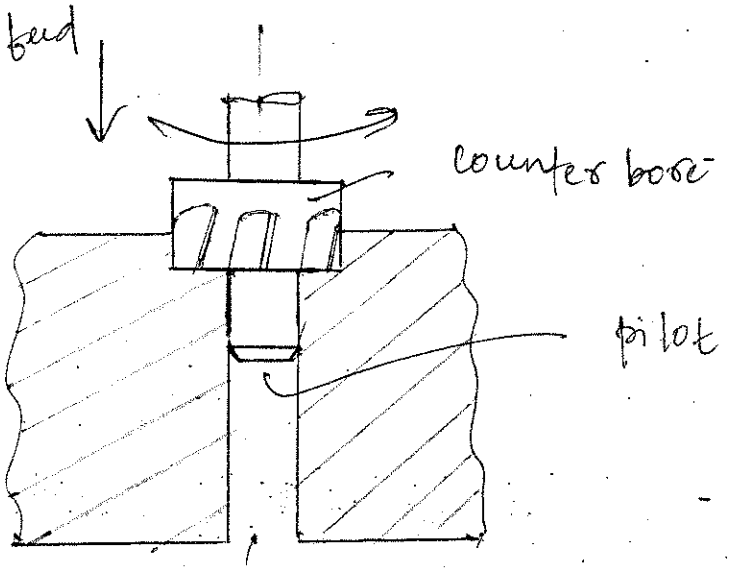
Boring.



process of enlarging a previously drilled hole.

It is also done to finish a hole accurately or to correct out of roundness of a hole.

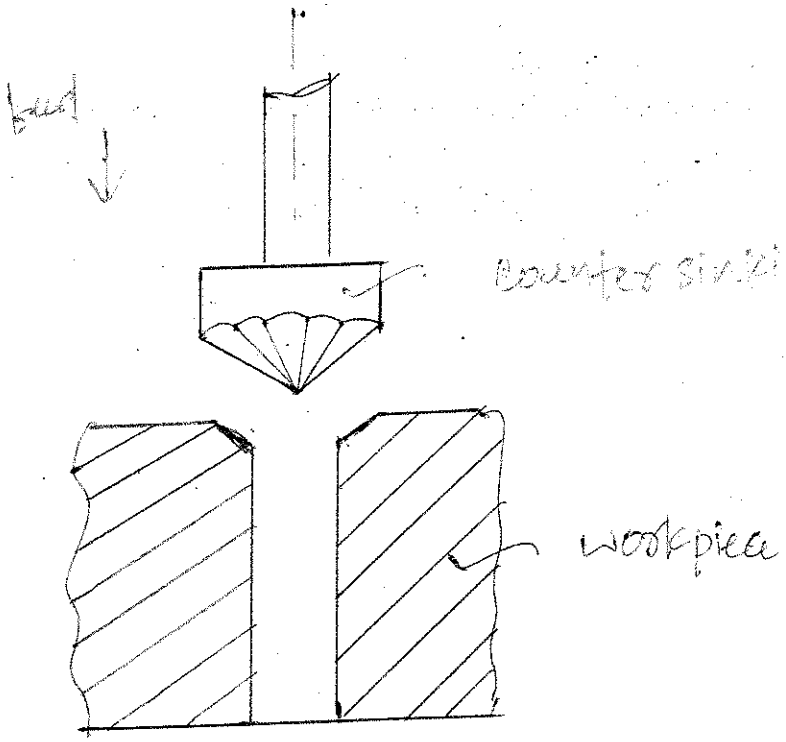
Counterboring



In order to accommodate the heads of bolts, studs, pins and screws, we need to enlarge the end of the cylindrical hole. It is an operation to enlarge the end of hole with counter bore tool.

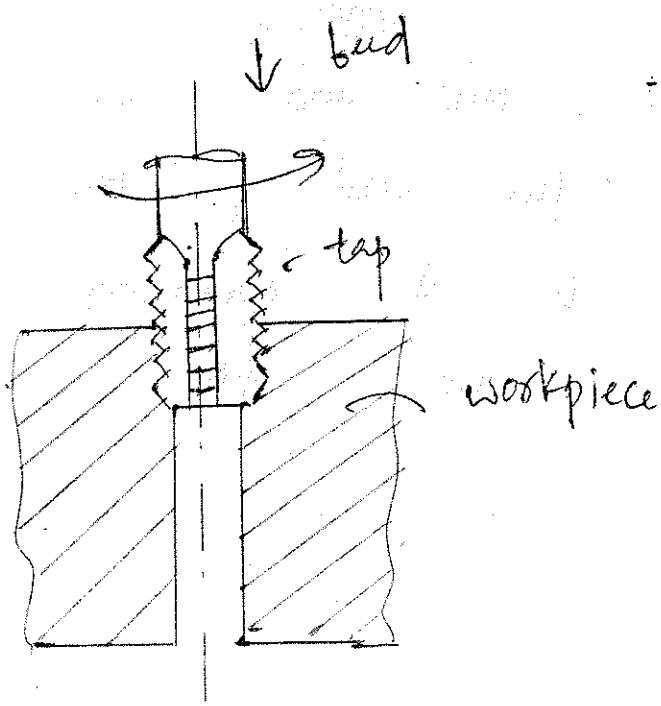
Pilot guides the tool while counterboring.

Counter sinking



It is an operation of making cone-shaped enlargement of hole end.
Flat head screws or counter sunk rivet can be fitted into hole.
Standard countersinks have 60° or 90° included angle.

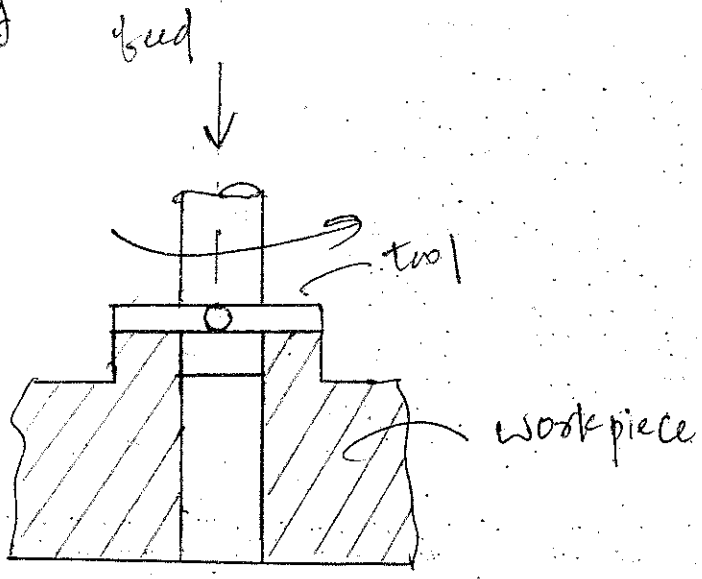
Tapping



It is an operation of cutting internal threads by means of tap.

Tap has accurate threads cut on it. these threads are hardened and ground cutting edges.

Spot facing



operation of smoothening and squaring the surface around a hole for the seat for a nut or head of a screw.

- It has cutting teeth on one end only.

~~Counterboring~~

MILLING & ITS MACHINES

Milling: It is a process of removing excess metal from a workpiece with a rotating multipoint cutter called milling cutter.
Material removal rate is quite high.

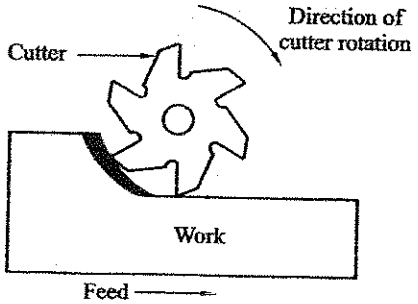
Methods of cutting

Peripheral milling - Surface generated is parallel with axis of rotation of the cutter.

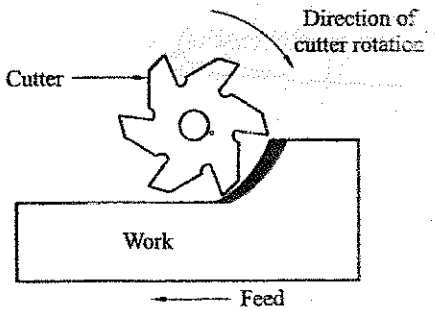
Face milling - Surface generated is at right angles to the cutter axis.

According to the relative motion between the cutter and the work, peripheral milling operations are classified as:-

i) up milling or conventional milling
ii) down milling or climb milling



up milling



Down milling

... workpiece is fed in a direction opposite to the direction of cutter rotation.

In down milling the workpiece is fed in the same direction as that of the rotating cutter.

Comparison between up & down milling

UP MILLING

1) Workpiece is fed in the direction opposite to that of rotating cutter.

2) Thickness of chip is minimum at the beginning of cut and reaches to the maximum when the cut ends.

3) Cutting force is directed upwards and this tends to lift the w/p from the table. Hence, greater clamping force is necessary.

4) Chips get accumulated at the cutting zone and it interfers with revolving cutter impairing surface finish

DOWN MILLING

1) Workpiece is fed in the same direction as that of the rotating cutter.

2) It is maximum at the beginning of cut and reaches to minimum when the cut ends.

3) Cutting force acts downwards that tends to keep the workpiece firmly on the table, thereby permitting lesser clamping forces.

4) Chips are disposed by cutter and hence no damage to surface finish.

5) Difficult for efficient cooling since the cutter rotates in the upward direction carrying away the coolant from the cutting zone.

6) used for machining hard surfaces such as castings & forgings.

5) Efficient cooling can be achieved since the coolant can easily reach the cutting zone.

6) used for finishing operation and small works.

MILLING MACHINE

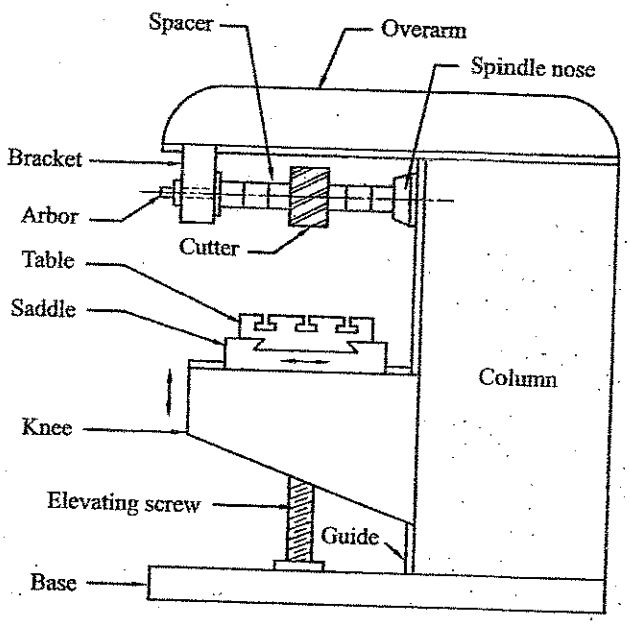
Few basic types of milling m/cs are!-

1) Knee and column type
   a) plain or horizontal milling m/c
   b) vertical milling m/c
   c) universal milling machine
2) Fixed bed type
3) Planer type
4) Special purpose milling machine

In knee and column type, the work table is supported on a knee shaped casting which can slide in a vertical direction along a column. In horizontal milling machine, the position of spindle is horizontal and in

vertical.

Horizontal Knee and Column milling machine



The principal parts are :-

- Base
- Knee
- Table
- Arbor
- Column
- Saddle
- Spindle
- overarm

* Base: Lower part of the machine upon which all others parts are mounted.
* Column: It is a vertical hollow casting which houses the driving mechanism. Front portion of column is machined to provide accurate guide for vertical travel of the knee.

* Knee: It supports the saddle. It can be raised or lowered with help of elevating screw.

* Saddle: It supports table and provides transverse movement.

* Table: It can travel longitudinally in a horizontal plane. T-slots are provided on top surface to hold the workpiece.

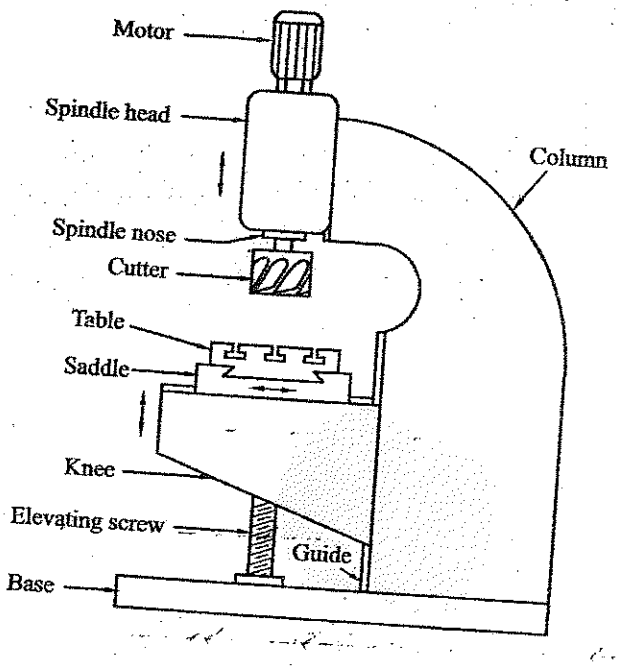
* Spindle: It is driven by an electric motor. Front end of spindle is spindle nose. Here milling cutter is mounted. It is provided with spacers which help in adjusting the position of cutter.

* Arbor: - It provides support and guideways for arbor supporting bracket. This bracket prevents ~~helping~~ bending or deflection of arbor under cutting loads.

Vertical knee and column milling machine

It has basically the same parts as that of horizontal milling machine, except the spindle shaft carrying the cutter is vertical and normal to surface of the table.

The column is cast in one piece with the base. The knee moves up and down the



Vertical knee and column milling machine

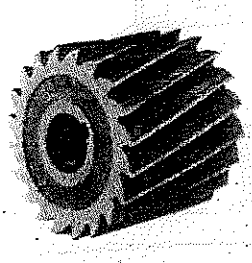
face of the column by means of an elevating screw and supports the saddle and table. the saddle moves transversely on the guide ways provided on the knee. the table is supported and guided by saddle ways and can travel longitudinally. T-Slots are provided on the table to hold the workpiece.

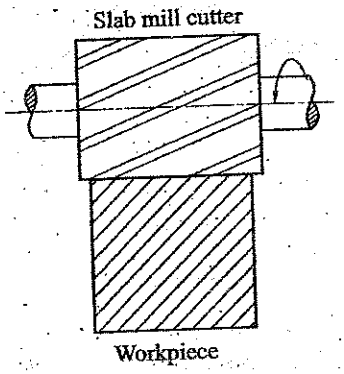
Motor which provides the drive to Spindle is mounted on the top of Spindle head. Spindle can be moved up and down.

MILLING OPERATIONS

1) Milling Operations in horizontal mill

a) Plain or Slab milling



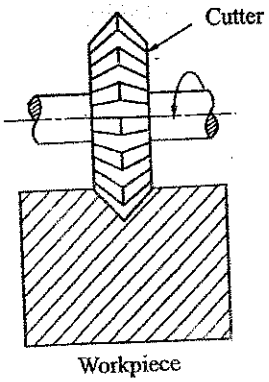


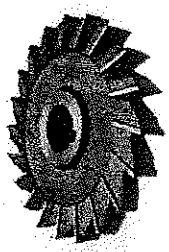
SLAB milling

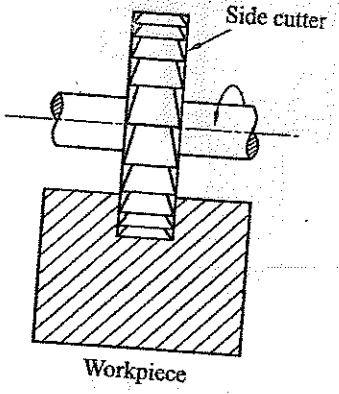
It is a method of producing flat surfaces parallel to the cutter axis.
Slab milling cutter has straight or helical teeth cut on periphery of cylindrical surface.

b) Angular milling

It is used to produce tapered surfaces with various angles. Cutter has teeth inclined to the axis.





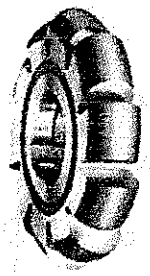


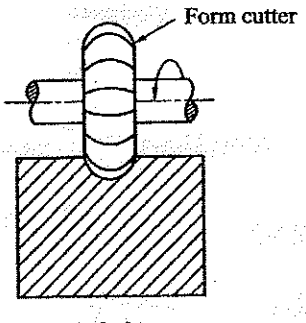
It is the process of cutting grooves or slots in the workpiece.

A side milling cutter is used for this operation.

Side milling cutters have cutting edges on both sides as well as on periphery.

d) Form milling

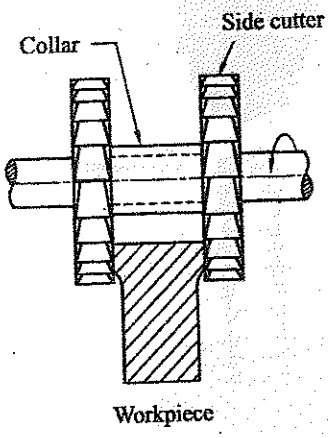

Form cutter



Form milling cutters will have the shape of its cutting teeth corresponding to the profile of the surface to be produced.

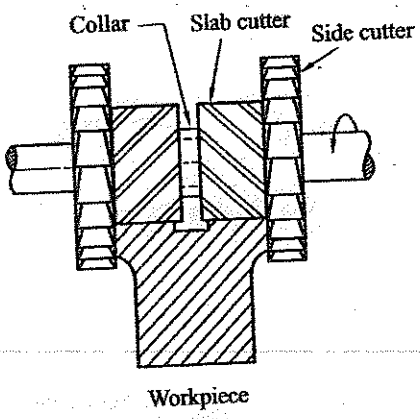
slots, convex edges and gear-tooth profiles.

e) Straddle milling



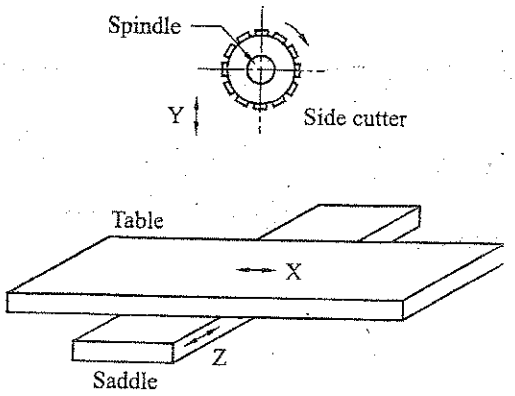
Here two parallel surfaces of workpiece can be milled simultaneously.

b) Gang milling

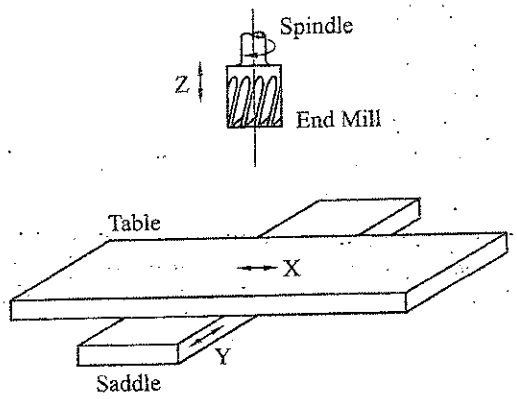


Operation of milling several faces at one pass of the cutters. Two or more cutters are used on the same arbor to produce the desired shape.

Milling machine specifications



Horizontal milling machine



Vertical milling machine

Milling machine may be specified as follows :-

1) Position of the spindle ie. horizontal or vertical

2) the maximum travel of the three primary axes

i) Longitudinal movement of table (X)

ii) Transverse movement of the saddle (Y or Z).

iii) Vertical ... table ... profile or knee (2 or 4)

3) the power of the motor and the maximum speed of the spindle.

4) the size and weight of the largest workpiece that can be machined.

UNIT - IV

Computer numerical control machines :

Numerical Control, Computer numerical control and Direct numerical control.

Metal Joining Process :

Welding, Soldering & brazing, oxyacetylene welding, Arc welding, electrodes used in welding.

Introduction to composites :

Role of matrix and reinforcements, MMCs, PMCs and CMCs, Advantages, Limitations & applications.

WELDING

It is the process of joining two pieces of metals by the application of heat and with or without application of pressure and filler material.

It results in permanent joint.

It is used in construction of buildings, bridges, pressure vessels, tanks, automobile, aircraft, railways and Shipbuilding industries.

Classification of welding process

1) Plastic welding - In this type of welding the metal pieces to be joined are heated to a plastic state and then joined together by the application of external pressure without the addition of filler material.

Ex: Forge welding, resistance welding, thermite welding.

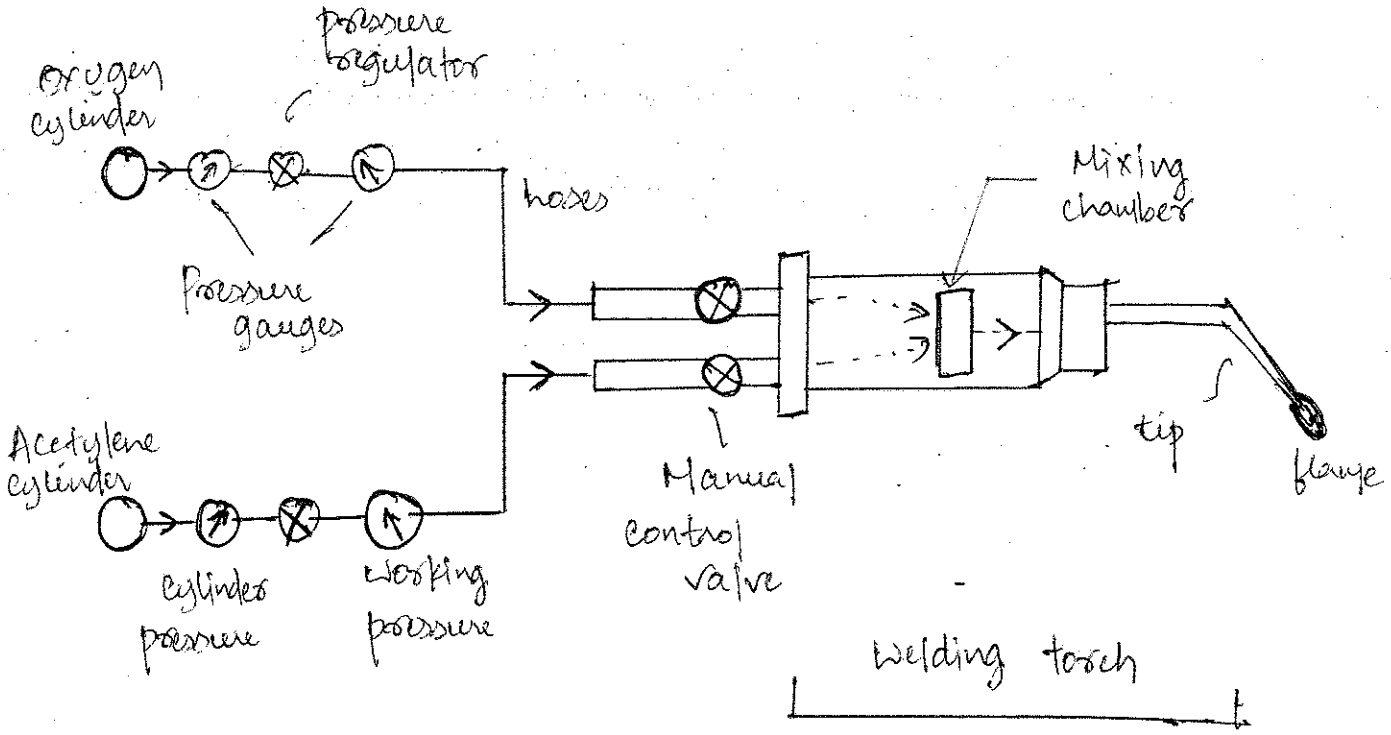
2) Fusion welding -

the metal pieces are heated to molten state at the joint and allowed to solidify without the application of pressure.

Filler material is used here.

Ex: Gas welding

Electric arc welding.



Oxyacetylene weld is produced by heating with a flame obtained from the combustion of oxygen and acetylene and with or without the use of filler metal.

Joint is ~~used~~ heated to a state of fusion, no pressure is used.

Filler material is used to supply additional material to the weld zone during welding.

Fluxes are used to clean the surfaces to be joined and remove others contaminants so as to promote formation of better bond.

Oxygen cylinder and acetylene cylinder are connected through regulating valves and

pressure gauges [illegible] connected to welding torch.

oxygen and acetylene are mixed in desired proportions in the mixing chamber.

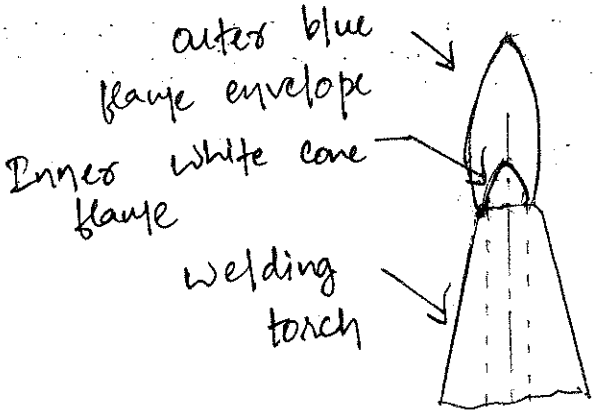
At the tip the combustible mixture is ignited to form flame which is then directed at the joint to be welded.

Temperature involved is around 3500°C.

Types of flame:

Three types of flame can be obtained by varying the proportion of oxygen & acetylene.

i) Neutral flame

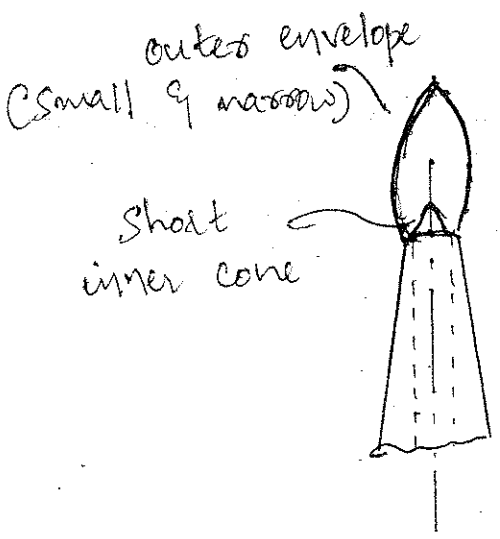


It is obtained by supplying equal volumes of oxygen and acetylene. Flame has two sharply defined zones :-

a) An inner luminous cone at tip of torch
b) An outer envelope flame which is only faintly luminous and slightly bluish in colour.

Neutral flame is widely used for welding steel, cast iron, copper, aluminium etc.

ii) Oxidizing flame



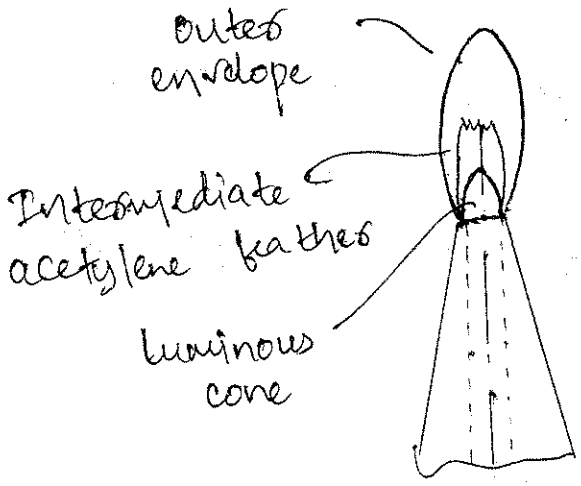
Flame is obtained when there is an excess of oxygen.

- Inner luminous cone is much shorter and outer envelope appears to have bright colour.

used in fusion welding of brass and bronze.

Not desirable for steels because it oxidizes steel.

iii) Reducing flame (carburizing flame)



It occurs due to excess of acetylene.

Between the luminous cone and the outer envelope there is an intermediate cone of whitish colour, the length of which is determined by

the amount of excess acetylene.

Reducing flame is used in welding of monel metal, nickel and many other non ferrous materials.

Advantages of oxy acetylene welding

- Equipment is portable and is comparitively inexpensive and requires little maintenance.
- Heat source and filler metal are separated, so easy to control both the heating & rate of feeding.
- Structural homogeneity of weld is more due to slow rate of heating & cooling.
- Same equipment can be used for gas cutting, brazing, preheating of workpieces.

Disadvantages of oxy acetylene welding

- It is slower than electric arc welding.
- Not suitable for heavy sections of workpiece.
- Gas cylinders should be handled carefully since they are explosive.
- More distortion of objects due to prolonged heating.

P.T.O

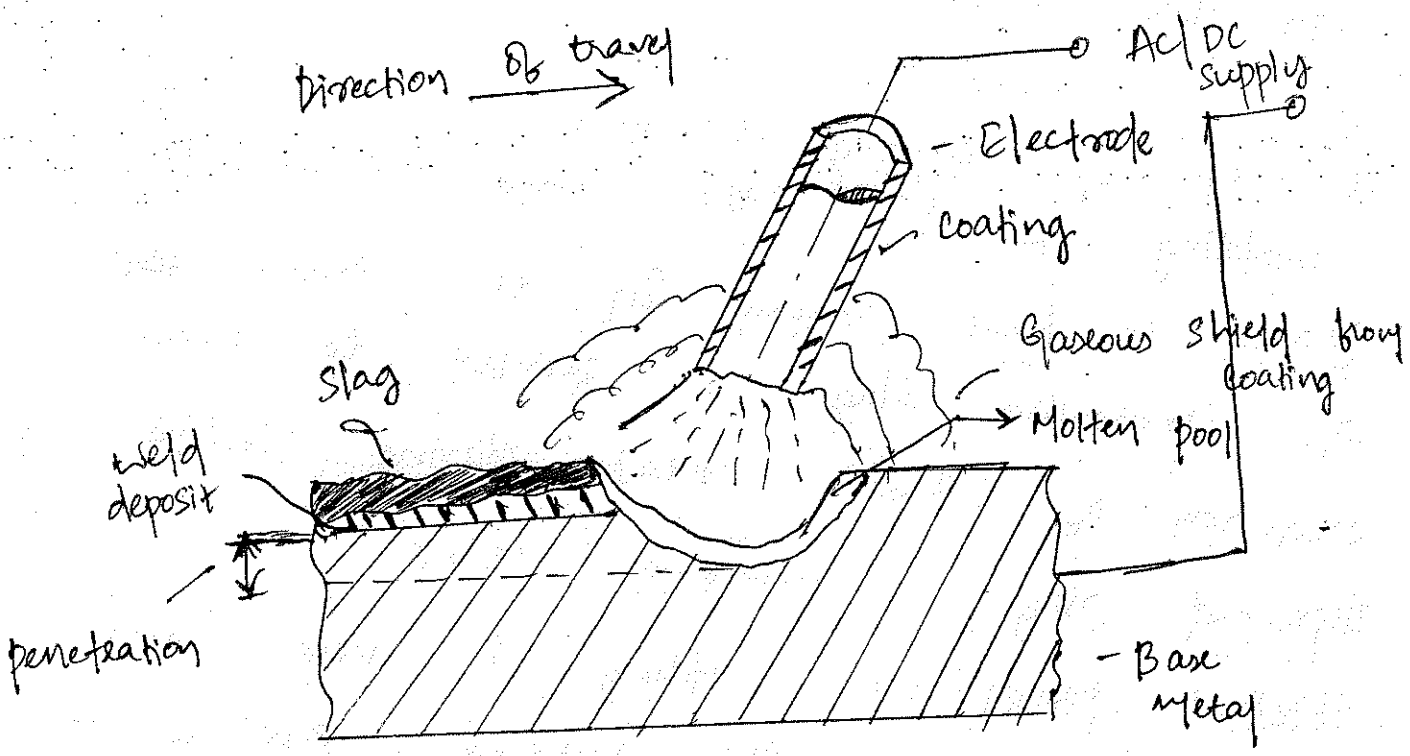
ELECTRIC ARC WELDING

It is a process in which coalescence is obtained by heat produced from an electric arc between the workpiece and electrode.

Electrode or filler metal is heated to liquid state and deposited to the joint to form the weld.

Temperature involved is generally around 5500°C.

Shielded metal arc welding



Electric arc is generated by touching the tip of a coated electrode against the workpiece and then withdrawing it quickly to a distance sufficient to

maintain the arc. Electrode may is of almost the same chemical composition as the material being welded.

Electrode forms one pole of the circuit and the parts/workpiece to be welded forms the other pole.

Temperature of arc ranges from 5000 - 6000°C. The heat from the electric arc melts the workpiece (at junction) & tip of the electrode. Molten metal of electrode is transferred into the molten metal of the workpiece in form of globules.

The electrode coating deoxidizes and provides a shielding gas in the weld area to protect it from oxygen in the environment. Also protective slag is formed to prevent oxidation of surface metal during cooling. Deposited slag is removed later.

Shielded metal arc welding is used in general construction, ship building, pipelines etc.

Electrodes used in welding

Are of two types :-

1) Consumable electrodes
2) Non-consumable electrodes

ii) Consumable electrode

- Made of metallic wire and are consumed during the welding process.
- they are further classified as coated electrodes and plain / bare electrodes.

Coated electrodes

- they are coated with flux.
- Both tip of this electrode and the workpiece melts at the same time.
- Flux that is coated performs the following functions :-
  i) prevents oxidation of molten metal
  ii) chemically reacts with oxides and forms protective slag.
  iii) Stabilizes the arc.

Plain / bare electrode

Metallic wire is left plain or uncoated.

↳ Flux materials - Titanium oxide, Manganese oxide, Mica, Iron oxide etc.

iv) Addition of alloying elements to the weld.
v) Increase deposition efficiency.
vi) Influence the depth of arc penetration.
vii) Reduce spatter of weld metal.

2) Non consumable electrode

Are made of carbon, graphite or tungsten. they do not get consumed during welding.

SOLDERING

It is the process of joining two metal pieces by the addition of filler metal with melting temp. below 450°C.
Filler metal is alloy of tin and lead and is called solder.
Soldering iron ordinary gas flames or electrical may be used to supply the required heat.
Fluxes used are rosin, zinc chloride & ammonium chloride.
Soldering is done to ensure good electrical contact, to secure fluid tightness, in sheet metal work and in sealing of metal containers.
Melting point of soldering process is determined by the proportions of tin and lead.
Two types of solder - Soft & hard solder is used.

Soft Solder - 63% tin & 37% lead by weight. Melting pt is between 150°C & 190°C.

Hard Solder - Alloy of lead and silver. Its melting point is between 350°C & 900°C.

- Function of fluxes is to remove the non-metallic oxide film from the metal surface and to permit the molten solder to wet and flow into the joint.

Procedure for soldering

1) Design the appropriate solder joint
2) Clean the surfaces to be joined
3) Apply a suitable flux to the components.
4) Heat the metal surface with a soldering iron/ equipment.
5) Apply solder on the heated section and allow the molten solder to fill the joint by capillary action.
6) Allow the joint to cool slowly and remove the flux residue by washing with water.

Advantages of Soldering

a) Simple & economical process.

b) No metallurgical damage to base metal since it is done at relatively low temp.
c) Easy to dismantle especially the soft soldered joints.

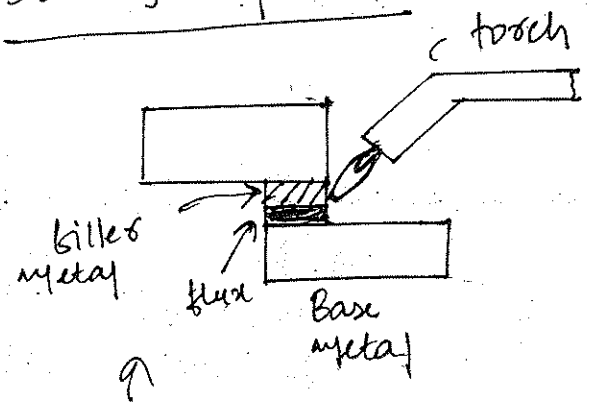
Disadvantages

a) Strength of soldered joint is relatively low.
b) Flux residue must be thoroughly cleaned off after soldering, as it is corrosive.

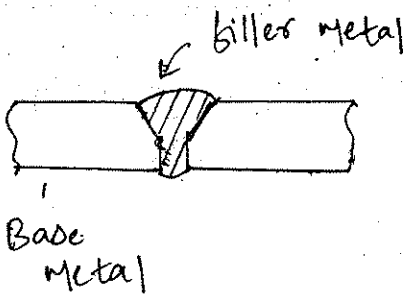
BRAZING

It is the process of joining two metal pieces through the use of heat and a non ferrous filler metal whose melting temperature is above 450°C. the filler metal must wetten the surfaces to be joined (there should be molecular attraction between molten filler material and the components being joined).
Heat for brazing may be provided by torch, induction furnace or hot dipping.
Applications: Joining of pipe fittings, tanks, radiators, heat exchangers, carbide tip on tool holders etc.
Filler material - Cu and its alloys, silver and its alloys etc. It is in form of sheet or wire or powder.
Fluxes used - Borax, boric acid, fluorides and chlorides. Available in the form of powder, paste and liquid.

Brazing



Braze welding



- Cleaning the surface to be joined by removing all grease and oxide
- Applying appropriate flux and filler material between the surface of metals to be joined.
- Heat the filler material with carburizing flame and allow the molten filler metal to fill the space by capillary action.
- Allow the joint to solidify after cooling.
- Removal of flux residue.

* In braze welding filler metal is melted and deposited at the point where the weld is to be made. It is not distributed by capillary action.

Advantages of brazing

- Dissimilar metals and parts having thin sections can be joined easily.
- It reduces metallurgical damage to base metal.
- Economical and quick process.
- Less amount of heat required than welding.
- Pressure tight joints are obtained.

Disadvantages of brazing

- Large sections cannot be brazed.

- Flux ... Blow

brazing operation.

Differences between brazing and soldering

Brazing	Soldering
- Melting point of filler material is above 450°C.	- Melting point of filler material is below 450°C.
- Dissimilar metals can be joined easily	- Only similar metals can be joined.
- Good surface finish	- Does not yield good surface finish.
- Strong joints & higher cost	- Less stronger joint & less cost.
- Strength of joint depends on attraction forces between the molecules of the brazing material.	- It depends on the alloy formed (Solder + small amounts of base metal).

Comparison of Soldering, brazing & welding

Description	Soldering	Brazing	Welding
- Strength of joint	Low	Medium	Stronger than base metal.
- Melting of base metal	No	No	Yes
- Flow of filler metal	Capillary action	Capillary action	Deposition into the joint
- Filler metal	Not same as base metal	Not same as base metal	Same as base metal.
- Metals to be joined	Dissimilar metals	Dissimilar metals	Same metals
- Surface finish	Good	Good	Requires finishing operations like grinding, filing etc.
- Heat affected zone (HAZ)	Negligible	Less	High.

NUMERICAL CONTROL

Automation - It is the technology concerned with the application of mechanical, electronic and computer based systems to operate and control production.

- Automation produces the final product at minimum cost, involving minimum labour intervention, producing components of high accuracy and desired tolerances repeatedly without causing rejections.
- Completely automated production system would involve automatic machine tools like machining centre to remove material as desired, industrial robots and material handling system, automated assembly lines and inspection system - and computer systems for planning, data collection, feedback etc.

Types

- Fixed automation

Sequence of processing or assembly operations is fixed by the equipment configuration. It is relatively not flexible in

accommodating changes.

* Programmable automation

- It is possible to accommodate the change in sequence of operations for new product by changing the program. New programs can be prepared and entered into the equipment to produce new products.

Ex: Numerically controlled machine tools.

* Flexible automation

- very less time or no time consumed for production of one product and changing over to new product. It is an extension of programmable automation.
- Complete information and program for the products desired to be produced are available in computer system and just code for new product has to be fed to computer and changes in all settings, tools etc are done automatically.
- continous production of variety of products is possible.
- Flexibility to deal with product design variations
- High investment in custom-engineered system.

Ex: Flexible manufacturing system for performing machining operations.

Applications of automation

- Numerical controlled machines
- Automated assembly lines
- Robots in manufacturing operations
- Flexible Manufacturing System
- CAD/CAM & computer integrated manufacturing
- Building Automation System (BAS)

NUMERICAL CONTROL MACHINE (NC)

- It is a form of programmable automation (CNC) in which the processing equipment is controlled by means of numbers, letters and other symbols.
- NC is used in machine tool application such as drilling, milling, turning etc.

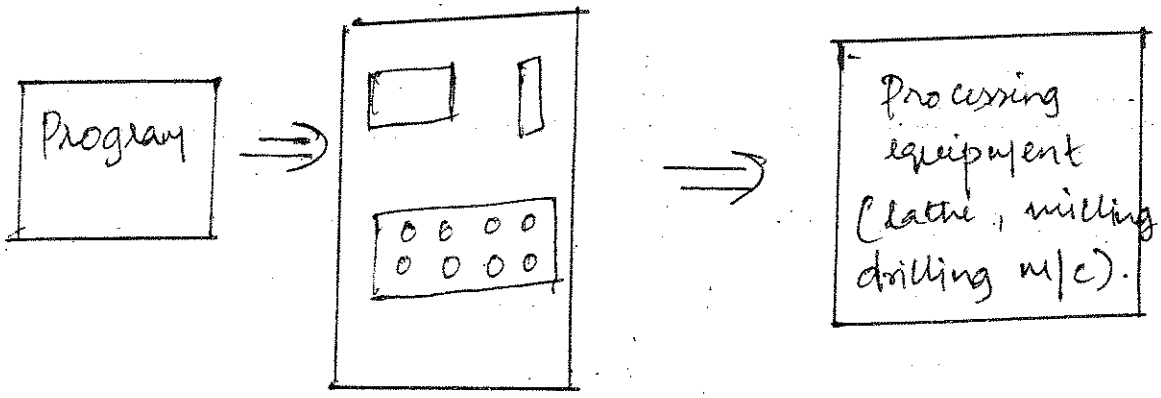
Basic components of NC

It consists of :-

i) Program of instructions

ii) Machine control unit

iii) Processing equipment.



Machine control unit

- NUMERICAL CONTROL SYSTEM (schematic)

i) Program of instructions

- It is detailed step by step instructions fed to the control unit that directs the processing equipment accordingly.
- Instructions or command may refer to position of a machine tool spindle with respect to the worktable, selection of spindle speeds, cutting tools and other functions.
- Program is coded in punched tape and fed into the machine control unit.

ii) Machine control unit

- It consists of electronics and control hardware that read and interpret the program of instructions. Also it converts

these instructions into appropriate actions of the machine tool or other processing equipment.

- All the controls for NC systems are designed around microprocessors.

iii) Processing equipment

It is the machine tool that performs different operations.

Advantages of NC

- Reduces the setup time for machines
- Decreases human error and hence the scrap rate and rework.
- Special jigs and fixtures are reduced in number.
- Improves quality of product

Disadvantages of NC

- High initial cost
- Requires special skills in programming and maintenance

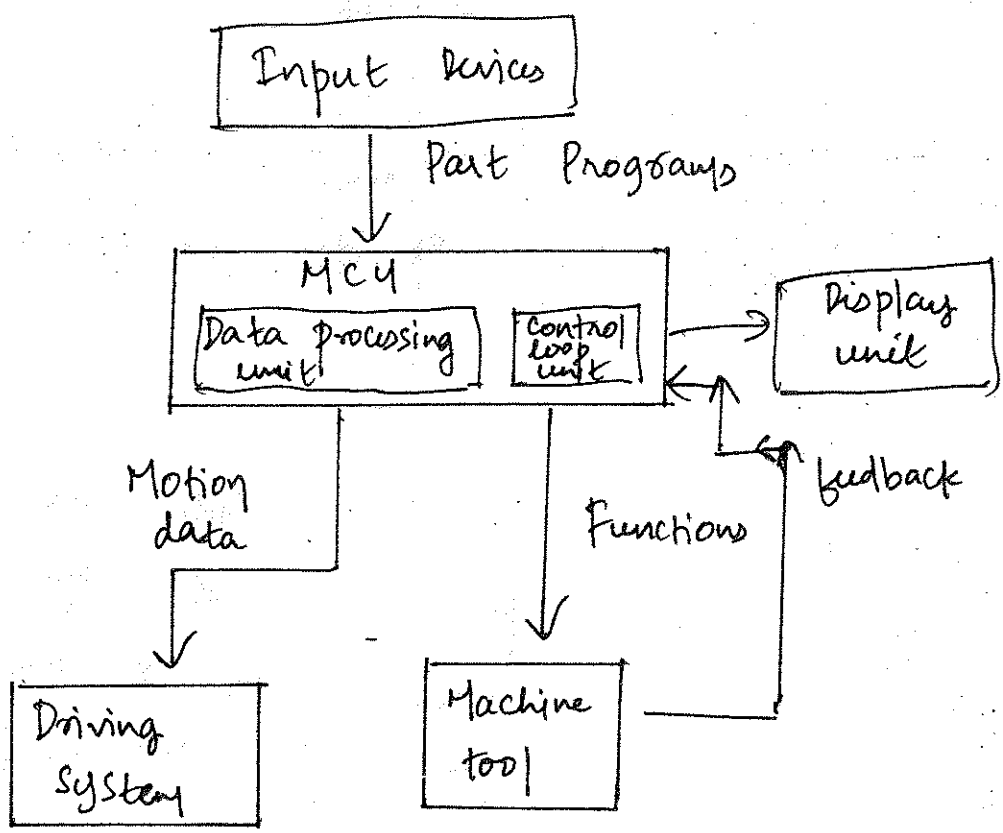
Computer Numerical control (CNC) m/cs

- It is the numerical control system in which a dedicated computer is built into the control system to perform basic and advanced NC functions.
- It is a computer assisted process to control general purpose machines from instructions generated by a processor and stored in a memory system.
- CNC machines helps in fabrication of components with high repeatability and precision.
- It improves production planning & increases productivity.
- the dedicated or onboard computer is 'soft' wired which means the machine functions are encoded into the computer at the time of manufacture and they wont be erased when the CNC machine is turned off.

BASIC COMPONENTS OF CNC

1) Input devices: Used to input the part program in the CNC machine.

P.T.O



2) Machine control unit (MCU)

It is the heart of the CNC machine. It performs all the controlling action of the CNC machine.

Various functions performed are :-

- It reads the coded instructions being fed and decodes it.
- It implements interpolation (linear, circular and helical) to generate axis motion commands.
- It feeds the axis motion commands to the amplifier circuits for driving the

axis mechanisms.

- It receives the feed back signals of position and speed for each drive axis.
- It implements the auxiliary control functions such as coolant or spindle ON/OFF & tool change.

3) Machine tool

CNC machine tool has a slide table and spindle to control position and speed. the machine table is controlled in x and y axis direction and the spindle is controlled in the z-axis direction.

4) Driving System:

It consists of amplifier circuits, drive motors and ball lead screw.

MCU feds the signals (ie. of position and speed) of each axis to the amplifier circuits. the control signals are then augmented to actuate the drive motors. these motors now rotate the ball lead screw to position the machine table.

5) Display unit

It is used to display the programs, commands and other useful data of CNC machine.

Advantages of CNC

1) Part program is directly entered into the computer memory. Program editing is possible at the machine site. this results in improved reliability.
2) High degree of accuracy and reduction of scrap.
3) Greater flexibilities & capabilities
4) Reduced non-machining time and lead time for production.
5) Faster in production and high productivity.
6) Easy to produce components of high quality and accuracy combined with reduction in manufacturing cost.
7) Easy to produce parts of various sizes and complex geometry.
8) Elimination of special jigs and fixtures
9) Greater operator safety.
10) Less inspection required.

Disadvantages of CNC

1) High initial cost
2) High maintenance cost
3) Requires skilled programmers and operators.

Direct numerical control (DNC)

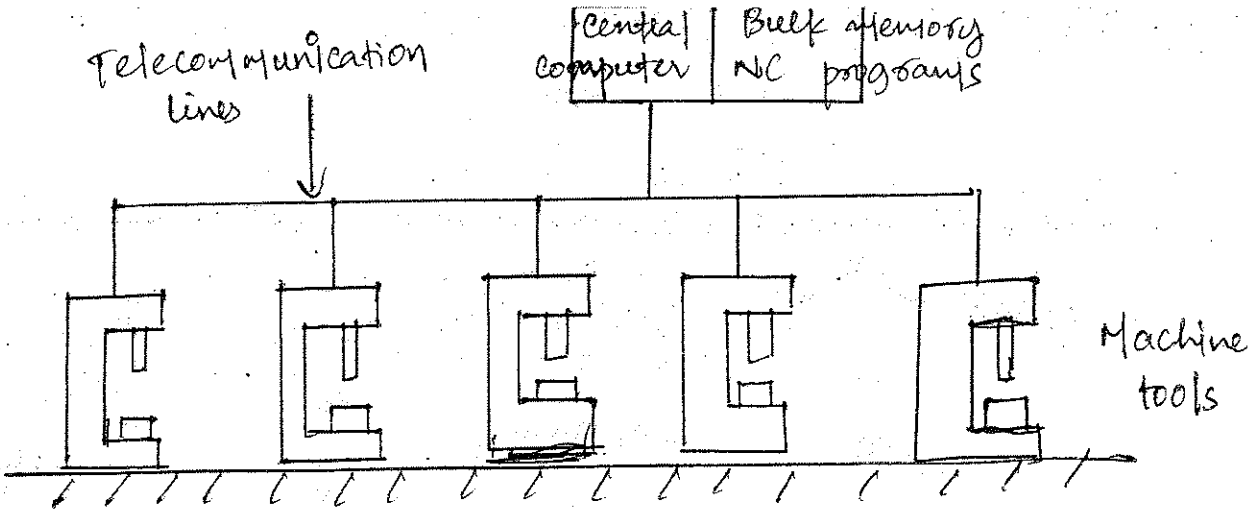
Comparison of NC and CNC System

Parameters	NC System	CNC System
* Mode of entering the program	- It is entered using punch tape, magnetic tapes, punch cards etc	- Entered by using keyboard, CD, DVD, floppy discs, thumb drives.
* Feed back device	- Absent	- Available
* Memory storage ability	- only one program can be stored at a time	- More than one program can be stored.
* Program editing	- It is difficult	- It is possible
* System flexibility	- Less flexible	- More flexible
* Productivity of Systam	- Less	- High
* Inibial cost	- Moderate	- High

DIRECT NUMERICAL CONTROL (DNC)

It is also known as distributed numerical control and it is used for networking CNC machine tools.

On some CNC machine controllers, the available memory is too small to contain the machining program (in case of machining complex surfaces), so here the program is stored in a separate computer and sent directly



to the machine, one block at a time. If the computer is connected to a number of machines it can distribute programs to different machines as required. DNC networking or DNC communication is always required when CAM programs are to run on some CNC machine control.

The part program is transmitted to the machine tool directly from the computer memory.

System consists of four components:-

- Central computer
- Bulk memory which stores NC part programs
- Telecommunication lines
- Machine tools

- It eliminates punched tape and tape reader.
- It can store large sized machining program on a separate computer and send it to the relevant machine tool at a time.
- Helps to monitor production and report performance.
- Production planning & scheduling become easier.
- Two way information flow between machine tool and central computer.
- Greater computational capacity and frequent modification to the program is possible.

Limitations of DNC

- In case of computer breakdown or network failure the entire operation comes to standstill which leads to wasting of time or delaying of production targets.
- Initial investment is quite high
- Maintenance and its cost is high.
- Requires multiple skills to operate the system effectively.

Applications

- In computer automated factories.
- Assembly lines of automotive factories.
- In printed circuit (PC) drilling machines or units.
- Wiring and testing machines in electrical industry.

LATHE AND

MACHINING: It is the process of removing the excess material from the workpiece in the form of chips, by forcing a cutting tool with one or more cutting edges.

Machine tool is a power driven machine to perform machining. It performs the following functions :-

i) It rigidly supports the workpiece and the cutting tool.

ii) It provides relative motion between the workpiece and cutting tool

iii) It provides a range of speeds and feeds.

LATHE

It is defined as a machine tool used to remove excess material by forcing a cutting tool against a rotating workpiece.

workpiece is turned or rotated between two centres.

they are used to produce cylindrical, plain and tapered surfaces and also

used for [illegible] on metal parts.

Parts of a lathe

It consists of :

i) Bed
ii) Head Stock
iii) Tail Stock
iv) Carriage
v) Feed rod
vi) Lead Screw

i) Bed : Rigid structure serving as base to support the headstock, tailstock, carriage etc. It is made of gray iron. It has guideways which helps in accurate movement of the carriage and tailstock.

ii) Headstock (Live center)

It is mounted at the left end of the lathe bed. It has gears or pulleys which makes the workpiece rotate at varying speeds.

Headstock supports the one end of workpiece by means of three jaw chuck or four jaw chuck.

iii) Tailstock (Dead center)

It is present at the left end of the lathe end. Its main functions are :-

i) to provide support to the [illegible] end of the rotating workpiece.

ii) to hold tool for performing operations like drilling, reaming, tapping etc.

Tailstock can slide along the bed and clamped at various locations so as to accommodate the workpiece of different lengths.

iv) Carriage

Cutting tool is supported, moved and controlled with the help of carriage. It consists of following parts:

a) Saddle - It can slide horizontally and it supports the cross-slide, compound rest and tool post.

b) Cross-slide: It is mounted on the saddle. It allows the cutting tool to move at right angles to the lathe axis and hence providing the necessary depth of cut to the workpiece.

c) Compound rest:

It is mounted on the cross-slide and supports the tool post. Compound rest

has a circular base graduated in degrees. The tool can be swivelled to any angle to obtain tapered surfaces.

d) Tool-post

It is mounted on the compound rest and is used to hold / support the cutting tool firmly in position during machining.

e) Apron:

It is fitted beneath the saddle facing the operator. It houses the gears, levers, hand wheels and clutches to operate the carriage by automatic power feed or manually.

v) Feed rod:

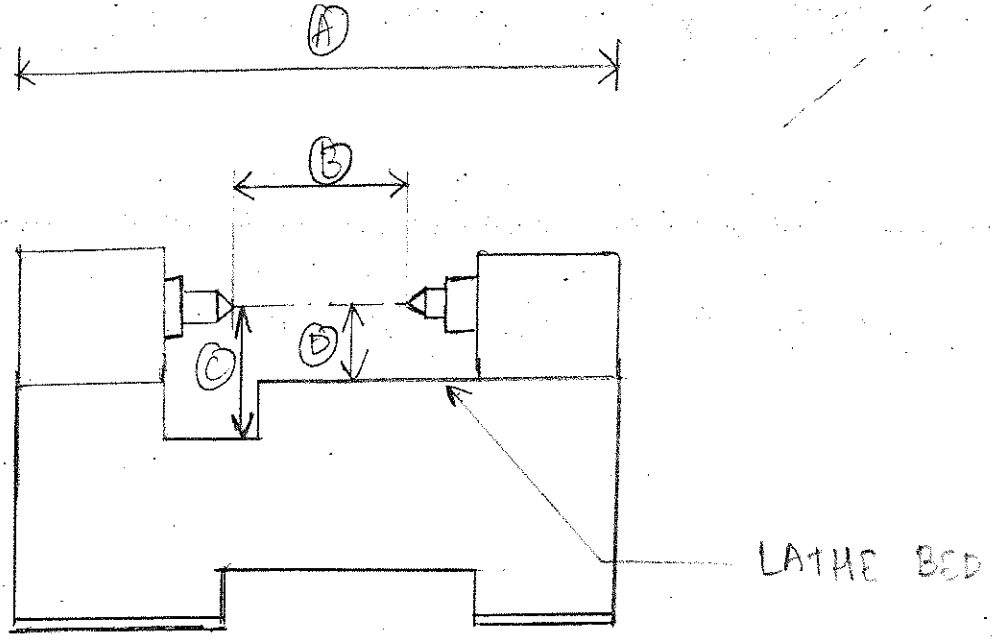
It is a long shaft that gives automatic feed to the carriage for various operations like boring, turning etc.

vi) Lead screw:

It is a long shaft with square threads on it. The rotation of lead screw facilitates the movement of carriage during thread cutting operations.

LATHE SPECIFICATIONS

1) Maximum diameter of the workpiece that can be revolved over lathe bed. Also known as "swing of lathe". {①}



(A) - Overall length of bed

(B) - Distance between centres

(C) - Swing of workpiece over gap in the bed.

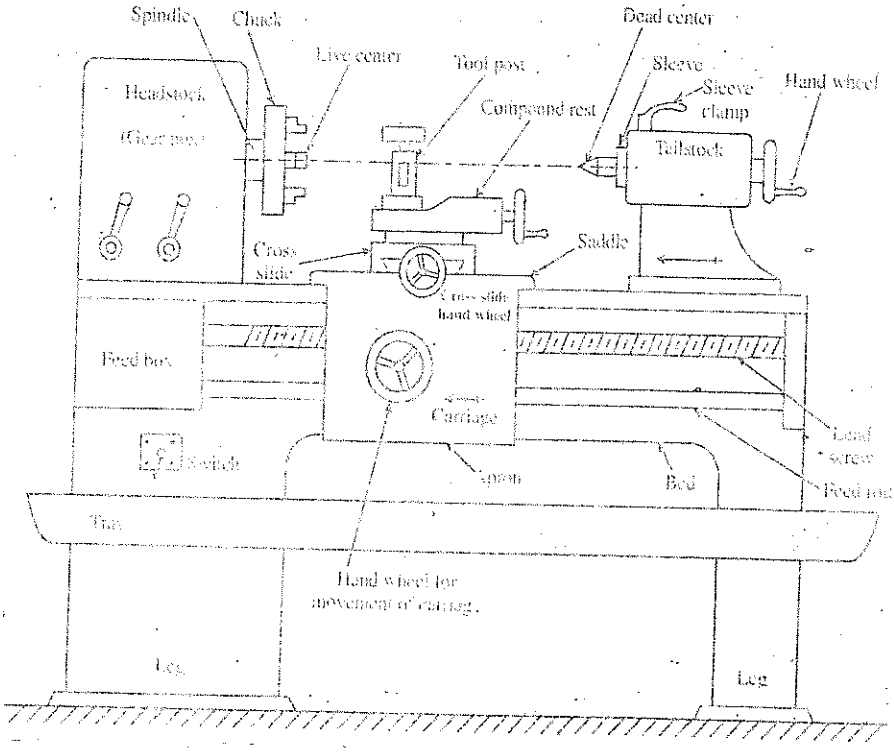
(D) - Swing of workpiece over lathe bed.

2) Maximum diameter and width of the workpiece that can swing when the lathe has a gap {(C)}.

3) the maximum ~~diameter~~ length of the workpiece that can be mounted between the centres. ~~{(A)}~~ {(B)}

4) overall length of bed (or total length of the lathe) {(A)}.

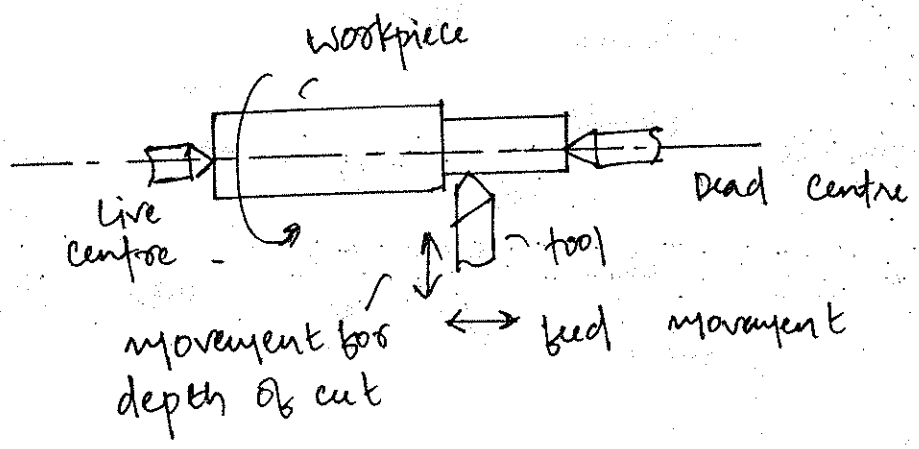
SKETCH PARTS OF LATHE



Important and general operations performed on a lathe are :-

i) Turning
ii) Taper turning
iii) Facing
iv) Parting
v) Knurling
vi) Thread cutting

i) Turning



Also known as cylindrical turning or plain turning or straight turning.

It is the operation of removing excess material from the workpiece to produce a cylindrical surface.

the workpiece is held rigidly between the two centres (live & dead). the cutting tool is fed against the revolving workpiece and is then moved parallel to the lathe axis so as to produce cylindrical

surface.
rough turning (large depths of cut & high feed rate) and finish turning (small depth of cut and lower feed rate).

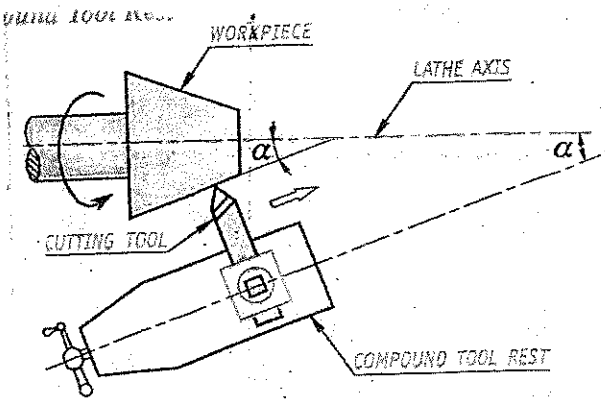
ii) Taper turning

It is operation on a lathe to produce conical surface on the workpiece.
It is accomplished either i) with the workpiece mounted coaxial with the axis of lathe centres and cutting tool being moved linearly inclined to it or
ii) the workpiece itself is mounted so as to have its axis inclined to the axis of lathe centres and the cutting tool being moved linearly parallel to the axis of the lathe bed.

In the first method, taper is obtained either by - a) Swivelling the compound rest or by b) using taper turning attachment.
In the second method, taper is obtained by offsetting the tailstock.

a) Taper turning by Swivelling the compound tool rest

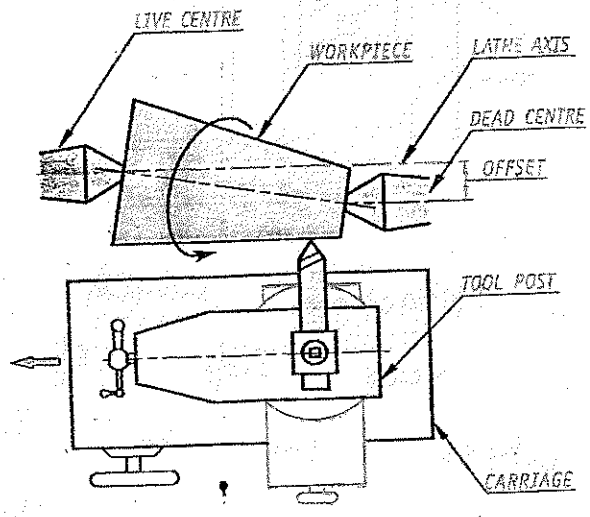
the compound rest is swivelled to the required taper angle and then locked in



the angular position. It is then moved linearly at an angle so that the cutting tool produces the tapered surface on the workpiece.

Steep tapers for short lengths are possible with this method.

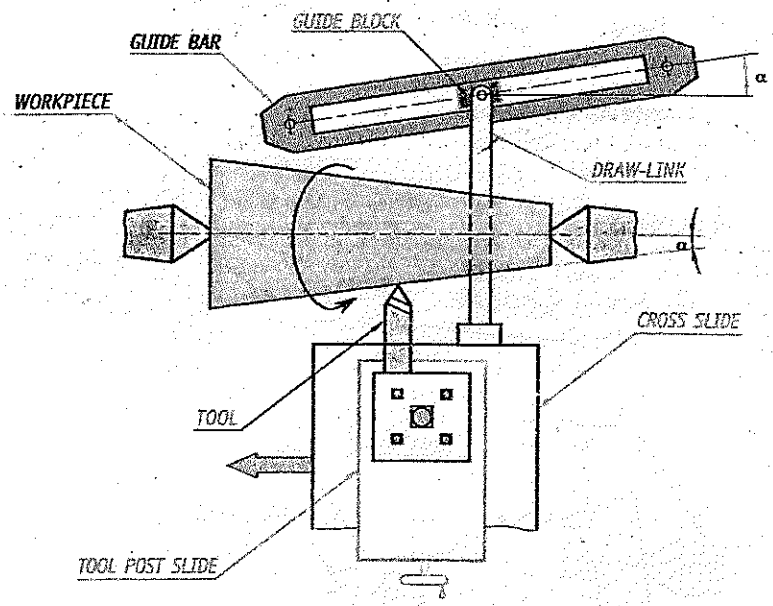
b) Taper turning by Offsetting the tailstock (tailstock set over method)



When the tailstock centre is set out of alignment, the workpiece gets taper turned

because its axis [illegible] angle with the longitudinal movement of the tool which will be parallel to the lathe bed. the entire carraige is moved parallel to the lathe bed to cut the taper. Since the amount of offset is limited by the size of the tail stock, this method is more suitable for jobs having less taper. It is possible to produce taper on long workpieces.

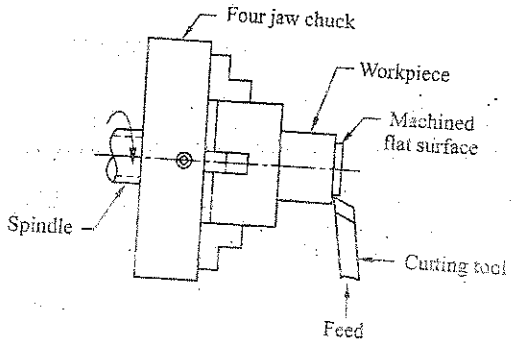
c) Taper turning by taper turning attachment



It consists of a bracket which will be connected to the rear side of lathe bed. A guide bar which can be swivelled in the horizontal plane and locked in position, is mounted over the bracket. A guide block pivoted to a draw-link

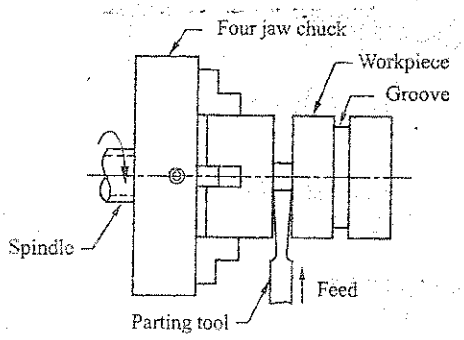
will slide in the longitudinal slot in the guide bar. the draw link is connected firmly to the cross slide. the tool is mounted on tool post slide. the cross slide is allowed to move freely on its ways by loosening the cross feed screw and the engaging nut. When the carriage is moved, the guide slides inside the slot in the guide bar. the sliding of the guide inside the slot forces the cross slide to move in transverse direction. the combined transverse motion of the cross slide and the longitudinal motion of the carriage moves the tool parallel to the inclined axis of the guide bar and produce the required taper on the workpiece.

iii) Facing - It is the operation to produce a flat surface normal to the rotational axis of the spindle. the carriage is locked to the lathe bed to prevent its movement. Using the cross slide, the tool is fed at right angles to axis of workpiece.



Facing

iv) Parting (or cutting off) :- It is the operation of separating a piece of finished work from the bar stock. It is done with a narrow cutting tool called as parting tool this tool is fed perpendicular to the rotational axis (lathe axis).



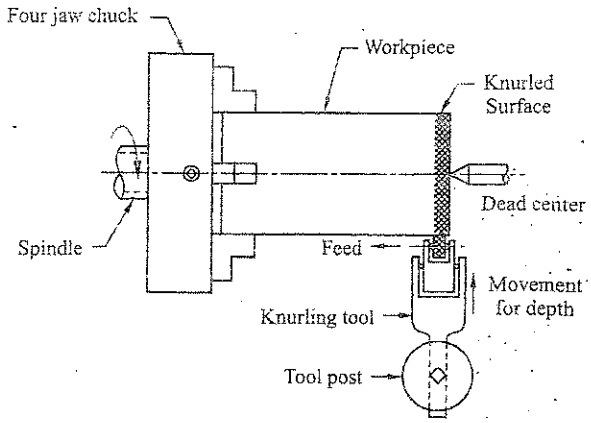
Parting operation

v) Knurling

It is the process of embossing a diamond shaped pattern on the surface of the workpiece by the use of revolving hardened steel wheels pressed against the workpiece.

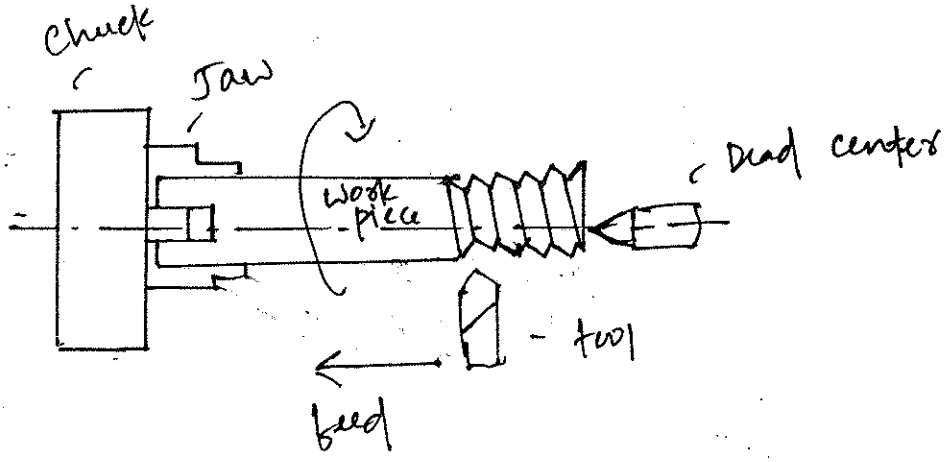
A separate knurling tool is used for this purpose.

knurling is done to provide grip on handles, screw heads and other cylindrical parts to be gripped by hand.



Knurling

vi) Thread cutting



It is the operation for cutting screw threads on metallic parts.

Speed of spindle is less than that in turning.