

MANUFACTURING PROCESS

The lathe is one of the oldest machine tools. At early it was tree lathe. In the year 1797 Henry Maudslay, an English man, designed the first screw cutting lathe.

Function of the lathe

The main function of a lathe is to remove metal from a piece of work to give it the required shape and size. This is done by holding the work securely and rigidly on the machine and then turning it against a cutting tool which will remove metal from the work in the form of chips. To cut the material properly the tool should be harder than the material of the work piece, the tool should be rigidly held on the machine and should be progressed in a definite way relative to the work.

TYPES OF LATHE

The types generally used are:

1. Speed lathe
 - a) Wood working
 - b) Centering
 - c) Polishing
 - d) Spinning
2. English lathe or center lathe
 - a) Belt drive
 - b) Individual motor drive
 - c) Gear head lathe.
3. Bench lathe
4. Tool room lathe
5. Capstan and Turret lathe

6. Special purpose lathe
 - a) Wheel lathe
 - b) Gap bed lathe
 - c) T- lathe
 - d) Duplicating lathe
7. Automatic lathe.

The size of a lathe

The size of a lathe is expressed by the following items:

1. The height of the centers measured from the lathe bed.
2. The Suring diameter over bed. This is the largest diameter of work that will revolve without touching the bed and is twice the height.
3. The length between centers. This is the maximum length of work that can be mounted between the lathe centers.

Parts of a lathe (and function)

1. Bed
2. Headstock
3. Tail stock
4. Carriage
5. Fed mechanism
6. Screw cutting mechanism.

Bed-The lathe bed forms the base of the machine, on which, head stock, tail stock, carriage etc. are located.

Headstock-The head stock is secured permanently on the inner ways at the left hand end of the lathe bed, and it provides mechanical means of rotating the work at multiple speeds.

Tailstock or loose Head stock:

The tail stock is located on the inner ways at the right hand end of the bed. This has two main uses,

1. It supports the other end of the work when it is being machined between center, and
2. It holds a tool for performing operation such as drilling, reaming, tapping etc.

Carriage: The carriage of a lathe has parts that serve to support, move and control the cutting tool. It consists of the following parts: 1. Saddle 2. Cross slide 3. Compound slide or compound rest, 4. tool post, and 5. Apron.

Feed mechanism: The movement of the tool relative to the work is termed as "Feed", A lathe tool may have three types of feed – longitudinal, cross, and angular longitudinal feed is effected by the movement of the carriage cross feed is effected by the movement of the cross slide and angular feed is effected by the movement of the compound slide cross and longitudinal feed are both hand and power operated, but angular feed is only hand operated.

Thread cutting mechanism: The rotation of the lead screw is used to traverse the tool along the work to produce screw threads. The half nut mechanism makes the carriage to engage or disengage with the lead screw.

Lathe accessories: Lathe accessories include centers. Catch plates and carriers, chucks, collets, faceplates, angle plate, mandrels and rests, they are used either for holding and supporting the work or for holding the tool.

Lathe operations: In order to perform different machining operations in a lathe, the work piece may be supported and driven by any one of the following methods.

1. Held between centers and driven by carriers and catch plates.
2. Held on a mandrel is supported between centers and drive by a catch plates.
3. Held and driven by a chuck or a faceplate or an angle plate.
4. Held and driven by chuck with the other end supported on the tailstock center.

The (above) methods may broadly classified water two heading:

1. Workpiece held between centers
2. Workpiece held by a chuck or by any other fixture.

operation which are performed in a lathe are:

3. By holding between centers or by chuck.
4. By using a chuck, or face plate or an angle plate.

Chucks: A chuck is one of the most important devices for holding and rotating a piece of work in a lathe.

Mandrels: Mandrel is a device for holding and rotating a hollow piece of work that has been previously drilled or bored. The work revolves with the mandrel which is mounted between two centers. Different type mandrels are- plain mandrel, step mandrel, Collar mandrel, Screwed mandrel, cone mandrel, Gang mandrel and expansions mandrel.

Rests: A rest is a mechanical device which supports a long slender work piece, when it is turned between Centers or by a chuck, at some intermediate point to prevent bending of the work

piece. The two types of rest used in an engine lathe are the steady rest and follower rest, used when is 10 to 12 times of the dia.

*The depth of cut for rough turning operation in average machine shop work is from 2 to 5 mm and the rate of feed is from 0.3 to 1.5 mm per revolution of the work.

The amount of taper in a work piece is termed as the conicity and its designated by the letter k,

$$k = (D-d)/L$$

A taper may be turned by any one of the following methods:

1. By a broad nose form tool.
2. By setting over the tailstock center.
3. By swirling the compound rest.
4. by a tapered turning attachment.
5. By combining longitudinal and crossed in a special lathe.

Filing: - It is the finishing operation performed after turning, Polishing is performed after filing to improve the surface quality of the work piece.

Grooving: It is the process of reducing the diameter of a work piece over a very narrow surface.

Spinning: It is the process of forming a thin sheet of metal by revolving the job at high speed and pressing it against a "Former" attached to the headstock spindle.

Spring winding: It is the process of making a coiled spring by passing a wire around a mandrel which is revolved on a chuck or between centers.

Forming: It is the process of turning a convex, concave or of any irregular space.

Drilling: It is the operation of producing a cylindrical hole in a work piece by the rotating cutting edge of a cutter known as the drill.

Reaming: Is the operation of finishing and sizing a hole which has been previously drilled or bored. The tool used is called reamer which has multiple cutting edges.

Knurling: It is the process of embossing a diamond shaped pattern on the surface of a work piece.

Boring: It is the operation of enlarging and turning a hole produced by drilling, punching, casting or forging. Boring cannot originate a hole.

Milling: It is the operation of removing metal by feeding the work against a rotating cutter having multiple cutting edges.

Grinding: It is the operation of removing metal in the form of minute chips by feeding the work against a rotating abrasive wheel known as the grinding wheel.

***The different types of chucks are:**

1. Four jaw independent chuck
2. Three jaw universal chuck
3. Combination chuck
4. Magnetic chuck
5. Air or hydraulic operated chuck
6. Collet chuck
7. Drill chuck

Collect chuck: Collet chuck are used for holding bar stock in production work where quick setting and accurate centering is needed.

Cutting Tools/Cutting- tool Nomenclature

For general purpose work, the tool used in a lathe is a single point tool, but for special operation multipoint tools may be used.

Classification: Single point lathe tools are classified under the following groups.

1. According to the method of manufacturing the tool.

- a) Forged tool.
- b) Tipped tool fastened mechanically to the carbon steel shank.
- c) Tipped tool brazed to the carbon steel shank.

2. According to the method of holding the tool:

- (a) Solid tool,
- (b) Tool bit inserted in the tool holder

3. According to the method of using the tool:

- (a) Turning
- (b) Chamfering
- (c) Thread cutting
- (d) Facing
- (e) Grooving
- (f) Forming
- (g) Boring
- (h) Internal thread cutting.
- (l) Parting- off.

4. According to the method of applying feed:

- a. Right hand
- b. Left hand
- c. Round nose.

CUTTING TOOL NOMENCLATURE

It means systematic naming of the various parts and angles of a cutting tool. The surfaces on the point of a tool bear definite relationship to each other that are defined by angles. The principles cutting –tool angles are the same whether the tool is a single–point tool, a multipoint tool, or a grinding wheel.

The shank is that portion of the tool bit which is not ground to form cutting edges and is rectangular in cross –section.

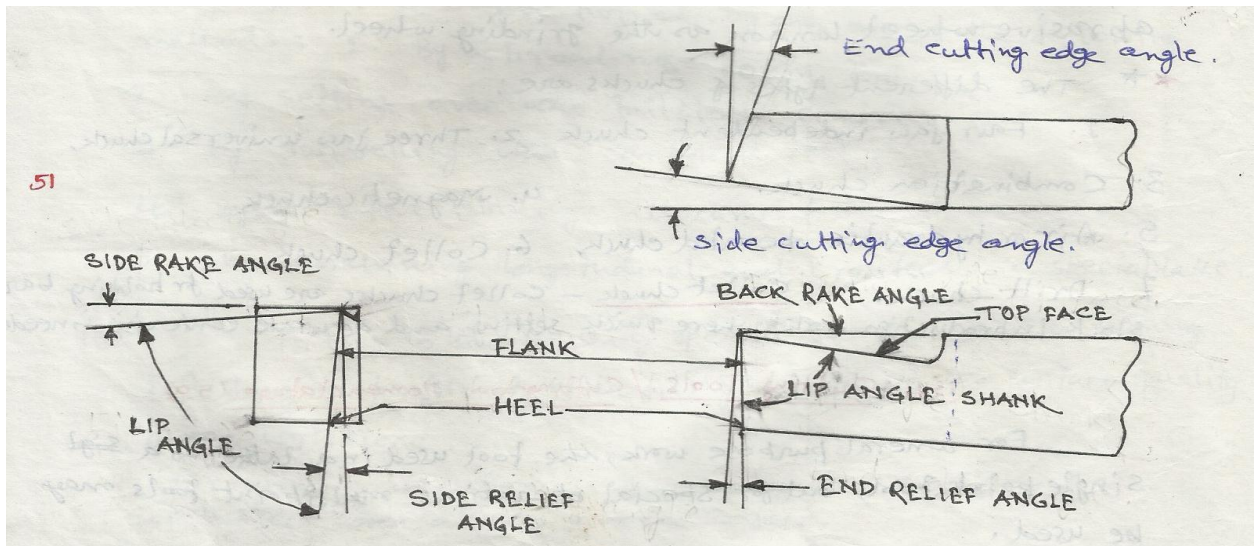


Fig.Tool nomenclature and tool angles

The face of the cutting tool is that surface against which the chip slides upward.

The flank of a cutting –tool is that surface which face the work piece. The base of a tool is the underside of the shank.

The nose of a tool is the conjunction of the side and end –cutting edges

The heel of a single point tool is the lowest portion of the side – cutting and end cutting edge.

The rake is the slope of the top away from the cutting edge. Each tool has a side and back rake.

The side clearance or side relief indicates that the plane that forms the flanks or side of a tool has been ground back at an angle sloping down from the side cutting edge. Likewise, the end clearance or end relief indicates that the nose or end of a tool has been ground back at an angle sloping down from the end cutting edge.

The end cutting edge angle indicates that the plane which forms the end of a tool has been ground back at an angle sloping from the nose to the side of the shank, whereas the side cutting edge angle indicates that the plane which forms the flanks or side of a tool has been ground back at an angle to the side of the shank.

Multipoint tool: Cutters like twist drills, reamers, taps, milling cutters have two or more tool points.

But each cutting blade acts as and has the basic features of a single point tool.

Cutting tool signature: The signature is a sequence of numbers listing the various angles, in degrees, and the size of the nose radius. This numerical method of identification has been standardized by the American standards association.

The seven elements that comprise the signature of a single point cutting tool are always stated in the following order: back rake angle, side rake angle, end relief angle, end cutting edge angle, side cutting edge angle, and nose radius. Thus a tool with a shape specified as

8-14-6-6-6-15-4

has 8° back rake, 14° side rake, 6° end relief, 6° end or side relief, 6° end cutting edge and 15° side cutting edge angles, and 4m.m. nose radius.

Cutting speed, Feed, Depth of cut, Machining time

Cuttingspeed: The cutting speed (v) of a tool is the speed at which the metal is removed by the tool from the work piece. In a lathe it is the peripheral speed of the work past the cutting tool expressed in meters per minute.

$$\text{Cutting speed} = \frac{\pi d n}{1000} \text{ m/min}$$

Where, d is the diameter of the work in mm and n is the r.p.m. of the work.

Example: A steel shaft of 20mm diameter is turned at a cutting speed of 40 m/min. Find the r.p.m of the shaft.

$$\text{Cutting speed} = \frac{\pi d n}{1000} \text{ m/min}$$

$$\Rightarrow 40 = \frac{\pi \cdot 20 \cdot n}{1000}$$

$$\Rightarrow n = \frac{(40 \cdot 1000)}{20 \cdot \pi}$$

$$\Rightarrow 637 \text{ rpm}$$

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 millimeters per revolution.

Increased feed reduces cutting time. But increased feed greatly reduces the tool life. Coarser feeds are used for roughing and finer feed for finished cuts.

Depth of cut: The depth of cut is the perpendicular distance measured from the machined surface to the uncut surface of the work piece. In a lathe the depth of cut is expressed as following:

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

Where d_1 = diameter of the work surface before machining and d_2 = diameter of the machine surface.

Machining time: The machining time in a lath work can be calculated for particular operation if the speed of the job, feed and length of the job is known.

If f is the feed of the job per revolution expressed in mm per revolution and l the length of the job in mm the number of revolutions of the job required for a complete cut will be: $\frac{l}{f}$

If the rpm of the work is n , time taken to revolve the job through $\frac{l}{f}$ number of revolution for a complete cut will be: $\frac{l}{f \cdot n}$ min

Therefore, the time taken for a complete cut = $\frac{l}{f \cdot n}$ min

Example: Find the time required for one complete cut on piece of work 700 mm long and 50 mm diameter. The cutting speed is 70 meters per minute and the feed is 0.5 mm per revolution.

$$\text{Cutting speed} = \frac{\pi d n}{1000} = \frac{\pi \cdot 50 \cdot n}{1000} = 70$$

$$n = \frac{1000 \cdot 70}{\pi \cdot 50} = 445$$

Number of revolution required for complete one cut = $\frac{700}{0.5} = 1400$

Time required for complete one cut = $\frac{1400}{445} = 3.14$ min

The tool post: -This is located on the top of the compound rest to hold the tool and to enable it to adjusted to a convenient working position. The type and mounting of the tool post depends upon the class of the work for which it is to be used. Such as are -

- i. Single screw tool post
- ii. Four bolt tool post
- iii. Open side tool post
- iv. Four-way tool post.

The Apron: The Apron is fastened to the saddle and hangs over the front of the bed. It contains gears, clutches and levers for operating the carriage by hand and power feed. The apron also contains friction clutches for automatic feeds. In addition, there is a split nut which engages, when required, with the lead screw, when cutting either internal or external threads.

Drilling Machine

The drilling machine is one of the most important machine tools in a work shop. As regards its importance it is second only to the lathe. Although it was primarily designed to originate a hole, it can perform a number of similar operations. The hole is generated by rotating edge of a cutting tool known as the drill which exerts large force on the work clamped on the table. As the machine exerts vertical pressure to originate a hole it is loosely called a "drill press". In a drilling machine holes may be drilled quickly and at a low cost.

Types of Drilling Machine

Drilling machines are made in many different types and sizes, each designed to handle a class of work or specific job to the best advantage; The different types of drilling machines are

1. Portable drilling machine
2. Sensitive drilling machine
3. Bench mounting
 - a) Floor mounting
4. Upright drilling machine
 - (a) Round column Section

(b) Box column section

5. Radial drilling machine

(a) Plain (b) semi universal (c) Universal

6. Gang drilling machine

Multiple spindle drilling machine.

5. Automatic drilling machine.

6. Deep hole drilling machine.

(a) Vertical

(b) Horizontal

SIZE OF A DRILLING MACHINE

The size of a Drilling Machine varies with the types of machine being considered.

A portable drilling machine is specified by the maximum diameter of the drill that it can hold.

The size of a radial drilling machine is specified by the diameter of the column and length of the arm. Other particulars such as maximum drilling radius, min drilling radius, spindle speeds and feeds etc., should also be to specify the machine fully.

An upright drilling machine parts are:

1. Base
2. Column
3. Table
4. Head
5. Spindle and Drill head assembly

6. Spindle drive and feed mechanism

A radial drilling machine parts are:

1. Base
2. Column
3. Radial arm
4. Drill head
5. Spindle speed and feed mechanism

Work Holding Devices

Before performing any operation in a drilling machine it is absolutely necessary to secure the work firmly on the drilling machine table. The work should never be held by hand, because the drill while revolving exerts so much of torque on the work piece that it starts revolving along with the tool and may cause severe injuries to the operator.

The devices commonly used for holding the **work in a drilling machine** are:

- 1) T-bolt and clamps
- 2) Drill press vise
- 3) Step block
- 4) V-block
- 5) Angle plate
- 6) Drill jigs.

Drilling machine operation

The different operations that can be **performed in a drilling machine** are:

- 1) Drilling
- 2) Reaming
- 3) Boring

- 4) Counter boring
- 5) Countersinking
- 6) Spot facing
- 7) Tapping
- 8) Lapping
- 9) Grinding
- 10) Trepanning.

Tap Drill Size

The size of the tap being the outside diameter of its threads, it is evident that the drilled hole must be smaller than the tap by twice the depth of the thread.

So, $D = T - 2d$ where D is the diameter of tap drill size.

T = diameter of tap or bolt to be used and d depth of thread.

In general Tap drill size = outside diameter (of tap or bolt) \times 0.8.

Drill: A drill is a fluted cutting tool used to originate or enlarge a hole in a solid material. Drills are manufactured in a wide variety of types and sizes. such as-

1. Flat or spade drill
2. Straight fluted drill
3. Two -lip twist drill
4. Tape shank core drill
5. Oil tube drill
6. Center drill.

Twist drills: The most common types of drill in use today are the twist drill. A twist drill is an end cutting tool. The present day twist drills are made by machining two spiral flutes or grooves that

run length wise around the body of the drill. Different types of twist drills are classified by Indian Standard Institution according to the type of the shank, length of the flute and overall length of the drill. Such as

- 1) Parallel shank (short Series) twist drill
- 2) Parallel shank (long series) twist drill.
- 3) Taper shank twist drill.

Drill Size: In metric system, drills are commonly manufactured from 0.2 to 100mm.

Number size: The drills sizes rang form no-1 to 80.

Number 80 is smallest having ϕ equal to 0.0135 inch and number 1 is largest having equal to 0.228 inch.

No-1 to 60 are the standard set drills. The no 61 to 80 size drills are not so commonly used.

Taps: A tap is a screw like tool which has threads like a bolt and three or four flutes cut across the threads. It is used cut thread on the inside of a hole as in a nut. The edges of the threads formed by the flutes are the cutting edges. The lower part of the tap is somewhat tapered so that it can well dig in to walls of drilled hole. The upper part of the tap consists of a shank ending in a square for holding the tap in the machine spindle or by a tap wrench. Taps are made from carbon steel or high speed steel and are hardened and tempered.

Taps are classified as—

1. Hand tap and
2. Machine tap

Hand taps are usually made in sets of three

- a) Taper tap

- b) Second tap.
- c) Bottoming tap.

Machine taps have straight or helical flutes. In machine tapping the chips always clear the cutting edges.

SHAPER

Introduction: The shaper is a reciprocating type of machine tool intended primarily to produce flat surface. These surfaces may be horizontal, vertical, or inclined. The metal working shaper was developed in the year 1836.

Types of shapers:

Shapers are classified in a number of ways depending upon the general features of design or the purpose for which they are intended. Shapers are classified under the following headings:

- 1) According to the types of mechanism used for giving reciprocating motion to the ram:
 - a) Crank types
 - b) Geared types
 - c) Hydraulic types
- 2) According to the position and travel of ram:
 - a) Horizontal types
 - b) Vertical types
 - c) Travelling head types
- 3) According to the type of design of the table:
 - a) Standard shaper
 - b) Universal shaper
- 4) According to the type of cutting stroke:

- a) Push type
- b) Draw type.

Crank shaper: This is the most common types of shaper in which a single point cutting tool is given a reciprocating motion equal to the length of the stroke desired while the work is clamped in position on an adjustable table. In construction the crank shaper employs a cranks mechanism to change circular motion of a large gear called "Bull gear" incorporated in the machine to reciprocating motion of the ram. The bullgear receives power either form an individual motor or form an overhead line shaft, it is a belt driven shaper.

Standard or plain shaper: A shaper is termed as standard or plain when the table has only two movements, vertical and horizontal to give the feed.

Universal shaper:In a universal shaper in addition to the two movement provide on the table of a standardshaper, the table can be swiveled about an axis parallel to the ram ways, and the upper portion of the table can be tilted about a second horizontal axis perpendicular to the first axis. As the work mounted on the table can be adjust in different planes, the machine is most suitable for different types of work and is given the name "Universal". A universal shaper is mostly used in tool room work.

Principle parts: Different parts of a standardshaper are –

1. Base
2. Column
3. Cross rail
4. Saddle
5. Table
6. Ram
7. Toolhead.

Parts brief description

The base is the necessary bed or support required for all machine tool. The Columns is a box like casting mounted upon the base and it encloses the ram driving mechanism. The cross rail is mounted on the front vertical guide ways of the column. The table may be raised or lowered to accommodate different sizes of jobs by rotating an elevating screw which causes the crossrail to slide up and down on the vertical face of the column. The saddle is mounted on the crossrail which holds the table firmly on its top. Cross wise movement of the saddle by the rotating the cross feed screw by hand or power cause the table to move sideways.

The table which is bolted to the saddle receives cross wise and vertical movement from the saddle receives cross wise and vertical movements from the saddle and crossrail. It is a box like casting having.

T-slots both on the top and sides for clamping the work. The ram is the reciprocating member of the shaper. This is semicylindrical in form, rigid and is connected to the reciprocating mechanism contained within the column. The tool head of a shaper holds the tool rigidly; provides vertical and angular feed movement of the tool and allows the tool to have an automatic relief during its return stroke.

Shaper size: The size of a shaper is determined by the maximum length of stroke or cut it can make. The usual size ranges from 175 to 900mm such as in a 500 mm shaper the length of stroke may be adjusted from 0 to 500 mm, the cross feed adjustment of the table will be 500 mm and the extreme bottom position of the crossrail will permit the table to accommodate a work piece of 500 mm high. other particulars, such as the types of drive, power input floor space required, weight of the machine, cutting to return stroke ratio etc. are also some time necessary.

Shaper mechanism: In a shaper, rotary movement of the drive is converted into reciprocating movement by the mechanism contained within the column of the machine. (the ram holding the tool gets the reciprocating movement). In a standard shaper metal is removed in the forward cutting stroke, while the return stroke goes idle and no metal is removed during this period. To

reduce the total machining time, it is necessary to reduce the time taken by the return stroke. Thus the shaper mechanism should be so designed that it can allow the ram to move at a comparatively slower speed during the forward cutting stroke, whereas during the return stroke it can allow the ram to move at a faster rate to reduce the idle return time. This mechanism is known as.

Quick return mechanism

The reciprocating movement of the ram and the quick return mechanism of the machine are usually obtained by any one of the following methods:

1. Crank and offset link mechanism
2. With Whitworth quick return mechanism
3. Hydraulic shaper mechanism

Disadvantage: speed is constant throughout the stroke, it is maximum when the rocker arm is vertical and minimum when the rocker arm is at the two extremities.

Planing machines

The planer is a machine tool primarily intended to produce plane and flat surfaces by a single point cutting tool.

A planer is very large and massive compared to a shaper and capable of machining heavy work pieces which cannot be accommodated on a shaper table. In a planer the work (job) reciprocates, cutting tool is stationary and the feed is applied by the lateral movement of the tool. Planing machine was developed by Richard Roberts an English man in the year 1817.

In case a shaper the job is mounted on a stationary table and tool is mounted by cross wise movement of the table.

The size of a standard planer is specified by the size of the largest rectangular solid that can reciprocate under the tool.

Double housing planers ranges from 750mmx750mmx2.5m at the smallest up to 3000mmx3000mmx18.25m at the largest size.

Principal parts of a planer are

(1) Bed, (2) Table, (3) housing or column (4) cross rail (5) Tool head (6) Driving and feed mechanism.

The different mechanism used to drive the table of a planer are (1) Reversible motor drive, (2) Hydraulic drive and (3) open and crossbelt drive.

Milling machine: A milling machine is a machine tool that removes metal as the work is fed against a rotating multipoint cutter. The machine can be also hold one or more number of cutter at a time.

The milling cutter was first developed in the in the year 1782. Universal milling machine invented by Joseph R. Brown a member of Brown and Sharpe company in the year 1861.

Classification: Milling machine may be classified according to the general design are:

(1) Column and knee type (2) Manufacturing of fixed bed type (3) Planer type (4) special type.

PARTS: Principal parts of a column and knee type milling machine is base, column, knee, saddle, Table, Overhanging arm, Front brace, spindle and arbor.

Size of milling machine: The size is designated by the dimensions of the working surface of the table and its maximum length of longitudinal, cross and vertical travel of the table. The following are the typical size of a horizontal knee type milling machine:

Table lengthxwidth=1100x310mm.

Power traverse:longitudinalxcrossx vertical=650x235x420mm.

In addition to the above dimension, number of spindle speeds, number of feeds, spindle nosetaper, power available, neat weight and the floor space required, etc. should also be stated in order to specify the machine fully. Both shaper and planer cutting tool is a single point cutting tool.

The ratio ofcutting time to return time usually variesfrom 2:1 to 4:1 in planer operation.

A milling cutter is multipoint cutter.

Amilling machine can also hold (one) or more number of cutters at time.

The cutting elements of a milling cutter are called teeth.

Grinding wheel is multipoint cutting tool.

GRINDING MACHINE

Grinding: Grinding is a metal cutting operation performed by means of a rotating abrasive wheel that act as a cutting tool.

This is used to finish workpieces which must show a high surface quality, accuracy of shape and dimension.

Kind of Grinding: Grinding may be classified broadly into two groups.

1. Rough or non -precision grinding, and 2. Precision grinding.

ROUGH GRINDING: The common forms of rough grinding are snagging and off- hand grinding where the work is held in the operator's hand. The work is passed hard against the wheel, or vice – versa. The accuracy and surface finish obtained are of secondary importance.

Snagging is done where considerable amount of metal is removed without regard to the accuracy of the finished surface.

PRECISION GRINDING: This is concerned with producing good surface finish and high degree of accuracy. The wheel or work both are guided in precise paths.

Grinding, in accordance with the type of surface to be ground, is classified as:

1. External cylindrical grinding, 2. Internal cylindrical grinding, 3. Surface grinding, 4. Form grinding.

GRINDING MACHINES: Grinding machines, according to the quality of surface finish, may be classified as: 1. Rough Grinders, 2. Precision Grinders.

ROUGH GRINDERS: Rough grinders are those grinding machines whose chief work is the removal of stock without any reference to the accuracy of the result. They are mainly of the following types:

1. Floor stand and bench grinders, 2. Portable and flexible shaft grinders, 3. Swing frame grinders, and 4. Abrasive belt grinders.

PRECISION GRINDERS: Precision grinders are those that finish parts to a very accurate dimensions. According to the type of surface generated or work done, they may be classified as follows: 1. Cylindrical grinders, 2. Internal grinders, 3. Surface grinders, (a) Rotating table and (b) Reciprocating table, 4. Tool and cutter grinders, 5. Special grinding machines.

SIZE AND CAPACITIES OF GRINDERS: Grinding machine size is specified according to the size of the largest workpiece that can be mounted on the machine.

PRINCIPLE GRINDING OPERATIONS: Principle operations which may be done on grinding machines includes the grinding of external and internal cylindrical grinding, tapered and formed surfaces, gear teeth, thread and others using appropriate wheels and fixtures of each job.

THE GRINDING WHEEL: A grinding wheel is a multi-tooth cutter made up of many hard particles known as abrasives which have been crushed to leave sharp edges which do the cutting. The abrasive grains are mixed with a suitable bond, which acts as a matrix or holder when the wheel is use.