GOVERNMENT POLYTECHNIC COLLEGE
MANANTHAVADY

Assignment- I

Course Outcome - C01

Machine Tool-3023

Name:______________________________

Class:______________________________

Roll No.:______________________________

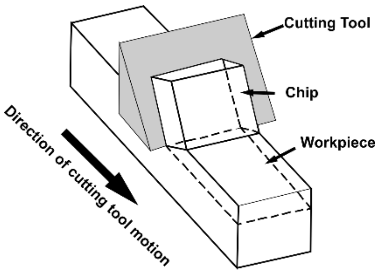
Reg.No.:______________________________

Contents

METAL CUTTING

- Metal cutting, commonly known as machining is the most common phenomenon used in manufacturing industries.
- The two mechanisms of metal cutting are:
  - **Orthogonal Cutting**
  - **Oblique Cutting**

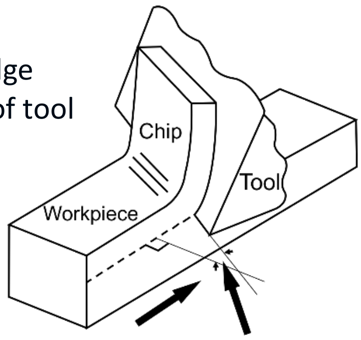
1.01 Orthogonal Cutting



Orthogonal Cutting

- Orthogonal cutting is a type of metal cutting in which the cutting edge of the wedge shaped cutting tool is perpendicular to the direction of the tool motion
- It is also known as 2D (two dimensional) cutting because the force developed during cutting can be represented by 2D coordinates

1.02 Oblique Cutting



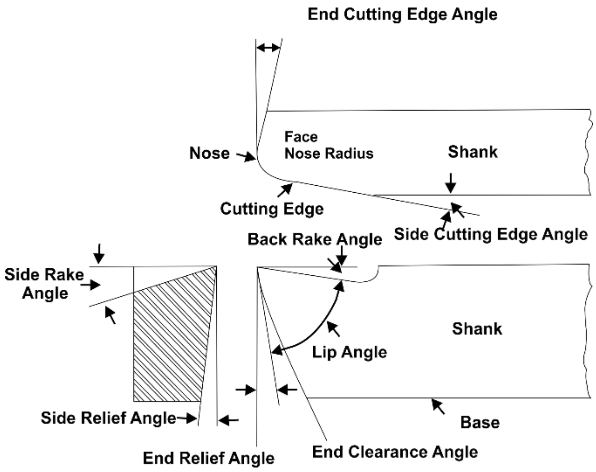
Oblique Cutting

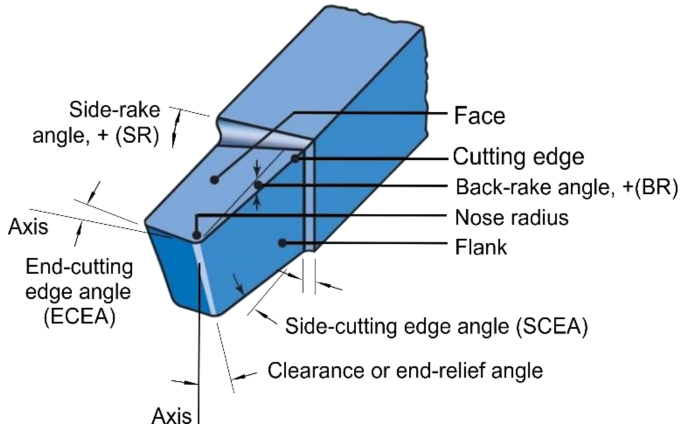
- Oblique cutting is a type of cutting in which the cutting edge of the wedge shaped cutting tool makes an angle except right angle to the direction of tool motion.
- Also known as 3D cutting since the cutting forces developed during cutting can be represented by 3D coordinates

Orthogonal Cutting V/S Oblique Cutting

Orthogonal Cutting	Oblique Cutting
1.Cutting edge of the wedge shaped cutting tool is perpendicular to the direction of the tool motion	1. Cutting edge of the wedge shaped cutting tool makes an angle except right angle to the direction of tool motion
2. The chip flows in the direction normal to the Cutting edge	2. The chip makes an angle with normal to the cutting edge
3. Only two components of forces considered cutting force and thrust force	3. Three components of forces considered cutting force, thrust force and radial force
4. Forces can be represented in 2D coordinate system	4. Force can be represented by 3d coordinate system
5. The shear force developed per unit area is high which increases the heat developed	5. The shear force developed per unit area is low and hence the heat developed is less and hence increased tool life

SINGLE POINT CUTTING TOOL





Single point cutting tool	Multi point cutting tool
1.One cutting point or tip is available	1. More than one point or tip is available
Eg. Lathe machine tool, Planing machine tool	Eg. Milling cutter, Grinding wheel, etc

1.03 Single Point Cutting Tool Geometry/ Nomenclature

Shank

- This is the main body of the tool. The shank is used to hold the tool (i.e tool holder)

Flank

- The surface or surface below and adjacent to the cutting edge is called flank of the tool.

Face

- The surface on which the chips slide is called the face of the tool.

Heel

- It is the intersection of the flan and the base of the tool. It is a curved portion at the bottom of the tool.

Nose

- It is the point where the side cutting edge and end cutting edge intersects.

Angle:

Back rake angle

- Back rake angle is the angle between the face of the single point cutting tool and a line parallel with base of the tool measured in a perpendicular plane through the side cutting edge

- If the slope face is downward toward the nose, it is negative back rake angle and if it is upward toward nose, it is positive back rake angle. Back rake angle helps in removing the chips away from the work piece

Side rake angle

- Side rake angle is the angle by which the face of tool is inclined side ways. Side rake angle is the angle between the surface the flank immediately below the point and the line down from the point perpendicular to the base.

- Side rake angle of cutting tool determines the thickness of the tool behind the cutting edge. It is provided on tool to provide clearance between work piece and tool so as to prevent the rubbing of work piece with end flake of tool

End relief angle

- End relief angle is defined as the angle between the portion of the end flank immediately below the cutting edge and a line perpendicular to the base of the tool, measured at right angles to the flank. End relief angle allows the tool to cut without rubbing on the work piece.

Side relief angle

- Side relief angle is the angle between the portion of the side flank immediately below the side edge and a line perpendicular to the base of the tool measured at right angles to the side.

- Side relief angle is the angle that prevents the interference as the tool enters the material. It is incorporated on the tool to provide relief between its flank and the work piece surface.

End cutting edge angle

- End cutting edge angle is the angle between the end cutting edge and a line perpendicular to the shank of the tool. It provides clearance between tool cutting edge and work piece.

Side cutting edge angle

- Side cutting edge angle is the angle between straight cutting edge on the side of tool and the side of the shank. It is responsible for turning the chip away from the finished surface

1.04 Tool Signature

- Tool signature is a standardized abbreviated system used for specifying tool angles. It indicates the angles that a tool utilizes during the cut. It specifies the active angles of the tool normal to the cutting edge.

- The seven elements that comprise the signature of a single point cutting tool are always stated in the following order: (ASA)

1) Back rake angle (0°)
2) Side rake angle (7°)
3) End relief angle (6°)
4) Side relief angle (8°)
5) End cutting edge angle (15°)
6) Side cutting edge angle (16°)
7) Nose radius (0.8 mm

If a tool has shown by 2, 9, 5, 5, 9, 11, 3 it means

1) Back rack angle: 2°
2) Side rack angle: 9°
3) End relief angle: 5°
4) Side relief angle: 5°
5) End cutting edge angle: 9°
6) Side cutting edge angle: 11°
7) Nose radius: 3mm

Cutting Tools Material

1.05 Properties of cutting tool

1) It should be harder than the work piece material
2) High hot hardness temperature
3) High toughness
4) High wear resistance
5) High thermal condectivity
6) Low co-efficient of friction
7) Low Cost
8) Ease in fabrication

1.06 Various Cutting Tool Materials

1) High Carbon Steel
2) High Speed Steel (H.S.S)
3) Cemented Carbides
4) Cermets
5) Diamond

6) Ceramics and sintered oxides

Comparison Of High Carbon Steel and High Speed Steel (H.S.S)

High Carbon Steel	High Speed Steel (H.S.S)
1) Its Composition is C=0.8 to 1.3%, Si=0.1 to 0.4%, and Mn=0.1 to 0.4%	1) It is a high carbon tool steel containing large amount of tungsten
2) Used for machining soft metals	2) A typical H.S.S is 18% tungsten, 4% chromium and 1% Vanadium
3) Used at cutting speed of 5 m/min	3)They are used in specific types of tools like drills,reamers, taps, etc
4) Loose hardness above 250^0C	

Tool Life

- The actual machining time between 2 successive regrinds of a cutting tool is known as tool life

1.07 FACTORS AFFECTING TOOL LIFE

1) Cutting Speed
2) Cutting Temperature
3) Feed and Depth of Cut
4) Tool Geometry
5) Tool Material
6) Work piece Material
7) Nature and Cutting
8) Use of Cutting Fluids
9) Operator's Skill.

Cutting Speed

- If increasing the cutting speed then tool life definitely decreases.

Cutting Temperature

- If increasing the temperature of the tool then decreases the life of the tool.

Feed and Depth of Cut

- If increasing the feed and depth of cut that causes friction will increases between the tip of the tool and work piece which decreases the life of the tool.

Tool Geometry

- If you are not making the proper rack angle, back rack angle, etc then also it will affect the life of the tool.

Tool Material

- Tools are made with different materials like carbide, ceramic, high-speed steel, carbon steel, etc. Which are the various mechanical properties on which the life of the tool depends.

Work piece Material

- If the cutting tool is not selected according to the workpiece material, it also affects the life of the tool.

Nature and Cutting

- Nature of material which type of environment cutting condition also affects the life of the tool.

Use of Cutting Fluids

- If the cutting fluid is not used properly or of good quality, it will reduce the life of the tool.

Operator's Skill

- Operators must be well skilled in operating machining processes otherwise tool life is likely to be reduced.

1.08 TAYLOR'S TOOL LIFE EQUATION

$$\boxed{VT^n = C}$$

- V= Cutting speed (m/min)
- T= Tool life (minutes)
- n= a constant whose value depends upon the material of the cutting tool & job, called tool life Index.
  - n=0.08 to 0.02 for H.S.S tools
  - n=0.2 to 0.4 for cemented carbide tools
  - n= 0.5 to 0.7 for Ceramic Tools
  - n = 0.1 to 0.15 for cast alloys
- C = a constant, called machining constant

➢ The machining cast iron use high-speed steel tool life of 50 minutes was observed with a cutting speed of 100 m/min. Determine the tool life with a cutting speed of 80 m/min. ? (n = 0.09)

➢ Find the tool life equation, if a tool life of 80min is obtained at a cutting speed of 30m/min and 8 min at 60m/min ?

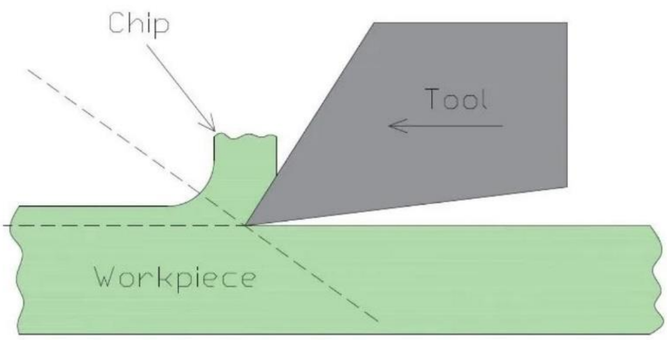
Chip Formation

- When the tool comes in contact with the metal surface, elastic compression and then plastic compression of the metal face in contact with the tool rake face takes place. This develops shear and ultimately yielding or fracture starts.
- Finally, the deformed metal or chip flows over the tool face and get removed.
- The chip will be removed and get further deformed due to friction, depending upon the cutting conditions.

Types Of Chips

- There are mainly three types of chips:
  1) Continuous Chips
  2) Discontinuous Chips
  3) Continuous Chips with built-up edge

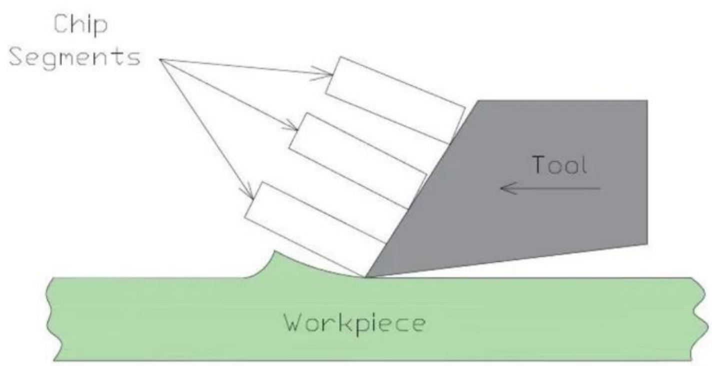
1.09 Continuous Chips



- They are formed by continuos plastic deformation of the metal without fracture in front of the cutting edge of the tool and is formed by smooth flow of the chip up to the tool face
- The chips formed have same thickness throughout
- Favourable conditions for forming continuous chips:
  1) Workpiece should be ductile
  2) Large rake angle
  3) High cutting speed
  4) Small chip thickness
  5) Minimum friction between tool face and workpiece material
  6) Proper use of coolant and lubricant
  7) Tools should have low co-efficient of friction
- Merits of Continuous Chips:
  1) Gives high surface finish while machining ductile material
  2) Minimizes friction loss
  3) High tool life
  4) Low power consuption

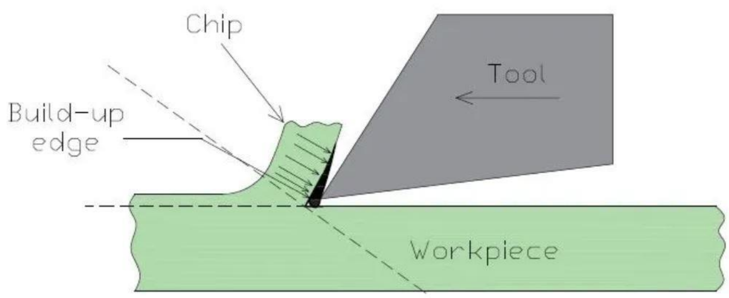
1.10 DISCONTINUOUS CHIPS

- These are the chips that form in segments
- They are formed by series of rupturing occurring approximately perpendicular to the tool face
- They are convenient to handle and dispose off
- Favourable conditions for forming discontinuous chips:
    1) The work piece should be brittle
    2) Slow cutting speed
    3) Small rake angle of the tool
    4) Large depth of cut
- Merits of discontinuous chips:
    1) They are easy to handle and dispose off



1.11 Continuous Chips with built-up edge

- This type of chips is formed during machining of ductile metal with excessive friction between tool and work piece
- It is same as that of continuous chips except for the formation of a built up edge on the tool face
- High friction and high local temperature between the tool work piece interface will lead to the welding of the work piece material to the cutting edge of the tool
- Surface finish will be less
- Favourable conditions for forming continuous chips with built-up edge:
    1) Ductile work piece
    2) High friction on tool face
    3) High temperature between tool and work piece
    4) Lack of coolant and Lubrication



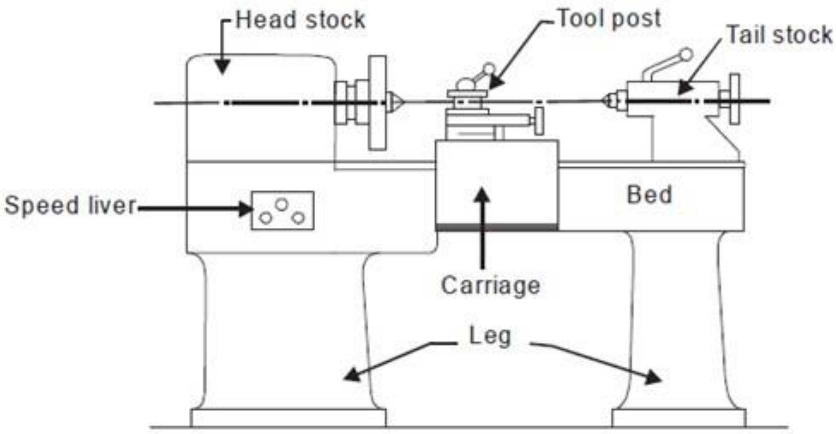
Comparison

Chip Type	Material type	Rack angle	Depth of cut	Cutting speed
Continuous Chip	Ductile	High	Small	Large/Medium
Discontinuous Chips	Brittle, Ductile But hard	Medium	High	Low
Continuous Chips with built edge	Ductile	Low/Medium	Medium	Medium

LATHE

- The lathe machine is one of the earliest machine tools and one of the most versatile and widely used as machine tool for performing the machining operations.

- A lathe is a large machine that rotates the work, and cutting is done with a nonrotating cutting tool. The shapes cut are generally round, or helical. The tool is typically moved parallel to the axis of rotation during cutting.



Principal components of a central lathe

- **Principle:** The job to be machined is held and rotated in a lathe chuck; a single point cutting tool is advanced which is stationary against the rotating job. Since the cutting tool material is harder than the work-piece, so metal is easily removed from the job.

1.12 Lathe Types

1) Speed lathe
2) Tool room lathe
3) Centre lathe or Engine Lathe
4) Bench lathe

Speed lathe

- It is very simple in design
- It has only headstock, tailstock, and a very simple tool post
- It can operate speed is very high
- It is used for light machine works like wood turning, metal spinning and metal polishing

Tool Room Lathe

- It is a very versatile lathe machine
- It can give better accuracy and finish
- It has wider range of speeds
- It can give different types of feeds
- It is very useful in manufacturing die

Centre lathe or Engine Lathe

- It is designed for low and high power operations
- Machine length can be up to 60 feet
- Various metal can be machined
- Machine can operate at wide range of speed rations

Bench lathe

- These types of lathe machines are small in size and are used for very small precision work.
- Bench lathe machines are mounted on the bench.
- It has all the similar parts of engine lathe and speed lathe. Bench lathe machine performs almost all the operations of engine lathe and speed lathe its only difference being in the size.

1.13 Lathe Parts

1) Lathe bed
2) Head stock
3) Tailstock
4) Carriage
5) Feed Mechanism
6) Gear Box

Lathe bed

- It is the base or foundation of the lathe. It is heavy, rugged and single piece casting made to support the working parts of the lathe. The headstock and tail stock are located at either end of the bed and the carriage rests over the lathe bed and slide over it. On the top of the bed, there are two sets of guide ways - outer ways and inner ways. Outer ways is for the carriage and the inner ways for the tailstock. The guide ways are of two types wide flat guide ways and inverted V-guide ways.
- The lathe bed is the main guiding member of the lathe machine so it must satisfy the following condition.
    a. It should be sufficiently rigid to prevent deflection
    b. It must be massive with sufficient depth and width to absorb vibration
    c. It must resist the twisting
    d. To avoid distortion
- For this point of view the bed material should have high compressive strength, should be wear resistant and absorb vibration. Cast iron alloyed with nickel and chromium forms a good material suitable for lathe bed.

Head stock

- The headstock is permanently fastened on the inner ways at the left side of the bed.

- The headstock spindle, a hollow cylindrical shaft supported by bearings, provides a drive from the motor to the work holding device.
- A live centre and sleeve, a face plate, or a chuck can be fitted to the spindle nose to hold and drive the work. All lathes receive their power with the help of a head stock.
- The power transmission device may be step cone pulleys or a geared head drive

Tailstock

- It is situated at the right hand end of the bed and is mounted on the inner guide ways.
- It can be moved towards or away from the operator. Tailstock can be locked in any position along the bed of the lathe by tightening the clamp lever or nut.
- The tailstock spindle is a hollow tapered shaft (left side end). It can be used to hold the dead centre or other tools having the same tapers such as drills and reamers.
- This has two main use:
    - It supports the other end of the work
    - it hold a tool for performing operation such as drilling, reaming, tapping etc.

Carriage

➢ The carriage controls and supports the cutting tool. By the help of this, tool moves away or towards the headstock. It has five major parts

- **Saddle**: It is an H-shaped casting mounted on the top of the lathe ways so it slides along the ways between the headstock and tailstock. On the top it supports the crossslide and tool post
- **Cross Slide**: It is mounted on the saddle. The cross slide has a dovetail that fits over the saddle
- **Dovetail**: It provides the cross movement (towards or away from the operator) to the cutting tool. It supports the compound rest.
- **Compound Rest**: It is mounted on the top of the cross-slide and is used to support the cutting tool. It can be swivelled to any angle for taper turning operations.
- **Tool Post**: It is mounted above the compound rest. A T-slot is machined in the compound rest to accommodate the tool post. It clamps the cutting tool or cutting tool holder in a desired position.
- Type of tool post :
    - Single screw tool post
    - Four bolt tool post
    - Open side tool post
    - Four way tool post
- **Apron**: It is fastened to the saddle and contains the feeding mechanism. The apron hand wheel can be turned by hand to move the carriage along the bed of the lathe. The automatic feed lever is used to engage power feeds to the carriage and the cross slide.

Feed Mechanism

- The movement of the tool relative to the work is termed as "feed".
- A lathe tool may have three types of feed:
    1) **Longitudinal Feed**: When the tool moves parallel to the work i.e. towards or away from the

headstock.

2) **Cross Feed**: When the tool moves perpendicular to the work i.e. towards or away from the operator.
3) **Angular Feed**: When the tool moves at an angle to the work. It is obtained by swivelling the compound slide.

- **Cross and longitudinal feed** are both hand and power operated but angular feed is only hand operated.
- **Lead screw** is used for cutting of the threads in combination with the split nut. Split nut (Half nut) ensures that carriage moves without any slippage.
- **Feed Rod** is used for powered longitudinal movement of the carriage and cross slide.

Gear box

- The quick-change gear-box is placed below the headstock and contains a number of different sized gears.

1.14 Work Holding Devices

- The work holding devices are used to hold and rotate the workpieces along with the spindle. Different work holding devices are used according to the shape, length, diameter and weight of the workpiece and the location of turning on the work. They are

1) Chucks
2) Face plate
3) Driving plate
4) Catch plate
5) Carriers
6) Mandrels
7) Centres
8) Rests

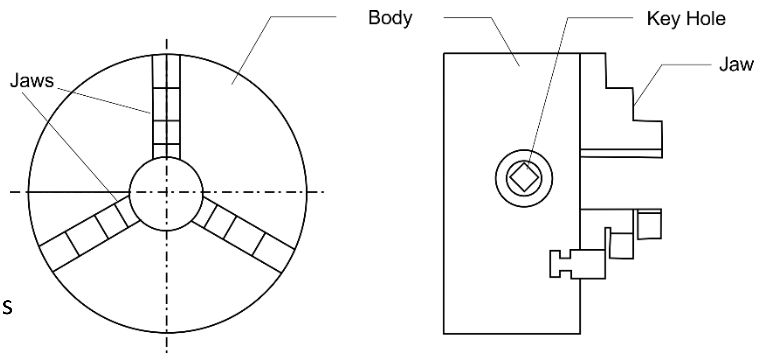
Chucks

- Workpieces of short length, large diameter and irregular shapes, which cannot be mounted between centres, are held quickly and rigidly in chuck. There are different types of chucks namely, three jaw universal chuck, four jaw independent chuck, Magnetic chuck, Collet chuck and Combination chuck.

1) Three Jaw self- centering chuck
2) Four Jaw Independent Chuck
3) Magnetic Chuck
4) Collet Chuck

1) Three Jaw self- centering chuck

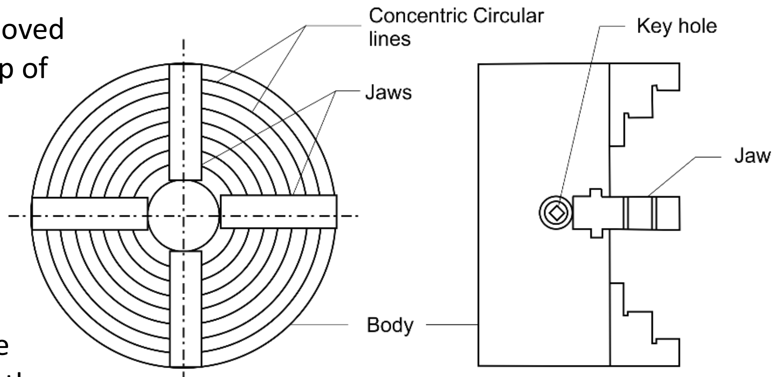
- The three jaws fitted in the three slots may be made to slide at the same time by an equal amount by rotating any one of the three pinions by a chuck key.
- This type of chuck is suitable for holding and rotating regular shaped workpieces like round or hexagonal rods about the axis of the lathe.
- Workpieces of irregular shapes cannot be held by this chuck



Three Jaw Chuck

2) Four Jaw Independent Chuck

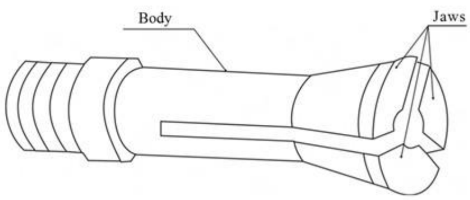
- There are four jaws in this chuck. Each jaw is moved independently by rotating a screw with the help of a chuck key.
- A particular jaw may be moved according to the shape of the work. Hence this type of chuck can hold woks of irregular shapes. But it requires more time to set the work aligned with the lathe axis.
- Experienced turners can set the work about the axis quickly. Concentric circles are inscribed on the face of the chuck to enable quick centering of the workpiece



Four Jaw Chuck

3) Collet Chuck

- Collet chuck has a cylindrical bushing known as collet. It is made of spring steel and has slots cut lengthwise on its circumference. So, it holds the work with more grip. Collet chucks are used in capstan lathes and automatic lathes for holding bar stock in production work

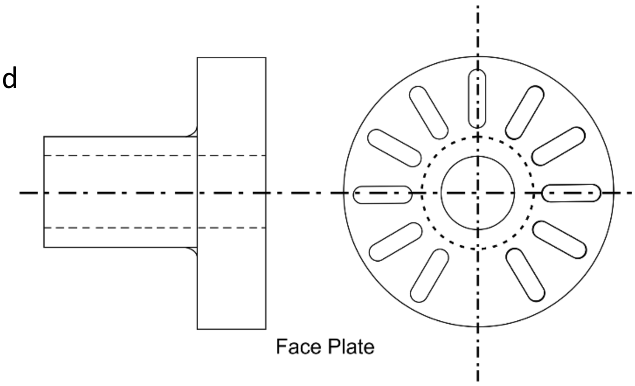


4) Magnetic Chuck

- The holding power of this chuck is obtained by the magnetic flux radiating from the electromagnet placed inside the chuck.
- Magnets are adjusted inside the chuck to hold or release the work. Workpieces made of magnetic material only are held in this chuck.
- Very small, thin and light works which cannot be held in an ordinary chuck are held in this chuck

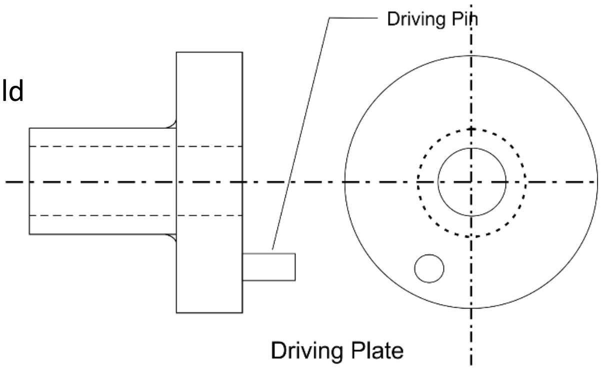
Face plate

- Faceplate is used to hold large, heavy and irregular shaped workpieces which can not be conveniently held between centres. It is a circular disc bored out and threaded to fit to the nose of the lathe spindle. It is provided with radial plain and 'T' – slots for holding the work by bolts and clamps



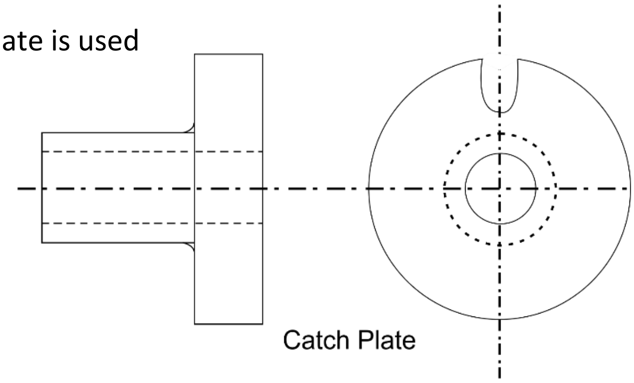
Driving plate

- The driving plate is used to drive a workpiece when it is held between centres. It is a circular disc screwed to the nose of the lathe spindle. It is provided with small bolts or pins on its face. Workpieces fitted inside straight tail carriers are held and rotated by driving plates



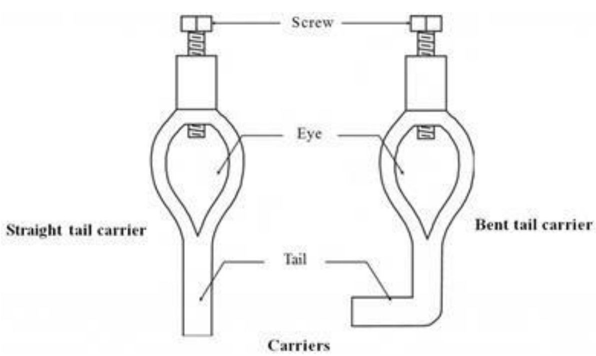
Catch plate

- When a workpiece is held between centres, the catch plate is used to drive it. It is a circular disc bored and threaded at the centre. Catch plates are designed with 'U' – slots or elliptical slots to receive the bent tail of the carrier. Positive drive between the lathe spindle and the workpiece is effected when the workpiece fitted with the carrier fits into the slot of the catch plate.



Carrier (Lathe Dogs)

- When a workpiece is held and machined between centres, carriers are useful in trans- mitting the driving force of the spindle to the work by means of driving plates and catch plates. The work is held inside the eye of the carrier and tightened by a screw. Carriers are of two types and they are:
  - Straight tail carrier
  - Bent tail carrier



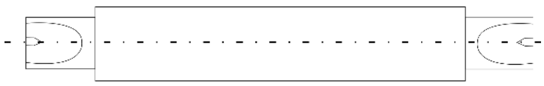
- Straight tail carrier is used to drive the work by means of the pin provided in the driving plate. The tail of the bent tail carrier fits into the slot of the catch plate to drive the work

Mandrel

- A previously drilled or bored workpiece is held on a mandrel to be driven in a lathe and machined. There are centre holes provided on both faces of the mandrel. The live centre and the dead centre fit into the centre holes. A carrier is attached at the left side of the mandrel. The mandrel gets the drive either through a catch plate or a driving plate. The workpiece rotates along with the mandrel. There are several types of mandrels and they are:
    - Plain mandrel
    - Collar mandrel
    - Step mandrel
    - Cone mandrel
    - Gang mandrel
    - Expansion mandrel

✓ **Plain mandrel**

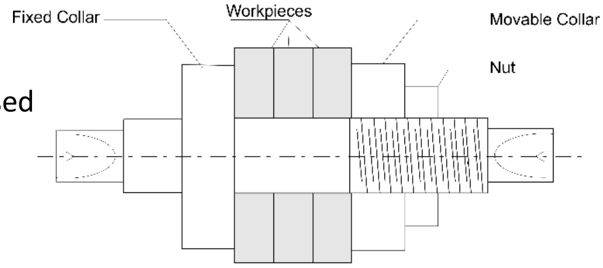
- The body of the plain mandrel is slightly tapered to provide proper gripping of the workpiece. The taper will be around 1 to 2mm for a length of 100mm. It is also known as solid mandrel. It is the type mostly commonly used and has wide application



Plain Mandrel

✓ **Gang mandrel**

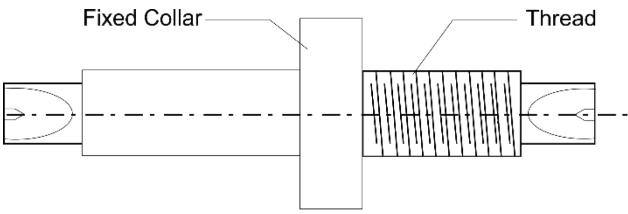
- It has a fixed collar at one end and a movable collar at the threaded end. This man- drel is used to hold a set of hollow workpieces between the two collars by tightening the nut



Gang Mandrel

✓ **Screwed mandrel**

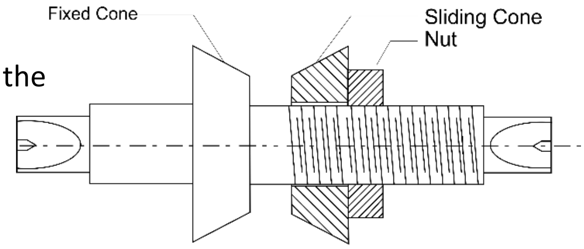
- It is threaded at one end and a collar is attached to it. Workpieces having internal threads are screwed on to it against the collar for machining.



Threaded Mandrel

✓ Cone mandrel

- It consists of a solid cone attached to one end of the body and a sliding cone, which can be adjusted by turning a nut at the threaded end. This type is suitable for driving workpieces having different hole diameters.



Cone Mandrel

Centres

- Centres are useful in holding the work in a lathe between centres. The shank of a centre has Morse taper on it and the face is conical in shape. There are two types of centres namely
  - Live centre
  - Dead centre

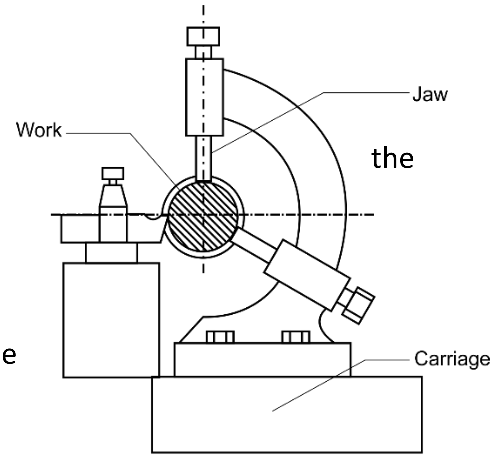

Centre

Rests

- A rest is a mechanical device to support a long slender workpiece when it is turned between centres or by a chuck. It is placed at some intermediate point to prevent the workpiece from bending due to its own weight and vibrations setup due to the cutting force. There are two different types of rests
  - Follower rest
  - Steady rest

✓ Follower rest

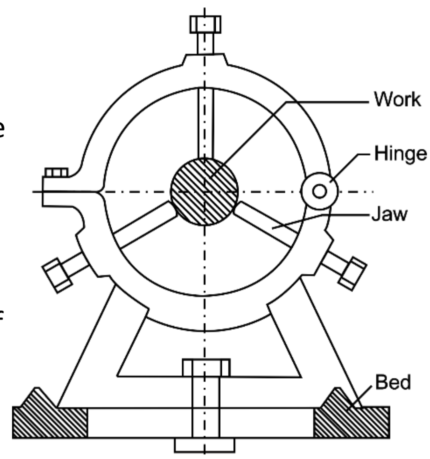
- It consists of a 'C' like casting having two adjustable jaws to support the workpiece. The rest is bolted to the back end of the carriage.
- During machining, it supports the work and moves with the carriage. So, it follows the tool to give continuous support to the work to be able to machine along the entire length of the work



Follower rest

✓ Steady rest

- Steady rest is made of cast iron. It may be made to slide on the lathe bed ways and clamped at any desired position where the workpiece needs support.
- It has three jaws. These jaws can be adjusted according to the diameter of the work. Machining is done upon the distance starting from the headstock to the point of support of the rest.
- One or more steady rests may be used to support the free end of a long work



Steady rest

Speed, Feed and Depth of Cut

1.15 Cutting Speed

- The cutting speed is the distance travelled by a point on the outer surface of the work in one minute. It is expressed in meters per minute

$$\text{Cutting speed} = \frac{\pi dn}{1{,}000}\ \text{m/min}$$

Where 'd'- is the diameter of the work in mm

'n'- is the r.p.m of the work

Recommended Cutting Speeds for six materials in RPM

Cutting Tool	Mild Steel	Carbon steel Annealed	Aluminium	Soft Brass	Cast iron	Annealed Stainless
HSS	100	80	250-350	175	100	80 to 100
Carbide	300	200	750-1000	500	250	200 to 250

1.16 Feed

- The feed of a cutting tool in a lathe work is the distance the tool advances for each revolution of the work. Feed is expressed in millimetre per revolution

Feed for Various Materials (using HSS tool)

Materials	Roughing Cut (IPR)	Finishing Cut (IPR)
Mild steel	.005-.020	.002-.004
Tool Steel	.005-.020	.002-.004
Cast Iron	.005-.020	.002-.004
Brass	.005-.020	.002-.004
Aluminum	.005-.020	.002-.004

1.17 Depth Of Cut

- The depth of cut is the perpendicular distance measured from the machined surface to the uncut surface of the workpiece. It is expressed in millimetre
- In a lathe, the depth of cut is expressed as follows

$$\text{Depth of cut} = \frac{d_1 - d_2}{2}$$

Where ‘d_1’- diameter of the work surface before machine

‘d_1’- diameter of the machined surface

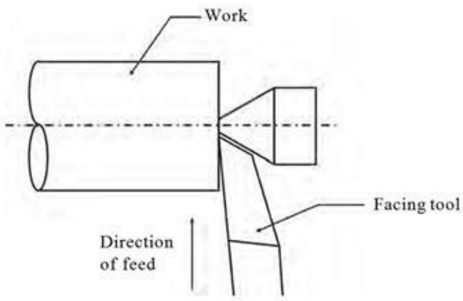
Lathe Operations

1.18 Lathe Operations

- Various operations are performed in a lathe machine other than plain turning. These are:-
  - Facing
  - Turning
    - Straight turning
    - Step turning
  - Chamfering
  - Grooving
  - Forming
  - Knurling
  - Undercutting
  - Eccentric turning
  - Taper turning
  - Thread cutting
  - Drilling
  - Reaming
  - Boring
  - Tapping

✓ **Facing**

- Facing is the operation of machining the ends of a workpiece to produce flat surface square with the axis. The operation involves feeding the tool perpendicular to the axis of rotation of the work

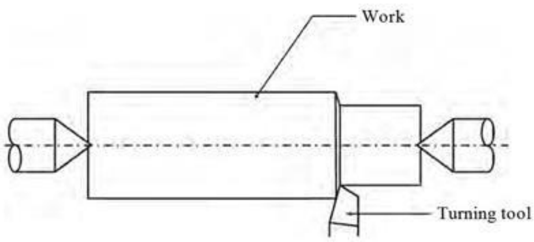


Facing

✓ **Turning**

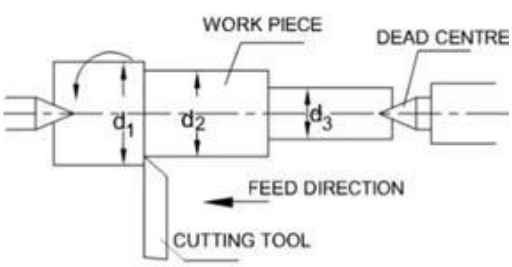
➢ **Straight Turning**

- Turning in a lathe is to remove excess material from the workpiece to produce a cylindrical surface of required shape and size.
  - Straight turning
- The work is turned straight when it is made to rotate



about the lathe axis and the tool is fed parallel to the lathe axis. The straight turning produces a cylindrical surface by removing excess metal from the workpieces

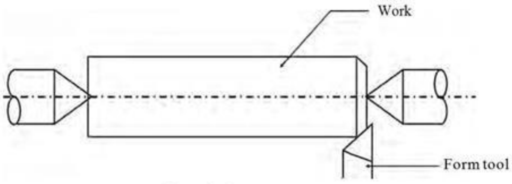
- **Step turning**



STEP TURNING

- Step turning is the process of turning different surfaces having different diameters. The work is held between centres and the tool is moved parallel to the axis of the lathe. It is also called shoulder turning

✓ Chamfering

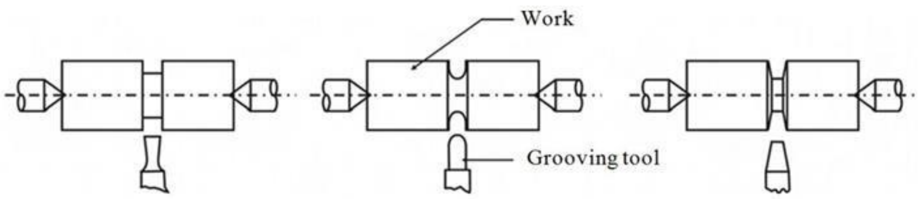


Chamfering

- Chamfering is the operation of bevelling the extreme end of the workpiece. The form tool used for taper turning may be used for this purpose. Chamfering is an essential operation after thread cutting so that the nut may pass freely on the threaded workpiece

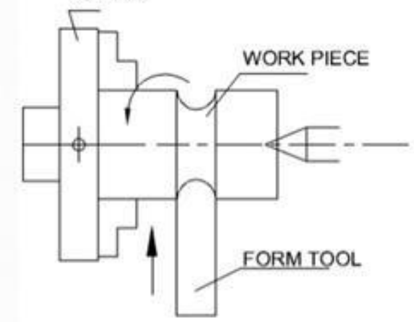
✓ Grooving

- Grooving is the process of cutting a narrow groove on the cylindrical surface of the workpiece. It is often done at end of a thread or adjacent to a shoulder to leave a small margin. The groove may be square, radial or bevelled in shape.



Grooving

✓ Forming

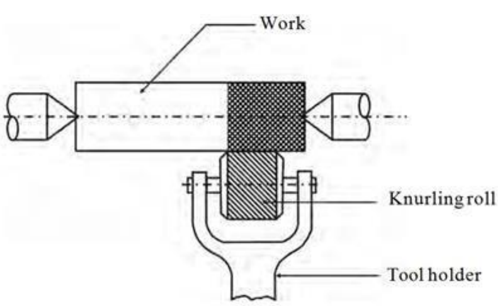


FORMING OPERATION

- Forming is a process of turning a convex, concave or any irregular shape. For turning a small length formed surface, a forming tool having cutting edges conforming to the shape required is fed straight into the work..

✓ Knurling

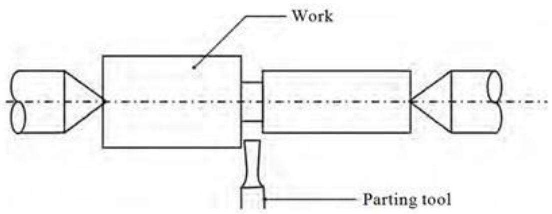
- Knurling is the process of embossing a diamond shaped pattern on the surface of the workpiece. The knurling tool holder has one or two hardened steel rollers with edges of required pattern. The tool holder is pressed against the rotating work. The rollers emboss the required pattern. The tool holder is fed automatically to the required length.



- Knurling is the process of embossing a diamond shaped pattern on the surface of the workpiece. The knurling tool holder has one or two hardened steel rollers with edges of required pattern. The tool holder is pressed against the rotating work. The rollers emboss the required pattern. The tool holder is fed automatically to the required length.
- The purpose of knurling is
  - To provide an effective gripping surface
  - To provide better appearance to the work
  - To slightly increase the diameter of the work

✓ Undercutting

- It is a process of enlarging the diameter if done internally and reducing the diameter if done externally over a short length. It is useful mainly to make fits perfect. Boring tools and parting tools are used for this operation

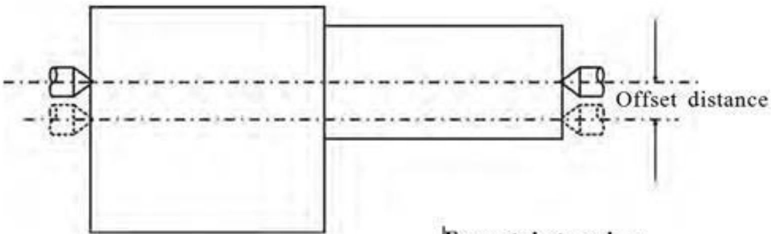


Undercutting

- Undercutting is done
  - At the end of a hole
  - Near the shoulder of stepped cylindrical surfaces
  - At the end of the threaded portion in bolts

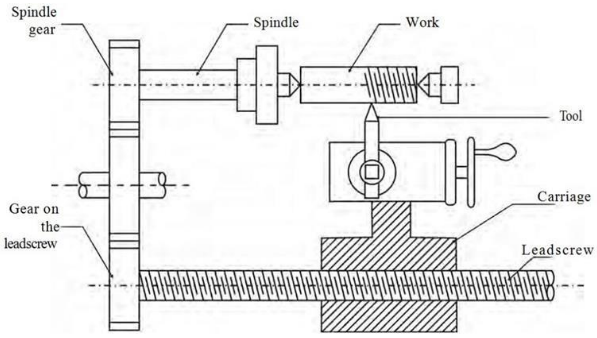
✓ Eccentric Turning

- If a cylindrical workpiece has two separate axes of rotating, one being out of centre to the other, the workpiece is termed as eccentric and turning of different surfaces of the workpiece is known as eccentric turning.
- The distance between the axes is known as offset. Eccentric turning may also be done on some special machines. If the offset distance is more, the work is held by means of special centres. If the offset between the centres is small, two sets of centres are marked on the faces of the work.
- The work is held and rotated between each set of centres to machine the eccentric surfaces.



Eccentric turning

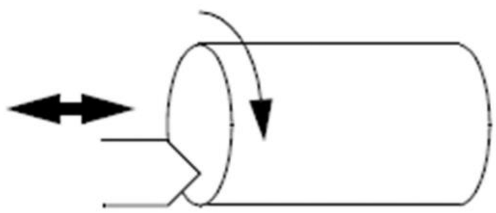
✓ Thread Cutting



Thread cutting

- Thread cutting is one of the most important operations performed in a lathe. The process of thread cutting is to produce a helical groove on a cylindrical surface by feeding the tool longitudinally.
    - The job is revolved between centres or by a the longitudinal feed should be equal to the pitch of the thread to be cut per revolution of the work piece.
    - The carriage should be moved longitudinally obtaining feed through the leadscrew of the
    - A definite ratio between the longitudinal feed and rotation of the headstock spindle should be found Suitable gears with required number of teeth should be mounted on the spindle and the leadscrew.
    - A proper thread cutting tool is selected according to the shape of the It is mounted on the tool post with its cutting edge at the lathe axis and perpendicular to the axis of the work.
    - The position of the tumbler gears are adjusted according to the type of the thread (right hand or left hand).
    - Suitable spindle speed is selected and it is obtained through back
    - Half nut lever is engaged at the right point as indicated by the thread chasing
    - Depth of cut is set suitably to allow the tool to make a light cut on the
    - When the cut is made for the required length, the half nut lever is The carriage is brought back to its original position and the above procedure is repeated until the required depth of the thread is achieved.
    - After the process of thread cutting is over, the thread is checked by suitable gauges

✓ Drilling



- The process which is used to make a cylindrical hole in the work piece is called DRILLING. It is done by a tool drill bit fixed it on the tail stock revolving against the revolution of work piece.

✓ Reaming

- The process which is used to finish already drilled holes in the work piece is called REAMING. It is also used to enlarge the drilled hole of the work piece. It is done by using a tool called reamer fixing it on the tail stock like drilling but at low speed

✓ Boring

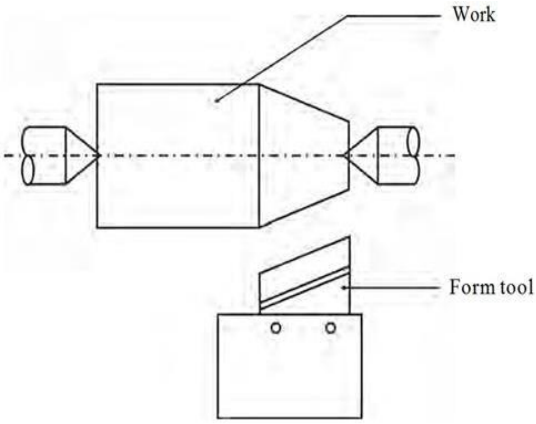
- The process in which material is removed from the inside of work piece is called BORING. It is used to enlarge the inner diameter of the hole. It is done by using a tool called boring bar along the axis of the work piece

✓ **Taper Turning**

- A taper may be defined as a uniform increase or decrease in diameter of a piece of work measured along its length.
- Taper turning methods
  - Form tool method
  - Compound rest method
  - Tailstock set-over method
  - Taper turning attachment method
  - Combined feed method

Form tool method

- A broad nose tool is ground to the required length and angle. It is set on the work by providing feed to the cross-slide.
- When the tool is fed into the work at right angles to the lathe axis, a tapered surface is generated.
- This method is limited to turn short lengths of taper only. The length of the taper is shorter than the length of the cutting edge.
- Less feed is given as the entire cutting edge will be in contact with the work

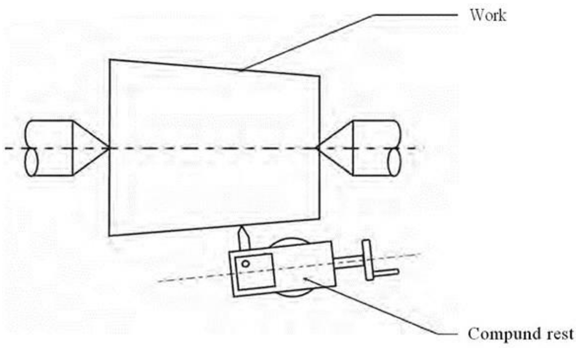


Taper turning by form tool method

Compound rest method

- The compound rest of the lathe is attached to a circular base graduated in degrees, which may be swivelled and clamped at any desired angle. The angle of taper is calculated using the formula

$$\tan\alpha = \frac{D-d}{2l}$$

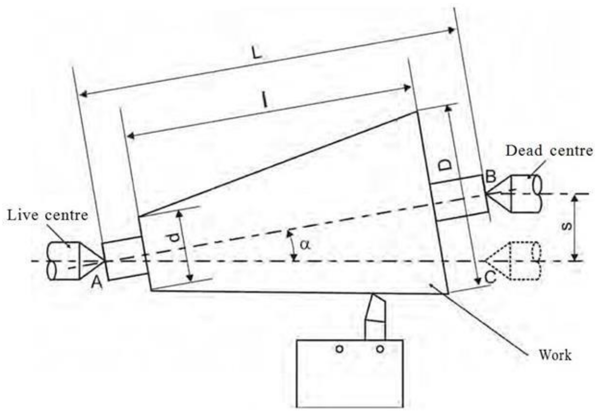


Taper turning by compound rest method

- The compound rest is swivelled to the angle calculated as above and clamped. Feed is given to the compound slide to generate the required taper

Tail stock set-over method

- Turning taper by the set-over method is done by shifting the axis of rotation of the workpiece at an angle to the lathe axis and feeding the tool parallel to the lathe axis.
- The construction of tailstock is designed to have two parts namely the base and the body. The base is fitted on the bed guideways and the body having the dead centre can be moved at cross to shift the lathe axis.
- The amount of set-over – s



Taper turning by tailstock setover method

$$S = L \times \frac{D-d}{2l}$$

Where s- Amount of setover D- Large diameter

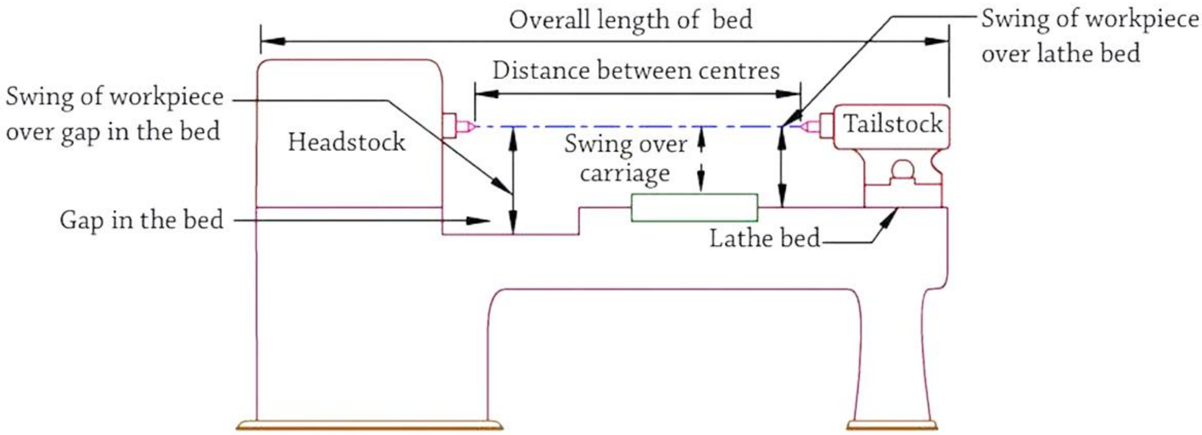
d- Small Diameter L- Length of the work

1-Length of the taper

LATHE SPECIFICATION

1.19 LATHE SPECIFICATION

- A lathe is generally specified by:
    - Swing : The largest work diameter that can be swung for the lathe bed.
    - The distance between headstock and tailstock centres.
    - Bed length in meter.
    - The pitch of the lead screw.
    - Horse Power of the machine.
    - Speed Range
    - The weight of the machine in tonne.



Lathe specification