CHAPTER 4

MACHINE TOOLS OPERATIONS

4.1 Introduction

Several metal cutting operations are carried out to produce a mechanical part of required shape and size. The metal cutting operations may be carried out either, manually by using hand tools such as chisels, files, saws, etc, or using metal cutting machines. When machines perform the metal cutting operations by the cutting tools mounted on them, they are called "machine tools". *A machine tool may be defined as a power driven machine which accomplishes the cutting or machining operations on it.* The fundamental machine tools that are used for most of the machining processes are, *lathe, drilling, tapping, planing, milling* and *grinding machines.* The working principles of machine tools such as lathe, drilling machine and milling machine are discussed in this chapter.

4.2 Lathe

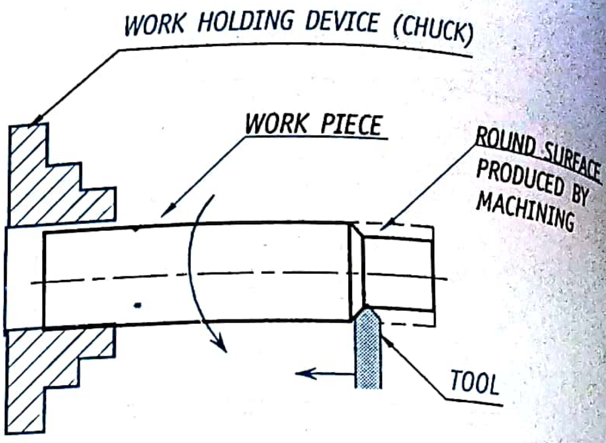
A lathe is a machine tool employed generally to produce circular objects. It is said to be the mother of all the machine tools, since it is so versatile, that almost all the machining operations which are performed on other machine tools like, drilling, grinding, shaping, milling, etc, can be performed on it. Various types of lathes are being used in practice to perform variety of machining operations. Depending on their characteristics functions, lathes are classified as : (1) Engine Lathe, (2) Speed Lathe, (3) Turret Lathe, (4) Capstan Lathe, (5) Automatic Lathe, (6) Computer Numerically Controlled (CNC) Lathe. All of these, except the engine lathe are out of purview of this book.

Engine Lathe

The most commonly used general purpose lathe used in engineering workshops is known as *Engine Lathe, or Centre Lathe, or* simply called as *Lathe.* The term engine used for this kind of lathes, simply means that it is a machine driven by a prime mover used for producing circular objects by manual operations.

4.3 Principle of Working

A lathe, basically a *turning machine* works on the principle that a cutting tool can remove material in the form of chips from the rotating workpieces to produce circular objects. This is accomplished in a lathe which holds the workpieces rigidly and rotates them at high speeds while a cutting tool is moved against it.



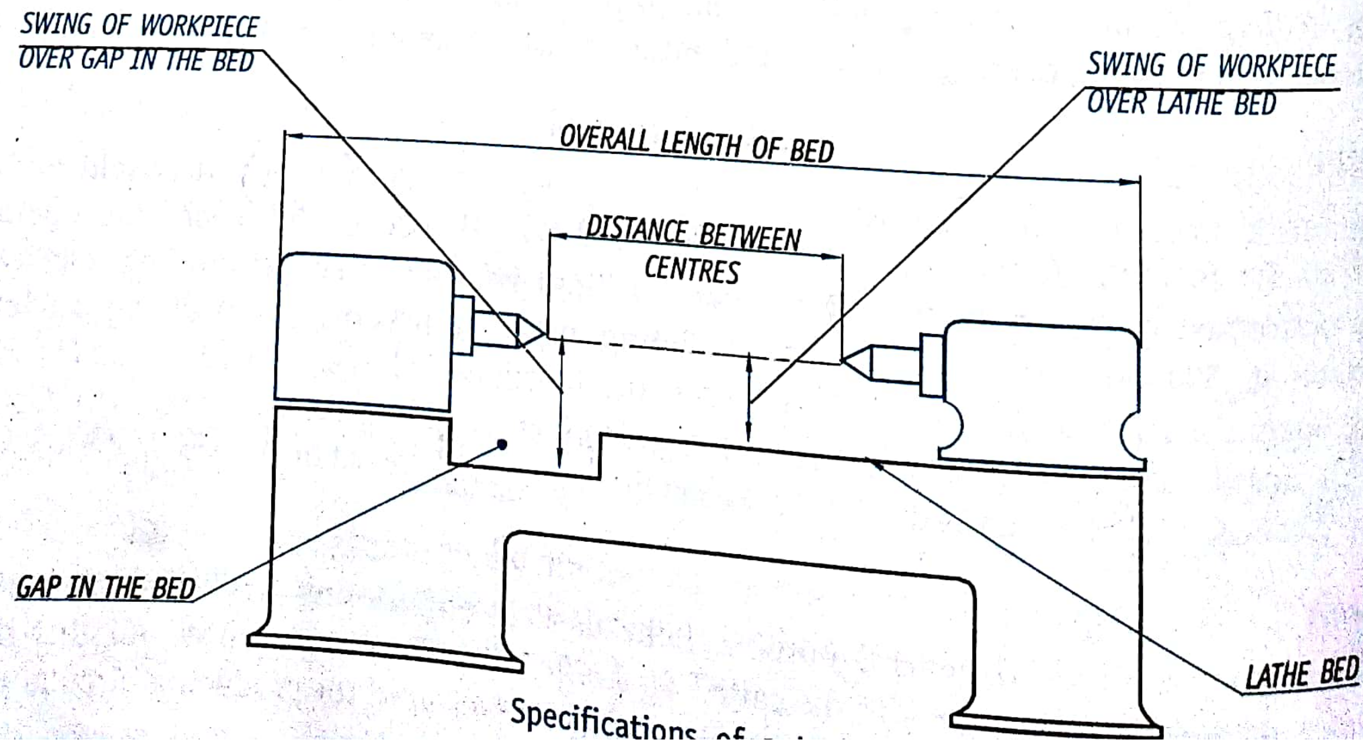
Principle of Working of a Lathe
Fig. 4.1

Fig. 4.1 shows a workpiece held rigidly by one of the workholding devices, known as chuck, and is rotated at very high speeds. A V-shaped cutting tool held against the workpiece opposite to its direction of rotation when moved parallel to the axis of the workpiece produces circular surfaces as shown in figure. The material of the tool will be harder and stronger than the material of the workpiece.

4.4 Lathe Specifications

The size of a lathe is specified by the following as shown in *Fig. 4.2*

1. Maximum diameter of the workpiece that can be revolved over the lathe bed. Instead o this sometimes, the height of the centres above the lathe bed is also specified. One o these specifications is given by the manufacturers, however both of them are loosel called as "Swing of the lathe".
2. The Maximum diameter and the width of the workpiece that can swing when the lath has a gap bed.
3. The maximum length of the workpiece that can be mounted between the centres.
4. Overall length of the bed. It is the total length of the lathe itself.

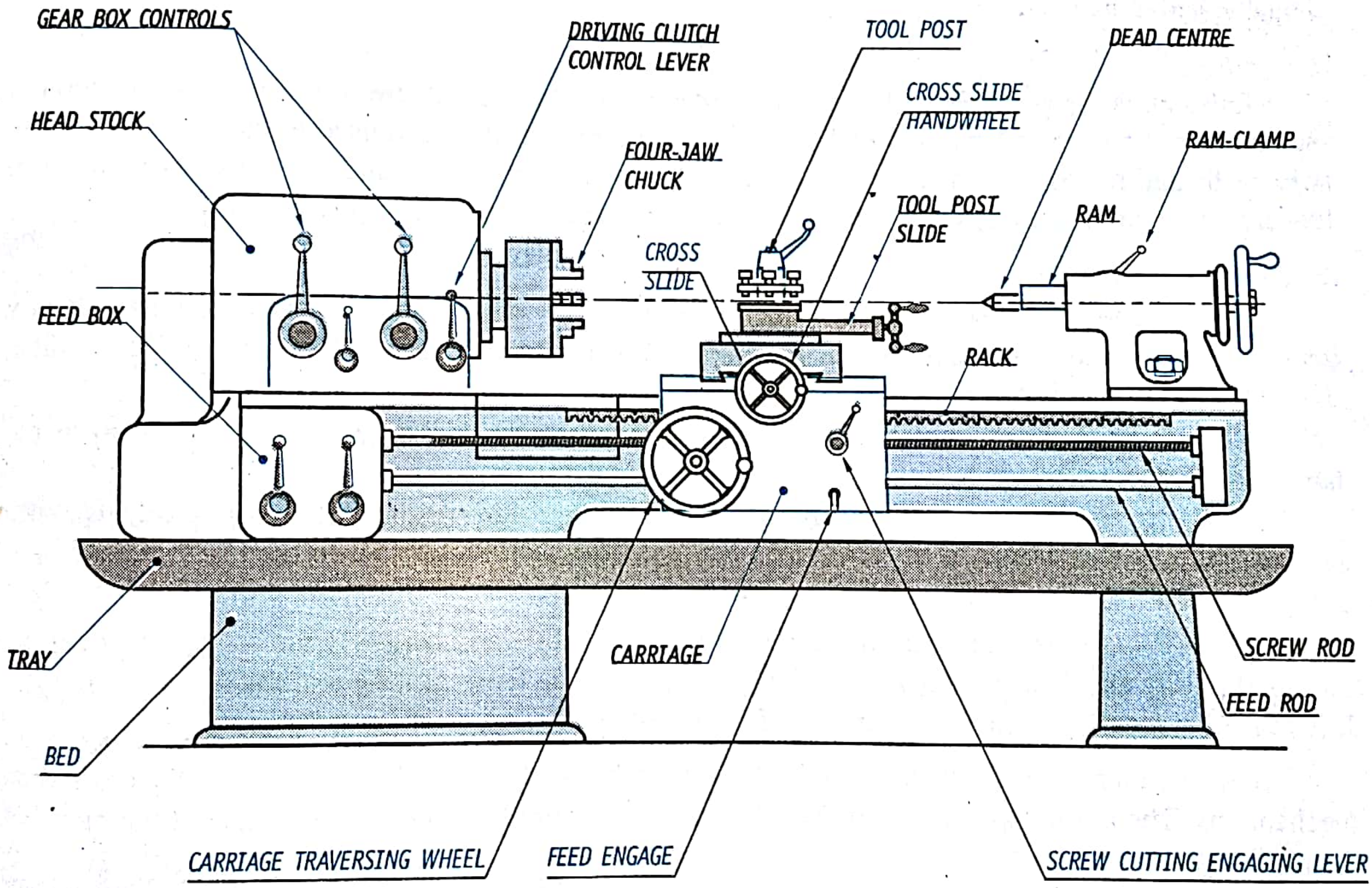


Specifications of ...

4.5 Major Parts of a Lathe and their Functions

Fig. 4.3 shows a lathe. Its major parts are :

1. Bed
2. Main Drive
3. Cone Pulley and Back Gear
4. Headstock
5. Tailstock
6. Lead Screw
7. Feed Rod
8. Carriage Assembly consisting of :
   (a) Saddle
   (b) Cross-slide
   (c) Compound Rest
   (d) Apron



Parts of a Lathe
Fig. 4.3

1. *Bed*

The bed is the foundation part of a lathe and supports all its other parts. The top of the bed is formed by precision machined guideways. There will be two sets of guideways, viz., outer ways and innerways. The headstock and the tailstock are mounted on the inner ways which keep them perfectly aligned with each other. The outerways guide the longitudinal movement of the carriage assembly and align it with the centre line of the lathe.

2. *Main Drive*

An electric motor mounted in the left leg of the lathe in conjunction with the transmission system like belt or gear drive from the motor to the spindle that form the main drive of the lathe.

3. *Cone Pulley and Back Gear*

The cone pulley which drives the main spindle through belting is driven by the motor. Various spindle speeds can be obtained by shifting the belt on the different steps of the cone pulley. Spindle speeds can be further varied using a back gear arrangement.

4. *Headstock*

The housing comprising of the feed gear box and the cone pulley is called headstock of the lathe. The main spindle projects out from the headstock. The headstock will be rigidly mounted on the lathe bed at its left end.

5. *Tailstock*

Tailstock is the movable part of the lathe that carries the dead centre in it. The main function of the tailstock is to support the free end of the long workpieces. It is also used to clamp the tools like twist drills and reamers for making holes, and taps and dies for cutting threads. Tailstock is mounted loosely on the lathe bedways and can be moved and locked in any desired position.

6. *Carriage Assembly*

The carriage assembly serves to support the tool and rides over the bedways longitudinally between the headstock and tailstock. It is composed of five main parts : 1. Saddle, 2. Cross Slide, 3. Compound Rest, 4. Apron, and 5. Tool Post.

Saddle is an H shaped casting that slides over the outer set of the guideways and serves as the base for the cross slide.

Cross Slide is mounted on the saddle and enables the movement of the cutting tool laterally across the lathe bed by means of cross-feed hand wheel. It also serves as the support for a compound rest.

Compound Rest is mounted on the top of the cross slide and supports the tool post. It can be swiveled to any angle in the horizontal plane to facilitate the taper turning and threading operations. It is moved manually by the compound rest feed handle independent of the lathe cross feed.

Apron is mounted at the front of the saddle beneath it and houses the carriage and the cross slide mechanisms. The apron hand wheel moves the carriage assembly manually by means of the rack and the pinion gears.

Tool Post is mounted in the T slot of the compound rest. The tool post clamps the tool holder in the proper position for machining operations.

7. *Lead Screw*

Lead screw is a screw rod which runs longitudinally in front of the lathe bed. The rotation of the lead screw moves the carriage to and fro longitudinally during thread cutting operations.

8. *Feed Rod*

The feed rod is a stationary rod mounted in front of the lathe bed and facilitates longitudinal movement of the carriage during turning, boring and facing operations.

9. *Feed Gear Box*

The feed gear box is mounted on the left side of the lathe bed and below the headstock. It houses the necessary gears and other mechanisms that transmit various feed gear ratios from the headstock spindle to either the lead screw or the feed rod.

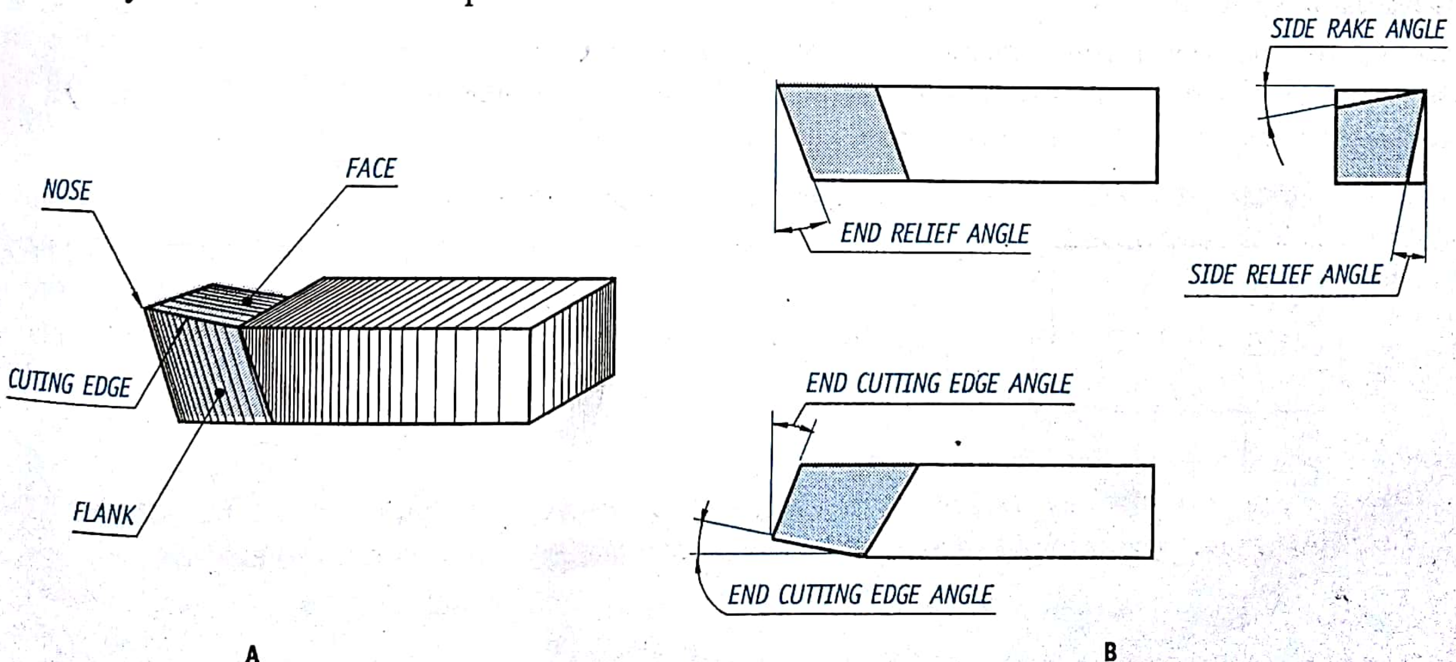
4.6 Nomenclature of a Single Point Lathe Tool

In a single point cutting tool, there will be a point contact between the cutting tool and the workpiece. Obviously the cutting tool should be provided with the clearances on the top, underside and the side faces. *Fig. 4.4* shows the nomenclature of a general purpose single point lathe cutting tool. The cutting portion of the tool is formed by a *face, cutting edge, flank, nose* and *base* as shown in *Fig. 4.4A*. The *face* is the top of the tool and is the surface over which the chip glides over it and passes away from the workpiece. The *cutting edge* is the part of the tool that does the actual cutting of the metal. The *flank* is the tapered surface directly below the cutting edge. The *nose* is the tip of the tool bit formed by the side and the end edges. The *base* is the bottom surface of the tool.

The functions of the different cutting tool angles are as follows :

Relief or *clearance angles* are ground on both the end and side faces of a tool to prevent it from rubbing on the workpiece. *Side relief* is the angle ground directly below the cutting edge on the flank of the tool. *End relief* is the angle ground from the nose of the tool. *Relief angles* are necessary to enable only the cutting edge to touch the workpiece.

Rake angles are ground on a tool to provide a smooth flow of the chip over the tool bit so as to move it away from the workpiece. A lathe tool generally uses *side* and *back rakes. Side rake angle* is ground on the tool face away from the cutting edge. Side rake influences the angle at which the chip leaves the workpiece. A general purpose lathe tool has a 14° side rake. *Back rake* is ground on the face of the tool. Back rake angle influences the angle at which the chip leaves the nose of the tool. Generally 8 to 10° back rake is provided.



Single Point Lathe Tool
Fig. 4.4

End and *side cutting edge angles* are ground on a tool so that it can be mounted in the correct position for various machining operations. The *end-cutting edge angle*, usually 20 to 30°, allows the cutting tool to machine close to the workpiece during turning operations. The *side-cutting edge angle*, approximately 15°, allows the flank of the tool to approach the workpiece first, thus reducing the initial shock of the cut to the tip point. This angle spreads the material over a greater distance on the cutting edge, thereby thinning out the chip.

The *nose radius* is the rounded tip on the point of the tool. The nose radius has two functions; to prevent the sharp fragile tip from breaking during use, and to provide a smoother finish on the workpiece during machining operations. A nose radius of 0.8 mm works well with most of the operations.

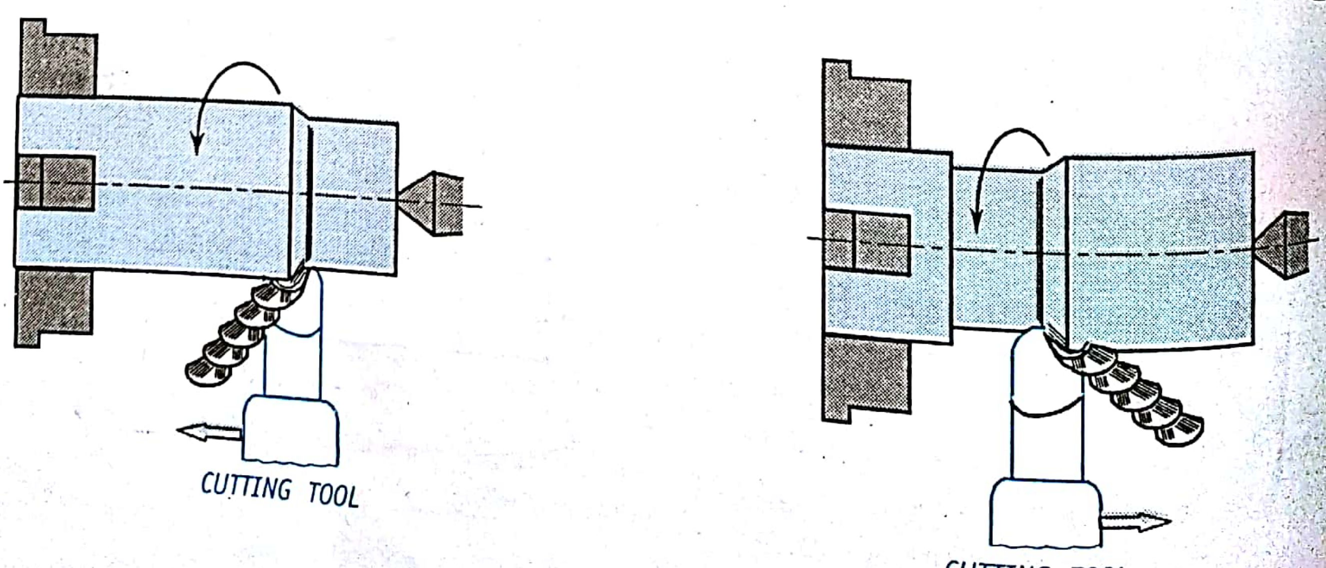
4.7 Lathe Operations

All most all the basic machining operations can be performed on a lathe. Some of the very important and generally performed lathe operations are :

1. Turning
2. Taper turning
3. Thread cutting
4. Boring
5. Facing
6. Drilling
7. Reaming
8. Knurling
9. Milling
10. Grinding

1. *Plain Turning*

Fig. 4.5 shows the principle of a metal cutting operation using a single-point tool on a lathe. The workpiece is supported in-between the two centres which permit the rotation of the workpiece. A single point cutting tool is fed perpendicular to the axis of the workpiece to a known predetermined depth of cut, and is then moved parallel to the axis of the workpiece. This operation will cut the material which comes out as shown in *Fig. 4.5*. This method of machining operation in which the workpiece is reduced to the cylindrical section of required diameter is called *'turning'*.



Turning
Fig. 4.5

9. *Feed Gear Box*

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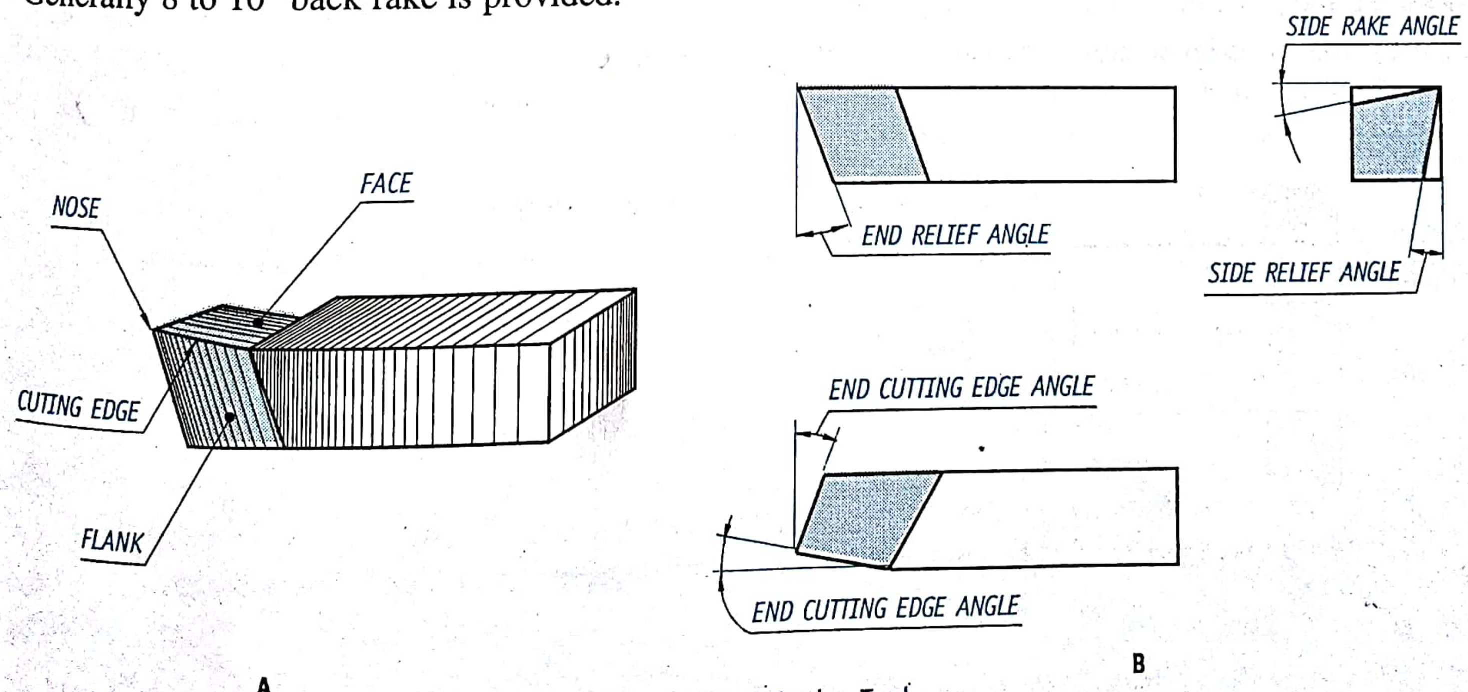
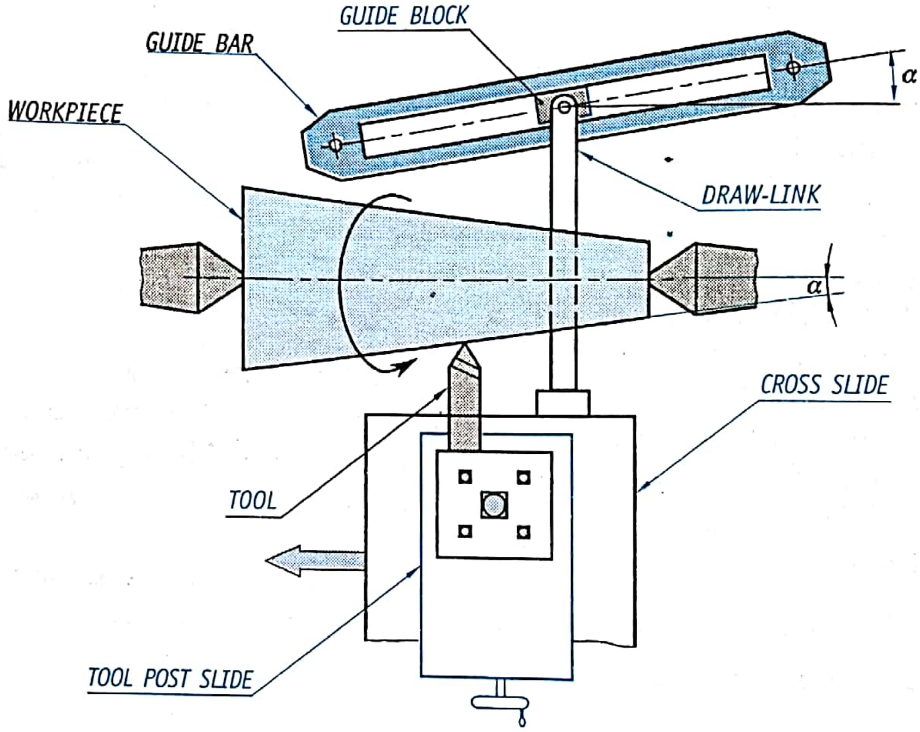


Single Point Lathe Tool
Fig. 4.4

5. *Taper Turning by Taper Turning Attachment*

A taper turning attachment is used to cut both internal and external tapers. The taper turning attachment shown in *Fig. 4.8* consists of a bracket (not shown in figure) which will be connected to the rear side of the lathe bed. A guide bar which can be swiveled in the horizontal plane and locked in position, is mounted over the bracket. A guide block pivoted to a draw-link will slide in the longitudinal slot in the guide bar. The draw-link is connected firmly to the cross slide. The tool is mounted on the tool post slide. The cross slide is allowed to move freely on its ways by loosening the cross feed screw and the engaging nut.



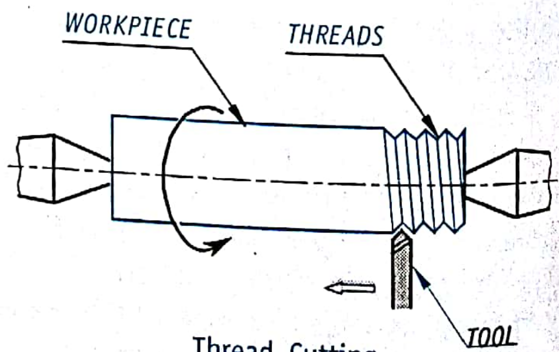
Taper Turning Attachment

Fig. 4.8

When the carriage is moved, the guide slides inside the slot in the guide bar. The sliding of the guide inside the slot forces the cross slide to move in the traverse direction. The combined traverse motion of the cross slide and the longitudinal motion of the carriage moves the tool parallel to the inclined axis of the guide bar and produce the required taper on the workpiece.

6. *Thread Cutting*

A *thread* is a helical ridge formed on a cylindrical or conical rod. It is cut on a lathe when a tool ground to the shape of the thread, is moved longitudinally with uniform linear motion while the workpiece is rotating with uniform speed as shown in *Fig. 4.9*. By maintaining an appropriate gear ratio between the spindle on which the workpiece is mounted, and the lead screw which enables the tool to move longitudinally at the appropriate linear speed, the screw thread of the required pitch can be cut. The pointed tool shown in *Fig. 4.9* is employed to cut *V-threads*. When *square threads* are to be cut, the tool is ground to a squared end.

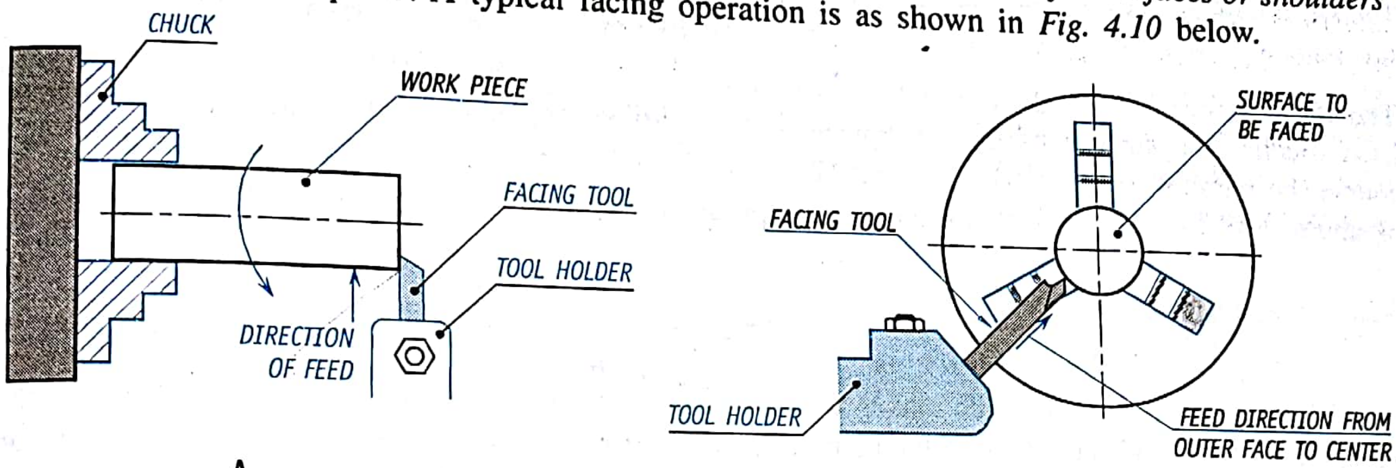


Thread Cutting

Fig. 4.9

7. Facing

Facing is defined as an operation performed on the lathe to generate either flat surfaces or shoulders at the end of the workpiece. A typical facing operation is as shown in *Fig. 4.10* below.



A
Front View

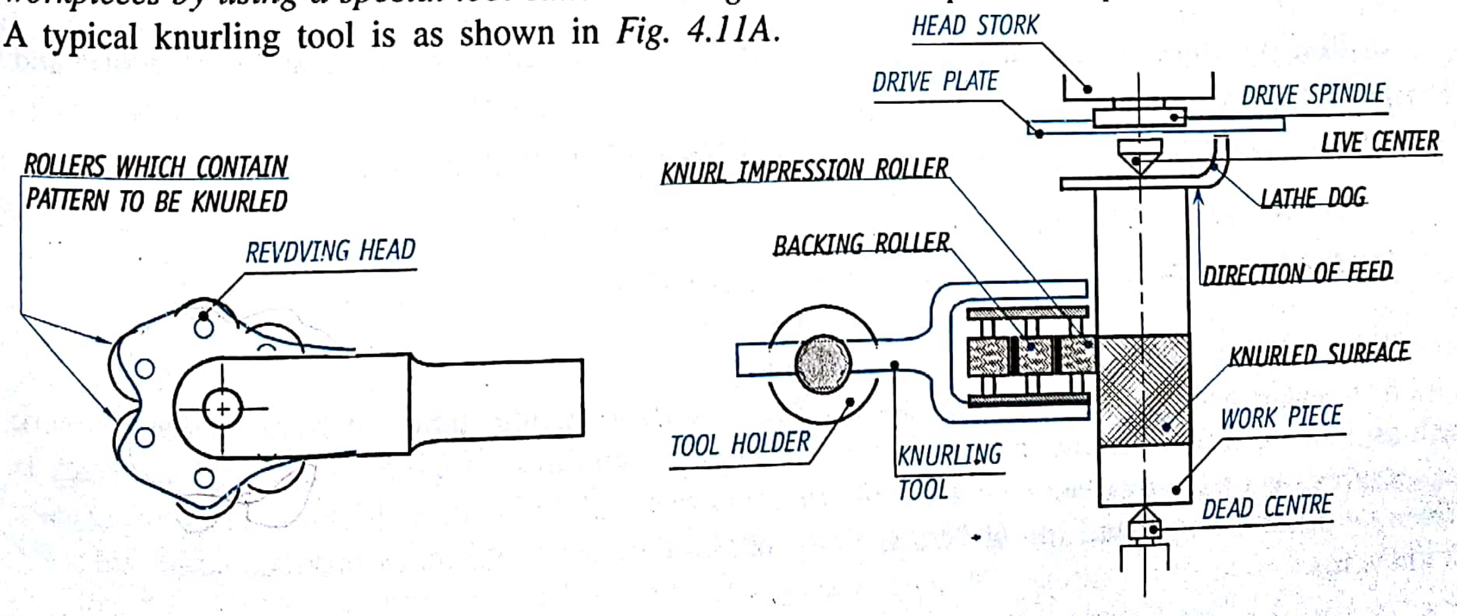
Facing Operation
Fig. 4.10

B
Side View

In facing operation, the direction of feed given is perpendicular to the axis of the lathe. The workpiece is held in the chuck and the facing tool is fed either from the outer edge of the workpiece progressing towards the centre or vice versa. The cutting tool is held by a tool holder in a tool post. Axial movement of the tool can be avoided by locking of the carriage. From the jaws of the chucks, the length extended should not be more than 1.5 times the diameter of the work. The finishing speeds and feeds are calculated w.r.t the largest workpiece diameter. Note that *the roughing cuts can be given either from outer surface of the workpiece to the centre or vice versa*. But the finishing cuts must always be given from centre to the outer edge of the workpiece.

8. Knurling

Knurling is defined as an operation performed on the lathe to generate serrated surfaces on workpieces by using a special tool called knurling tool which impresses its pattern on the workpiece. A typical knurling tool is as shown in *Fig. 4.11A*.



A

Knurling Operation
Fig. 4.11

B

It consists of one upper roller and one lower roller on which the desired impression pattern can be seen. The serration or impression pattern can be straight lines or diamond pattern. The serrated surface on the workpiece formed by knurling is used for applications where grip is required to hold the part. A typical knurling operation is as shown in *Fig. 4.11B*.

The knurling tool is set in the tool post in such a way that the upper and lower rollers of the knurling head touches the surface of the workpiece to be knurled. The axis of the knurling head will of course, be parallel to the workpiece axis. Usually a low speed of about 60 to 80 rpm with a feed of about 0.38 to 0.76 mm/revolution of the spindle is prescribed for knurling operation.

4.8 Drilling Machine

Drilling is a metal cutting process carried out by a rotating cutting tool to make circular holes in solid materials. The tool which makes the hole is called a *drill.* It is generally called as *twist drill,* since it has a sharp twisted edges formed around a cylindrical tool provided with a helical groove along its length to allow the cut material to escape through it. The sharp edges of the conical surfaces ground at the lower end of the rotating twist drill cuts the material by peeling it circularly layer by layer when forced against a workpiece. The removed material chips get curled and escapes through the helical groove provided in the drill. A liquid coolant is generally used while drilling to remove the heat of friction and obtain a better finish for the hole.

4.9 Drilling Machine

A power operated machine tool, which holds the drill in its spindle rotating at high speeds and when manually actuated to move linearly simultaneously against the workpiece produces a hole, is called *drilling machine.* In a drilling machine the holes can be produced to the sizes as small as *thousandth of a centimetre and upto 7.5 cm diameter.* The various other operations that can be performed on a drilling machine are : reaming, counterboring, countersinking, spot facing, thread tapping, etc.

4.10 Types of Drilling Machines

Drilling machines are manufactured in different sizes for different classes of work and classified as follows :

1. Portable Drilling Machine
2. Bench Drilling Machine
3. Pillar Drilling Machine
4. Radial Drilling Machine
5. Gang Drill
6. Multiple Drilling Machine

1. Portable Drilling Machine

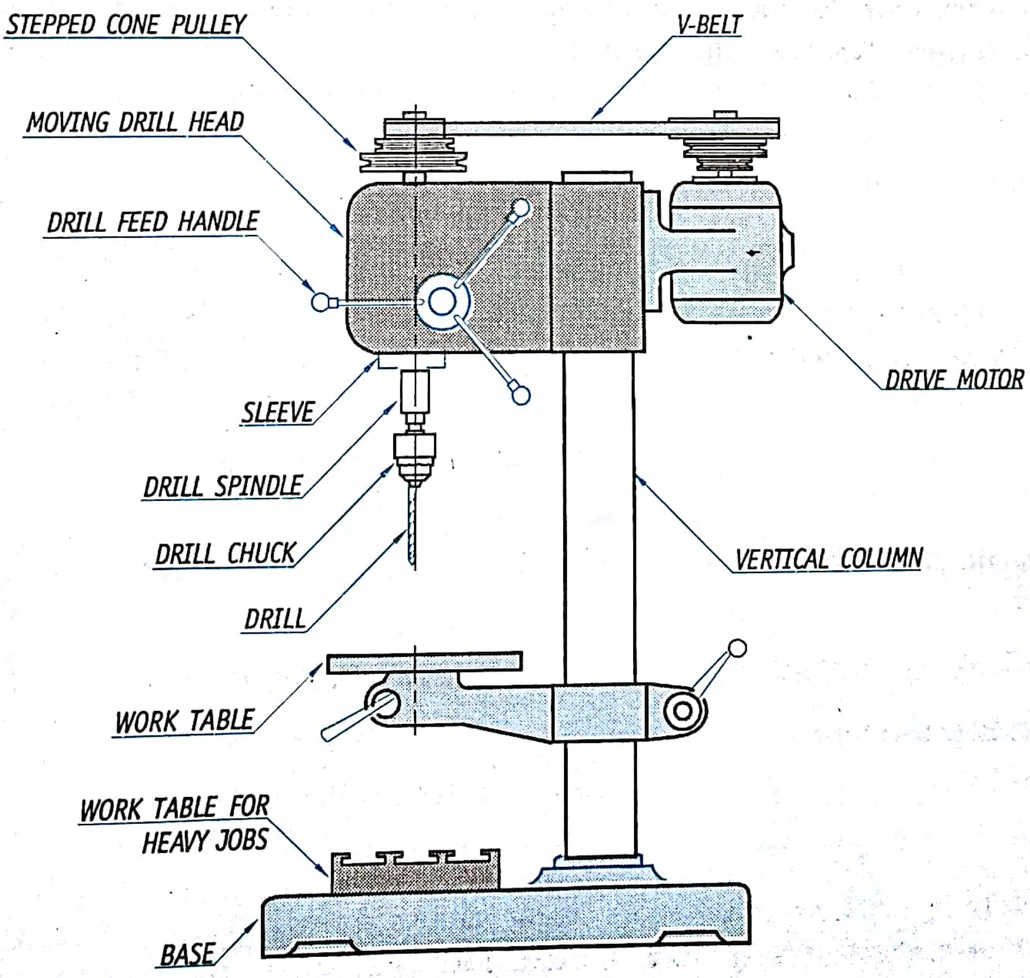
A portable drilling machine is generally employed for drilling holes in light classes of work such as, structural fabrications, fitting work in assemblies, and also in cases where high accuracy is not required. They are available in different sizes and can drill holes upto 12 mm. They are usually driven by electric motor and run at very high speeds as they are required to produce small holes for short depths.

2. *Bench Drilling Machine*

Bench drilling machines are light duty drilling machines widely used in small workshops. They are usually placed on workbenches, hence the name. This type of drilling machines are also called *sensitive drilling machines* because of its accurate and well balanced spindle, which enable the operator to sense or feel the cutting action and apply the required pressure while drilling. Generally holes of sizes upto 15 mm are drilled in these machines.

Parts of a Bench Drilling Machine

Fig. 4.12 shows a bench drilling machine. It consists of a *vertical main column* mounted over a *base*. The vertical column carries a *moving head* housing in it a *speed gear box and spindle feeding mechanism*, and a job mounting table, called *work table* which can also be raised or lowered An *electric motor* is mounted at the top end of the vertical column on its rear side. The power is transmitted to the main spindle through the stepped cone pulley drives and gearing systems. A drill chuck for small size drills is fitted in the spindle at its lower end. For bigger sizes the drill itself will be fitted directly in the spindle. The workpiece will be mounted on the work table and is clamped to it.



Bench Drilling Machine
Fig. 4.12

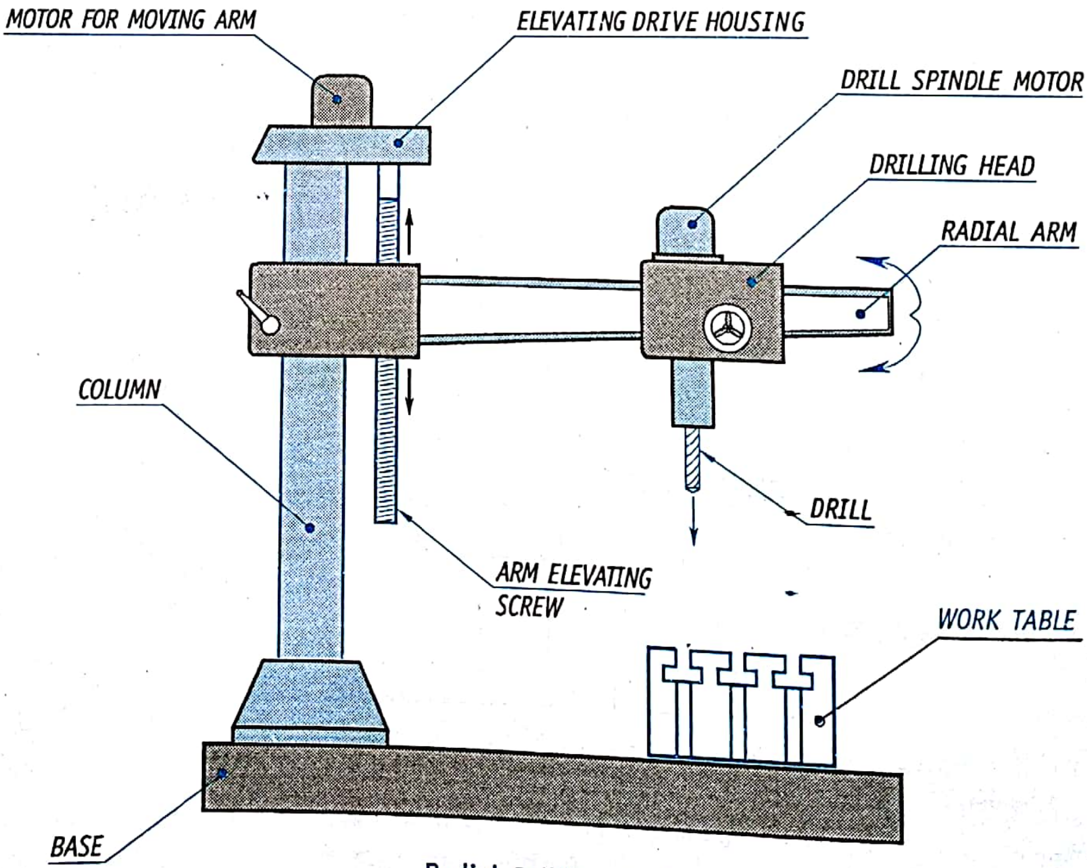
The work table can be moved up and down over the arm and locked in the required position. The centre of the hole to be drilled will be punched with a mark initially on the workpiece. Before drilling, the tip of the drill will be aligned with the centre punch mark and by the feed-wheel the rotating spindle is lowered to perform the drilling operation.

3. *Pillar Drilling Machine*

Pillar drilling machines are generally employed for both medium and heavy duty jobs and are used for drilling holes upto 50 mm diameter. A pillar drilling machine consists of a robust pillar erected over a sturdy base which is fixed on the floor. The pillar carries an adjustable table and the drill mechanism.

4. *Radial Drilling Machine*

A radial drilling machine shown in *Fig. 4.13* is used to perform the drilling operations on the workpieces which are too heavy and also may be too large to mount them on the work table of the vertical spindle drilling machine. It consists of a heavy *base* and a *vertical column* with a long *horizontal arm* extending from it and can be rapidly raised, lowered and swung in the horizontal plane about the main column to any desired location. The *drilling head* can move to and fro along the arm and can be swiveled only in the universal radial drilling machines, to drill holes at an angle. The combination of motions of the radial arm and drilling head offers a great deal of flexibility in moving the drill to any position. The main advantage of the radial drilling machine is that the drilling can be carried out on heavy work pieces in any position without moving them.



Radial Drilling Machine
Fig. 4.13

5. *Multiple Spindle Drilling Machine*

The multiple spindle drilling machines permit drilling of several holes of different diameters simultaneously. Generally the spindles numbering 2 to 3 or even more are driven by only one gear in the head through universal joint linkages. Each spindle is mounted with a twist drill. A jig is used to guide the twist drills. This machine finds its application in mass production.

6. *Gang Drill*

A gang drill is made up of many drilling heads placed side by side and the workpieces mounted on a long common work table. A gang drilling machine mounted with a drill, a reamer, a countersinking tool and a tapping attachment on its successive spindles, a threaded hole with some portion reamed and countersunk can be made by moving the workpiece mounted with a jig successively to the successive spindles to perform first drilling, secondly reaming, thirdly countersinking and finally tapping operations. Thus with a gang drilling machine various operations can be performed without changing the tools and the spindle speeds.

4.11 Nomenclature of a Twist Drill

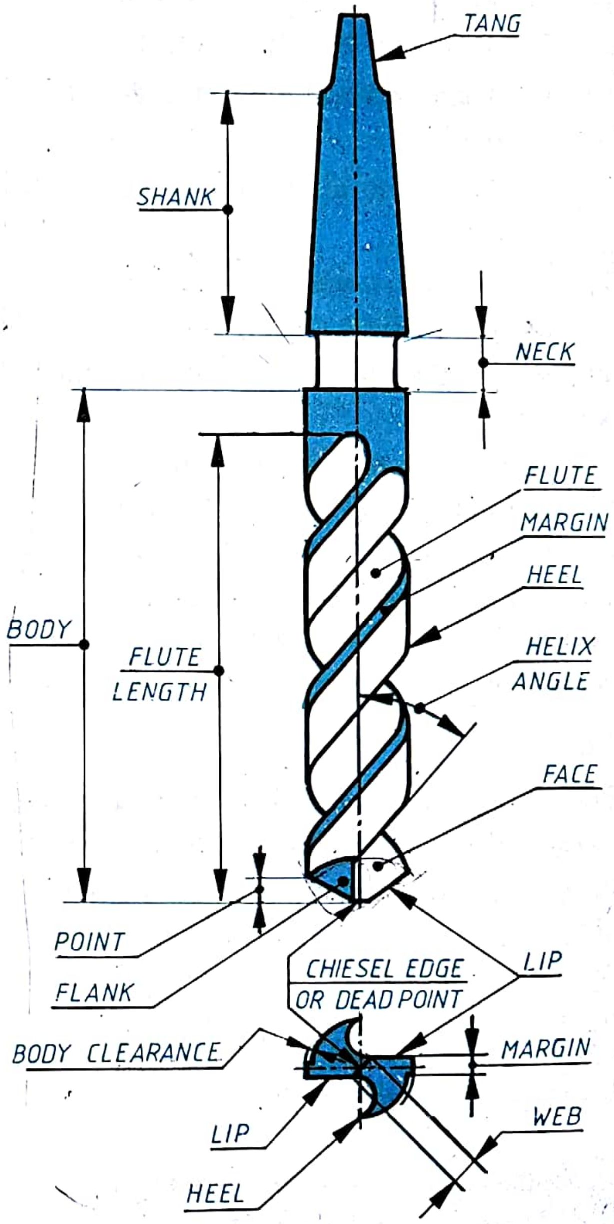
A *twist drill* shown in *Fig. 4.14* is the cutting tool that is employed in the drilling machines. Two long diametrically opposite helical flutes are formed throughout its effective length. A twist drill is composed of three major parts — *point*, *body* and *shank*. The functions of these are as follows.

1. *Point*

The *point* is the cone shaped end of the drill which cuts the material to produce the hole. It is produced by grinding the end of the drill to a conical shape so that the *chisel edge, flank* and *lips* are formed.

The *chisel edge* also known as *dead centre,* is the sharp edge formed at the extreme tip of the drill by the intersection of the two conical portions. The chisel edge will be aligned with the centre punch mark made in the workpiece at the point where the centre of the hole will lie when the hole is drilled.

The *flank* is the conical surface of the point of the drill which extends from the lip to the flute.



Nomenclature of a Twist Drill
Fig. 4.14

The *lip* is the cutting edge formed at the intersection of the flank and the inner surface of the flute. Since there are two flutes and two flanks, two lips are formed at their intersection. When the drill rotates both the lips cut the material to produce the hole.

2. *Body*

The *body* is the portion of the drill that extends from the tip of the drill to the lower edge of the neck. It consists of *flutes, margin, heel, web* and *body clearance.*

The *flutes* are the helical grooves that are cut on the cylindrical surface of the drill. The flutes serve the following functions.

1. They enable to form the lips.
2. They curl the chips for the easy removal of the material.
3. They serve as the passages for the flow of the curled chips out of the hole as it is being drilled.
4. They also allow the coolant or the lubricant to flow down the body of the drill while drilling.

The *margin* also called as *land* is the narrow strip along side of the flute. The margin guides the drill and prevent rubbing of the heel in the drilled hole.

The *heel* is the edge formed by the intersection of the flute surface and the undercut surface of the body.

The *body clearance* is the narrow surface gap left between the margin and the undercut portion of the body of the drill. It helps to prevent the rubbing of the entire body surface with the internal surfaces of the hole and reduces the rubbing friction.

The *web* is the thickness of the drill between the two flutes. It is the thin portion in the centre of the drill which extends through the entire length of the flutes. It is the backbone of the drill. Its thickness gradually increases from the point to the shank and makes the drill stronger at the shank.

3. *Shank*

The *shank* is the portion of the drill above the neck. Twist drills have either *straight* or *tapered shank*. Straight shanks are provided on small drills, i.e., less than 15 mm.

Bigger size drills have tapered shanks. The shank end of the drills is provided with a small tapered tenon, called *tang*. The tapered shank drills are mounted directly into the tapered bore of the main spindle of the drilling machine. When the drill is inserted into the tapered bore of the main spindle, the tang fits into a slot provided in the tapered bore. It drives the drill and prevents the shank from slipping. The tang also offers as a means of removing the taper shank drill from the spindle by using a wedge piece.

4.12 Drilling Machine Operations

Apart from drilling, a number of other operations that can be performed on a drilling machine using the various tools are :

1. Boring
2. Counterboring
3. Countersinking
4. Spot facing
5. Tapping
6. Reaming

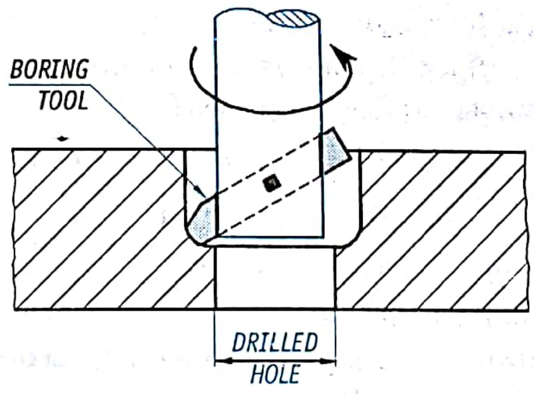
1. Reaming

Reaming is the process of smoothing the surface of the drilled holes with a reamer. A *reamer* is similar to the twist drill, but has straight flutes. After drilling the hole to a slightly smaller size, the reamer is mounted in place of twist drill and with the speed reduced to half of that of the drilling, reaming is done in the same way as drilling. It removes only a small amount of material and produces a smooth finish on the drilled surfaces.

2. Boring

Boring is done on a drilling machine to increase the size of an already drilled hole. When a suitable size drill is not available, initially a hole is drilled to the nearest size and using a single point cutting tool, the size of the hole is increased as shown in *Fig. 4.15.*

By lowering the tool while it is continuously rotating, the size of the hole is increased to its entire depth. *Fig. 4.15* shows when the boring operation is in progress. It will be continued till the lower surface of the workpiece.

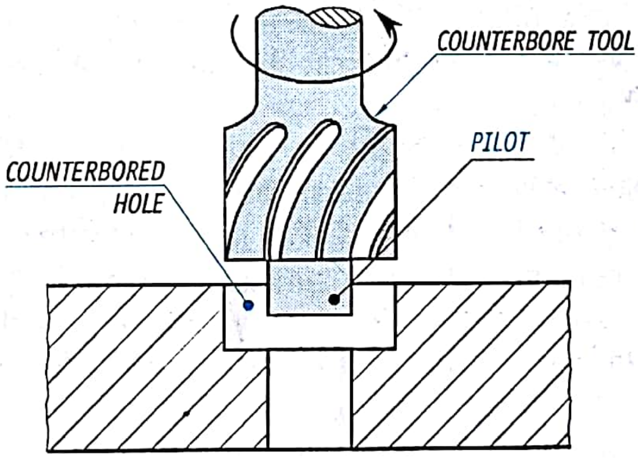


Boring
Fig. 4.15

3. Counterboring

Counterboring is to increase the size of a hole at one end only through a small depth as shown in *Fig. 4.16.* The counterboring forms a larger sized recess or a shoulder to the existing hole. The cutting tool will have a small cylindrical projection known as pilot to guide the tool while counterboring. The diameter of the pilot will always be equal to the diameter of the previously drilled hole. Interchangeable pilots of different diameters are also used for counterboring holes of different diameters. The *speeds for counterboring must be two-thirds of the drilling speed the corresponding size of the drilled hole.*

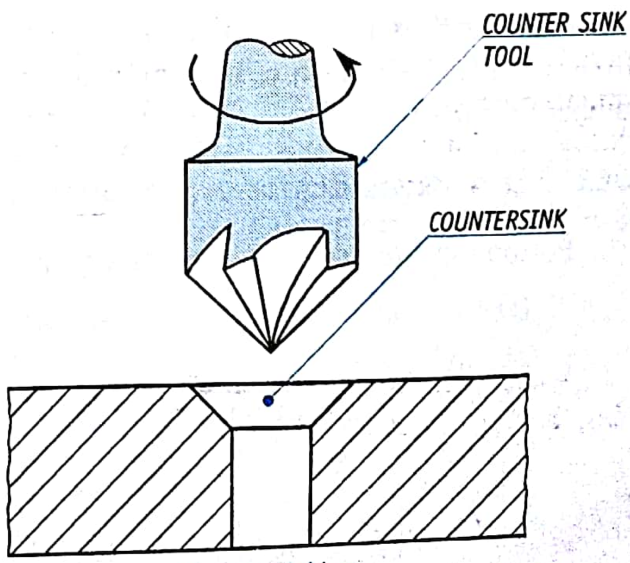
Generally the counterboring is done on the holes to accommodate the socket head screws, or grooved nuts, or round head bolts.



Counterboring
Fig. 4.16

4. Countersinking

Countersinking shown in *Fig. 4.17* is the operation of making the end of a hole into a conical shape. It is done using a countersinking tool shown in figure. The countersinking process may also be employed for deburring the holes.



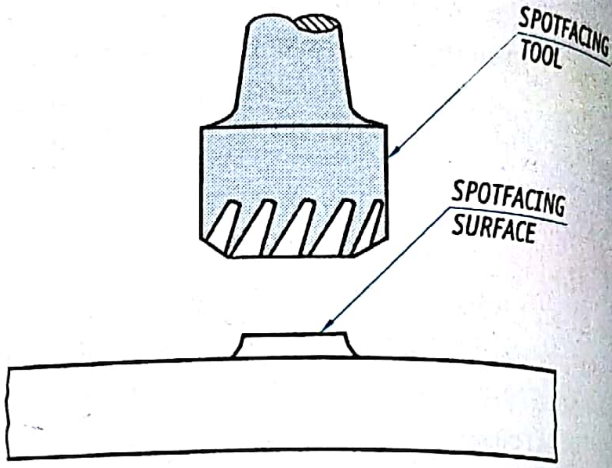
Countersinking
Fig. 4.17

The *cutting speeds for countersinking must be about one-half of that used for similar size drill.*

The countersunk holes are used when the countersunk screws are to be screwed into the holes so that their top faces have to be in flush with the top surface of the workpiece.

5. Spot Facing

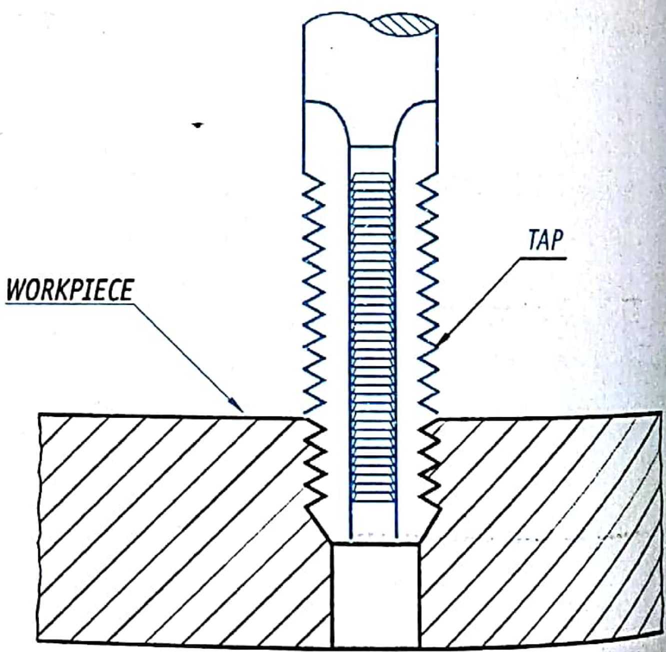
Spot facing is a finishing operation to produce a flat round surface usually around a drilled hole, to give a good bearing surface for the proper seating of a bolt head or a nut. The spot that is faced may be a circular raised pad on a casting or merely the surface around a bolt hole. Spot facing may be done with a counterboring tool shown in *Fig. 4.16,* or using a special spot facing tool shown in *Fig. 4.18.*



Spot Facing
Fig. 4.18

6. Tapping

The tapping, shown in *Fig. 4.19* is the process of cutting internal threads with a thread cutting tool called *tap. A tap is a fluted threaded tool used for cutting internal threads.* Before tapping, a hole which is slightly smaller than the size of the tap is drilled. For cutting the threads, the tap is fitted in the tapping attachment which in turn is mounted in the drilling machine spindle, and the threads are cut in the same way as drilling. While tapping in a drilling machine the spindle has to rotate at very slow speeds. The tap will be held in a collapsible type of tapping chuck, which is inserted in the spindle of the drilling machine. Generally tapping is done on a drilling machine when identical threading is required on large number of parts.



Tapping
Fig. 4.19

4.13 Specifications of a Radial Drilling Machine

Following are some of the important specifications of a Radial Drilling Machine:

1. **Drilling in steel expressed in mm** : This is the depth that can be drilled in steel. For example, it can be 32 mm.
2. **Drilling in Cast Iron expressed in mm** : This is the depth that can be drilled in steel. For example, it can be 35 mm.
3. **Maximum drilling radius expressed in mm** : It is the maximum extent of radius of the job that can be drilled. For instance it can be 900 mm.

4. **Minimum drilling radius expressed in mm** : It is the minimum extent of radius of the job that can be drilled. For instance it can be 350 mm.
5. **Vertical power movement of arm expressed in mm** : It is the distance of the vertical distance by which the arm moves. For instance it can be 500 mm
6. **Horizontal power movement of head expressed in mm** : It is the distance by which the head holding the spindle can traverse horizontally. For instance it can be 600 mm.
7. **Drilling motor power expressed in kW** : It is the power capacity of the drilling motor. For instance it can be 1.5 kW
8. **Spindle speed range expressed in rpm** : It is the range of speed within which the spindle rotates for the given design. For instance it can be 50-2800 rpm
9. **Swing of arm expressed in degrees** : It is the angular swing of the arm of the machine. It will be usually 360 degrees.
10. **Stroke of spindle expressed in mm** : It is the vertical distance by which the spindle can traverse. For instance it can be 250 mm
11. **Power feed range expressed in mm/rev** : It is the range of feed that can be given per revolution of the spindle. For example: 0.030-0.315 mm per revolution.

4.14 Specifications of a Drilling Machine

A Drilling machine can be specified by the following Specifications :

1. Drilling Capacity in Steel :

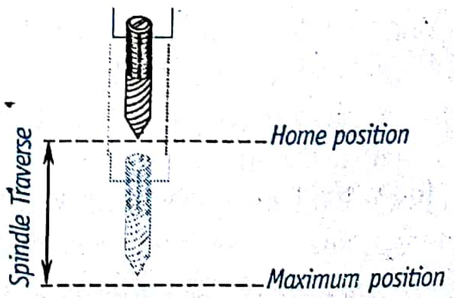
This denotes the capacity of the drilling machine to drill into jobwork mode of steel. It is usually expressed by the depth upto which drilling is done. Drilling machines capable of drilling upto a depth of 20 mm are available in the market.

2. Spindle Traverse :

This is the extent by which the rotating spindle of the drilling machine can traverse vertically from its home position of position of rest to the maximum vertical distance downwards. This is expressed in mm.

3. Spindle Speed Range :

This is the range of speed by which the Spindle of the drilling machine is able to rotate. This is expressed in revolutions per minute or RPM. For example, the range can be from 500 – 2000 rpm.



Spindle Traverse

Fig. 4.20

4. Table Overall Size :

This is the area on the work table where the targeted jobs are to be clamped to the table. They are usually expressed as Length X width (mm × mm) of the table for instance, the table size is 280 × 280 sq.mm.

5. *Table Working Surface*

This is the area available out of the overall size of the table for carrying out the desired work. For instance, as shown in the above figure, the Working surface is 200 × 200 sq.mm out of 280 × 280 sq.mm

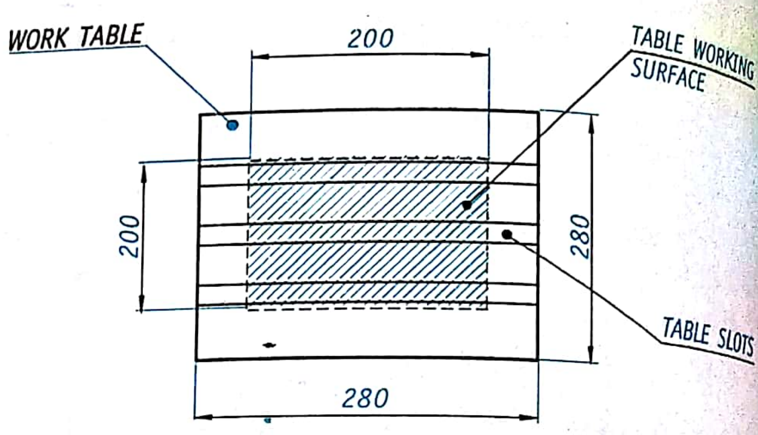


Table Working Surface
Fig. 4.21

6. *Power and Speed of the Motor :*

Power, usually expressed in kW (or HP) and its speed in RPM is helpful in power calculations and cost calculations. For instance, the power and speed can be 1 HP/ 1440 rpm in Standard Bench Drilling Machines.