ELEMENTS OF MECHANICAL ENGINEERING

PART – B

Unit - III

UNIT – V

LATHE & DRILLING MACHINES

Machine Tools

Unit – V, Lathe & Drilling Machines

Objectives:

1.1 To understand the Principle of working of Lathe, Parts and Operations on Lathe.

1.2 Classification

1.3 Specification of Lathe

1.4 Taper turning methods

1.5 To understand the Principle of working and classification of drilling machines

1.6 Operations on drilling machine

1.7 Specification of radial drilling machine

UNIT – V LATHE

Preamble:

Metal Cutting – Shape & Size – Manually – hand tools – files, chisels, saws.

Metal cutting machines – m/c s – power driven, tool, Machine Tools.

Machine tool

Driven by motor – metal cutting – Hold Work Piece & tool – Accurate shape & Size – remove unwanted material – form of chips – relative motion between work piece & cutting tool.

Ex: Lathe, Drilling machine, Milling, Grinding, planing, tapping, shaping, slotting etc..

Lathe: M/c Tool – gen purpose, W/p rotated @ desired speed – Cutting tool moved manually or mechanically – specific direction – to achieve cutting action. It is the first m/c tool which led to the inventions of other m/c tools –

"Mother of machine tools."

Designed – Produce Cylindrical/circular objects – By attachments & accessories – 200 operations – so "King of machine tools"

UNIT – V LATHE

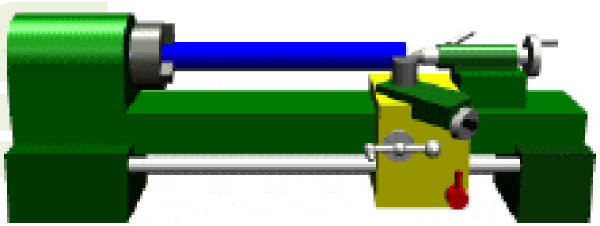
Classification:

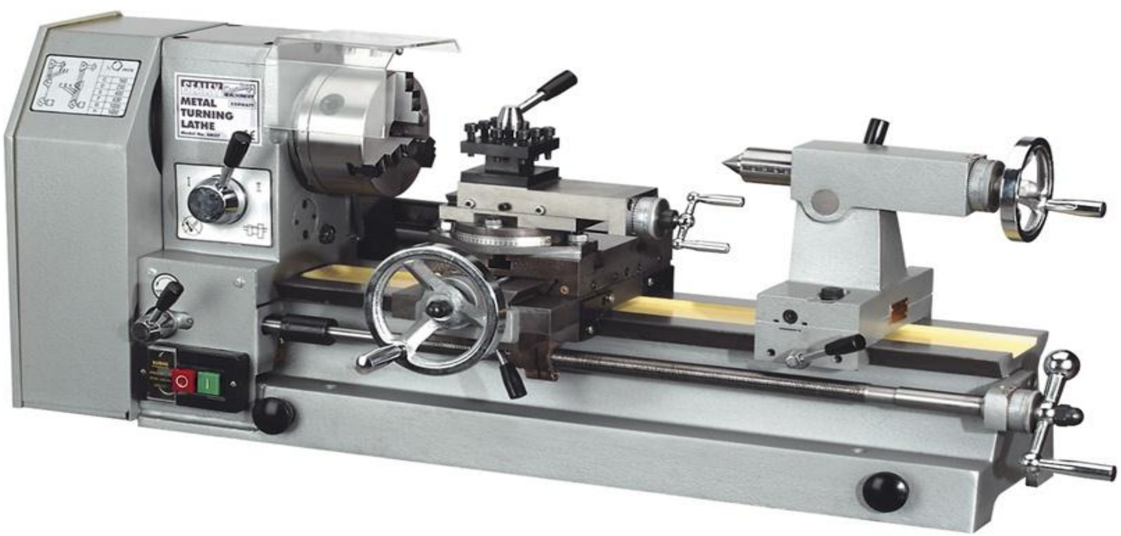
Basis- Drive Mechanism, Process, Purpose.

1) Centre lathes/ Engine Lathes – most commonly used – lathe – m/c steam/motor driven – engine lathe , to produce circular objects – manual operation – cutting tool – feeding – longitudinal & lateral direction – support the w/p – live centre & dead centre – centre lathe -
2) Speed Lathes
3) Bench Lathes
4) Tool room lathes
5) Production Lathes
6) Special Purpose Lathes
7) Automatic Lathes
8) NC/ CNC Lathes
9) Machining Centers

Working Principle:

A lathe is a machine tool which turns cylindrical material, touches a cutting tool to it, and cuts the material. The lathe is one of the machine tools most well used for machining.





Working Principle:

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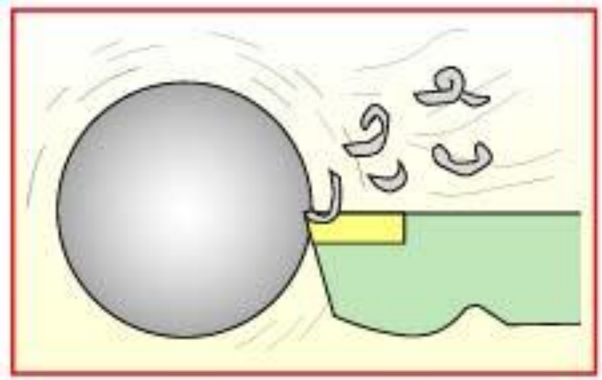
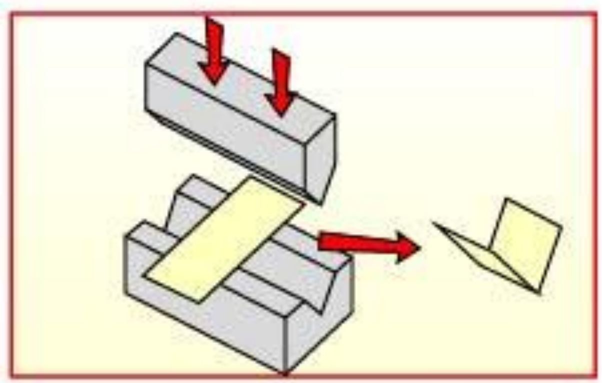


(a) Cutting Processing



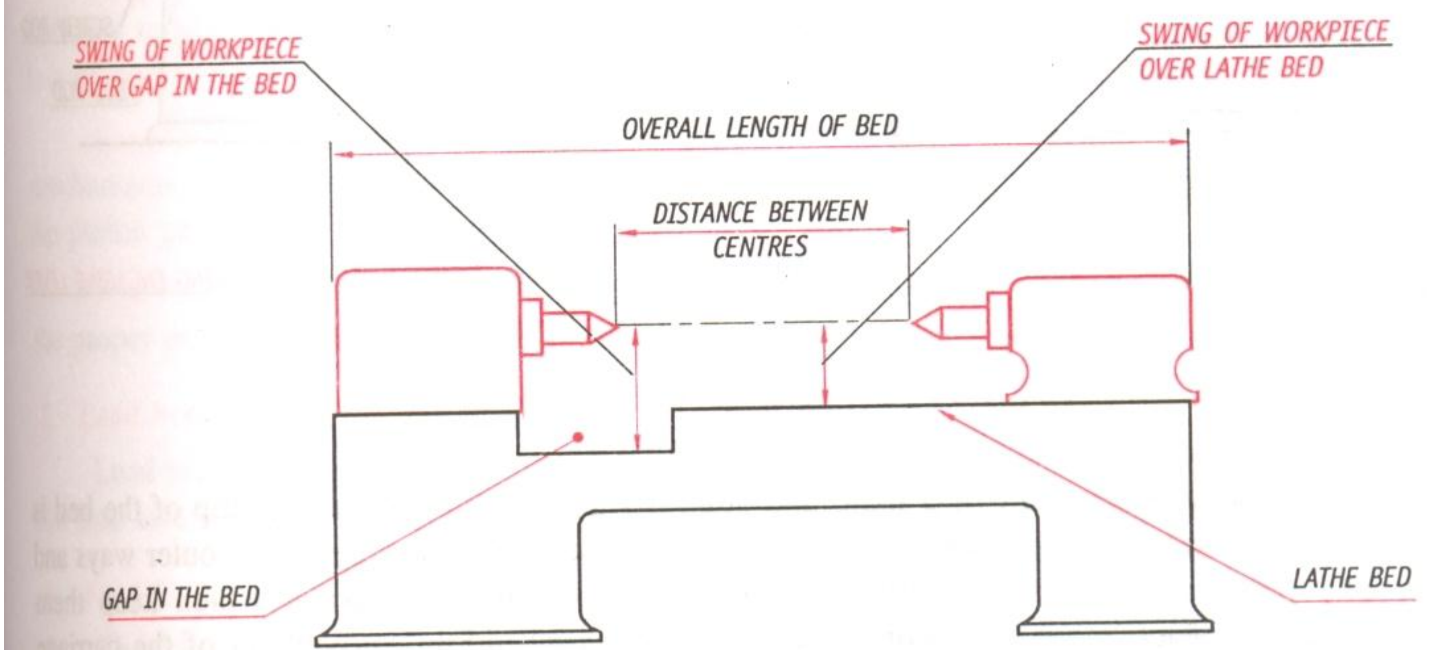
(b) Die-Casting Processing

Working Principle:

In lathe a w/p is held securely & rigidly by work holding devices between a live centre & dead centre. It is then made to rotate at desired speed with the help of inbuilt motor. A single point cutting tool will be fed against the rotating w/p and moved in longitudinal direction to remove the unwanted material in the form of chips. As a result the diameter of w/p reduces.

Apart from cylindrical turning, other contours such as tapers, shoulders, threads, holes, slots, concave, convex etc. may be produced by using suitable fixtures and cutting tools. To carry out different operations the w/p has to be gripped in head stock using fixtures like Chucks, drive plates, lathe dog and other accessories.

Lathe Specifications/ size of lathe:



Specifications of a Lathe
Fig. 5.2

1) Maximum Length: This is the max length of w/p that can be mounted between the live & dead centre.

2) The Maximum diameter of w/p : It is known as SWING of the lathe.

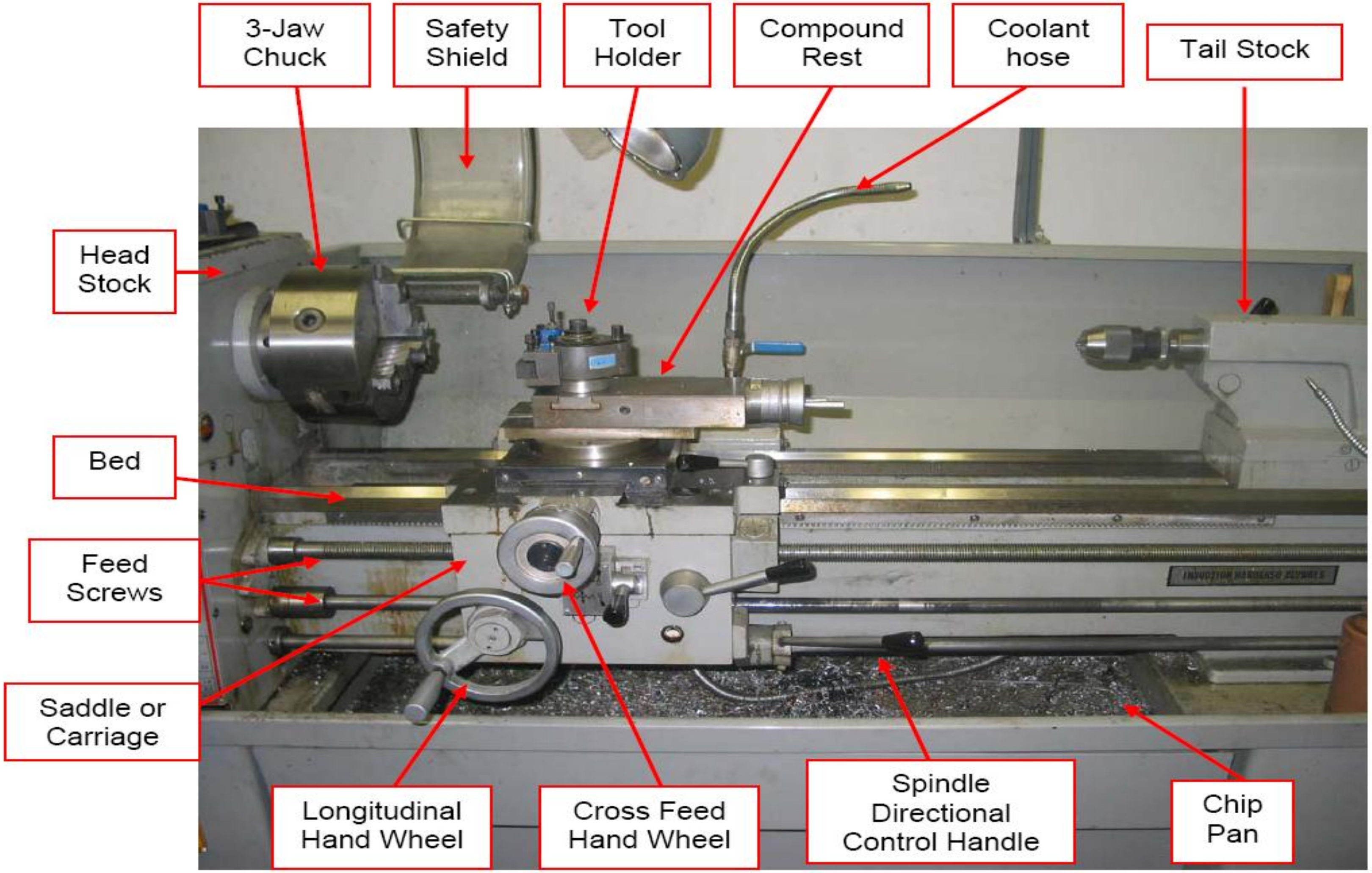
   Max Swing dia over carriage : It is the largest dia of w/p which revolves over the saddle.

   Max swing over bed: It is the largest dia of w/p which revolves over the bed with out touching it.

3) Overall length of bed: it is the length of the floor or space occupied by the lathe.

4) The max dia of the barstock: Is the max dia of the w/p that can be passed through the head stock spindle hole.

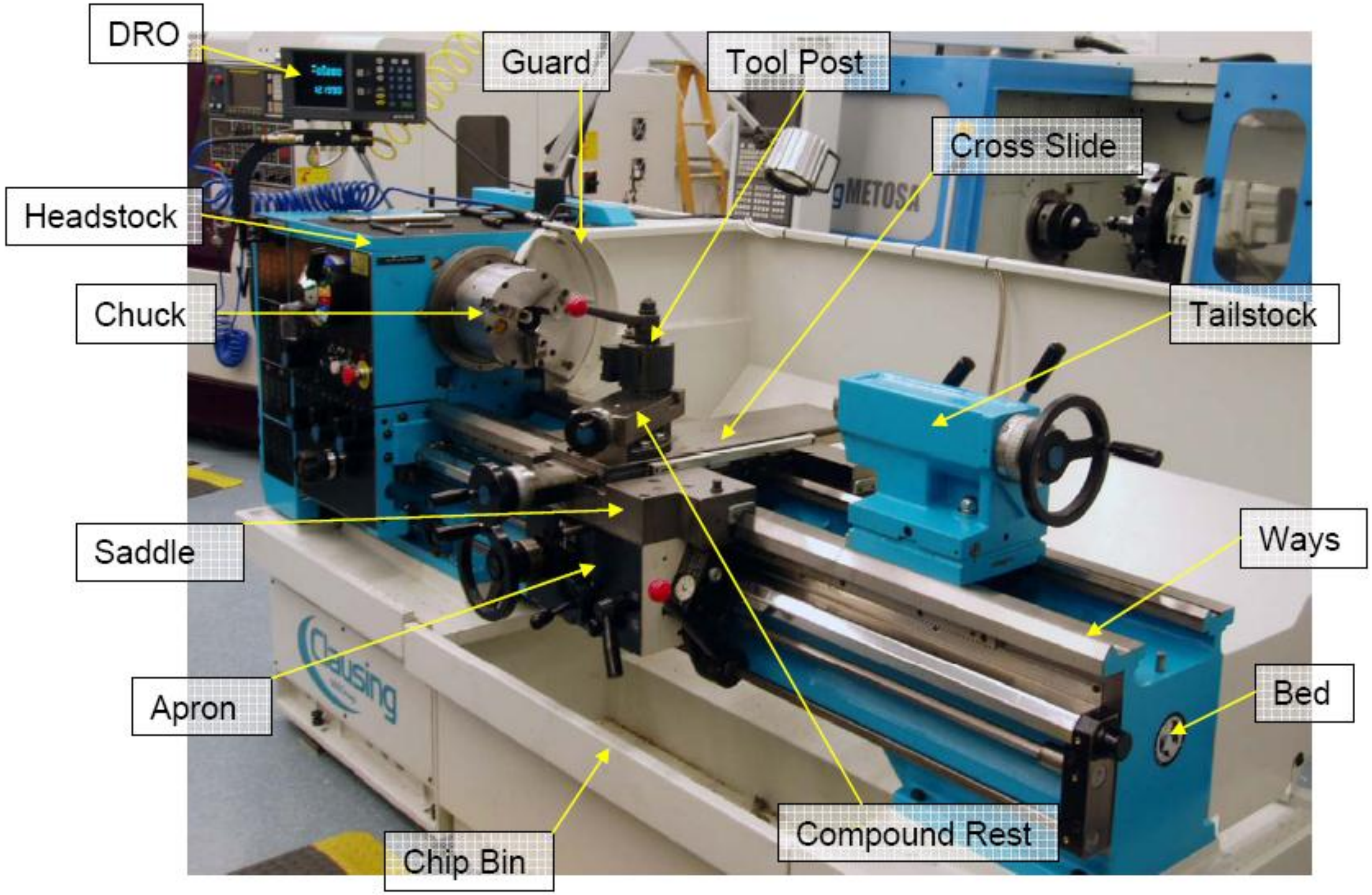
Major Parts of Lathe & Their Functions.



Major Parts of Lathe & Their Functions.

Lathe

Remember: Only one person operates the machine



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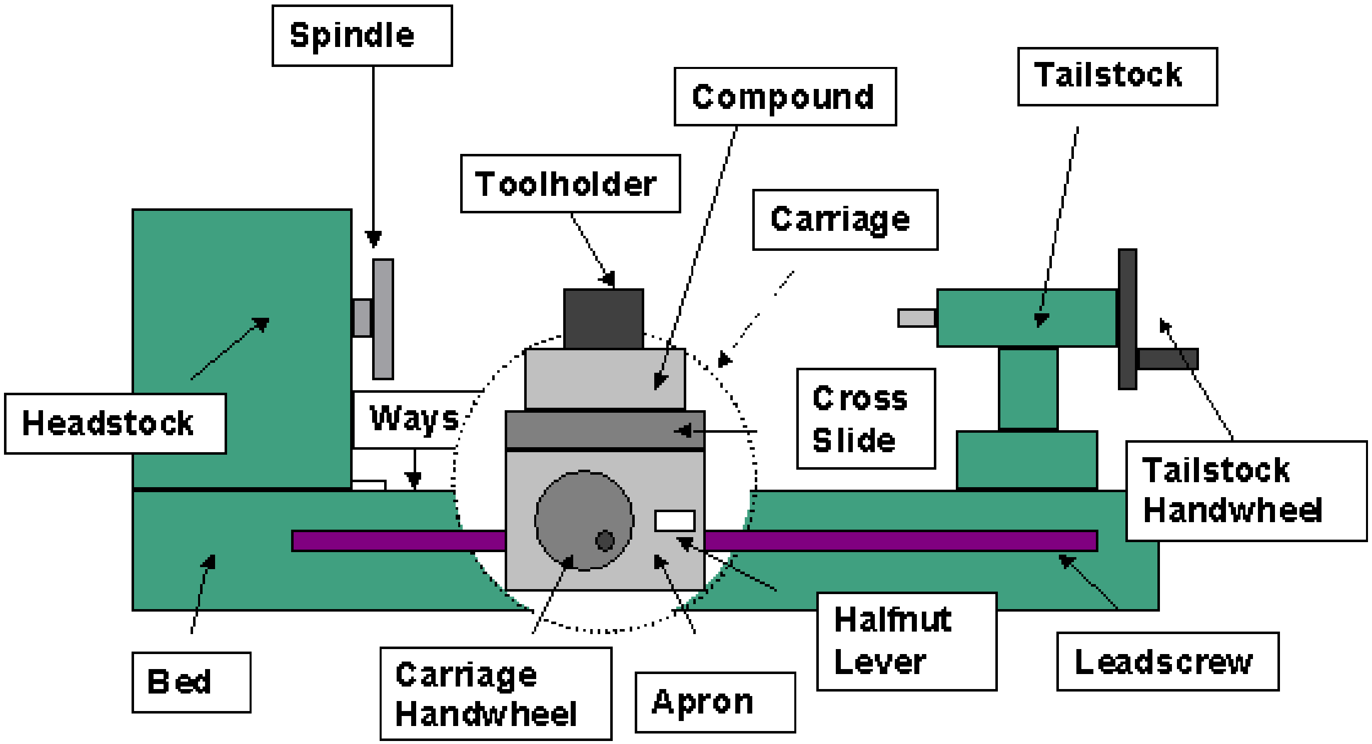
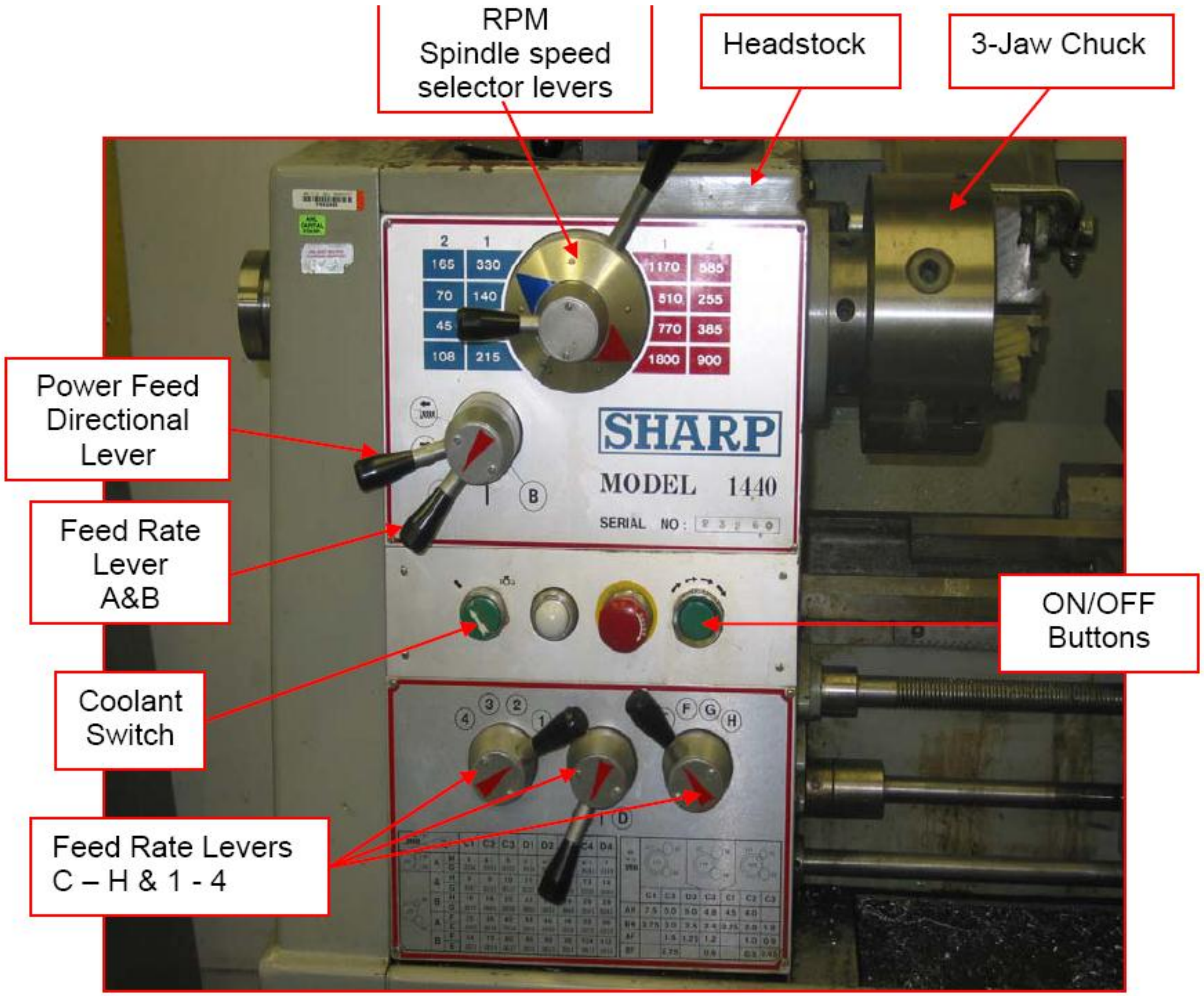
Major Parts of Lathe & Their Functions.



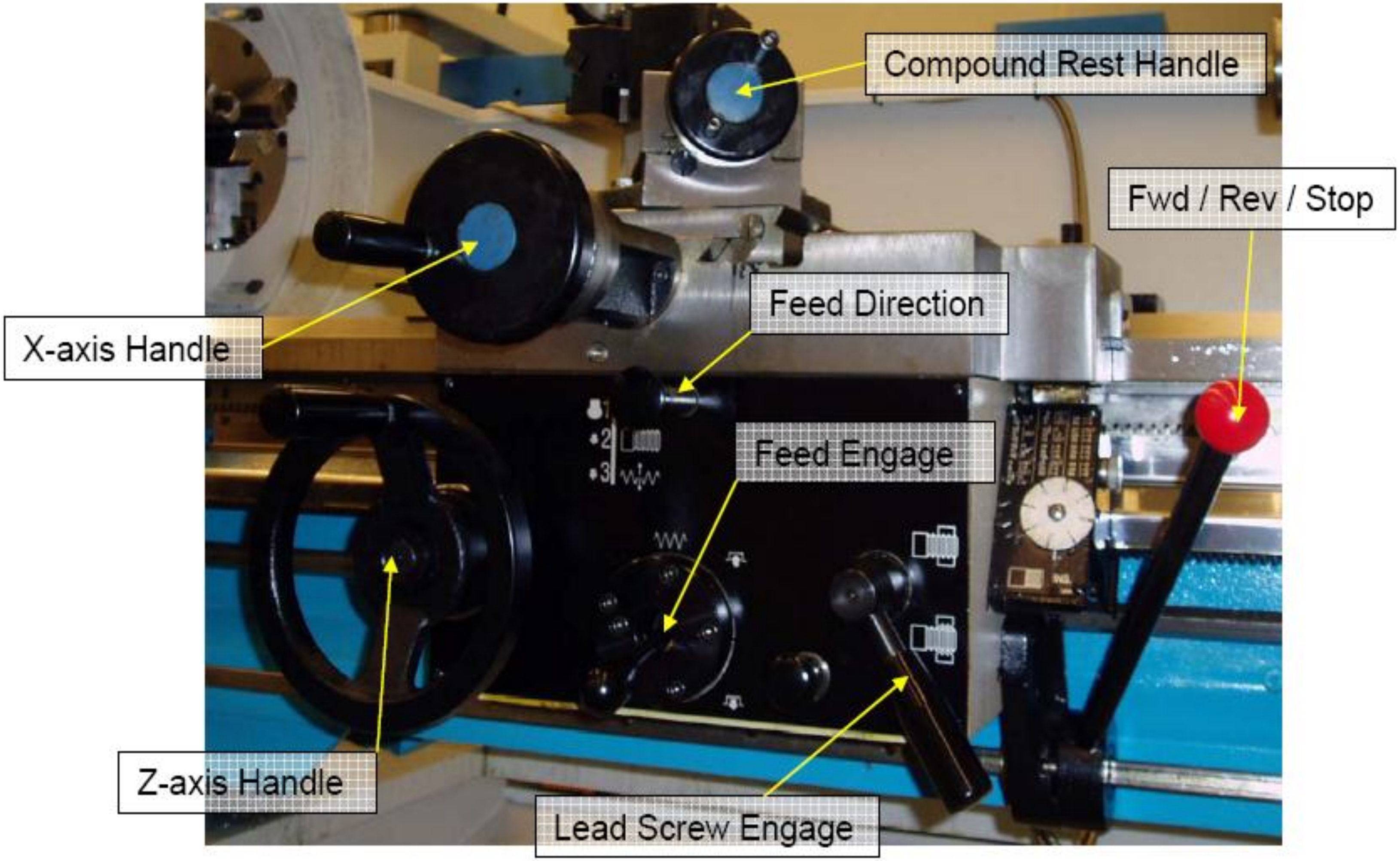
Unit - III

Head Stock

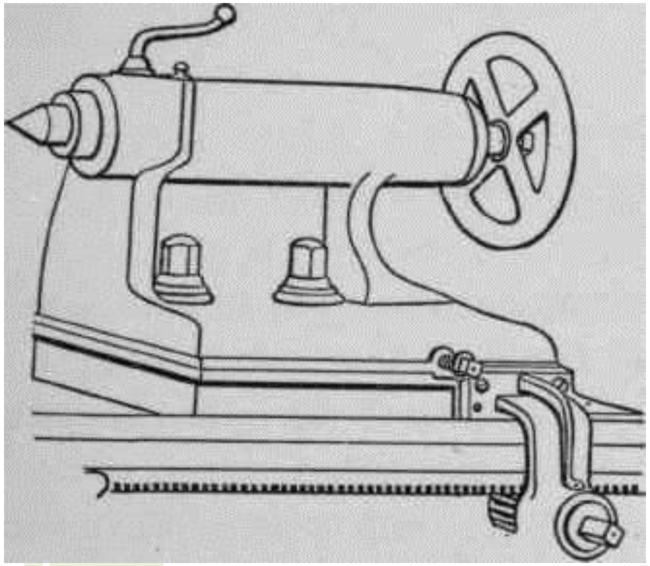

RPM
Spindle speed
selector levers
Headstock
3-Jaw Chuck
Power Feed
Directional
Lever
Feed Rate
Lever
A&B
Coolant
Switch
Feed Rate Levers
C – H & 1 - 4
ON/OFF
Buttons
SHARP
MODEL 1440

Lathe Carriage

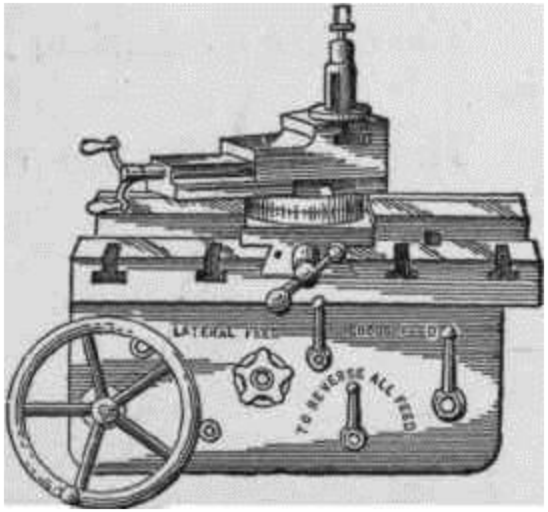
Remember: Only one person operates the machine



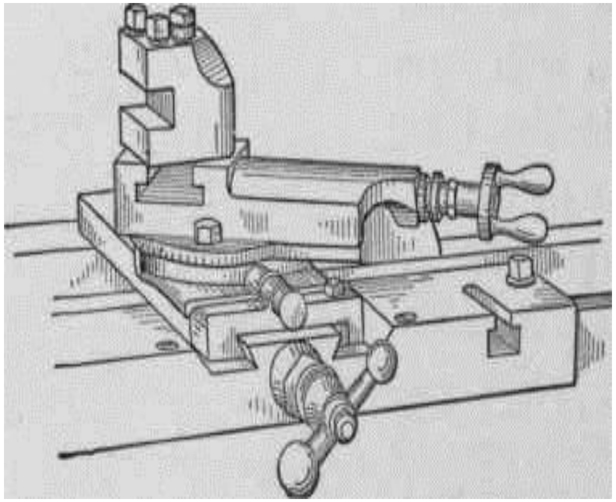
UNIT – V LATHE



Tailstock

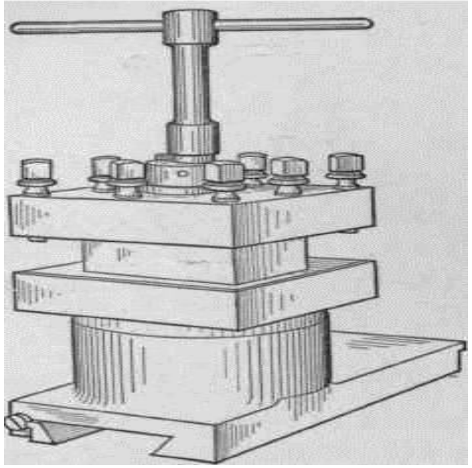


Carriage



Compound rest

Tool Holder



Dead centre

Three Jaw Chuck

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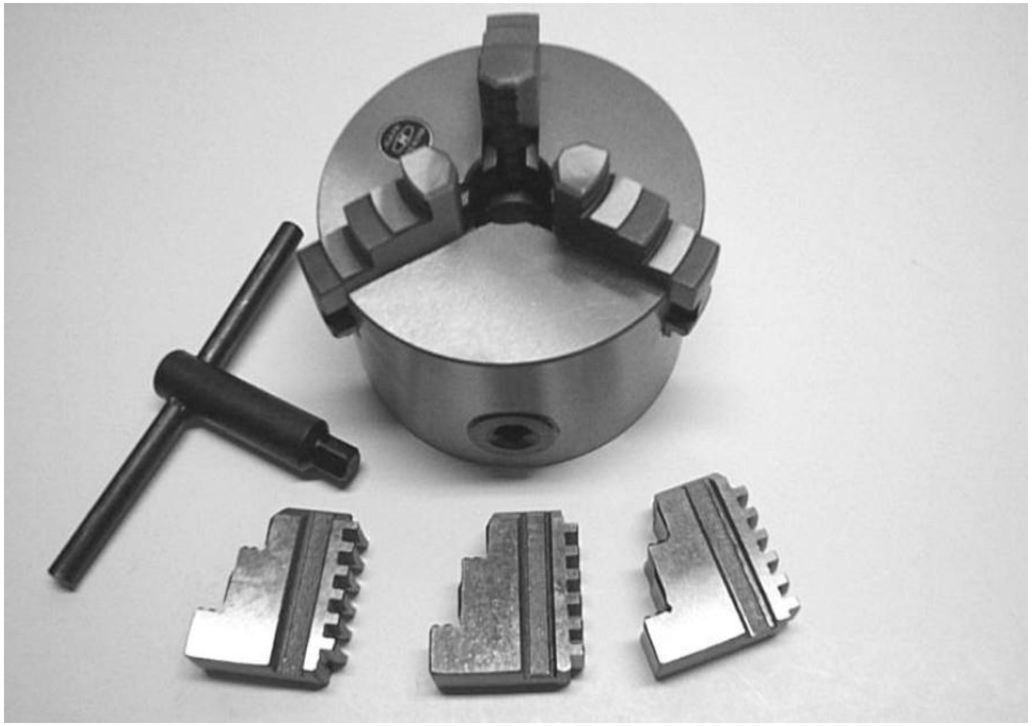

Four Jaw Chuck

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Face Plate

Unit - III

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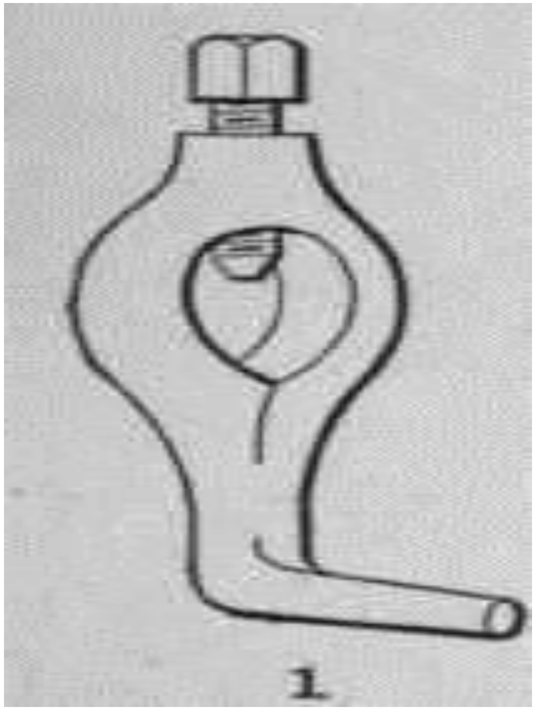
Study rest

Lathe Dog

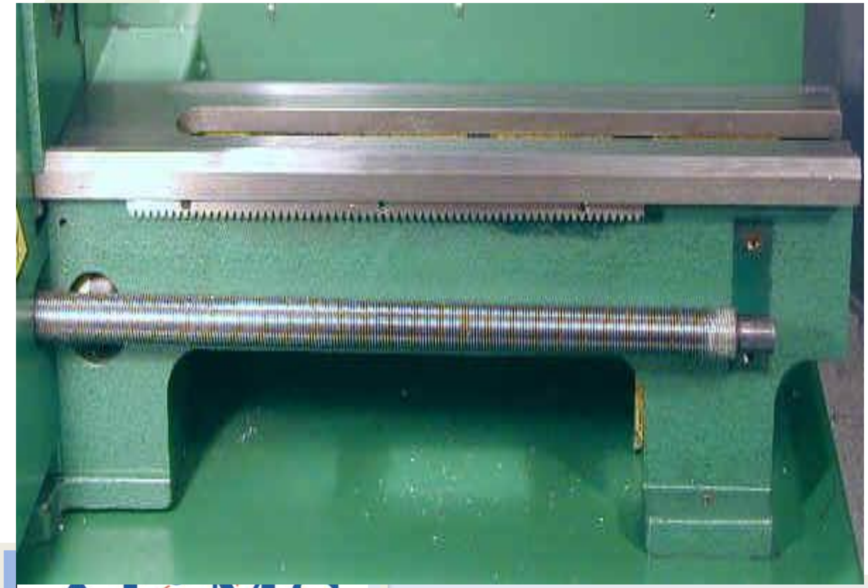


The bed is the main body of the lathe, made from rough but sturdy cast iron. The ways are the ground surfaces on the top side of the bed on which the carriage and tailstock ride.

The ways have a inverted V-shaped ridge on the front side and are flat on the back side. A matching groove on the underside of the saddle rides along this ridge. The headstock casting also has a V-groove which aligns it with the ways. The ways are not hardened so you must be careful not to drop tools or the chuck on them or you will create dents and gouges.

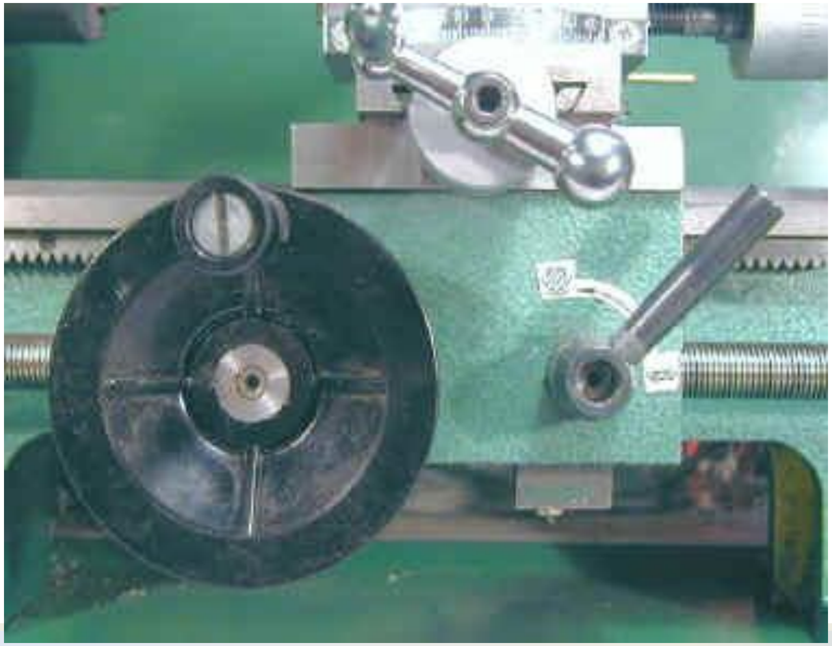
Guide Ways – Flat & *Inverted* V Shaped ways

LATHE BED



Carriage and Saddle

The carriage supports the cross-slide, compound and tool post and moves along the ways under manual or power feed. It comprises the saddle, a casting that rides across the top of the ways, and the apron, a casting which extends down from the saddle in front of the lathe and supports the carriage hand wheel, half nut assembly and threading dial. The lever to the right of the carriage hand wheel is the half-nut lever. It engages and disengages the power feed to the lead screw as described in a later section. The carriage hand wheel moves the carriage along the ways by means of a rack and pinion drive. The rack teeth are visible just below the ways. The pinion is driven by a reduction gear connected to the hand wheel.



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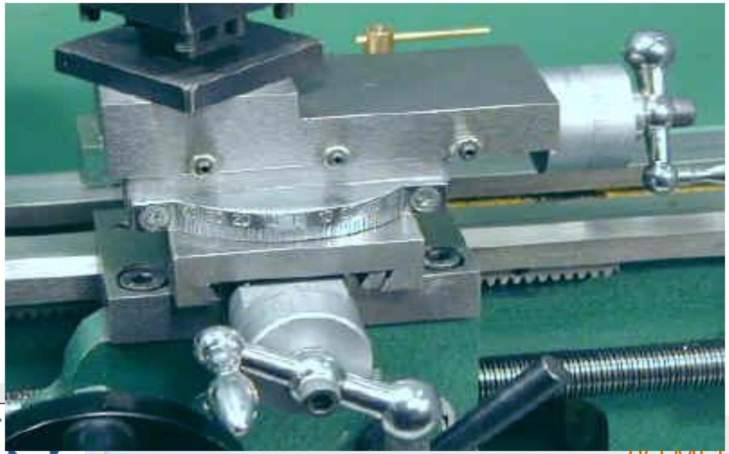
Cross Slide and Compound

The cross slide consists of a dovetailed slide that moves at a right angle to the ways. The compound is mounted on top of the cross slide. In the following picture the compound has been removed, showing the cross-slide mounted on the saddle. The compound bolts into the disk in the cross-slide which enables the compound to be rotated.

The cross feed advances the cutting tool into the work at a right angle to the work piece by means of a lead screw and hand wheel. More expensive lathes have power feed capability on the cross feed.

The compound sits on top of the cross slide and can be rotated to set the tool to advance at an angle to the work piece. For example, by setting the compound at a 4 degree angle, you can cut shallow tapers suitable for making hand wheels. An angle of 30 degrees is sometimes used so that advancing the compound hand wheel by .001" actually advances the tool by .0005" (since sine of 30 = .500).



Toolpost and Tools

The tool post can hold up to four tools at once, each locked in place by hex-head cap screws.

Tools can be ready-made carbide tipped tools of various types or high speed steel (HSS) ground to shape by the user from commonly available tool blanks.

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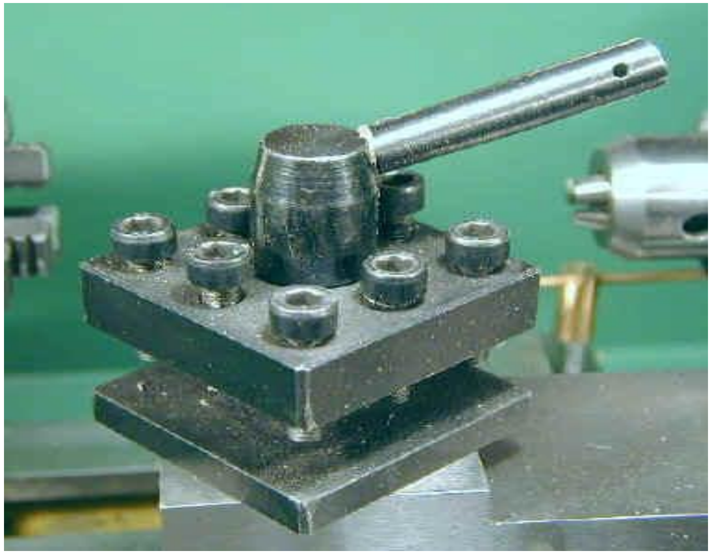
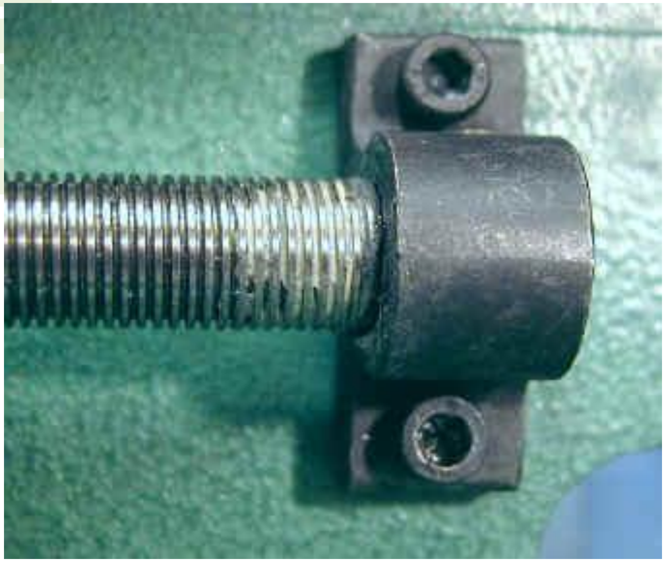


Lead screw, Power Feed

Extending from the gear drive train on the left side of the headstock, through the speed control box and out to a pillow block supporting the right end, the lead screw can be driven under power to advance the carriage in either direction for turning or threading.

The rotational speed of the lead screw relative to the spindle speed can be adjusted by manually adding and removing gears to and from the gear train. These adjustable gearing ratios also, of course, determine the number of threads per inch during threading operations.



Bed: Main supporting casting running the length of the lathe.

Carriage: Assembly that moves the tool post and cutting tool along the ways.

Apron: Front part of the carriage assembly on which the carriage hand wheel is mounted

Chuck: A clamping device for holding work in the lathe or for holding drills in the tailstock.

Compound Rest: Movable platform on which the tool post is mounted; can be set at an angle to the work piece. Also known as the compound slide and compound rest.

Cross Slide: Platform that moves perpendicular to the lathe axis under control of the cross-slide hand wheel.

Lathe Dog: An "L"-shaped adaptor, usually made of cast iron, with a hole for the work piece and locking bolt in the short end. Used to clamp a work piece and apply rotational force to it while the work piece is mounted between centers along with a faceplate. The dog engages with a hole in the faceplate to apply the force to the work piece. Used in place of a chuck, especially in pre-1940's work, and/or when tapers are cut by offsetting the tailstock.

Faceplate / Drive Plate: A metal plate with a flat face that is mounted on the lathe spindle to hold irregularly shaped work.

Headstock: The main casting mounted on the left end of the bed, in which the spindle is mounted. Houses the spindle speed change gears.

Lead screw: Precision screw that runs the length of the bed. Used to drive the carriage under power for turning and thread cutting operations. Smaller lead screws are used within the cross-slide and compound to move those parts by precise amounts.

Saddle: A casting, shaped like an "H" when viewed from above, which rides along the ways. Along with the apron, it is one of the two main components that make up the carriage.

Spindle: Main rotating shaft on which the chuck or other work holding device is mounted. It is mounted in precision bearings and passes through the headstock.

Tailstock: Cast iron assembly that can slide along the ways and be locked in place. Used to hold long work in place or to mount a drill chuck for drilling into the end of the work.

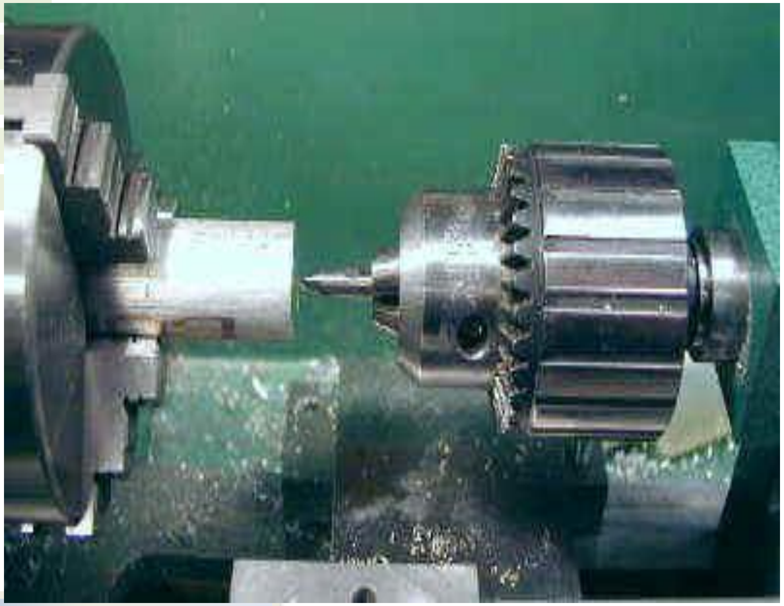
Tool: A cutting tool used to remove metal from a work piece; usually made of High Speed Steel or carbide.

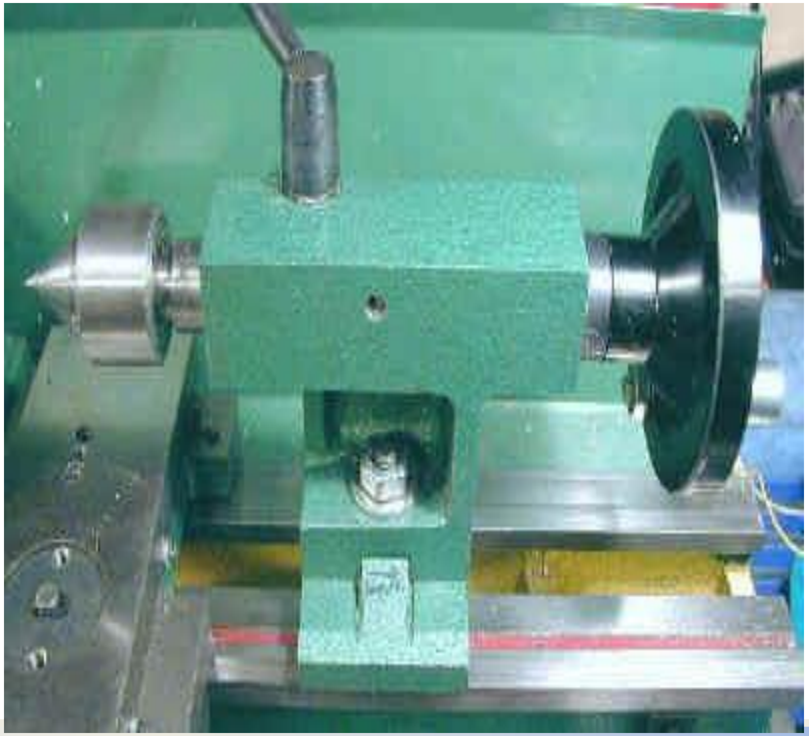
Tool Post: A holding device mounted on the compound into which the cutting tool is clamped

Guide Ways: Precision ground surfaces along the top of the bed on which the saddle rides. The ways are precisely aligned with the centerline of the lathe.

Tailstock, Centers and Drill Chuck

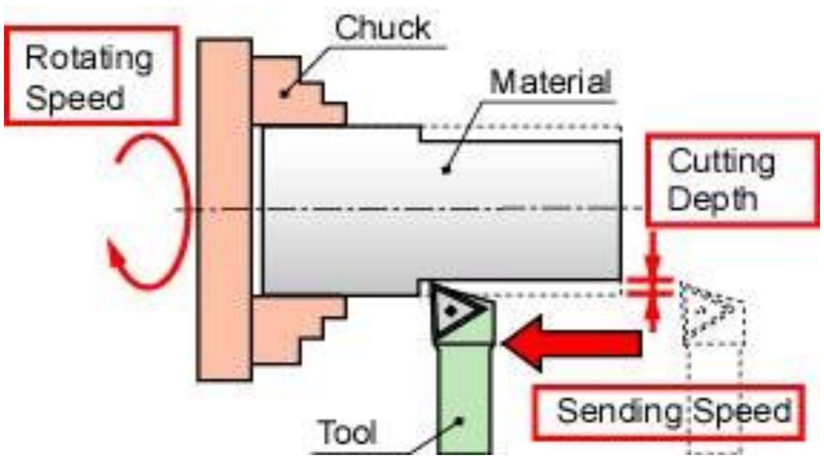
The tailstock casting rides on the ways and is locked in place by means of a nut and wrench. A hand wheel advances the tailstock spindle for drilling and tapping operations.





Three Important Elements – TERMINOLOGY

In order to get an efficient process and beautiful surface at the lathe machining, it is important to adjust a rotating speed, a cutting depth and a sending speed. Please note that the important elements can not decide easily, because these suitable values are quiet different by materials, size and shapes of the part.



UNIT – V LATHE

Cutting Speed v, m/min

It expresses with the number of rotations (rpm) of the chuck of a lathe. When the rotating speed is high, processing speed becomes quick, and a processing surface is finely finished. However, since a little operation mistakes may lead to the serious accident, it is better to set low rotating speed at the first stage.

Is the peripheral speed of the w/p past the cutting tool per unit time.

$v = \pi d n / 1000$, m/min   d= dia of w/p mm, n = speed of w/p rpm.

Depth of Cut t, mm

The cutting depth of the tool affects to the processing speed and the roughness of surface. When the cutting depth is big, the processing speed becomes quick, but the surface temperature becomes high, and it has rough surface. If you do not know a suitable cutting depth, it is better to set to small value.

It is the perpendicular distance measured from the m/c surface to the original surface of w/p.

$t = (d1 - d2)/2$ mm d1 = original dia of w/p mm, d2 = final dia of m/c ed w/p mm.

Feed mm/revolution

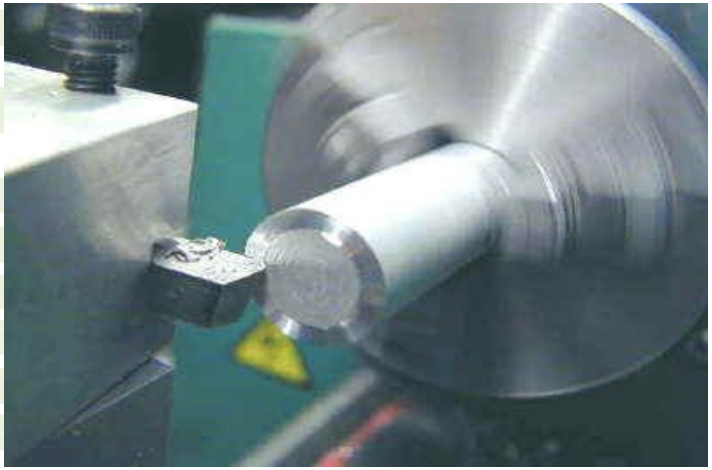
The sending speed of the tool also affects to the processing speed and the roughness of surface. When the sending speed is high, the processing speed becomes quick. When the sending speed is low, the surface is finished beautiful. There are 'manual sending' which turns and operates a handle, and 'automatic sending' which advances a byte automatically. A beginner must use the manual sending. Because serious accidents may be caused, such as touching the rotating chuck around the byte in automatic sending, It is the distance travelled by the tool during each revolution of work piece.

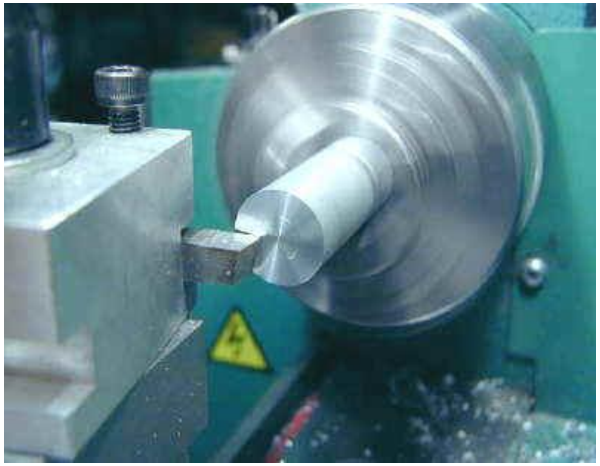
Facing Operations

1) Facing is the process of removing metal from the end of a work piece to produce a flat surface. Hence reduces the length.
2) Tool fixed at a height equal to centre of w/p & carriage locked for axial movement
3) Work is held in live centre with small projection – suitable speed – lathe started – depth of cut – moved perpendicular to axis of w/p – cross slide - manual operation.
4) Most often, the work piece is cylindrical, but using a 4-jaw chuck you can face rectangular or odd-shaped work to form cubes and other non-cylindrical shapes.

When a lathe cutting tool removes metal it applies considerable tangential force to the work piece. To safely perform a facing operation the end of the work piece must be as close as possible to the jaws of the chuck. The work piece should not extend more than 2-3 times its diameter from the chuck jaws unless a steady rest is used to support the free end.

Facing Operations





7. Boring
8. Under cutting or grooving
9. Threading
10. Knurling
11. Forming.

1. **Facing.** Refer Fig. 4.8.

- *"Facing" is an operation of machining the ends of a workpiece to produce a flat surface square with the axis.* It is also used to cut the work to the required length.
- The operation involves feeding the tool *perpendicular* to the axis of rotation of the workpiece.
- A properly ground facing tool is mounted in the tool post. A regular turning tool may also be used for facing a large workpiece. The cutting edge should be set at the same height as the centre of the workpiece.
- The facing operation is usually performed in *two steps.*

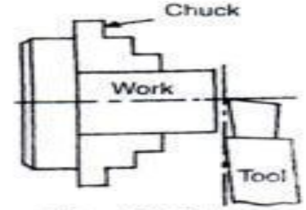


Fig. 4.8. Facing.

In the first step a *rough facing* operation is done by using a *heavy cross feed* of the order of 0.5 to 0.7 mm and a deeper cut upto 5 mm (maximum). It is followed by a *finer cross feed* of 0.1 to 0.3 mm and a smaller depth of cut of about 0.5 mm.

2. **Plain turning**. Refer Fig. 4.9.

- It is an operation of removing excess material from the surface of the cylindrical workpiece.
- In this operation, the work is held either in the chuck or between centres and the longitudinal feed is given to the tool either by hand or power.

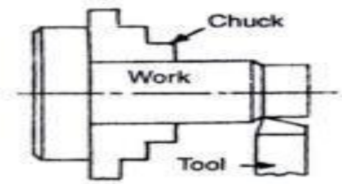


Fig. 4.9. Plain turning.

3. **Step turning**. Refer Fig. 4.10.

- In this type of lathe operation various steps of different diameters in the workpeice are produced.
- It is carried out in the similar way as plain turning.

4. **Taper turning.**

Taper. A taper *may be defined as a uniform increase or decrease in diameter of a piece of work measured along its length.*

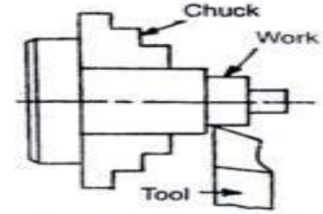


Fig. 4.10. Step turning.

Refer Fig. 4.11. The amount of taper in a workpiece is usually *specified by the ratio of the difference in diameters of the taper to its length.* This is termed as the *"capacity"* and it is designated by the letter K.

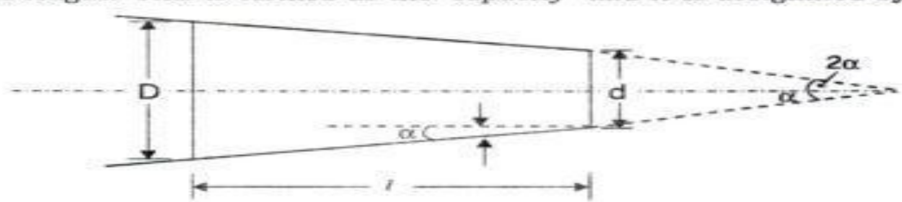


Fig. 4.11

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Unit - III

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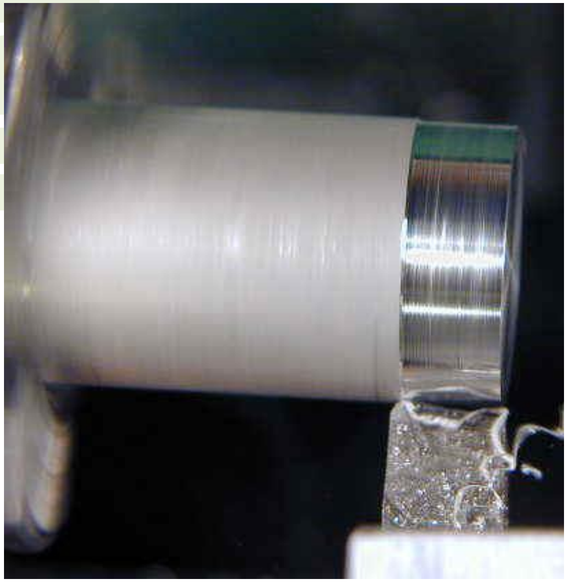
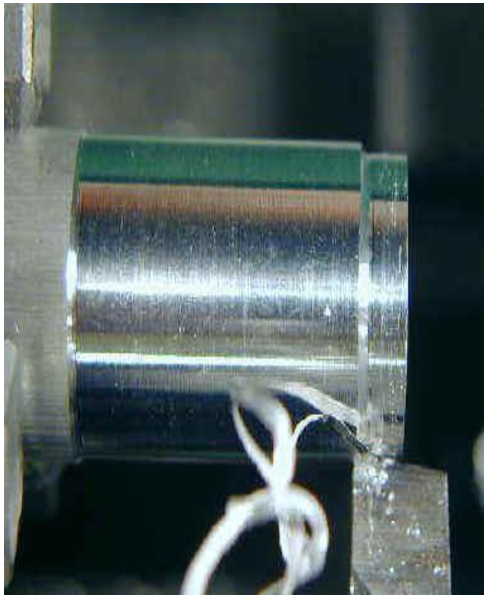
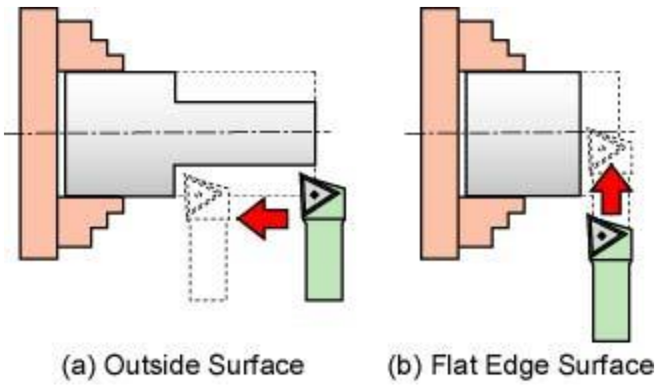
Turning Operations

1) Turning is the removal of metal from the outer diameter of a rotating cylindrical work piece. Turning is used to reduce the diameter of the work piece, usually to a specified dimension, and to produce a smooth finish on the metal. Often the work piece will be turned so that adjacent sections have different diameters.

2) Facing of ends – centre marking & punching – alignment of centers – proper tool – tool height – feed – depth of cut







Turning a Shoulder

A shoulder is a point at which the diameter of the work piece changes with no taper from one diameter to the other. In other words, there is a 90 degree face moving from one diameter to the other.

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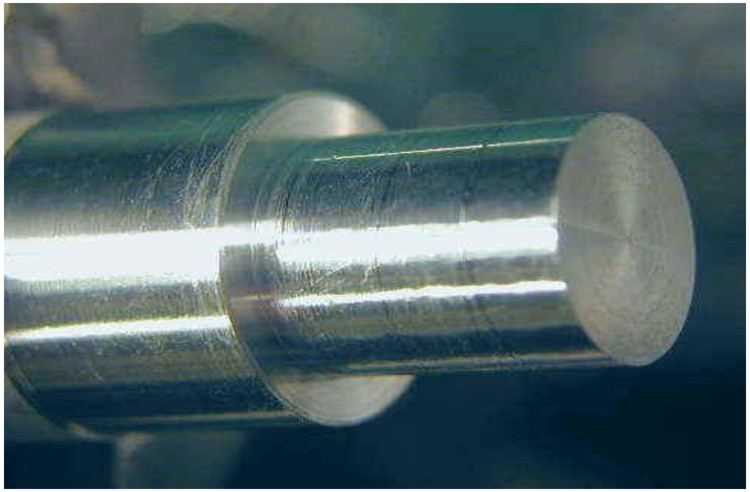
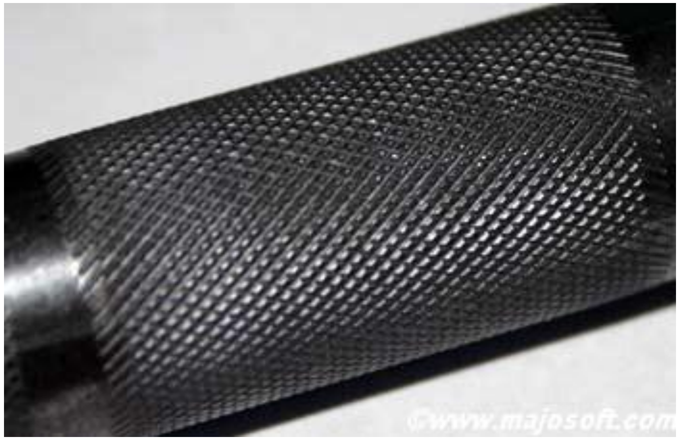
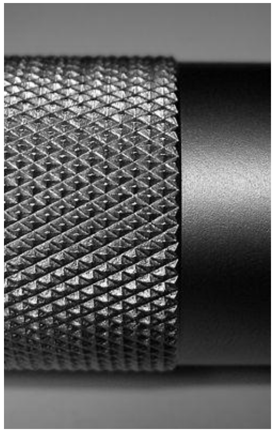


Knurling:

1) Embossing a roughened surface- Diamond- straight pattern – knurling tool – held on tool post – shape provide - grip – prevent slipping – slowly revolving w/p – lubricating oil – handles of m/c parts , measuring instruments.





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Thread Cutting

V- Square threads – right hand/ left hand – pitch – thread cutting tool.

w/p held – turn to dia = major dia of thread – calculate gears of required size and arrange spindle & lead screw – tool – speed based on w/p material – engage split nut – depth of cut – tool moved parallel to axis with automatic arrangement.

Right hand thread – move tool from right to left – vice varsa.

At the end with draw tool using cross slide and dis engage split nut.

TAPER TURNING

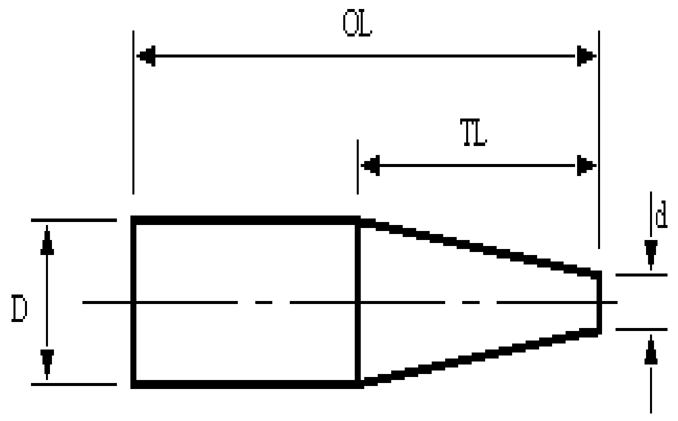
Conical Surface – taper – conicity $k= D-d/L$ - on circular w/p – using tool.

There are some common methods for turning tapers on a lathe,

- Off-setting the tail stock
- Using the compound slide
- using a taper turning attachment
- using a form tool

1) Off-Set Tail Stock/ Tail stock set over method:- In this method the normal rotating part of the lathe still drives the work piece (mounted between centres), but the centre at the tailstock is offset towards/away from the cutting tool. Then, as the cutting tool passes over, the part is cut in a conical shape.

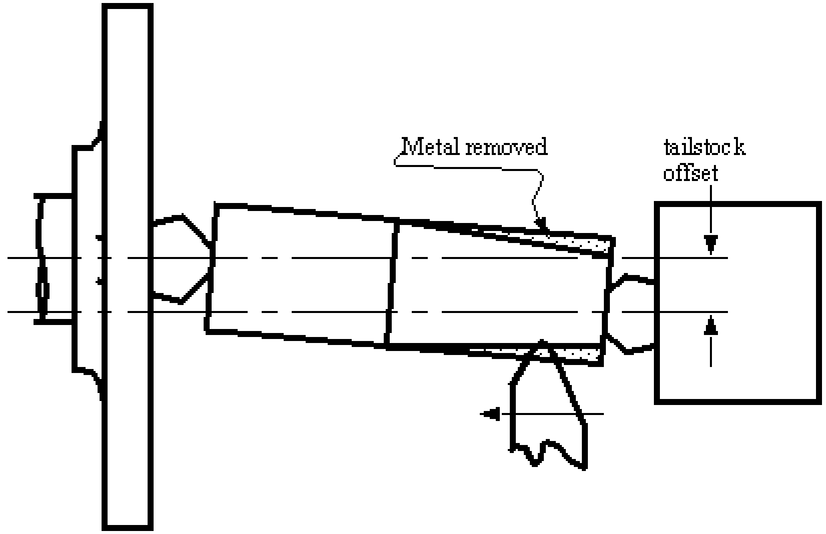
2) Rotation of axis of w/p shifts by semi taper angle to the lathe axis and the tool travel parallel to lathe axis.



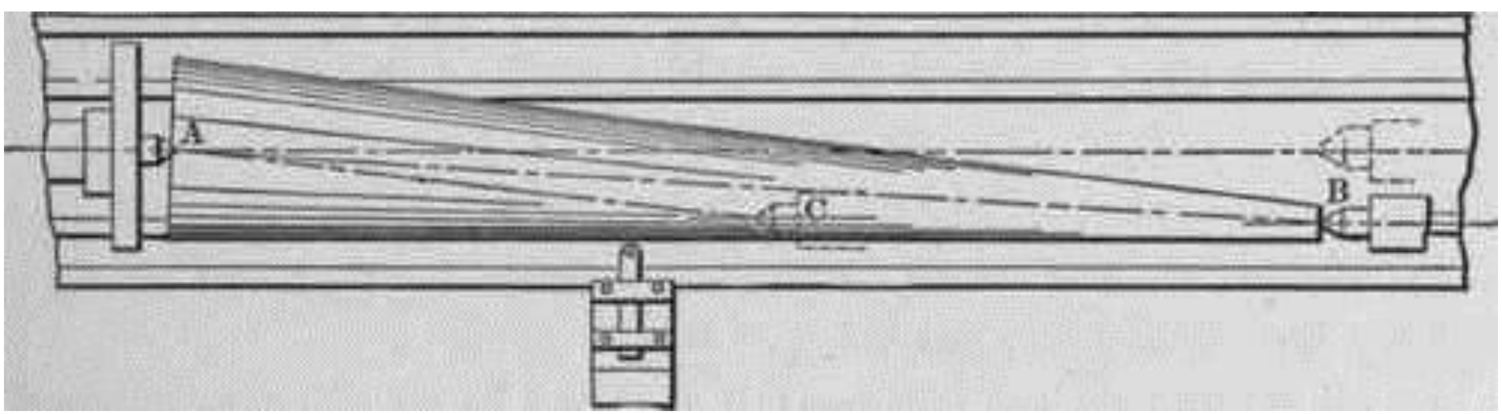
$$OFFSET = \frac{OL}{TL} \times \frac{(D-d)}{2} = \frac{tpf \times OL}{24}$$

where,

OL = overall length
TL = taper length
D = the large taper diameter
d = the small taper diameter
tpf = taper per foot (in.)
OFFSET = the distance to move the tailstock from the zero setting



3) w/p held – tailstock slides – screw tightened – tool – depth of cut – tool moved till taper length – processed for next cut.



i.e.,

$$K = \frac{D - d}{l}$$

where, D = large diameter of taper in mm,
d = small diameter of taper in mm,
l = length of tapered part in mm, and
α = half of taper angle.

Taper turning. *Taper turning means to produce a conical surface by gradual reduction in diameter from a cylindrical workpiece.*

— The tapering of a part has wide applications in the construction of machines. Almost all machine spindles have taper holes which receive taper shanks of various tools and work holding devices.

Taper turning methods. Taper turning can be carried out on lathes by the following methods :

1. By setting over the tail stock centre.
2. By swivelling the compound rest.
3. By using a taper turning attachment.
4. By manipulating the transverse and longitudinal feeds of the slide tool simultaneously.
5. By using a broad nose form tool.

1. By setting over the tail stock centre :

- This method is used for *small tapers only* (the amount of setover being limited)
- It is *based upon the principle of shifting the axis of rotation of the workpeice, at an angle to the axis, and feeding the tool parallel to the lathe axis*. The angle at which the axis of rotation of the workpiece is shifted is *equal to half angle of taper*. This is done when the body of the tailstock is made to slide on its base towards or away from the operator by a setover screw as shown in Fig. 4.12.

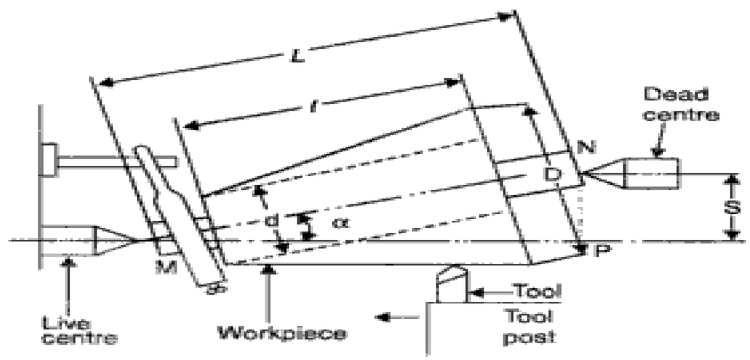


Fig. 4.12. Turning taper by tailstock set-over method.

- By setting tailstock centre to the back (away from the operator) the taper will have bigger diameter towards the tailstock. If the tailstock centre is taken in the front,

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The Compound Slide swiveling method Method - The compound slide is set to travel at half of the taper angle. The tool is then fed across the work by hand, cutting the taper as it goes.

Tool travel linearly at an angle to the axis of rotation of w/p.

1) Semi angle is calculated – tool – The compound slide – circular base – graduated in degrees – swiveled - carriage is locked for axial movement – depth of cut – tool – job – feed thro compound slide – tool move at an angle – linear movement – end of taper – with draw using cross slide – next cut.

$$\text{Angle} = \tan^{-1} D\text{-}d/2L$$

$$\tan\alpha \text{ or } \alpha = \tan^{-1}\left(\frac{D-d}{2L}\right)$$

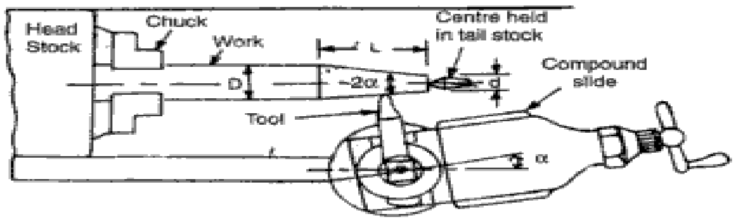

Fig. 4.13. Taper turning.

- Owing to the limited movement of the cross-slide, this method is limited to turn a *short taper* ; a *small taper* may also be turned.
- This method gives a *low production capacity and power surface finish because the movement of the tool is completely controlled by hand.*

3. By using a taper turning attachment

- This method *provides a very wide range of taper.*
- In this method of taper turning a *tool is guided in a straight path set at an angle to the axis of rotation of the workpiece, while the work is being revolved between centres or by a chuck aligned to the lathe axis.*
- As shown in Fig. 4.14, a taper turning attachment essentially consists of a *bracket or frame* which is attached to the rear end of the lathe bed and supports a *guide bar* pivoted at the centre. The bar is provided with graduations and may be swivelled on either side of the zero graduation and is set at the desired angle with the lathe axis.

The taper turning attachment is used as follows :

— The cross-slide is first made free the lead screw by removing the *binder screw*. The rear end of the cross-slide is then tightened with the guide block by means of a bolt.

— On the engagement of the longitudinal feed, the tool mounted on the cross-slide will follow the angular path, as the guide block slides on the guide bar set at an angle to the both axes.

— The required depth of cut is given by the compound slide which is placed at right angles to the axis of the lathe.

— The guide bar must be set at half taper angle and the taper on the work must be converted in degrees. The maximum angle through which the guide bar may be swivelled is 10° to 12° on either side of the centre line.

- After every cut, the feed to the tool is given by moving the compound rest which is positioned parallel to the cross-slide (*i.e.*, at 90° to the axis of the job).
- The required angle (*i.e.*, angle of swivelling the guide bar) can be found out from the following relation :

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Taper Turning by Taper turning attachment method

It consists of bracket which is connected to the rear side of the lathe bed. It is having a guide bar which can be swiveled in horizontal plane & locked in position which is mounted over the bracket. A guide block pivoted to draw link which 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. When carriage moved the guide slides inside the slot in guide bar. So the cross slide move in transverse direction. The combined motion of cross slide & longitudinal motion of carriage moves the tool parallel to the inclined axis of guide bar and produce required taper on the work piece.

UNIT – V LATHE

$$\tan \alpha = \frac{D-d}{2l} \text{ (all dimensions in mm)}$$

or

$$\alpha = \tan^{-1}\left(\frac{D-d}{2l}\right) \text{ degrees.}$$

where D = larger dia. in mm,
d = smaller dia. in mm, and
l = length of taper in mm.

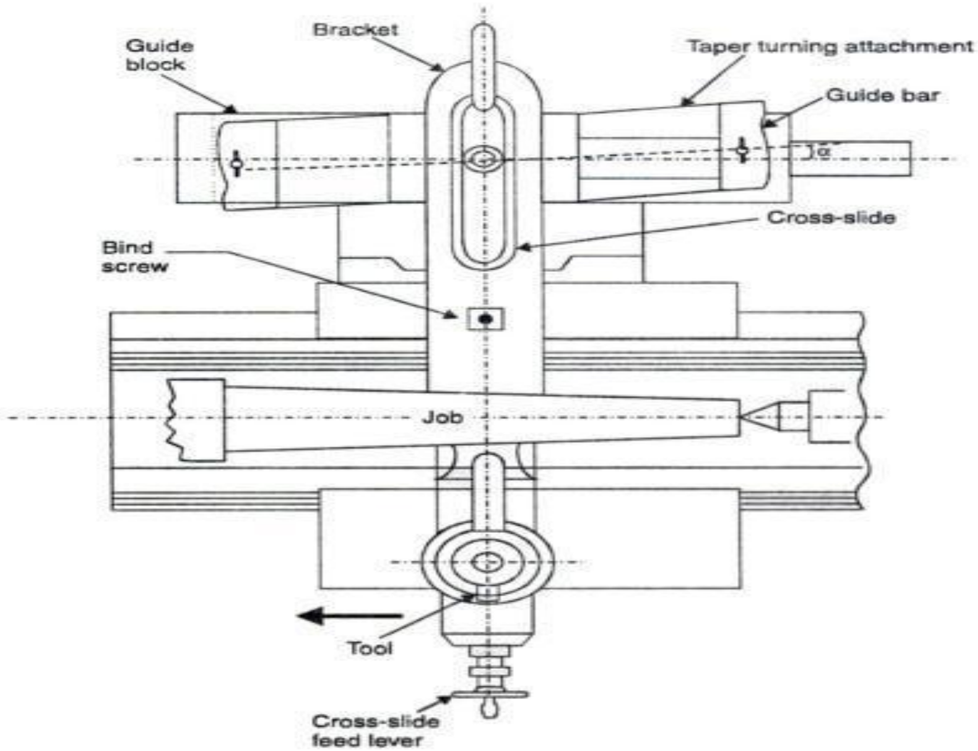

Fig. 4.14. Use of taper turning attachment.

Advantages of using a taper turning attachment :

1. Easy and quick setting.

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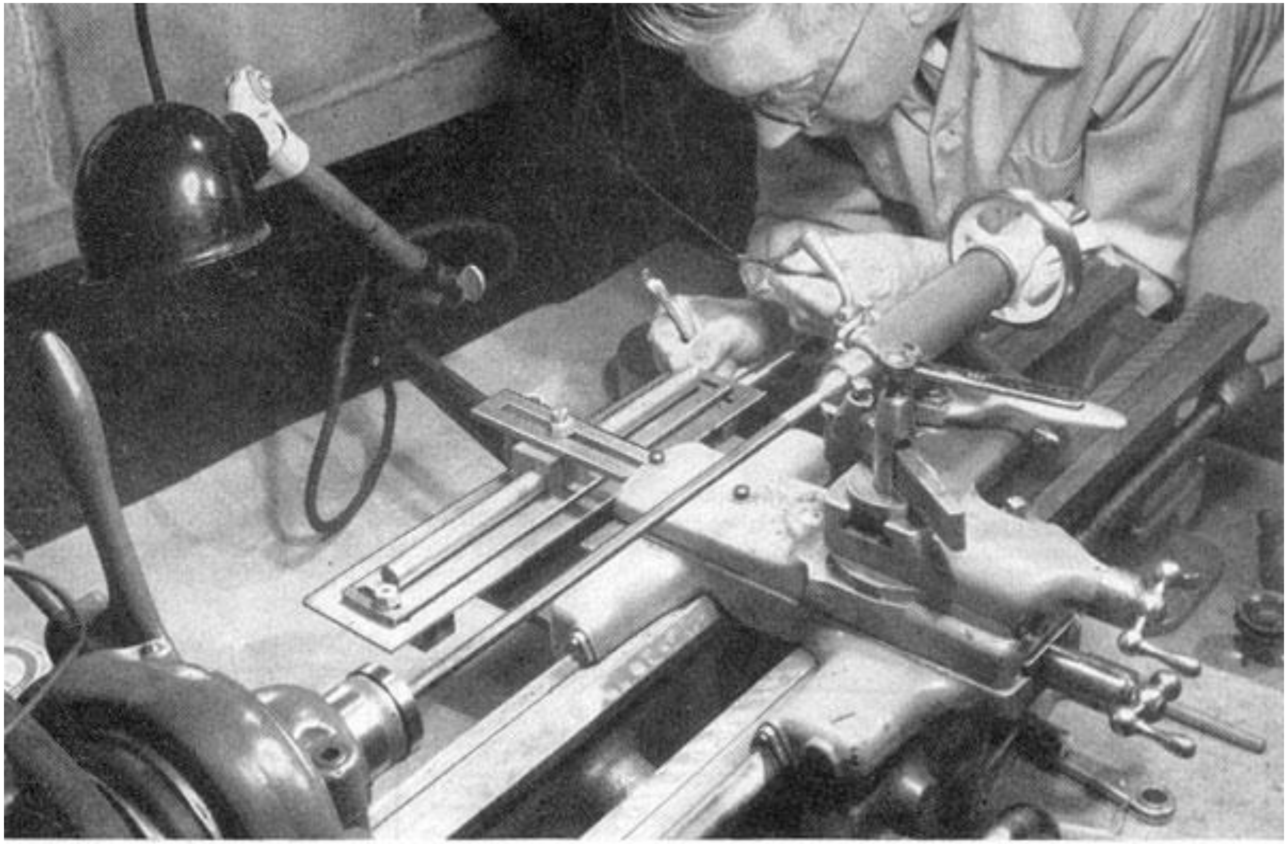
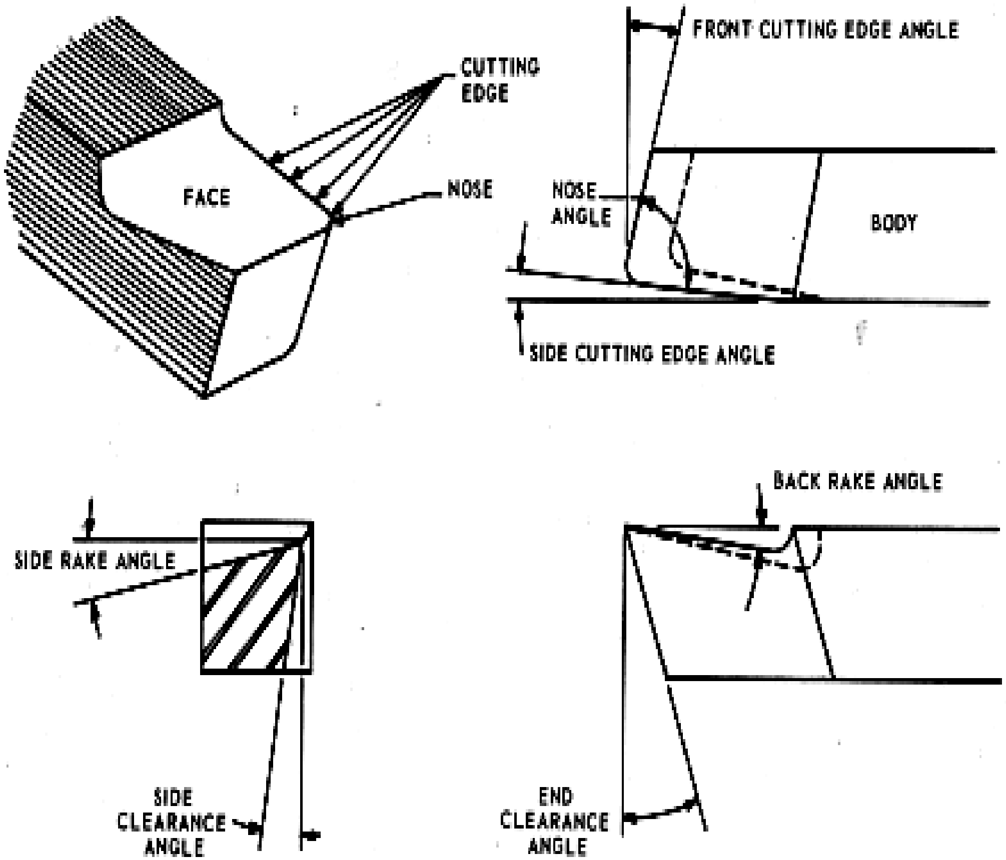
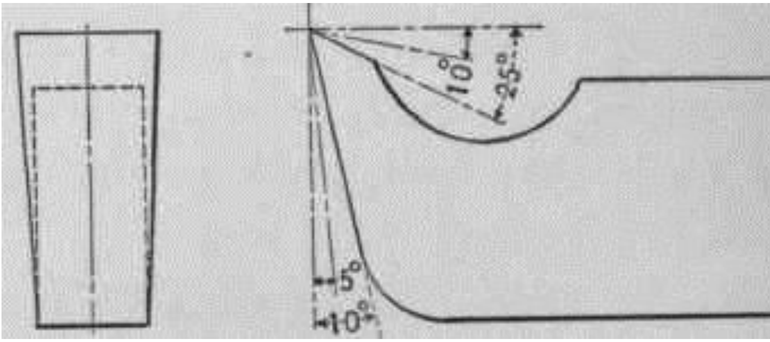
Unit - III

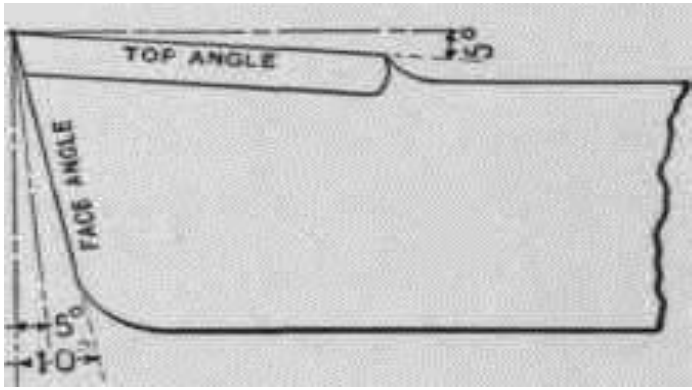


1. SHOP-MADE TAPER ATTACHMENT mounted on small lathe can be adjusted to turn outside or inside tapers on work mounted between centers or in a chuck for taper boring. Attachment is made entirely from stock materials

Nomenclature of a Single point cutting tool







Single point cutting tool – point contact – clearance on top, underside, side faces.

Relief / clearance angles – ground on end & side faces – to prevent rubbing of tool on w/p.

Side relief – ground below cutting edge on flank. End relief angle ground from nose of the tool.

Relief angle to make only the cutting edge to touch the w/p

Rake angle to have smooth flow of chip over the tool.

Side rake – on tool face away from cutting edge – on which chip leaves w/p – 14 degree.

Back rake – to make chip leave the nose of the tool is 8 to 10 degree.

End & side cutting edge angle – to mount the tool in correct position for various machining operations – end cutting edge angle – 20 to 30 degree – side cutting edge angle 15 degree to reduce initial shock to the tip.

Nose radius – to prevent tip from breaking and to provide smooth finish. Nose radius 0.8 mm.

Drilling Machines

These are the machine tools designed to produce hole/s in solid materials with the help of rotating drills by exerting vertical force on the w/p. these are often called drill presses.

Introduction

Drilling is a process of producing round holes in a solid material or enlarging existing holes with the use of multi-tooth cutting tools called *drills* or *drill bits*. Various cutting tools are available for drilling, but the most common is the *twist drill*.

Drilling operation.

Drilling Machines

Drilling: It is the operation of producing the hole/s in solid materials using rotating cutting tool called drills.

Drills: types

1) Flat drills
2) Twist drills

Twist drills

These are manufactured by twisting & grounding the toll longitudinally. Helps in easy drilling – remove chips. These are classified based on type of shank, length of flute, direction of helix, overall length etc. made from carbon steels & HSS.

Size, Coolant, cutting speed , operating speed are standardized based on different materials.

Two types of twist drills:

1) Straight or Parallel shank twist drill – portable/electric drilling m/c, held by using chuck & key, holes from 0.2 to 16 mm diameter.
2) Tapered shank twist drill.

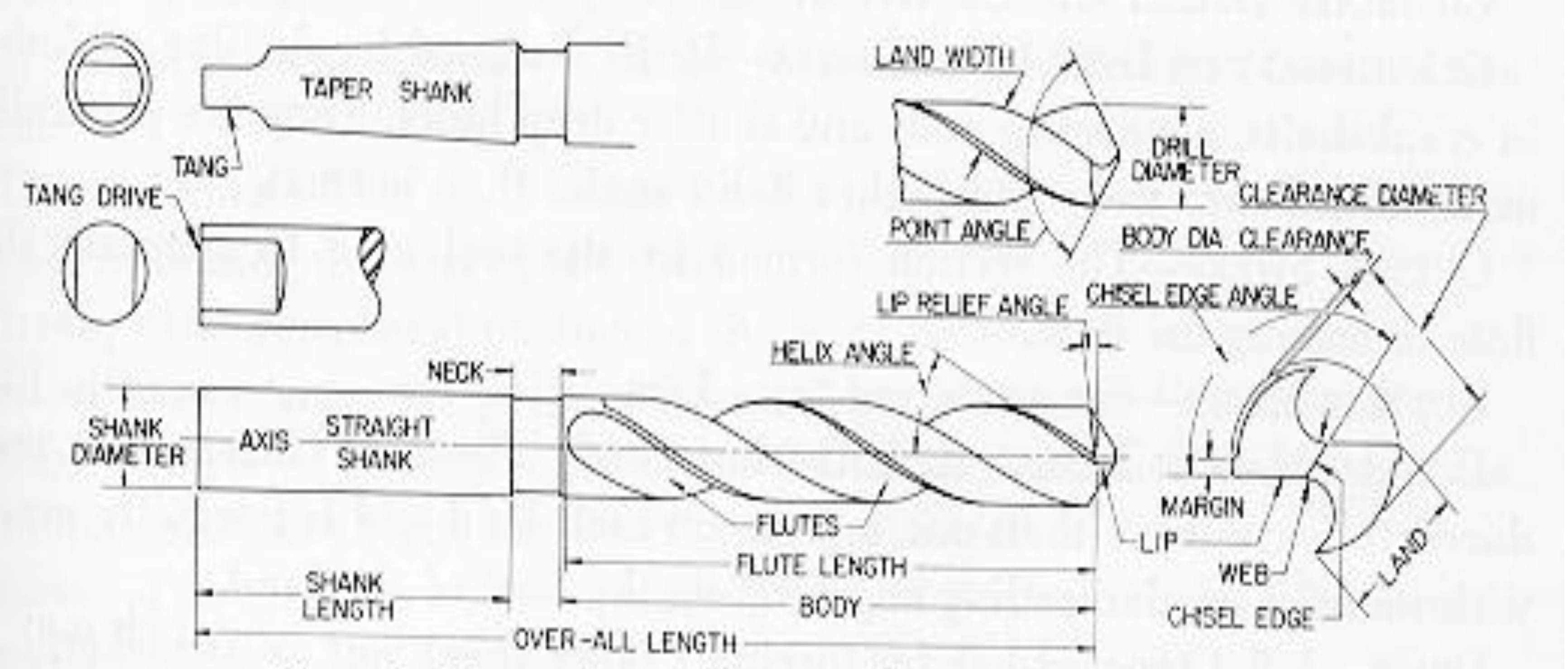
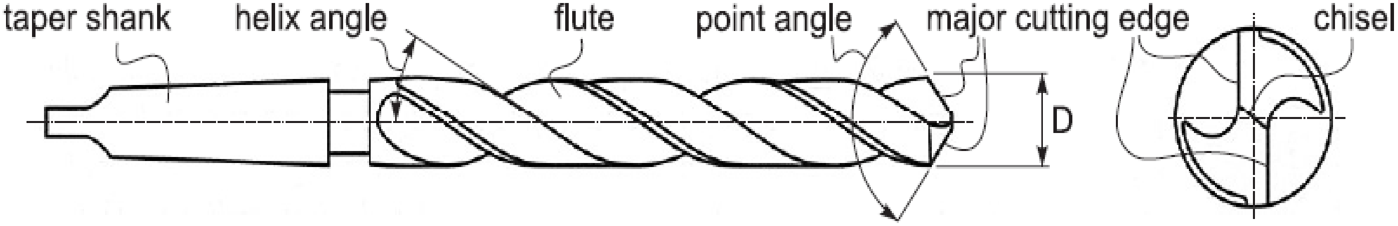


Figure 1—Illustrations of Terms applying to Twist Drills.

Drills and reamers

Twist drill

The twist drill does most of the cutting with the tip of the bit. It has two flutes to carry the chips up from the cutting edges to the top of the hole where they are cast off. The standard drill geometry is shown in the figure:



Standard geometry of a twist drill.

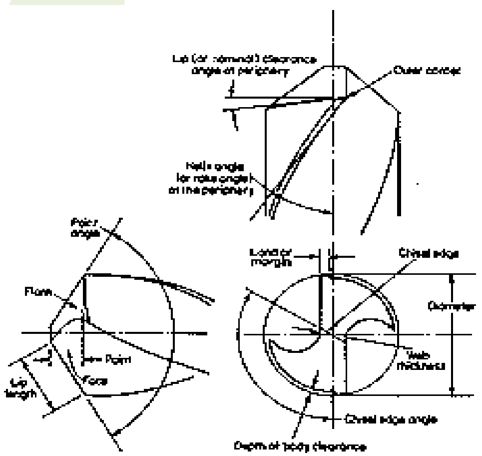
The typical helix angle of a general purpose twist drill is 18~30° while the point angle (which equals two times the major cutting edge angle, see page 101) for the same drill is 118°.

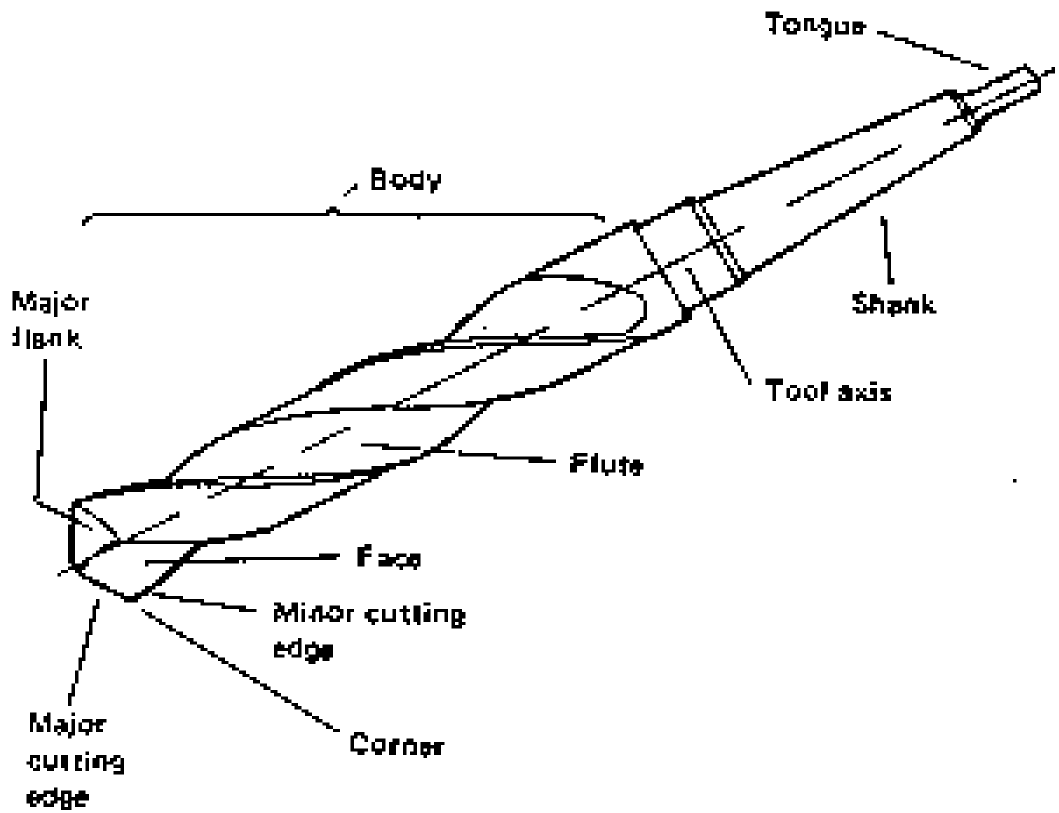
Some standard drill types are,

- straight shank: this type has a cylindrical shank and is held in a chuck;
- taper shank: his type is held directly in the drilling machine spindle.

Drills are normally made of HSS but carbide-tipped drills, and drills with mechanically attached carbide inserts are commonly used in many operations, especially on CNC drilling machines:

Taper shank – holes from 3 to 100 mm dia, directly inserted into the spindle of the m/c. drift is used to remove it from m/c.





Coated HSS twist drills.

Carbide-tipped twist drills.

Indexable inserts twist drills.

Reamers

The reamer has similar geometry. The difference in geometry between a reamer and a twist drill are:

- The reamer contains four to eight straight or helical flutes, respectively cutting edges.
- The tip is very short and does not contain any cutting edges.

Straight-flute reamer with taper shank.

Helical-flute reamer with taper shank.

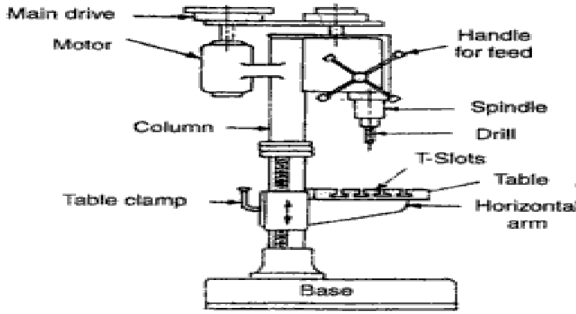


Fig. 4.40. Upright drilling machine.

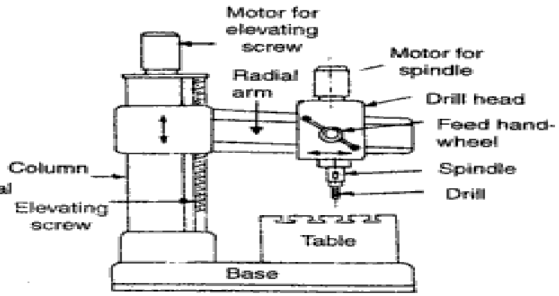


Fig. 4.41. Radial drilling machine.

Figs. 4.42, 4.43 show a twist drill and its nomenclature respectively.

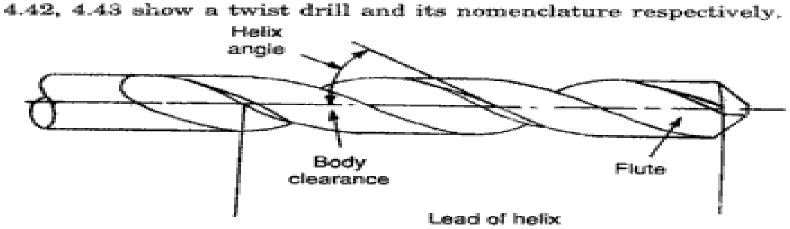
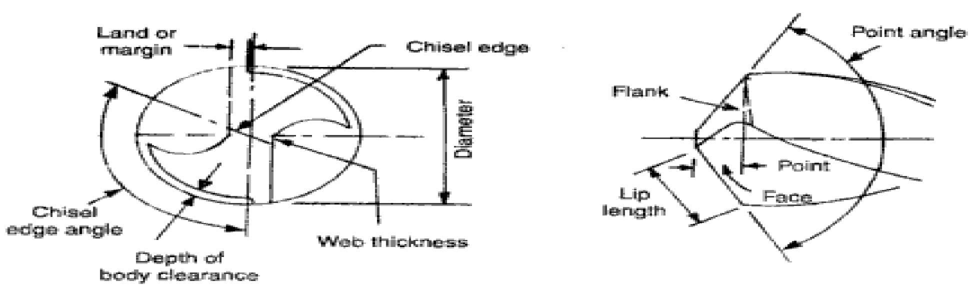


Fig. 4.42. Twist drill.



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Parts of Twist Drill

Body: It is the cutting unit of the drill which has helical flutes.

The portion of the drill extending from the shank or neck to the outer corners of the cutting lips

Shank: it is the portion of the drill which is held in the m/c to drive the drill

Point: It is the entire conical surface at the cutting end of the drill.

Axis: The imaginary straight line which forms the longitudinal center line of the drill.

Chisel Edge/dead centre: The edge at the end of the web that connects the cutting lips

Chisel Edge Angle: The angle included between the chisel edge and the cutting lip, as viewed from the end of the drill

Clearance: The space provided to eliminate undesirable contact between the drill and the work piece

Parts of Twist Drill:

Drift: A flat tapered bar for forcing a taper shank out of its socket

Drift Slot: A slot through a socket at the small end of the tapered hole to receive a drift for forcing a taper shank out of its socket.

Flutes: Helical or straight grooves cut or formed in the body of the drill to provide cutting lips, to permit removal of chips, and to allow cutting fluid to reach the cutting lips.

Flute Length: The length from the outer corners of the cutting lips to the extreme back end of the flutes; it includes the sweep of the tool used to generate the flutes and, therefore, does not indicate the usable length of the flutes.

Helix Angle: The angle made by the leading edge of the land with a plane containing the axis of the drill

Land: The peripheral portion of the body between adjacent flutes.

Land Width: The distance between the leading edge and the heel of the land measured at a right angle to the leading edge.

Parts of Twist Drill:

Neck: The section of reduced diameter between the body and the shank of a drill Oil Grooves: Longitudinal straight or helical grooves in the shank, or grooves in the lands of a drill to carry cutting fluid to the cutting lips Oil Holes or Tubes: Holes through the lands or web of a drill for passage of cutting fluid to the cutting lips.

Overall Length: The length from the extreme end of the shank to the outer corners of the cutting lips; it does not include the conical shank end often used on straight shank drills, nor does it include the conical cutting point used on both straight and taper shank drills.

Peripheral Rake Angle: The angle between the leading edge of the land and an axial plane at the drill point.

Tang: The flattened end of a taper shank, intended to fit into a driving slot in a socket.

Web: The central portion of the body that joins the lands; the extreme end of the web forms the chisel edge on a two-flute drill

Terminology:

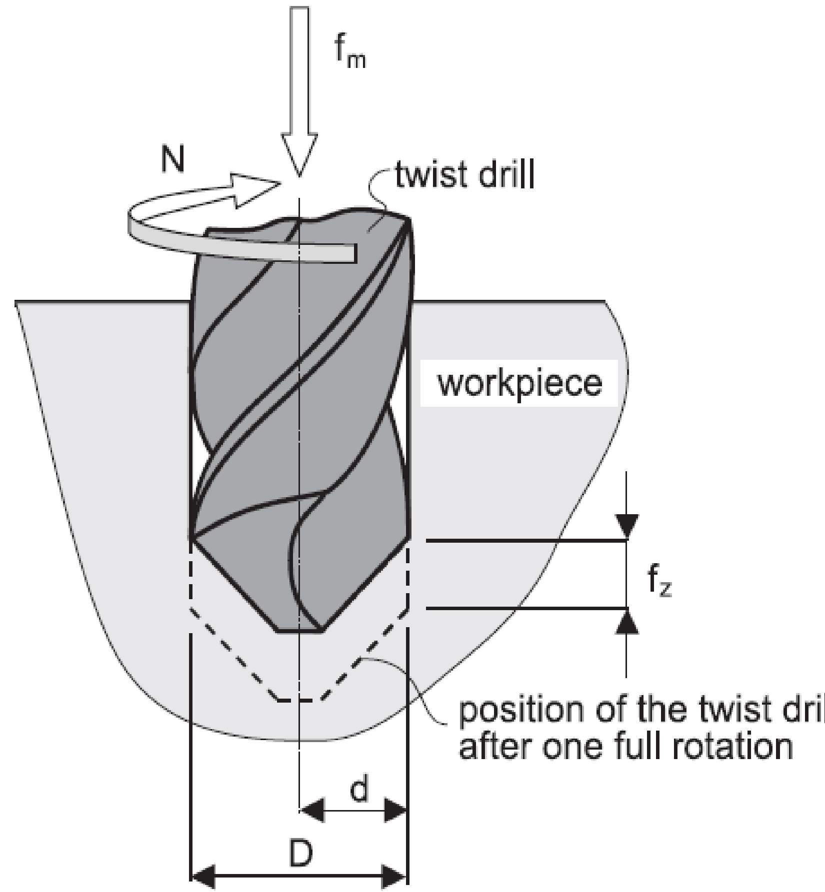
Feed: is the axial distance moved by the drill into the w/p during one revolution of the spindle. It is expressed in mm per revolution.

Cutting speed: v m/s:

It is the distance that a drill would roll for one min at the given speed of the spindle. It is the speed of its circumference. It is expressed in m/min.

$V = \pi dn/1000 \quad m/min$

d= dia of drill in mm n= spindle speed rpm.



Basics of a drilling operation.

Classification of Drilling Machines:

1) Portable/hand/electric D.M:
2) Sensitive/bench/floor mounted D.M
3) Upright/vertical D.M -
4) Radial D.M
5) Gang/multiple spindle D.M
6) Multiple drill head D.M
7) Automatic D.M

Sensitive/bench/floor mounted D.M – belt driven – gen purpose – small size – small dia holes – sensitive since skilled operator – sense the feed.

Construction: Base, Table, Column, work table – up & down & radially, Head, Motor, V-belt drive, Cone pulley, driving mechanism have Sleeve, Spindle, hand wheel & Drill chuck.

Operation:

hole location – punch – guide the drill – drill bit – coolant – fix drill in chuck – use key – w/p on table – fixture – raised to height – drill penetrate w/p – drill is fed – pressure by operator – feed – feel cutting action – with draw drill – rotate reverse direction.

Dis Adv: a) Skilled worker b) Small holes.

Drilling machines

Drill press

Although a *hand drill* is commonly used for drilling of small holes, a *drill press* is preferable when the location and orientation of the hole must be controlled accurately. A drill press is composed of a base that supports a column, the column in turn supports a table. Work can be supported on the table with a *vise* or hold down *clamps*, or the table can be swivelled out of the way to allow tall work to be supported directly on the base. Height of the table can be adjusted with a table lift crank than locked in place with a table lock. The column also supports a power head containing a motor. The motor turns the spindle at a speed controlled by a variable speed control dial. The spindle holds a drill chuck to hold the cutting tools (drill bits, center drills, reamers, etc.).The machine tool described is a typical *upright drill press*. The smaller modifications, mounted on a table rather than the floor are known as *bench drills*.

Upright drill press.

Bench drill press.

2. **Boring.** It is an *operation of enlarging an existing hole.*
3. **Counter boring.** It is an *operation of enlarging a drilled hole partially, that is for a specific length.*
4. **Countersinking.** It is an *operation of forming a conical shape at the end of a drilled hole.*
5. **Tapping.** It is an *operation in which external threads are cut in the existing hole.*
6. **Spot facing.** It is the *operation of smoothing and squaring the surface around a hole for the seat for the nut or the head of a screw.* A counter bore or a special spot facing tool may be employed for this purpose.
7. **Trepanning.** It is the operation of *producing a hole by removing the metal along the circumference of a hollow cutting tool*. This operation is performed for *producing large holes*.

4.11.4. Classification of Drilling Machines

Some of the common drilling machines used in production work are :

1. **Hand drill-power operated.** It is used to produce holes (small) where it is not possible to bring the workpiece requiring the hole onto the work table of a drilling machine.
2. **Bench drilling machine.** It is used to drill hole from 1.5 mm to 15 mm diameter.
3. **Upright drilling machine.** It is mounted on floor and is used to drill holes upto 25 mm.
4. **Radial drilling machine.** It is used when a drilling operation is to be performed on heavy or bulk workpiece. Also used where the workpiece cannot be adjusted to locate the point of drilling.
5. **Gang drilling machine.** It is used where a series of operations have to be performed like drilling, boring, reaming, tapping etc.
6. **Multispindle drilling machines.** It is used whenever a number of holes are to be drilled on a workpiece.

Figs. 4.39, 4.40, 4.41 show block diagrams of a bench drilling machine, upright drilling machine and radial drilling machine respectively.

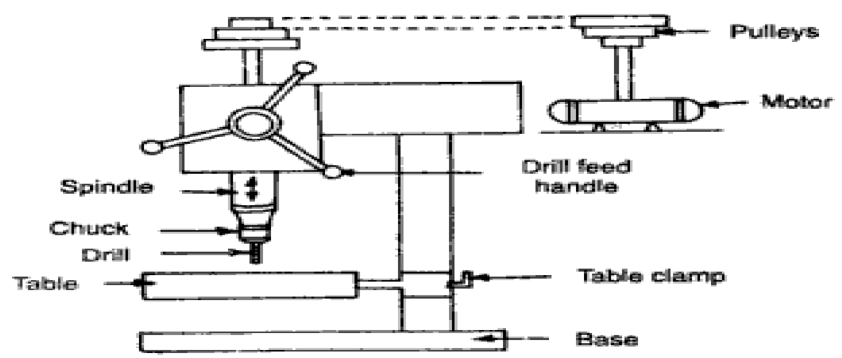


Fig. 4.39. Bench drilling machine.

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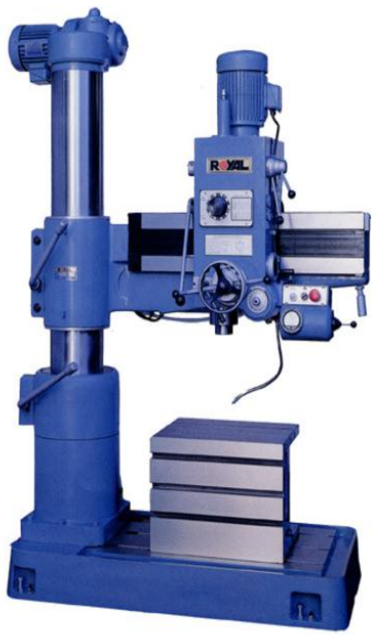
Radial Drilling Machine:

Radial drill

This is the largest drill press designed to drill up to 100-mm diameter holes in large workparts. It has a radial arm along which the drilling head can be moved and clamped.



Radial drill press.

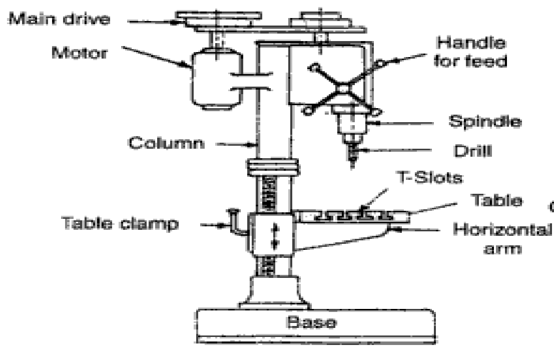


Fig. 4.40. Upright drilling machine.

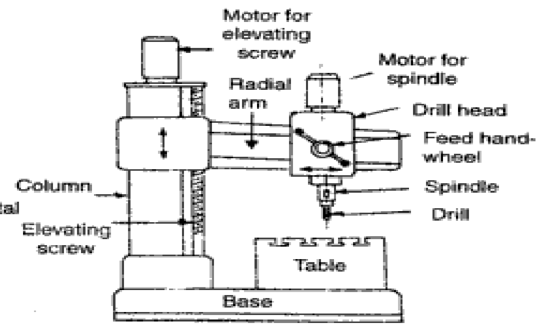


Fig. 4.41. Radial drilling machine.

Figs. 4.42, 4.43 show a twist drill and its nomenclature respectively.

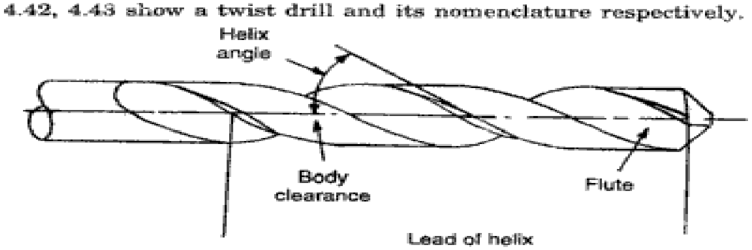
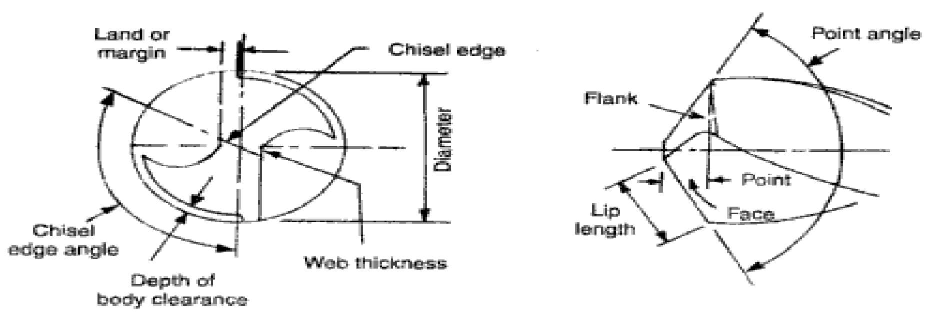


Fig. 4.42. Twist drill.



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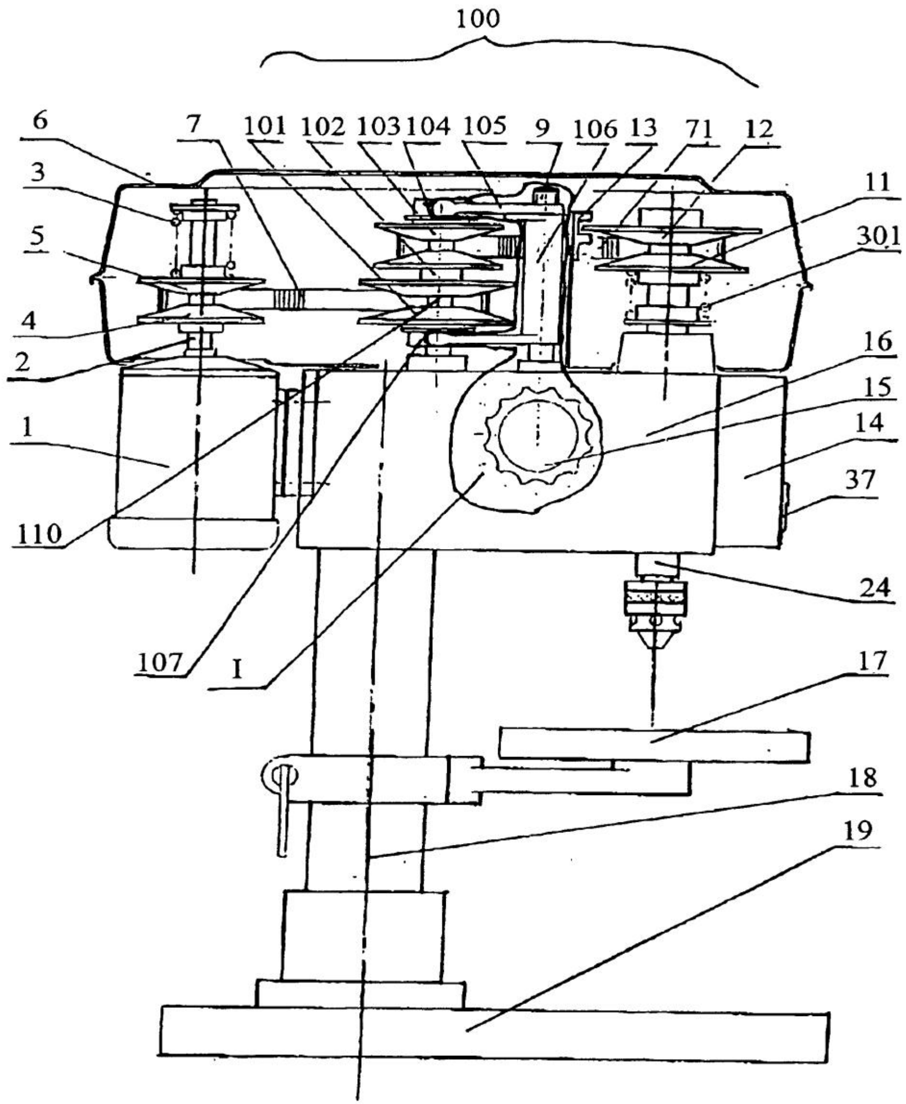
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Radial Drilling machine:

Heavy duty precision tool – designed for universal moments of the arm with a tool head – stationary w/p.

Construction: Base, working table , Cylindrical Column, Radial Arm – up, down, swung around axis to any position, Motor, elevating screw, drill head – gear box-speed feed, Sleeve & spindle unit, Horizontal arm guide ways, Hand wheel - feed, Operative switches.

Operation: Hole positions – w/p on table – fixtures – drill bit – coolant – tool head to w/p – up, down, left, right direction, swinging.

Adv: universal movements – five direction of tool head, moved to any position, odd shaped jobs, larger diameter, Accurate precision.

Other drilling machines

The *gang drill* is a drill press consisting of a series of drill presses connected together in an in-line arrangement so that a series of drilling operations can be done in sequence.

In the *multiple-spindle drill*, several drill spindles are connected together to drill multiple holes simultaneously into the workpart.

Numerical control drill presses are available to control the positioning of the holes in the workparts. These drill presses are often equipped with turrets to hold multiple tools that can be indexed under control of the NC program. The term *CNC turret drill* is used for these machine tools.

Workholding equipment

Workholding on a drill press is accomplished by clamping the part in a *vise*, *fixture*, or *jig*.

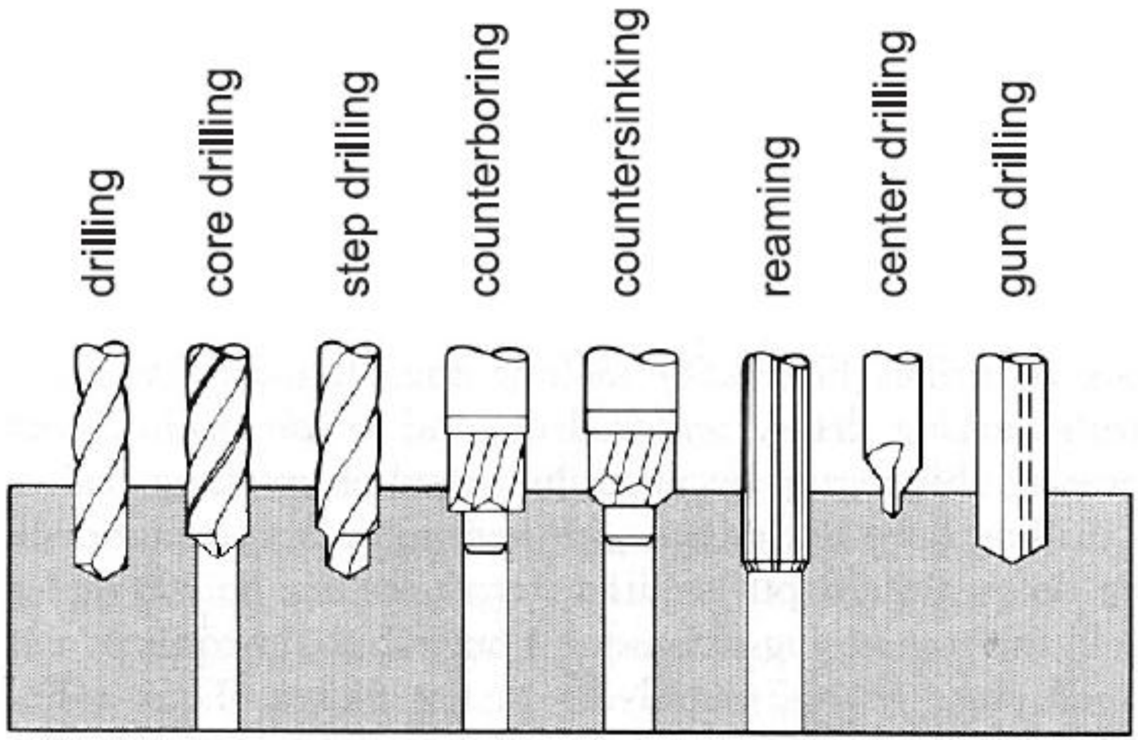
A *vise* is a general-purpose workholding device possessing two jaws that grasp the work in position.

A *fixture* is a workholding device that is usually custom designed for the particular workpart. The fixture can be designed to achieve higher accuracy in positioning the part relative to the machining operation, faster production rates, and greater operator convenience in use.

A *jig* is a workholding device that is also specially designed for the workpart. The distinguishing feature between a jig and a fixture is that the jig provides a means of guiding the tool during the drilling operation. A fixture does not provide this tool guidance feature. A jig used for drilling is called a *drill jig*.

Drilling and reaming operations

Several operation are related to drilling, most of them illustrated in the figure:



Drilling and reaming operations.

- **Radial drilling machine**. *The length of the arm and column diameter.*
- **Multiple sprindle drilling machine**. *The drilling area, the size and number of holes a machine can drill.*

4.11.3. Operations Performed

Although drill press is mainly meant for drilling operation, it can also be used for performing the following operations : Refer Fig. 4.38.

1. **Reaming.** It is an *operation of finishing an existing drilling hole.* The tool used is reamer.

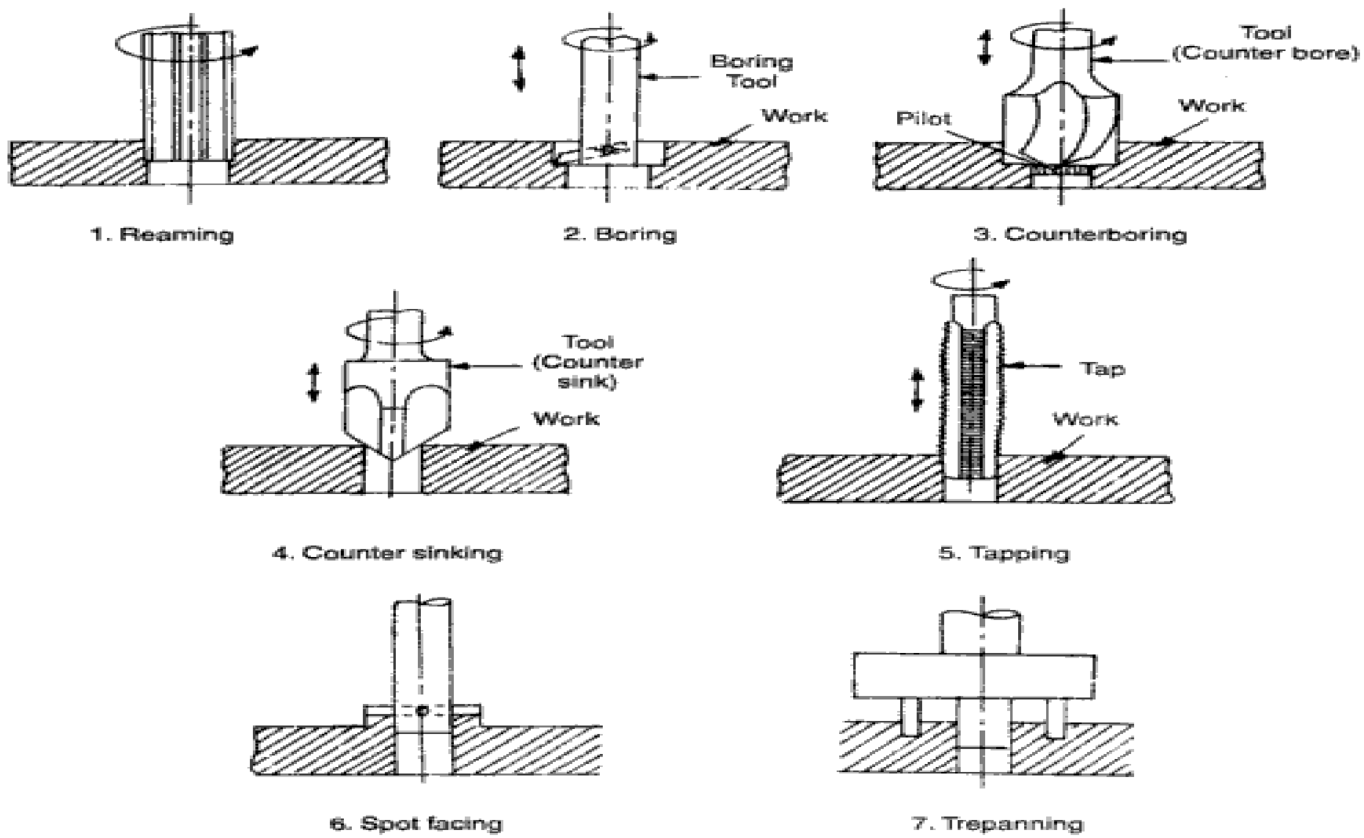


Fig. 4.38

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Reaming:

Finishing operation – under size predrilled hole by drilling - Reamer – Multi longitudinal flutes – amount of material removal 0.125 mm.

Boring: enlarging operation – boring tool – single point cutting – used to produce non standard size holes – first standard hole is drilled then enlarged.

Tapping: generate internal thread on drilled hole – standard size Taps.

Counter Sinking: conical surface at the end of predrilled hole – counter sink cutting tool - angle size of hole – screw head or rivet head – prevents un wanted top surface – Furnitures, joint in doors, windows.

Counter Boring:

Enlarge one end of predrilled hole concentrically to reqd depth – counter bore tool – square shoulder – socket head screws, bolts, pins.- pilot – concentricity.

Spot Facing: Smooth flat seating – special spot facing tool / counter bores - top of the hole surface – Bolt heads, Washers, Nuts.

Specifications of Drilling machines:

1) The max dia of drill 2)Max size of w/p 3) size of working table 4) No of spindles 5) power capacity 6) for radial drilling m/c dia of column & length of the arm have to be specified.