GOVT. TOOL ROOM AND TRAINING CENTRE
KARNATAKA

REFERENCE NOTES

PRODCUTION TECHNOLOGY -2

FOR
: DIPLOMA IN TOOL AND DIE MAKING
: DIPLOMA IN PRECISION MANUFACTURING

UNIT 1: SHAPING MACHINE

Workshop Safety Rules

1. Always listen carefully to the teacher and follow instructions.

2. Do not run in the workshop, you could Jump into another pupil and cause an accident.

3. Know where the emergency stop buttons are positioned in the workshop. If you see an accident at the other side of the workshop you can use the emergency stop button to turn off all electrical power to machines.

4. Always wear an apron as it will protect your clothes and hold loose clothing such as ties in place.

5. Wear good strong shoes.

6. When attempting practical work all tools should be put away.

7. Bags should not be brought into a workshop as people can trip over them.

8. When learning how to use a machine, listen very carefully to all the instructions given by the teacher. Ask questions, especially if you do not fully understand.

9. Do not use a machine if you have not been shown how to operate it safely by the teacher.

10. Always be patience, never rush in the workshop.

11. Always use a guard when working on a machine.

12. Keep hands away from moving/rotating machinery.

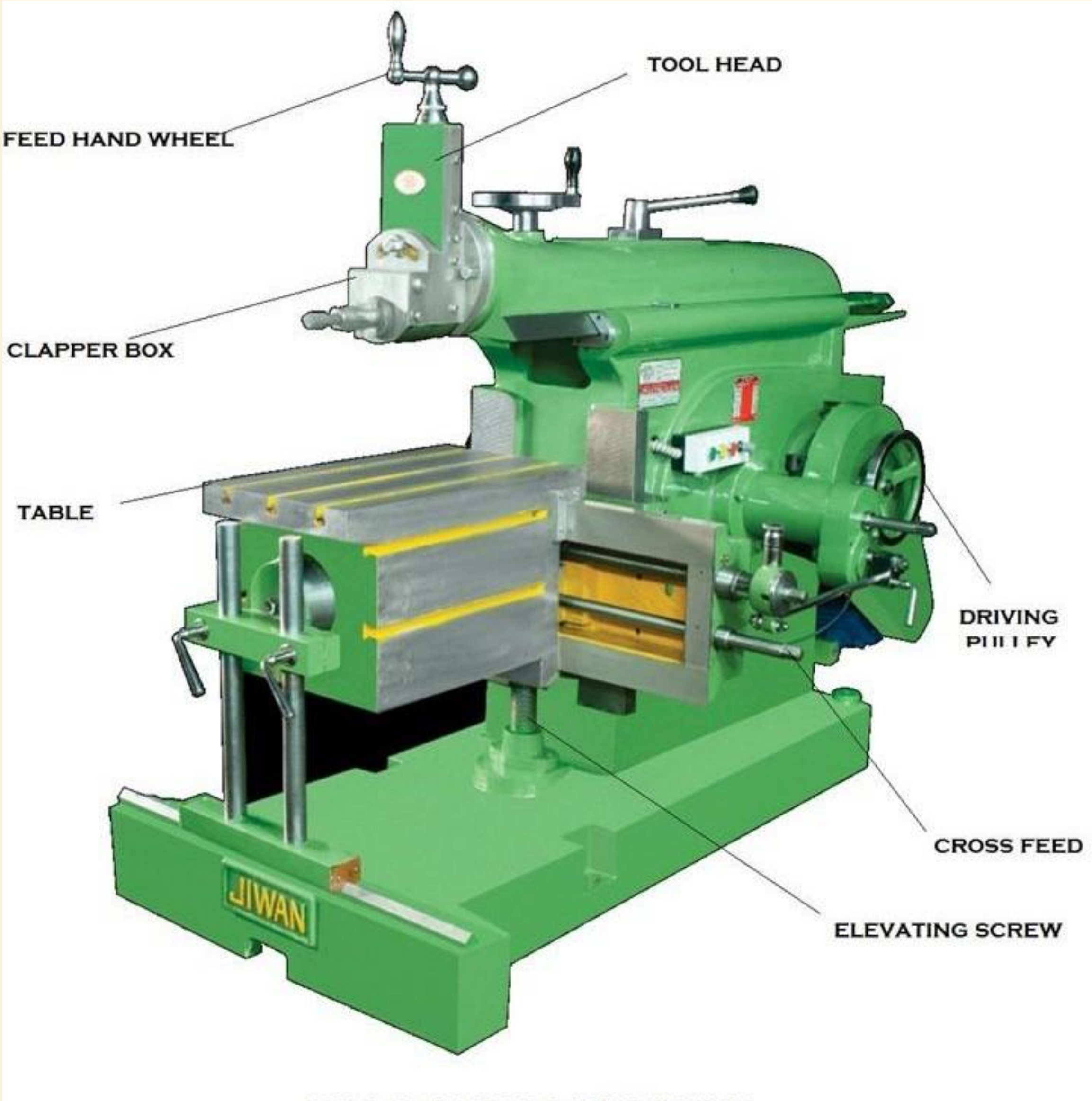
13. Use hand tools carefully, keeping both hands behind the cutting edge.

14. Report any damage to machines/equipment as this could cause an accident.

SHAPING MACHINE

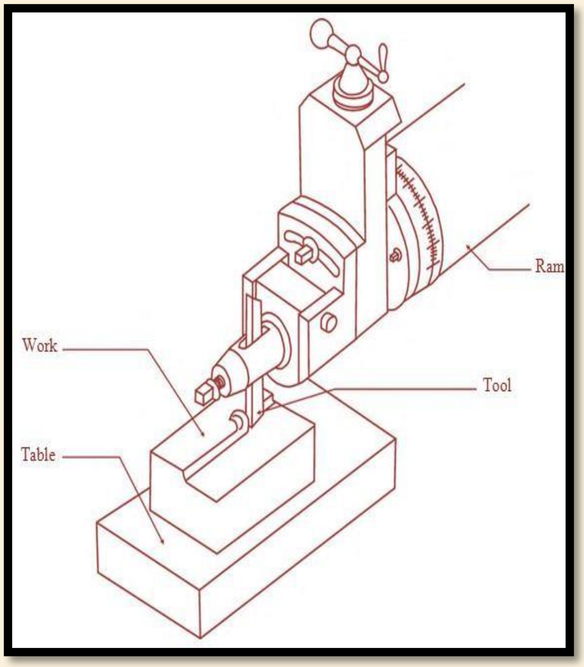
Introduction

Shaping is a process of machining a flat surface which may be horizontal, vertical , inclined, concave or convex using a reciprocating single point tool. A shaping machine is a reciprocating type of machine tool. James Nesmith, an Englishman designed a shaping machine to produce flat surfaces in the year 1836.



PARTS OF SHAPER MACHINE

Method of machining



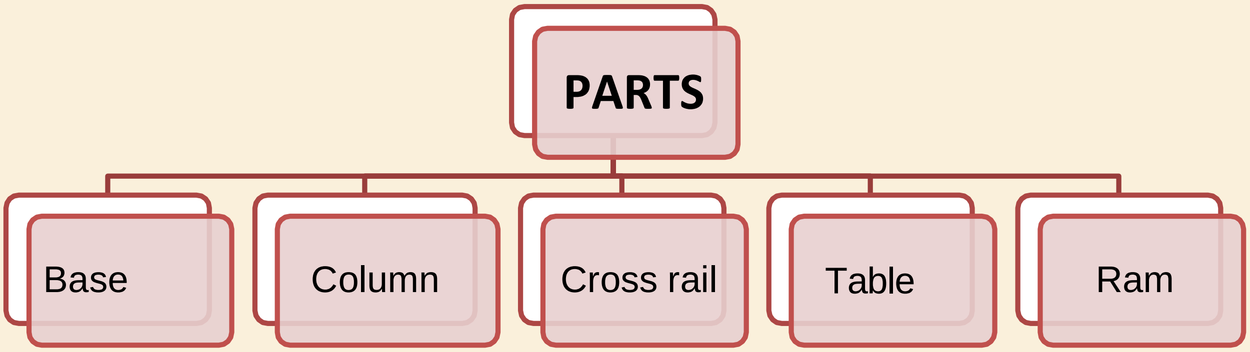
The work is held firmly on the table and the ram is allowed to reciprocate over it. A single point cutting tool is attached to the ram. When the ram moves horizontally in the forward direction, the tool removes metal from the work. On the return stroke, metal is not removed. The ram moves at a slow speed during forward stroke. But during return stroke, the ram moves at a faster speed. Though the distances of ram movement during the forward and return stroke remain the same, the time taken by the return stroke is less as it is faster. It is possible by ‗Quick return mechanism.

In a shaping machine, a flat horizontal surface is machined by moving the work mounted on the table in a cross direction to the tool movement. When vertical surfaces are machined, the feed is given to the tool.

When a inclined surface is machined, the vertical slide of the tool head is swiveled to the required angle and the feed is given to the tool by rotating the down feed hand wheel.

The method of machining in a shaper is illustrated in Fig

Main parts of a shaping machine



Base: The base is hollow and is made of cast iron. It provides the necessary support for all the other parts of the machine. It is rigidly bolted to the floor of the workshop.

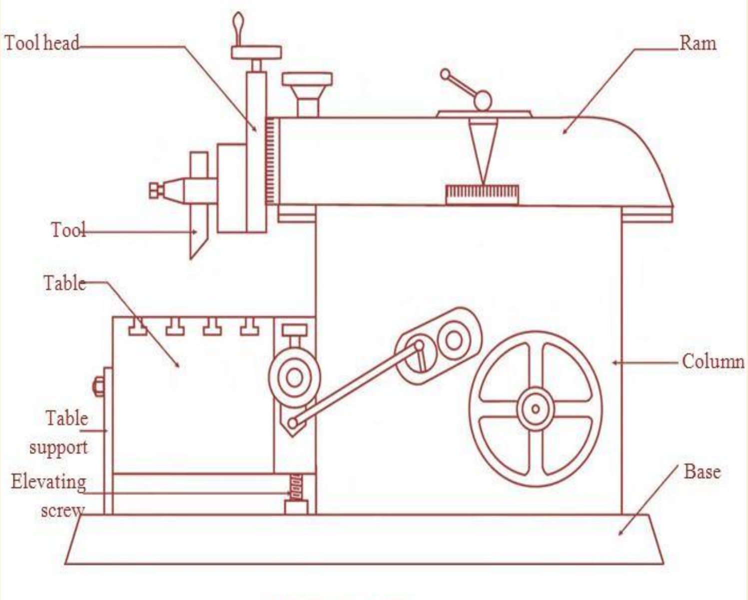
Column: It is a box like casting mounted vertically on top of the base. Two accurate guide ways are machined on the top of the column. The ram reciprocates on these guide ways. The front face of the column is provided with two vertical guide ways. They act as guide ways for the cross rail. Cross rail moves vertically along these guide ways. The column encloses the ram reciprocating mechanism and the mechanism for stroke length adjustment.

Cross rail: It is mounted on the front vertical guide ways of the column. The table may be raised or lowered by adjusting the cross rail vertically. A horizontal cross feed screw is fitted within the cross rail.

Table: It is an important part useful in holding the work firmly on it. It is mounted on the saddle which is located above the cross rail. The top and sides of the table are accurately machined and have T-slots. Work pieces are held on the table with the help of shaper vise, clamps and straps.

Ram: Ram supports the tool head on its front. It reciprocates on the accurately machined guide ways on the top of the column. It is connected to the reciprocating mechanism placed inside the column. The position of ram reciprocation may be adjusted according to the location of the work on the table

Tool head: The tool head is fitted on the face of the ram and holds the tool rigidly. It provides vertical and angular feed movement of the tool. The swivel tool head can be positioned at any required angle and the vertical slide can be moved vertically or at any desired angle to machine vertical or inclined surfaces.



Shaping machine

Advantages of shaper

- The single point cutting tool used in shapers is inexpensive.
- Single point cutting tool can be easily grounded to any desirable shape.

- The simplicity and ease of holding work.
- Easy adjustment and the simple tool give the shaper its great flexibility.
- Shaper set up is very quick and easy and can be readily changed from one job to another.
- Lower cost.
- Thin and fragile jobs can be conveniently machined on shaper because of lower cutting forces.

Disadvantages of shaper

- Due to simple point tooling shaper is not suited for production work.
- Slower machining process compare to other machining process due to single point cutting tool is used.
- Slower machining process compare to other machining process due to lesser cutting speed.
- Shaper is limited in holding close tolerance because of the long unsupported overhang of the arm at the end of each stroke.

Application of shaper

- Machining horizontal surface
- Machining vertical surface
- Machining angular surface
- Machining irregular surface
- Machining splines & Machining a “V” block
- Cutting external & internal gears
- Cutting slots, T-slots & grooves, etc.
- Cutting external & internal keyways

Classification of shaping machine

The shaping machines are classified as follows:

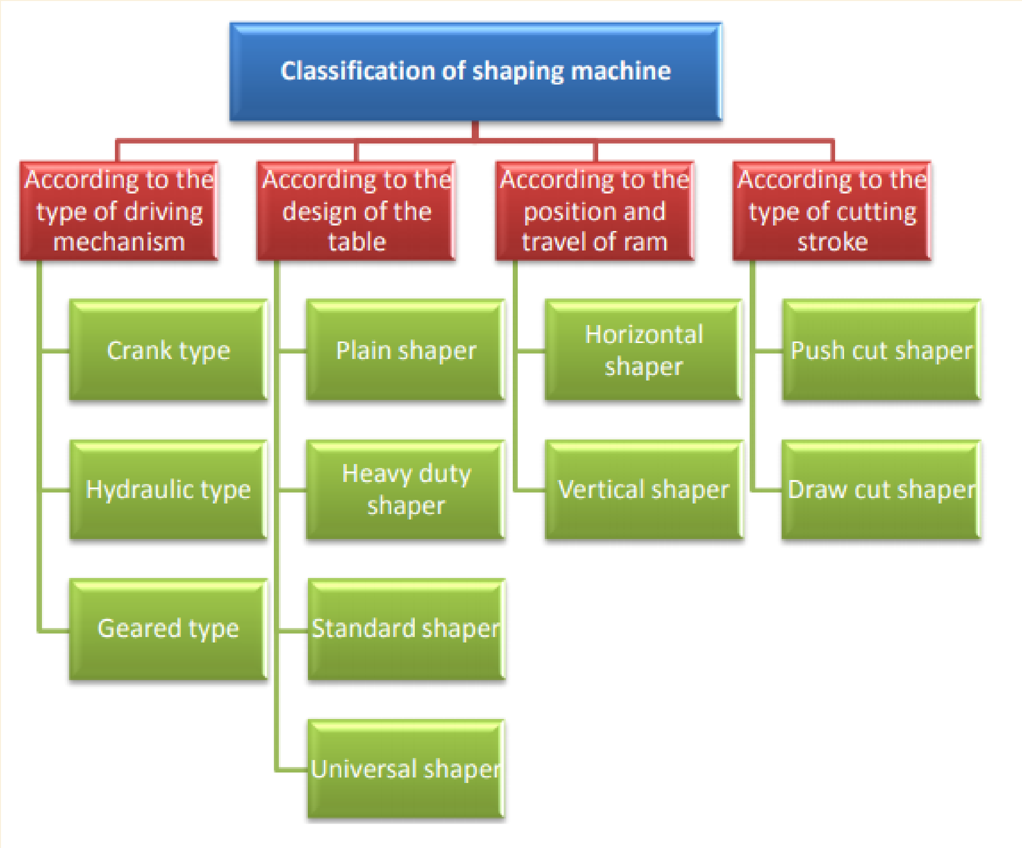
- According to the type of driving mechanism

- Crank type
- Hydraulic type
- Geared type

- According to the design of the table
  - Plain shaper
  - Heavy duty shaper
  - Standard shaper
  - Universal shaper

- According to the position and travel of ram
  - Horizontal shaper
  - Vertical shaper

- According to the type of cutting stroke
  - Push cut shaper
  - Draw cut shaper



Crank type shaper

Crank and slotted link mechanism of a crank type shaper converts the rotation of an electric motor into reciprocating movement of the ram. Though the lengths of both the forward and return strokes are equal, the ram travels at a faster speed during return stroke. This quick return is incorporated in almost all types of shaper.

Hydraulic shaper

The ram of a hydraulic shaper is connected to a piston. Oil at high pressure is pumped to the cylinder of the hydraulic system. As the oil pushes the the piston, the ram reciprocates. Hydraulic shapers are high power machines and are used for heavy duty work.

Universal shaper

The universal shaper has a special type of table which can be swiveled and positioned at any angle about a horizontal axis. Apart from the cross and vertical travel, the table of a universal shaper can be swiveled to any angle to machine inclined surfaces. In the process, the position of the work in the table need not be changed. These machines are utilized in precision workshops.

Quick return mechanism

The ram moves at a comparatively slower speed during the forward cutting stroke. During the return stroke, the mechanism is so designed to make the tool move at a faster rate to reduce the idle return time. This mechanism is known as quick return mechanism.

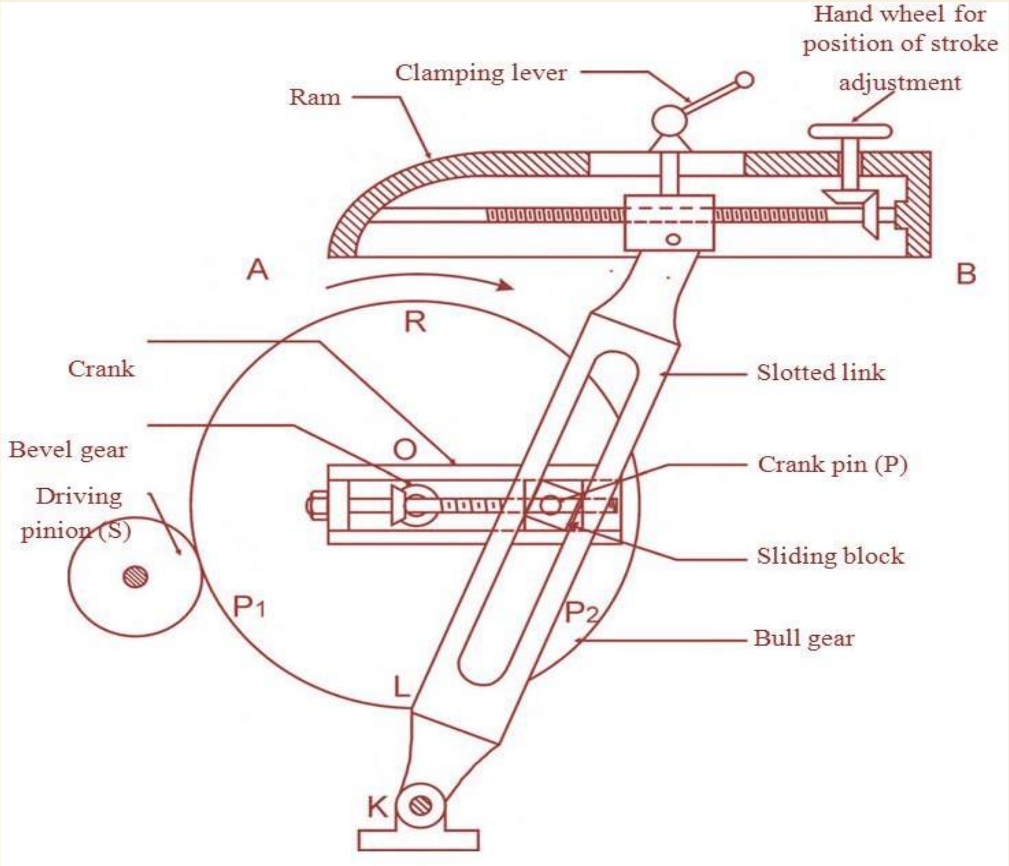
As the ram moves at a faster rate during return stroke, the time taken becomes less. The total machining time decreases and the rate of production increases. The following mechanisms are used for quick return of the ram.

- Crank and slotted link mechanism
- Hydraulic mechanism
- Whitworth mechanism

Crank and slotted link mechanism

An electrical motor runs the driving pinion(S) at a uniform speed. This pinion makes the bull gear(M) to rotate at a uniform speed. Bull gear is a large gear fitted inside the column. The point ‗O‘ is the centre of the bull gear. A slotted link having a long slot along its length is pivoted about the point ‗K‘. A sliding block ‗N‘ is fitted inside the slot and slides along the length of the slotted link. ‗P‘ is the crank pin and ‗OP‘ can be considered as a crank. Fig. shows the crank & slotted link mechanism.

When the bull gear rotates, the sliding block also rotates in the crank pin circle. This arrangement provides a rocking movement to the rocker arm. As the top of the slotted link is connected to the ram, the ram reciprocates horizontally. So, bull gear rotation is converted into the reciprocating movement of the ram.



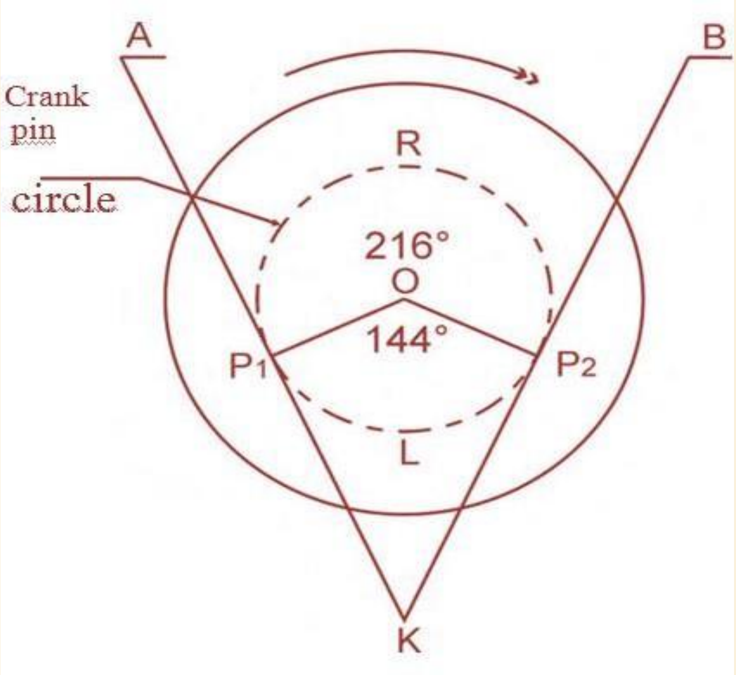
Quick return mechanism

As shown in the diagram, ‗KA’ indicates the starting point of the forward cutting stroke and ‗KB‘ the end of the cutting stroke. The rotation of the crank ‗OP‘ in clockwise direction through the angle P_1RP_2 refers to the forward cutting stroke. The rotation of the crank in the same direction through the angle P_2LP_1 refers to the return stroke. As the angle P_2LP_1 is smaller than the angle P_1RP_2, the time taken for the return stroke is less than that of forward stroke. So, it is evident that the speed at which the ram travels during return stroke is more.

$$\frac{\text{Time taken for forward cutting stroke}}{\text{Time taken for the idle return stroke}} = \frac{\text{angle } P_1RP_2}{\text{angle } P_2LP_1} = \frac{216^\circ}{144^\circ} = \frac{3}{2}$$

In some machines this ratio can be set as 7/5.

The stroke length of a ram is the distance the ram moves forward or backward. It depends upon the distance between the center of the bull gear and the center of the sliding block. it is adjusted according to the length of the work



The size of a shaper

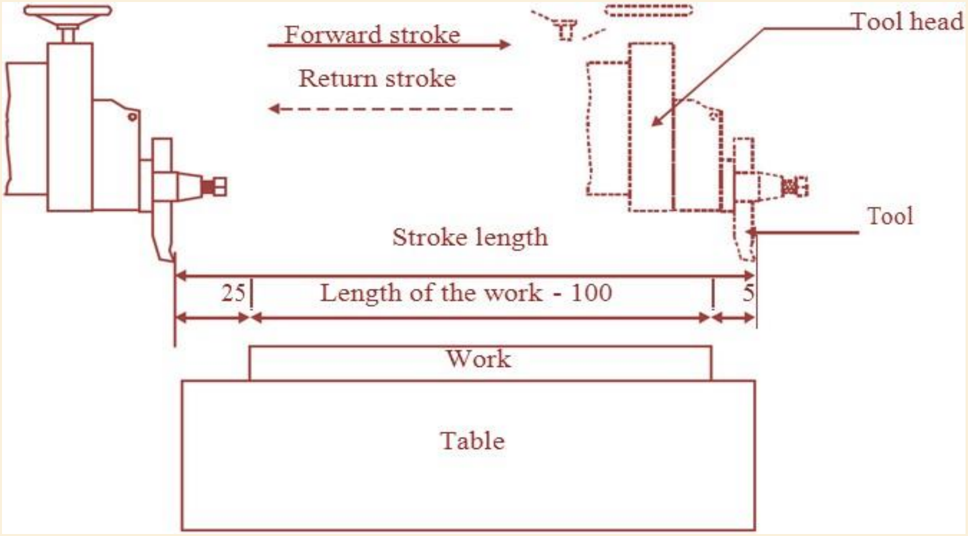
The size of a shaper is determined by the maximum length of stroke it can make. Shapers with maximum stroke length of 175mm to 900mm are available. Machines with maximum stroke length of 300mm, 450mm and 600mm are used widely.

To specify the machine further, the following points are to be provided.

- The type of drive
  - a) Individual motor b) Belt driven
- The method of obtaining different speeds
  - a) Gear box b) Step cone pulley
- Horse power of the motor
- Cutting to return stroke ratio
- Number and range of speed arrangement
- The type of the table

Stroke length calculation and adjustment

The length of the stroke is calculated to be nearly 30mm longer than the work. The position of stroke is so adjusted that the tool starts to move from a distance of 25mm before the beginning of the cut and continues to move 5mm after the end of the cut. For example, as shown in Fig. 3.5, the length of the work is 100mm. The stroke length of the ram is calculated to be 130mm. (25+100+5). Fig. illustrates the calculation of stroke length.



Adjusting the stroke length

The crank pin fastened to the sliding block can be adjusted by a lever placed outside the column. Through the bevel gears placed at the centre of the bull gear, the radial slide lead screw can be rotated. This rotation of lead screw changes the position of the sliding block to move towards or away from the bull gear centre. The stroke length of the ram is adjusted by placing the sliding block at a required position from the centre of the bull gear.

Note: The stroke length of the ram and its position should not be adjusted when the machine is in operation. The machine should be stopped before these adjustments are made.

Method of table movement

- The table moves in a cross direction when the cross feed screw is rotated.
- A crank handle is provided to rotate the cross feed screw manually.
- When the cross feed screw is rotated in clockwise direction, the table will move towards left.
- When the elevating screw is rotated, the table slides up and down on the face of the column.
- As the handles meant for cross feed screw rotation and elevating screw rotation are placed side by side, it is not possible to operate both of them at the same time.
- The work mounted on the table is provided with required feed only during the end of the return stroke

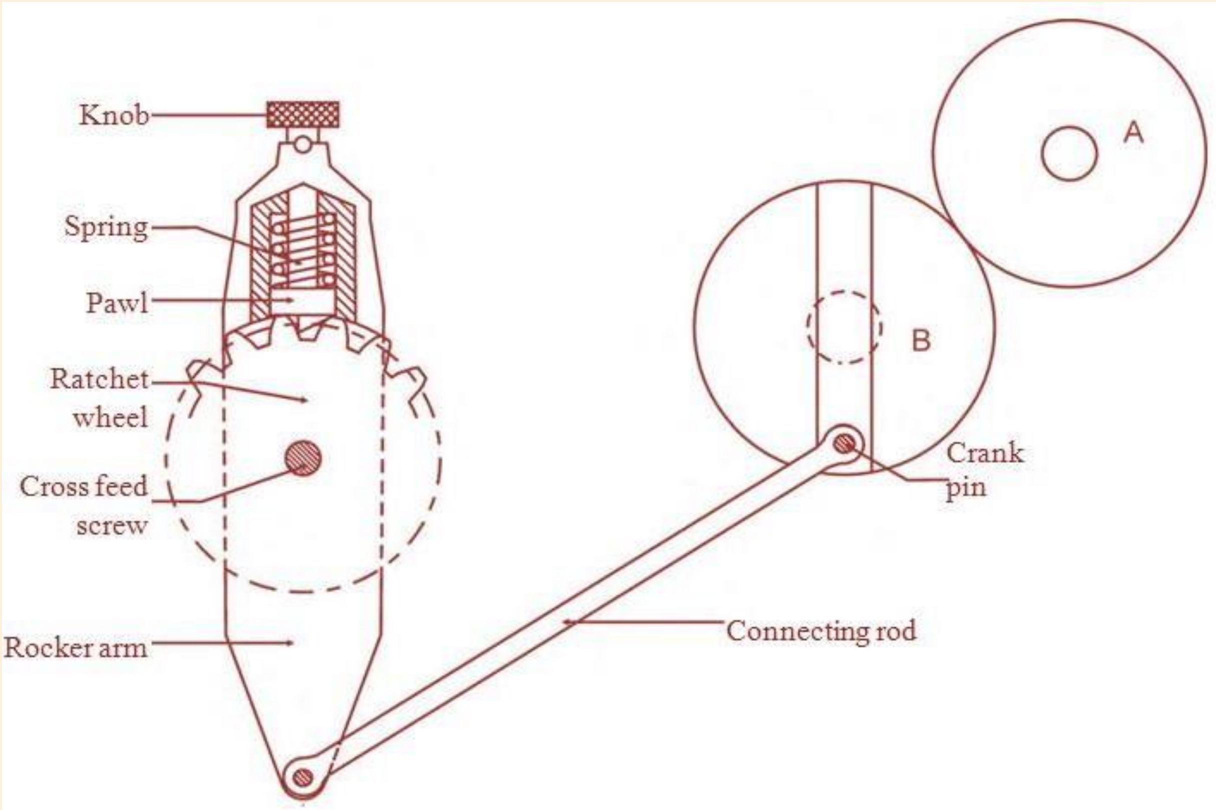
Ratchet and Pawl mechanism (Automatic feed mechanism for the table)

The table of a shaping machine travels in a cross direction when the cross feed screw is rotated. The cross feed screw is attached to the ratchet wheel. A spring loaded ‗pawl' is positioned to be placed between the teeth of the ratchet wheel. The pawl is housed within a frame known as rocker arm. The bull gear placed inside the column of the shaping machine drives the gear B through the gear A.

There is a diametric slot provided on the face of the gear B. A crank pin is attached to a slider placed in the slot. The bottom of the rocker arm and the crank pin are connected by a connecting rod. The rotation of the gear B makes the crank pin to rotate. This movement makes the rocker arm to rock about the center of the ratchet wheel. The pawl makes the ratchet to rotate by a small amount in one direction only. As the cross feed screw is attached to the ratchet wheel, the rotation of the ratchet wheel will make the table to move in a cross direction.

If the direction of the table feed is to be reversed, the pawl is turned about 180° from its position. The ratchet wheel and the cross feed screw will rotate in the opposite direction resulting in the table movement in the opposite direction.

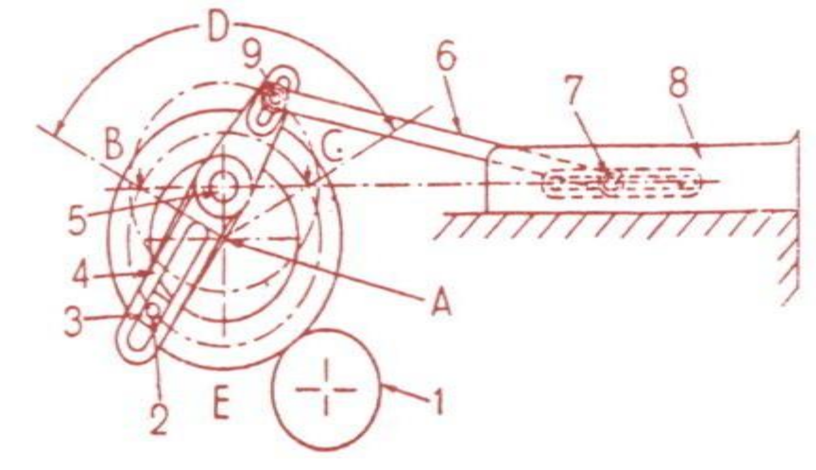
When power feed is not necessary for the table, the pawl is disengaged from the ratchet wheel



Whitworth quick return mechanism:

The Whitworth quick return mechanism is shown in fig and a simple line diagram of the mechanism is shown ion fig. The bull gear is mounted on a large fixed pin A upon which it is free to rotate. The crank plate ‗4‘is pivoted eccentrically upon the fixed pin at 5. Fitted on the face of the bull gear is the crank pin 2 on the top of which are mounted the sliding block 3. Sliding block 3 fits into the slot provided on the crank plate

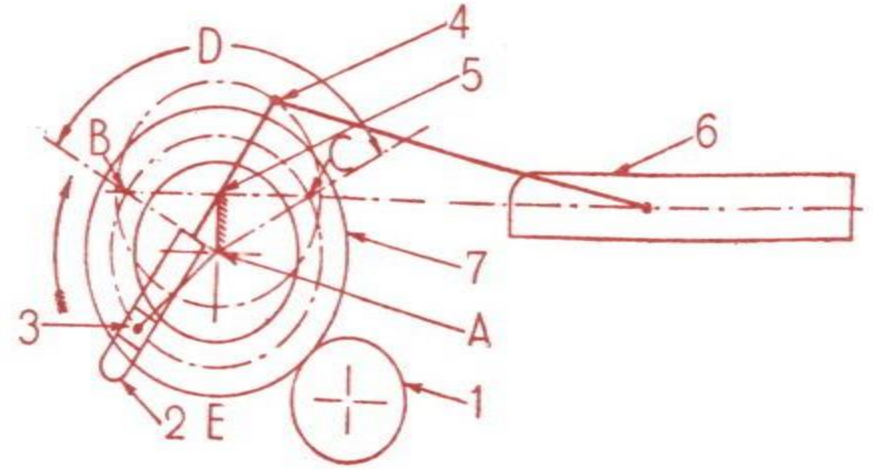
4. At the other end of the crank plate 4, a connecting rod 6 connects the crank plate by a pin 9 and the ram 8 by a pin 7. When bull gear will rotate at constant speed the crank pin 2 with the sliding block 3 will rotate on a crank circle of radius A2 and the sliding block 3 will cause the crank plate to rotate about the point 5 with a variable angular velocity. Pin 9 fitted on the other end of the crank plate 4 will rotate in a circle and the rotary motion of the pin 9 will be converted in to reciprocating movement of the ram similar to the crank and connecting rod mechanism. The axis of reciprocating of the ram passes through the pin 5 and is normal to the pin A5.



Whitworth quick return mechanism

1. Driving pinion, 2. Crank pin, 3. Sliding block, 4. Crank plate, 5. Pivot for crank plate, 6. Connecting rod, 7. Connecting pin for ram, 8. Ram, 9. Pin, A. Fixed pin.

When the pin 2 is at the position C the ram will be at the extreme backward position but when the pin is at the position B, the extreme forward position of the arm will have been reached. When the pin 2 travels from C to B the crank pin 9 passes through the backward position to the forward position to the cutting stroke, and the return stroke is completed when the pin 2 travels from B to C or the pin 9 passes from the forward position



Line diagram of quick return mechanism

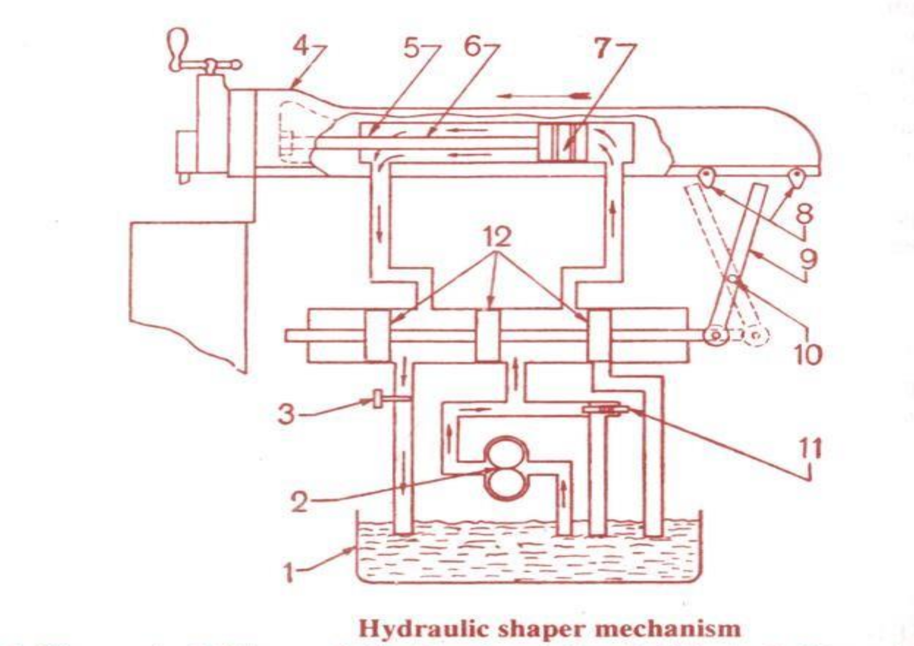
1. Driving pinion, 2. Crank plate, 3. Sliding block, 4. Crank pin for connecting rod, 5. Pivot for crank plate, 6. Ram, 7. Bull gear, A. Fixed pin.

to the backward position. As the angular velocity of the crank pin in uniform, the time taken from the crank pin 2 to travel through an arc covering CEB is greater than the time taken to move through an arc covering BDC. Thus a quick return motion is obtained by the mechanism.

The length of stroke of the ram may be changed by shifting the position of pin 9 closer or away from the pivot 5. The position of stroke may be altered by shifting the position of pin 7 on the ram.

Hydraulic shaper mechanism:

In a hydraulic shaper the ram is moved forward and backward by a piston moving in a cylinder placed under the ram. The machine mainly consists of a constant discharge oil pump 2, a valve chamber, a cylinder, and a piston 7. The piston rod 6 is bolted to the ram body. As shown in fig. The oil under high pressure is pumped from the reservoir 1 and is made to pass through the valve chamber to the right side of the oil cylinder 5 exerting pressure on the piston. This causes the ram 4 connected to the piston 7 to perform forward stroke, and any oil present on the left side of the cylinder is discharged to the reservoir through the throttle valve 3. At the end of extreme forward stroke, the shaper dog 8 hits against the reversing lever 9 causing the valve 12 to alter their position within the valve chamber. Oil under high pressure is now pumped to the left side of the piston causing the ram to perform return stroke. Oil present on the right side of the piston is now discharged to the reservoir. At the end of the return stroke another shaper dog hits against the reversing lever alerting the direction of stroke of the piston and the cycle is thus repeated.



Hydraulic shaper mechanism
1. Oil reservoir, 2. Oil pump, 3. Throttle valve, 4. Ram, 5. Cylinder, 6. Piston rod, 7. Piston, 8. Reversing dog, 9. Reversing lever, 10. Reversing lever pivot, 11. Relief valve, 12. Valves.

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The quick return motion is affected due to the difference in stroke volume of the cylinder at both ends, the left hand end being smaller due to the presence of the piston rod. As the pump is a constant discharge one, within a fixed period, the same amount of oil will be pumped into the right or to the left hand side of the cylinder. This will mean that the same amount of oil will be packed within a smaller stroke volume causing the oil pressure to rise automatically and increasing the speed during the return stroke. The length and position of stroke is adjusted by shifting the position of reversing dogs.

The cutting speed may be changed by controlling the throttle valve 3 which regulates the flow of oil. When the throttle valve is partially closed the excess oil flows out through the relief valve 11 to the reservoir maintaining uniform pressure during cutting stroke. A hydraulic shaper is now widely used for having many advantages. Some of them are listed below.

1. The cutting and return speeds are practically constant throughout the stroke. This permits the cutting tool to work uniformly during cutting stroke.
2. The reversal of the ram is obtained quickly without any shock as the oil on the other of the cylinder provides cushioning effect.
3. Infinite number of cutting speed may be obtained from zero to the maximum value and the control is easier.
4. With a high rate of return speed, a greater number of cutting strokes may be available within the range of cutting speed.

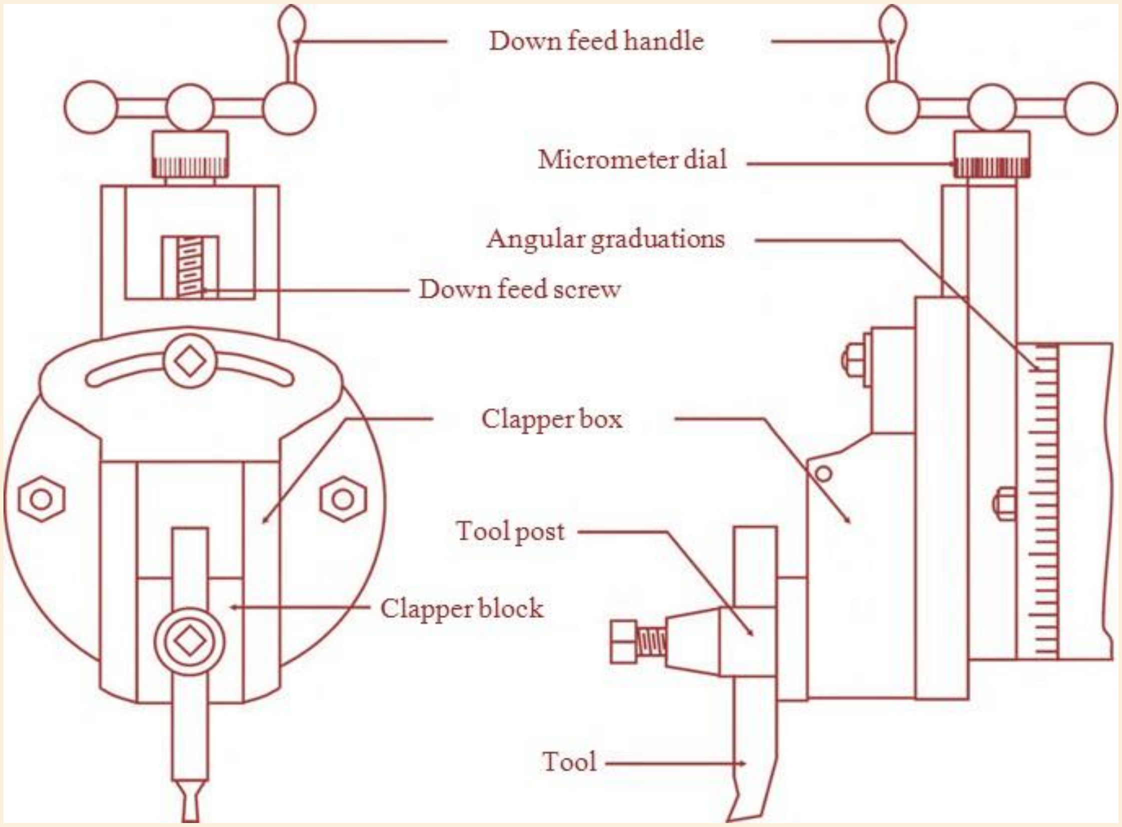
The relief valve ensures safety to the tool and the machine when the machine is overloaded.

Swivel tool head

The tool head of a shaper holds the cutting tool rigidly. It is fitted on the face of the ram. The vertical slide of the tool head can be moved vertically or at a particular angle to provide vertical and angular feed movement to the tool. It allows the tool to have an automatic relief during the return stroke of the ram.

The tool head has a swivel base attached to the circular seat on the ram. The swivel base has angular graduations marked on it. As the vertical slide is mounted on the swivel base of the tool head, it may be set and moved at any desired angle to machine angular surfaces like V grooves and dove tail grooves.

The down feed screw handle is rotated to move the vertical slide up and down. A graduated dial is placed on the top of down feed screw to control the amount of depth of cut or feed accurately.

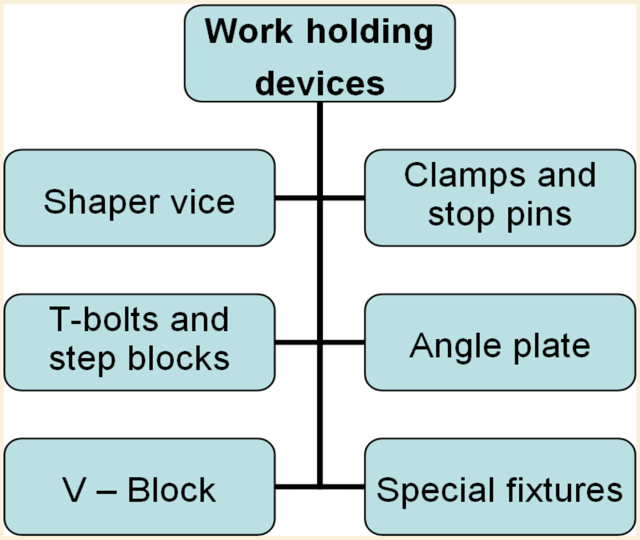


Apron consisting of clapper box, clapper block and tool post is clamped on the vertical slide by a screw. By releasing the clamping screw, the apron can be swiveled either towards left or towards right with respect to the vertical slide. The clapper box has two vertical walls within which the clapper block is housed. It is connected to the clapper box with the help of a hinge pin. This arrangement provides relief to the tool while machining vertical or angular surfaces. The tool post is mounted upon the clapper block. The tool post is provided with a slot to accommodate the tool and a screw to hold the tool rigidly on the tool post.

The clapper block fits securely inside the clapper box to provide a rigid tool support during forward stroke. On the return stroke, a slight frictional drag of the tool on the work lifts the block out of the clapper box and prevents the tool cutting edge from dragging on the work surface. Fig. illustrates the swivel tool head of a shaper.

Work holding devices

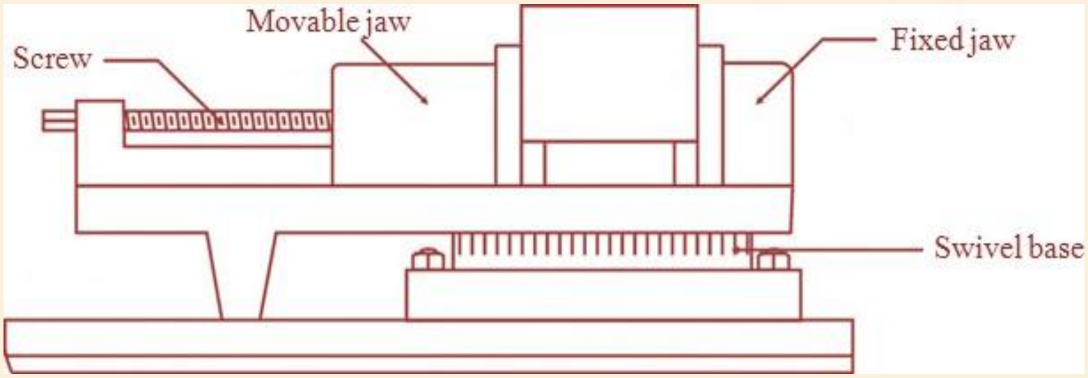
Work pieces can be held and supported on the shaper table directly or by having some special devices. Depending on the size and shape of the work, it may be supported on the table by any one of the following methods.



Vice

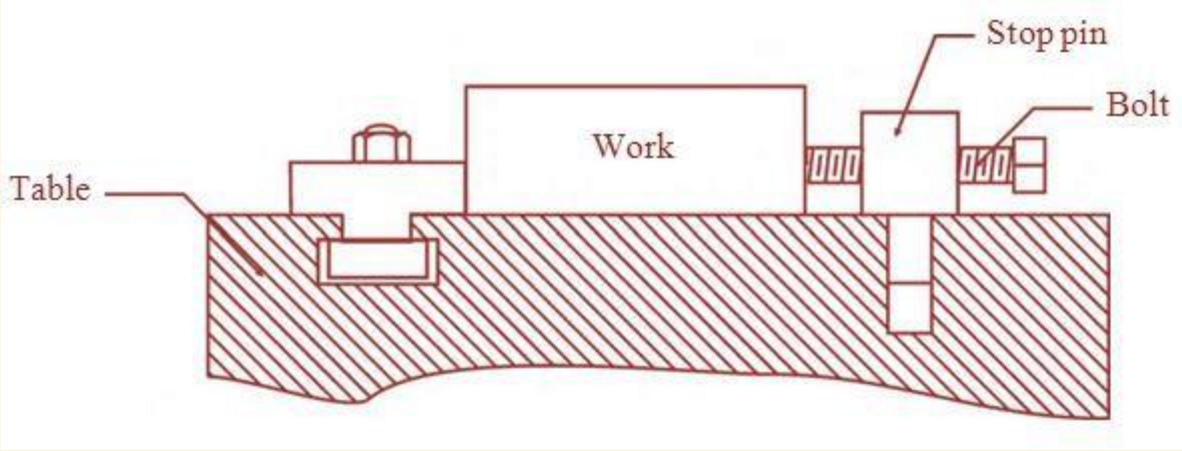
Vice is the most common and simple work holding device used in a shaper. Different types of vices are used in a shaping machine according to the need and they are:

1. Plain vice
2. Swivel vice
3. Universal vice

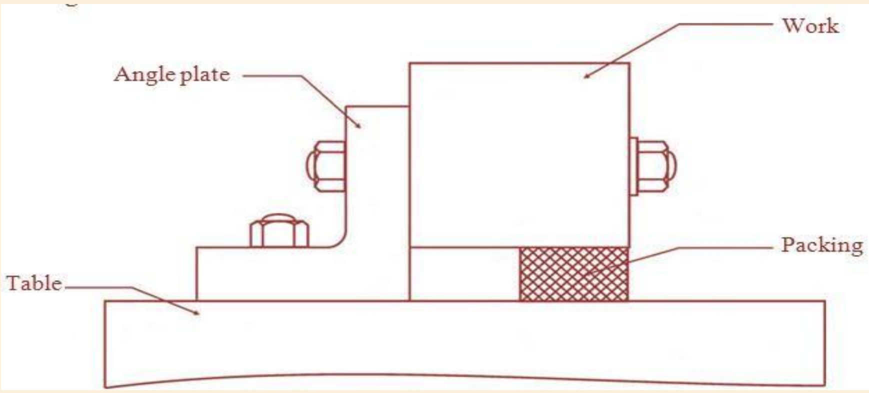


lamps and stop pins

T – Bolts are fitted into the T - slots of the table. The work is placed on the table The work is supported by a rectangular strip at one end and by a stop pin at the other side. The screw is tightened to secure the work properly on the machine table. The use of stop pin is shown in Fig.

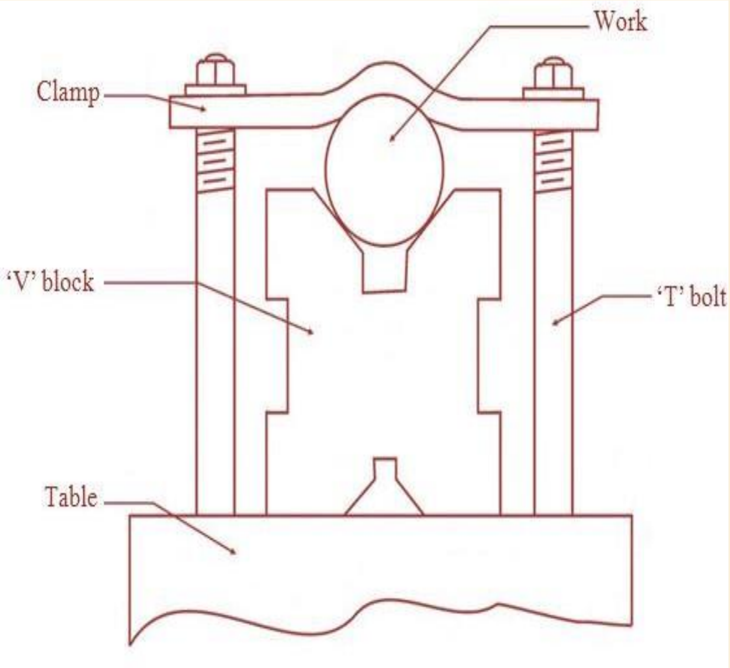


Angle plate: Angle plate resembles the English alphabet _L‘. It is accurately machined to have two sides at right angles. Slots are provided on both the sides. One of the sides is bolted to the machine table and the work pieces are held on the other side. The use of an angle plate is shown in Fig.



V – block: V – block is a metal block having a V shaped groove on it. It is used for holding cylindrical work pieces. Operations like keyway cutting, slot cutting and machining flat surfaces can be performed on the cylindrical work pieces held on a V block. The use of a V block is illustrated in Fig.

Special fixtures: When internal keyways are to be machined on the holes, the work is held with a special fixture. The fixture has a V-block attached to it and the cylindrical work is mounted on it.



cutting Tools material - shaping

The material of the cutting tool used in a shaping machine should have more hardness and temper when compared to the material of the work piece. So, the shaper tools are made of the following materials

- High Carbon Steel
- High Speed Steel
- Carbide tipped tool

Basic properties that cutting must possess are:

- Tool material must be at least 30 to 50% harder than the work piece material.
- Tool material must have high hot hardness temperature.
- High toughness
- High wear resistance
- High thermal conductivity
- Lower coefficient of friction
- Easiness in fabrication and cheap

1. High Carbon Steel tools

- Its composition is C = 0.8 to 1.3%, Si = 0.1 to 0.4% and Mn = 0.1 to 0.4%.
- It is used for machining soft metals like free cutting steels and brass and used as chisels etc.
- These tool loose hardness above 250°C.
- Hardness of tool is about Rc = 65.
- Used at cutting speed of 5m/min.

2. High speed steel (H.S.S) General use of HSS is 18-4-1.

18 - Tungsten is used to increase hot hardness and stability.

4 - Chromium is used to increase strength.

1 - Vanadium is used to maintain keenness of cutting edge.

In addition to these 2.5% to 10% cobalt is used to increase red hot hardness.

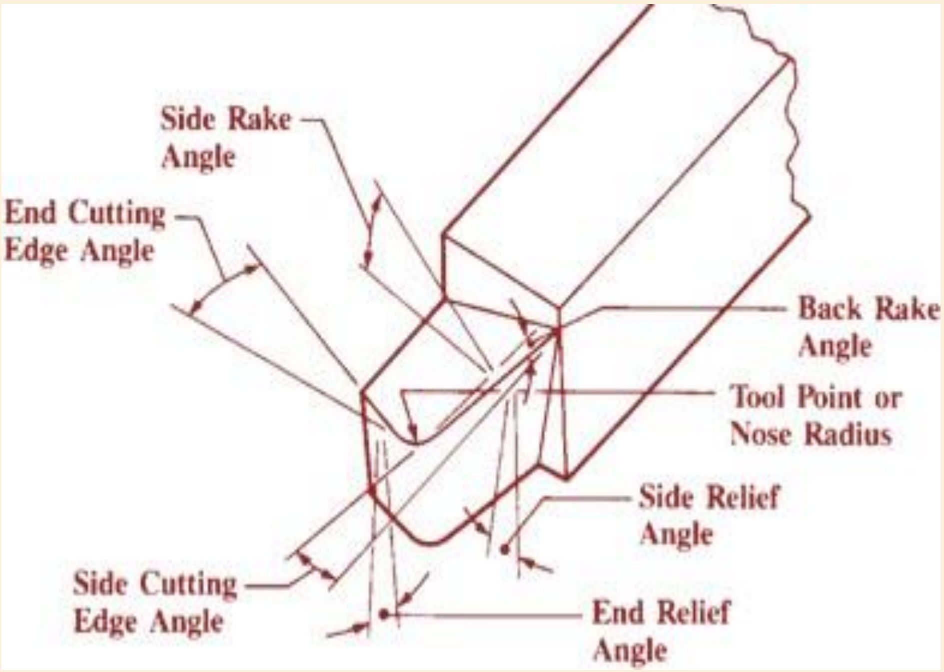
3. Cemented carbides

- Produced by powder metallurgy technique with sintering at 1000°C.
- Speed can be used 6 to 8 times that of H.S.S.
- Can withstand up to 1000°C.
- High compressive strength is more than tensile strength.
- They are very stiff and their young's modulus is about 3 times that of the steel.
- High wear resistance.
- High modulus of elasticity.
- Low coefficient of thermal expansion.
- High thermal conductivity, low specific heat, low thermal expansion.

Different elements used in cutting tool materials and their properties are

Element	Properties
Tungsten	Increases hot hardness Hard carbides formed Abrasion resistance
Molybdenum	Increases hot hardness Hard carbides formed Improving resistance
Chromium	Depth harden ability during heat treat hard carbides are formed improving abrasion resistance some corrosion resistance
Vanadium	combines with carbon for wear resistance retards grain growth for better toughness
Cobalt	Increases hot hardness, toughness
Carbon	Hardening element forms carbides

TOOL GEOMETRY AND NOMECLATURE



CLEARANCE: The intentional relief provided on the faces of the cutting tool to give a sharp cutting edge and thereby preventing the other portions of the tool from rubbing the job is called as clearance. The tool may get heated up because of the friction caused by the rubbing action if a proper clearance for the cutting edge is not provided. The side adjacent to the cutting edge is ground and relieved. This is called as the Side clearance angle. Too much side clearance will weaken the cutting edge and cause the cutting edge to chip off. Similarly, the front portion is also ground at an angle and this is called the Front clearance angle. Too much front clearance will weaken the cutting edge. The common angles provided on a Right Hand Roughing tool.

Back Rake is to help control the direction of the chip, which naturally curves into the work due to the difference in length from the outer and inner parts of the cut. It also helps counteract the pressure against the tool from the work by pulling the tool into the work.

Side Rake along with back rake controls the chip flow and partly counteracts the resistance of the work to the movement of the cutter and can be optimized to suit the particular material being cut. Brass for example requires a back and side rake of 0 degrees while aluminum uses a back rake of 35 degrees and a side rake of 15 degrees.

Nose Radius makes the finish of the cut smoother as it can overlap the previous cut and eliminate the peaks and valleys that a pointed tool produces. Having a radius also strengthens the tip, a sharp point being quite fragile.

All the other angles are for clearance in order that no part of the tool besides the actual cutting edge can touch the work. The front clearance angle is usually 8 degrees while the side clearance angle is 10-15 degrees and partly depends on the rate of feed expected.

Minimum angles which do the job required are advisable because the tool gets weaker as the edge gets keener due to the lessening support behind the edge and the reduced ability to absorb heat generated by cutting.

The Rake angles on the top of the tool need not be precise in order to cut but to cut efficiently there will be an optimum angle for back and side rake.

Types of shaper tools

According to the type of work and the type of operation, various tools are used in a shaper. They are

Right hand (R. H) tool

This is a tool used for machining by moving the job from right to the left.

Left hand (L. H) tool

This is a tool used for machining by moving the job from left to right.

Roughing tool: When it is required to remove a good amount of material from the work piece, roughing tools are used. The cutting edge will be very thick, sharp and strong to withstand the cutting pressure and to dissipate the heat generated at the cutting point. The surface obtained will be very rough.

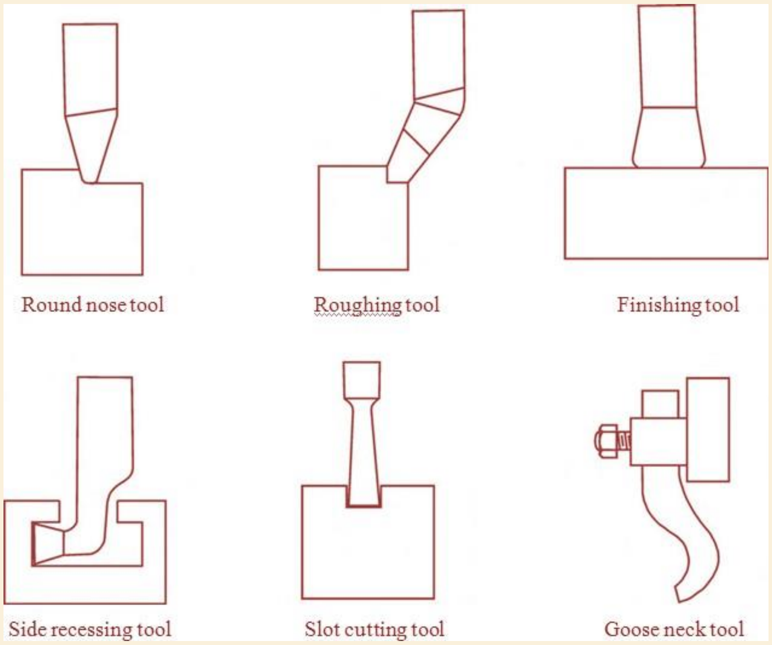
Finishing tool: After the rough machining is performed, the finishing tool is used to obtain a very high quality of surface finish. The cutting edge will be either flat or slightly convex. Different types of shaper tools are shown in Fig.

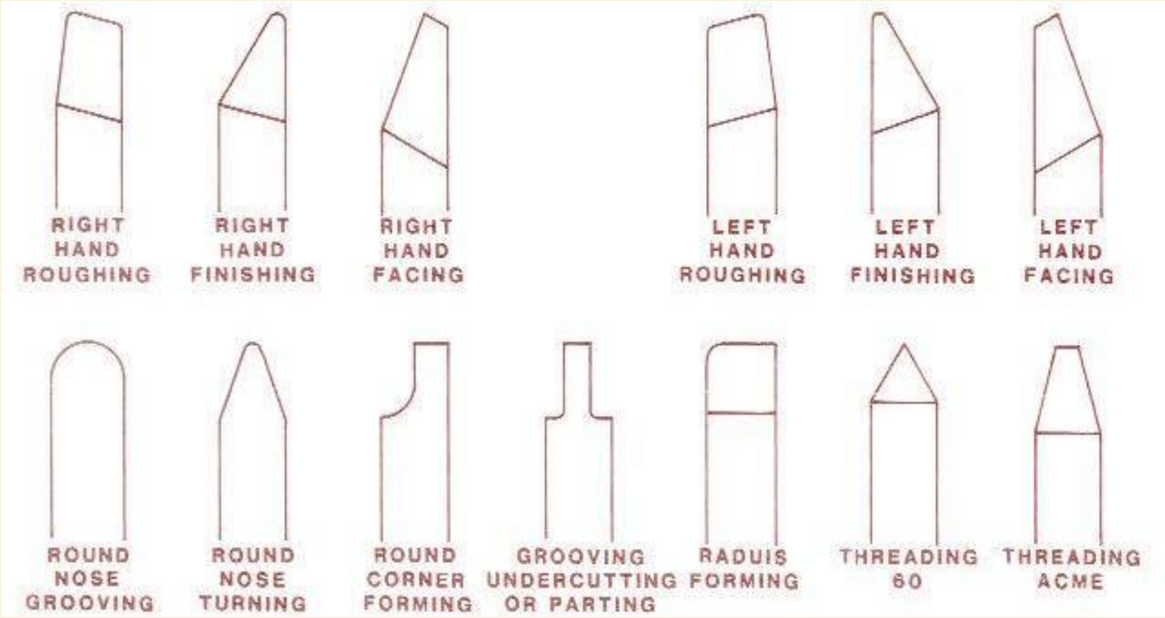
Goose neck tool: This is a special type of tool used for finish machining. Very good surface finish will be obtained. The cutting edge of goose neck tool has a springy action. The tip of the cutting edge lies in the same line with the rear side of the shank.\

Slot cutting tool: Wide rectangular or square grooves are known as slots. Rough machining of the slot is carried out using round nose tool. After that, a slot cutting tool is used for finish machining work.

T-slot cutting tool: The central rectangular (or square) slot is first machined using rough machining tool and then by using parting tool (or slot cutting tool). After that, a T-slot cutting tool is used to machine underneath the rectangular groove.

Form tool: Form tools are made to suit some specific requirements for machining V shaped grooves or similar special shaped grooves in concave or convex form.





Different types of tool used in shaping

Setting of shaper table, vise and tool head

The machining accuracy will not be perfect if the machine table and tool head are not set properly. When the sides are perpendicular, it is referred as squares. Parallelism means the two sides are absolutely parallel to each other. Alignment is an arrangement in which the relative positions of the table, the jaws of the vise, the tool head and the ram are perfect. The above setting of the table, work and the tool are done with the help of test bars and feeler gauges.

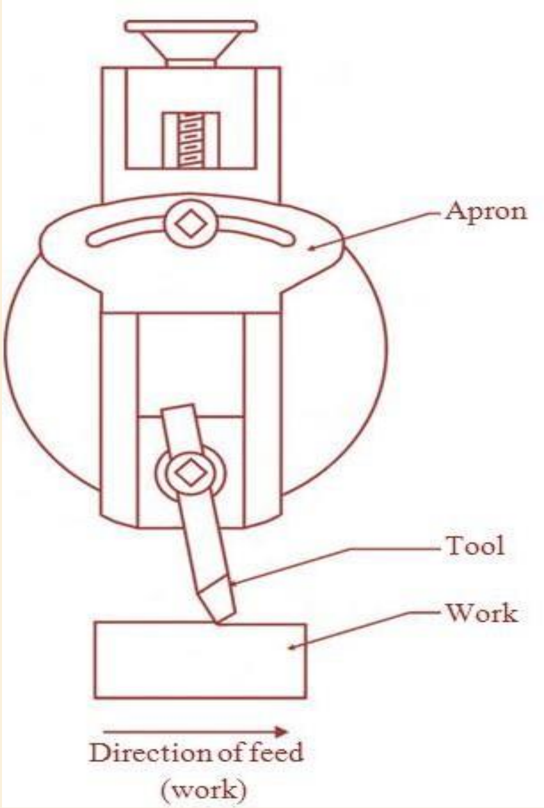
Operations performed in a shaping machine

Different types of operations are performed in a shaping machine. They are broadly classified as

1. Regular operations 2. Special operations

Regular operations

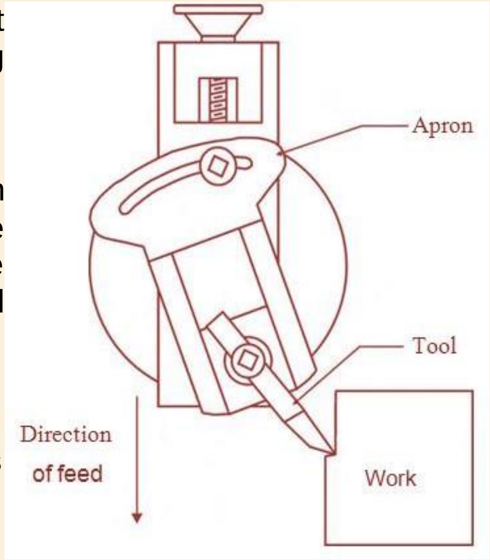
Machining horizontal surfaces: A shaper is mostly used to machine a flat, true surface on a work piece. Horizontal surfaces are machined by moving the work mounted on the machine table at a cross direction with respect to the ram movement. The clapper box can be set vertical or slightly inclined towards the uncut surface. This arrangement enables the tool to lift automatically during the return stroke. The tool will not drag on the machined surface.



Machining vertical surfaces: A vertical cut is made while machining the end of a work piece, squaring up a block or machining a shoulder. The feed is given to the tool by rotating the down feed screw of the vertical slide. The table is not moved vertically for this purpose. The apron is swiveled away from the vertical surface being machined as shown in the diagram.

Machining angular surfaces: If the surface to be machined is neither horizontal nor perpendicular, the surface is called inclined surface. Machining V grooves and dovetail grooves are some examples for angular machining. Machining the inclined (angular) surfaces can be done in several ways.

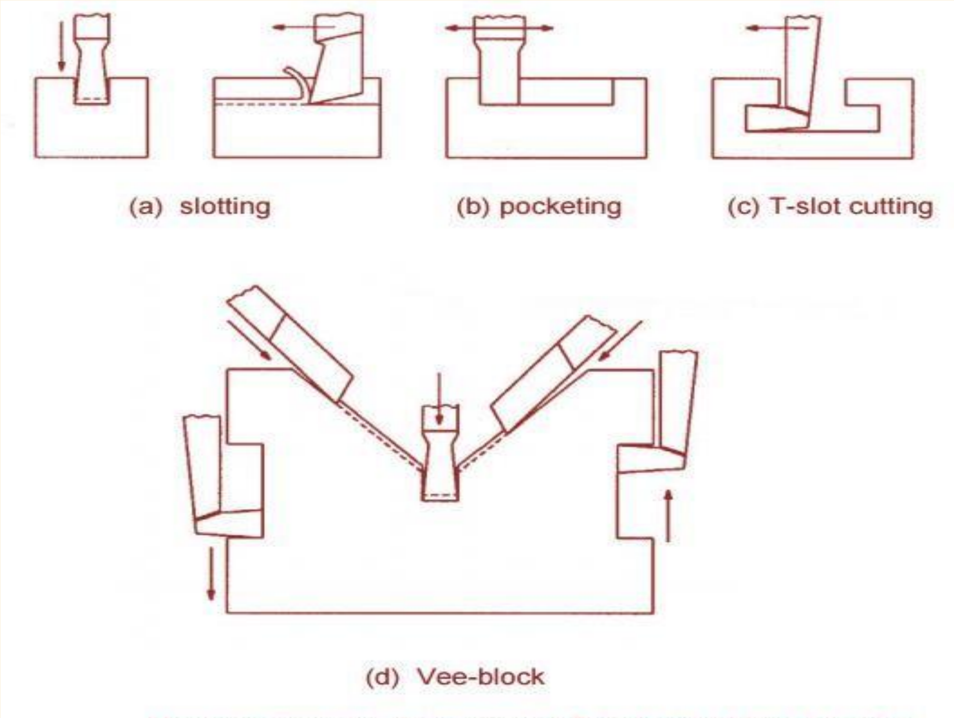
Swivel tool head method: An angular cut is made at any angle other than a right angle to the horizontal or to the vertical plane. The work is set on the table and the vertical slide of the tool head is swiveled to the required angle either towards left or towards right from the vertical position. The apron is then further swiveled away from the work to be machined. Fig. illustrates machining an angular surface by swivel tool head method Special operations



Apart from machining horizontal, vertical and vertical flat surfaces, the shaping machine can do some special machining operations. Various shaping operations are shown in Fig.

Machining dovetail groove: Dove tail joint is machined on two separate pieces of work as male and female elements. The required shape is marked on the face of the work and the unwanted metal is first removed by the round nose tool. A special form tool is used to finish the machining

Machining a 'V' block: The required shape of a V block is marked on the face of the work and machining is done by any suitable method of angular machining.

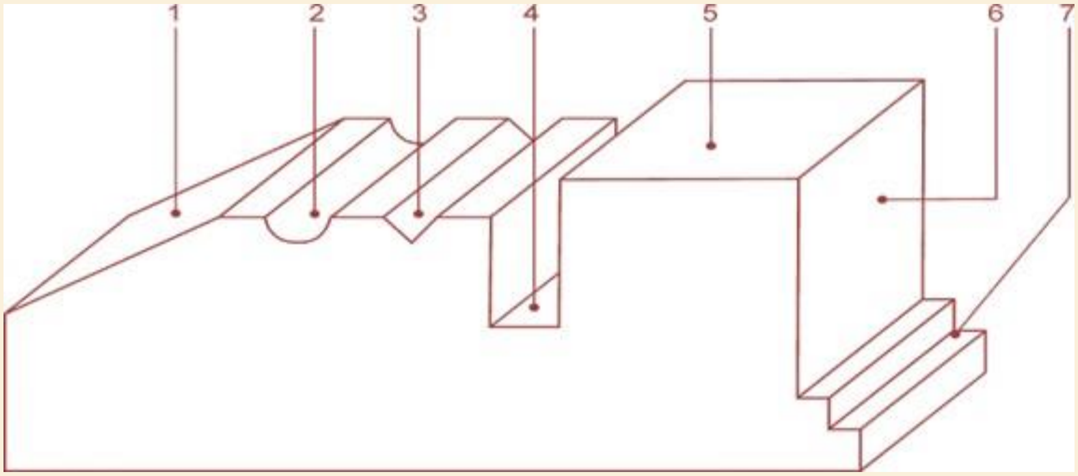


Machining (a) slot, (b) pocket (c) T-slot and (d) Vee block in shaping machine

Machining a tongue and groove joint

The male and female elements of the tongue and groove joint having vertical surfaces is machined after the exact shape are marked on the face of the work.

1. Inclined surface 2. Concave surface 3. V groove 4. Deep slot
5. Horizontal surface 6. Vertical surface 7. Step cut surface



Machining external keyways: Machining external keyways refers to the cutting of long slots along the length of cylindrical rods. Initially a round nose tool is used and then a square nose tool is used to finish the operation. A hole of depth equal to the depth of the keyway is made at the blind end to leave a clearance to the tool at the end of the stroke. When a keyway is cut at the middle of the shaft, holes are drilled at both ends of the keyway.

Machining internal keyways: Internal keyways are cut inside the holes of gears and pulleys. It is done by holding the tool on a special tool holder called snout bar. The snout bar is directly fitted on the clapper block.

T-slot machining: The shape of the T-slot is marked on the face of the work. A parting off tool is fitted on the tool post and a rectangular slot is machined at the middle for the required depth. The broad base of the T slot is machined by a T-slot cutting tool.

Machining a rack gear: Rack gear cutting is a process of cutting teeth elements at linear pitch on a flat piece of work. Firstly, the groove is machined with a square nose parting tool. Then, the groove is further machined with a form tool conforming the shape of the teeth.

Machining irregular surfaces: A shaper can also produce a contoured surface using a round nose tool. To produce a small contoured surface a forming tool is used. If the curve is sufficiently large, powered cross feed along with manual down feed is so adjusted that the tool will trace the required contour.

CUTTING SPEED, FEED AND DEPTH OF CUT:

CUTTING SPEED:

In a shaper, the cutting speed is the rate at which the metal is removed by the cutting tool. This is expressed in meters per minute. In a lathe as the cutting action is continuous the cutting speed expressed by the peripheral speed of the work. But in the shaper the cutting action is intermittent. In a shaper the cutting is considered only during the forward cutting stroke.

CUTTING SPEED CALCULATIONS:

The cutting speed in shaper is expressed by the formula:

$$\text{Cutting speed} = \frac{\text{length of the cutting stroke}}{\text{time required by the cutting stroke}}$$

Example:

Length of the cutting stroke L = 360mm, Time of the working stroke t_A = 0.03min.

For the return stroke t_R = 0.15 min. Find the cutting speed V_A and the return speed v_R (v_A and v_R are not the maximum, but the average speed).

Result: $\text{Speed} = \frac{\text{Distance}}{\text{Time}}$

$$\text{Cutting speed} = \frac{\text{length of the cutting stroke}}{\text{required by the cutting stroke}} = \frac{L}{t_A} \text{ time}$$

$$= \frac{0.36\text{m}}{0.03\text{min.}} = 12 \text{ m/min}$$

Return speed = $\frac{\text{length of the cutting stroke}}{\text{time required by the non-cutting stroke}} = \frac{L}{t_R}$

$= \frac{0.36\text{m}}{0.015\text{min.}}$ **=** 24 m/min

Machining time for Shaper:

L = Length of stroke ; L $= l + l_a + l_u$ l = Length of job

V_R = return speed m/min l_a = Approach length

V_A = cutting speed in m/min l_u = Over travel

s = feed per cycle in mm

The basic equation for the calculation of the machining time is :

$$\text{Time} = \frac{\text{Distance travelled}}{\text{speed}}$$

the distance is the length of the stroke . By means of speeds V_A and V_R the time for the working and non-cutting stroke can be calculated

$$\text{Time for the working stroke} = \frac{\text{Length of stroke (m)}}{\text{Cutting speed (m/ min)}}$$

$$\boxed{t_A = \frac{L}{V_R} \text{ min}}$$

$$\text{Time for non cutting stroke } t_R = \frac{\text{Length of stroke (m)}}{\text{Return speed (m/min.)}}$$

$$\boxed{t_R = \frac{L}{V_R} \text{ min}}$$

Time for cycle t = *time* for working stroke + time for non-cutting stroke

$$\boxed{t = t_A + t_R}$$

For shaping a work piece, a certain number of cycles is necessary, depending on the amount of feed and the width of the work piece, plus allowance. The shaping width consists of the width of the work piece plus an allowance of 5 mm

Shaping width B = width of work piece + allowance form both sides B

= b + (2 x 5) mm

If the shaping width is divided by the feed, the required cycles are obtained.

Thus number of required cycles Z = $\frac{\text{Shaping width (B)}}{\text{Feed (s)}}$

The machining time is calculated by multiplying the number of cycles with the time per cycle.

Machining time t_m = Number of cycles (Z) x time per cycle (*t*)

Example: A plate is to be shaped with a roughing cut. Calculate the machining time.

Given : Length of plate l = 260 mm,
width 90 mm ; l_a = 30 mm,
l_u = 10mm, V_A =
10m/min, V_r =
20m/min,
feed = 1mm/cycle,

allowance from the left = 5mm

allowance on the right = 5mm each.

Result:

1. Length of stroke L = $l + l_a + l_u$

= 260+30+10

= 300mm

2. Time for the working stroke $t_A = \frac{L}{V_A} = \frac{0.3m}{10\ m/min} = 0.03min$

3. Time for non-cutting stroke $t_R = \frac{L}{V_R} = \frac{0.3m}{20m/min} = 0.015min$

4. Time for one cycle $t = t_A + t_R$

= 0.03min + 0.015min

= 0.045min

5. Shaping width b = b +(2 x 5)mm = 100mm;

6. Number of required cycles $Z = \frac{100mm}{1mm/cycles}$ = 100 cycles;

7. Machining time tm = Z x t

= 100cycles x 0.05 min/cycle

= 4.5 min

Safety precautions

The following safety precautions should be observed while working on a shaping machine.

Safety precautions regarding operators

- No alteration or adjustment should be done on the machine parts while the machine is functioning.
- Clamps holding the work should not be adjusted while the machine is in operation.
- The machine is to be stopped before cleaning the metal chips.
- The sharp edges of the work should be handled with care.
- The measuring of the work should be done only after the machine is switched off.
- The operator should not seek the assistance of others for starting and stopping the machine.
- Machining of precise parts and internal surfaces of the work piece are to be carried out with great care and attention.
- The operator should stay away from direction of the ram movement.

Safety hints regarding the shaping machine

- The work piece is to be positioned in such a way that the ram will not hit the work piece while performing the forward stroke.
- Stroke length of the ram and the position of stroke are to be set correctly before performing the operation.
- Proper holding of the work should be ensured. Work holding devices like clamps and vice jaws should not come in the way of the reciprocating tool.
- We have to ensure that the tool or the tool post or the ram will not hit the job or the job holding clamps or the vise jaws.

The machine should be stopped before making any adjustment to the stroke length, position of stroke, apron and tool position

Specification:

The shaping machine can be specified as follows,

1. Maximum length of stroke in mm.
2. Table size, top (length × width).
3. Table horizontal travel on slides.
4. Table vertical travel.
5. Tool head vertical adjustment.
6. Number and range of speed obtainable.
7. Number and range of feeds.

EXAMPLE FOR SPECIFICTION OF SHAPING MACHING

Horse power of the motor. Model		BC6090C
Maximum cutting length(mm)		900
Maximum table horizontal travel(mm)		600
Maximum distance from ram bottom to table surface(mm)		450
Maximum table vertical travel(mm)		400
Dimensions of table top surface(L×W)(mm)		900×400
Travel of tool head(mm)		150
Swivel of tool head(°)		±60°
Maximum size of tool shank(W×T)(mm)		22×30
Number of ram strokes per minute(mm)		0.25-1.8
Range of table power feed		Stepless
Max loading weight on worktable(kg)		200
Speed of rapid travel of table	Horizontal	1.57
	Vertical	0.35
width of the T-slot for center positioning(mm)		18
Power of the main motor(kw)		4
Power of the motor for rapid travel of table(kw)		0.75
N.W/G.W(kg)		2700/2850
Overall dimensions(L×W×H)(mm)		2670×1350×1600

QUESTIONS

I. Choose the correct option

1. The shaping machine was developed by

   a. Henry Maudslay b. Eli Whitney

   c. Michael Faraday d. James Nasmith

2. The operation mainly done on a shaping machine is

   a. Turning b. Drilling

   c. Machining a flat surface d. Thread cutting

3. The mechanism used to move the shaper table automatically is

   a. Back gear mechanism

   b. Crank & slotted link mechanism

   c. Tumbler gear mechanism

   d. Ratchet & pawl mechanism

4. The part involved in reciprocation by quick return is

   a. Table b. Ram c. Column d. Cross rail

5. The ratio of forward stroke time to return stroke time is a.

   3 : 2 b. 5 : 3 c. 1 : 3 d. 1 : 2

II. Answer the following questions in one or two words

1. What type of surfaces are machined on a shaper?
2. Which stroke of the shaper is faster?
3. What is the use of ratchet & pawl mechanism?
4. What type of cutting tool is used in a shaper -a single point or a multi- point?
   Which part of the shaper is involved in automatic lifting of the tool during Return stroke of the ram?

III. Answer the following questions in one or two sentences

1. Name any four important parts of a shaping machine.
2. What is the use of crank & slotted link mechanism?
3. Define feed in a shaping machine.
4. Name any two points in specifying the size of a shaping machine.
5. What is the use of a clapper box?
6. What is the use of swivel tool head of a shaping machine?

I V . Answer the following questions in about a page

1. List out the types shaping machines.
2. Write short notes on
   - Changing the stroke length of the ram
   - Position of the ram
3. Explain any two work holding devices used in a shaping machine with diagrams.
4. List out the types of tools used in a shaping machine.
5. Explain any two operations performed in a shaping machine with diagrams.

V. Answer the following questions in detail

1. Draw a neat diagram of a shaping machine and explain its important parts.
2. Explain the crank & slotted link mechanism of quick return of the ream with a diagram.
3. Explain the ratchet & pawl mechanism with a diagram.
4. Explain any four work holding devices used in a shaping machine with diagrams.
5. Explain any four operations performed in a shaping machine with diagrams.

UNIT 2: LATHE

SAFETY PRECAUTIONS

All lathe operators must be constantly aware of the safety hazards that are associated with using the lathe and must know all safety precautions to avoid accidents and injuries. Carelessness and ignorance are two great menaces to personal safety. Other hazards can be mechanically related to working with the lathe, such as proper machine maintenance and setup.

Some important safety precautions to follow when using lathes are:

1. Correct dress is important, remove rings and watches, and roll sleeves above elbows.
2. Always stop the lathe before making adjustments.
3. Does not change spindle speeds until the lathe comes to a complete stop.
4. Handle sharp cutters, centers, and drills with care.
5. Remove chuck keys and wrenches before operating.
6. Always wear protective eye protection.
7. Handle heavy chucks with care and protect the lathe ways with a block of wood when installing a chuck.
8. Know where the emergency stop is before operating the lathe.
9. Use pliers or a brush to remove chips and swarf, never your hands.
10. Never lean on the lathe.
11. Never lay tools directly on the lathe ways. If a separate table is not available, use a wide board with a cleat on each side to lay on the ways.
12. Keep tools overhang as short as possible.
13. Never attempt to measure work while it is turning.
14. Never file lathe work unless the file has a handle.
15. File left-handed if possible.
16. Protect the lathe ways when grinding or filing.
17. Use two hands when sanding the work piece. Do not wrap sand paper or emery cloth around the work piece.

INTRODUCTION:

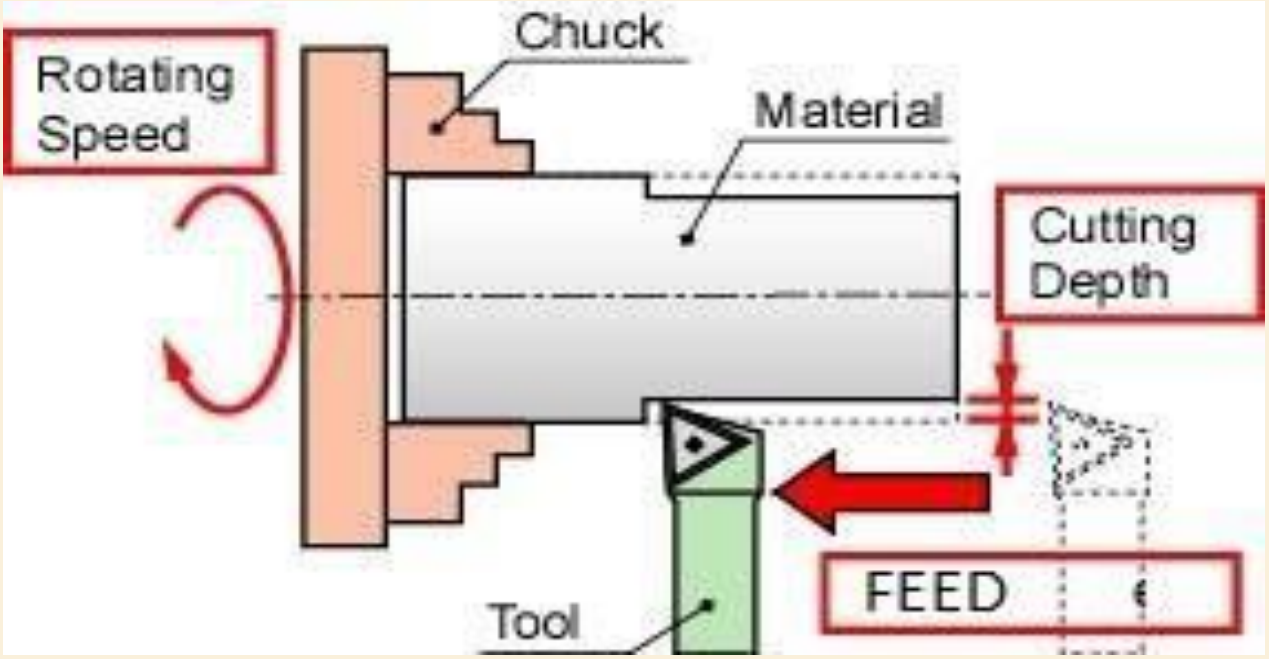
- Lathe is one of the oldest important machine tools in the metal working industry. A lathe operates on the principle of a rotating work piece and a fixed cutting tool.
- A rope wound round the work with its own end attached to a flexible branch of tree and other end being pulled by man caused job to rotate intermittently. With its further development a strip of wood called ―lath‖ was used to support the rope and that is how the machine came to be known as ―lathe‖.
- The cutting tool is feed into the work piece, which rotates about its own axis, causing the work piece to be formed to the desired shape.
- Lathe machine is also known as ―the mother/father of the entire tool family‖.
- A lathe is a machine tool that rotates the work piece on its axis to perform various operations such as cutting, sanding, knurling, drilling, or deformation, facing, turning, with tools that are applied to the work piece to create an object with symmetry about an axis of rotation

HISTORY :

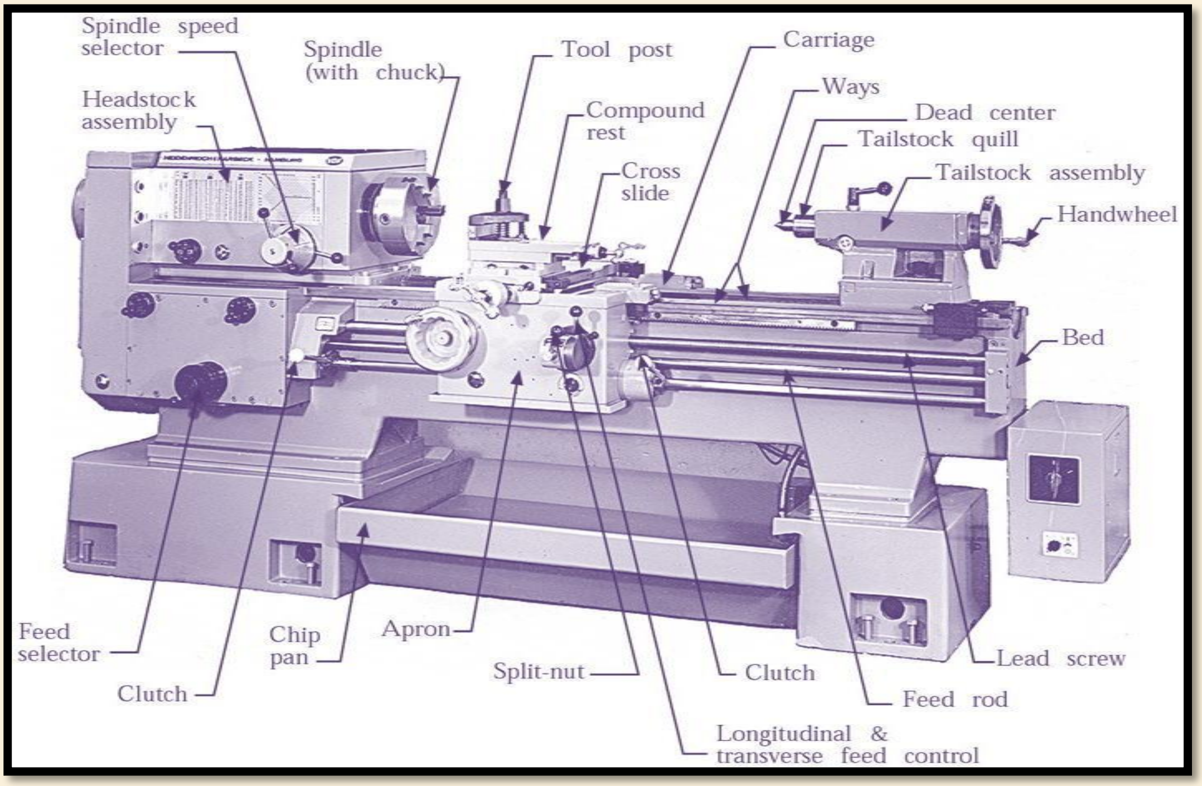
- The Lathe Machine is one of the oldest and most important machine tools. As early as 1569, wood lathes were in use in France. The lathe machine was adapted to metal cutting in England during the Industrial Revolution.
- Lathe machine also called ―Engine Lathe‖ because the first type of lathe was driven by a steam engine.
- Lathe forerunner of all machine tools
- First application was potter's wheel
- Rotated clay and enabled it to be formed into cylindrical shape
- Very versatile (many attachments)
- Used for turning, tapering, form turning, screw cutting, facing, drilling, boring, spinning, grinding and polishing operations
- Cutting tool fed either parallel or right angles

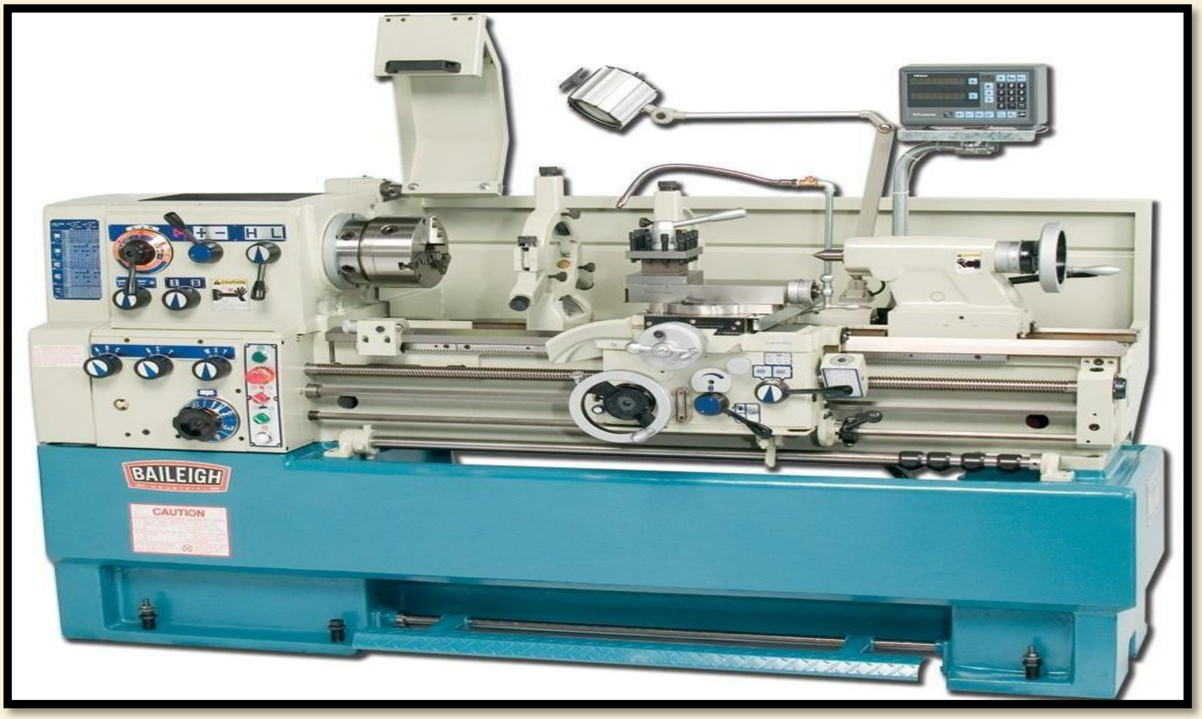
Lathe is considered as one of the oldest machine tools and is widely used in industries. It is called as mother of machine tools. It is said that the first screw cutting lathe was developed by an Englishman named Henry Maudslay in the year 1797. Modern high speed, heavy duty lathes are developed based on this machine.

The primary task of a lathe is to generate cylindrical work pieces. The process of machining a work piece to the required shape and size by moving the cutting tool either parallel or perpendicular to the axis of rotation of the work piece is known as turning. In this process, excess unwanted metal is removed. The machine tool useful in performing plain turning, taper turning, thread cutting, chamfering and knurling by adopting the above method is known as lathe. Fig shows turning operation.



LATHE MACHINE

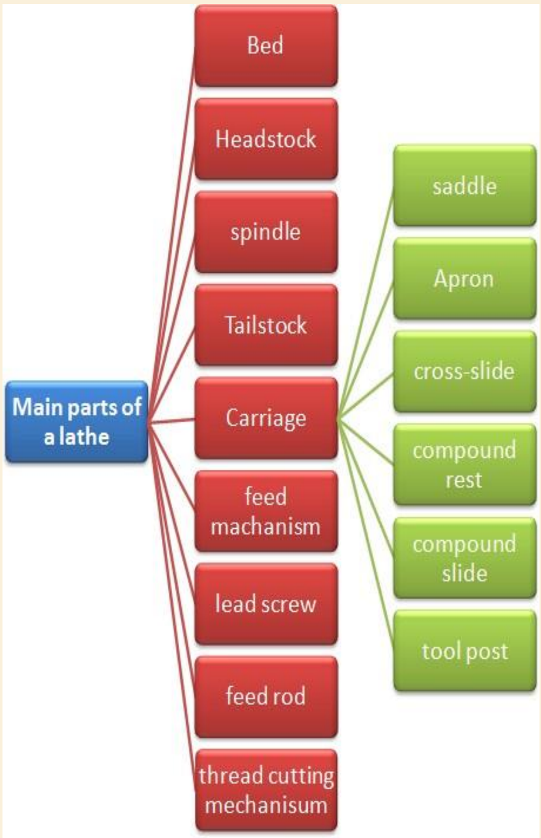




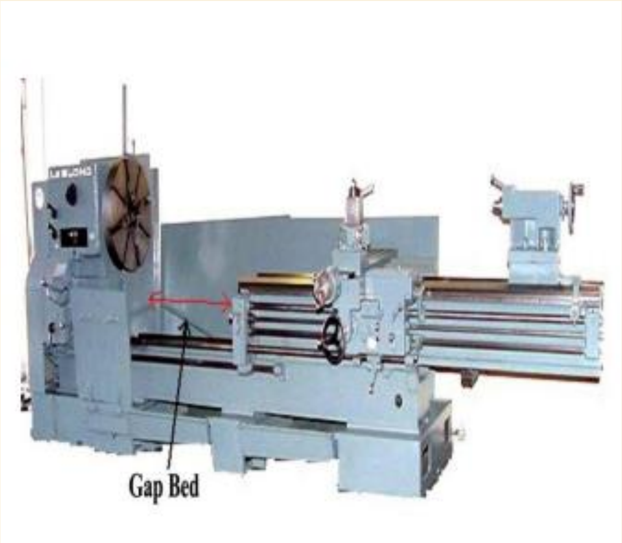
Main parts of a lathe

Every individual part performs an important task in a lathe. Some important parts of a lathe are listed below.

- ❖ Bed
- ❖ Headstock
- ❖ Spindle
- ❖ Tailstock
- ❖ Carriage
  - ✓ Saddle
  - ✓ Apron
  - ✓ Cross-slide
  - ✓ Compound rest
  - ✓ Compound slide
  - ✓ Tool post
- ❖ Feed mechanism
- ❖ Lead screw
- ❖ Feed rod
- ❖ Thread cutting mechanism

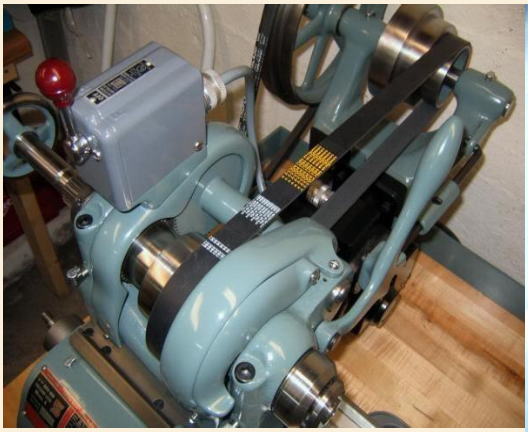


Bed: Bed is mounted on the legs of the lathe which are bolted to the floor. It forms the base of the machine. It is made of cast iron and its top surface is machined accurately and precisely. Headstock of the lathe is located at the extreme left of the bed and the tailstock at the right extreme. Carriage is positioned in between the headstock and tailstock and slides on the bed guide ways. The top of the bed has flat or "V" shaped guide ways. The tailstock and the carriage slides on these guide ways. Inverted "V" shaped guide ways are useful in better guide and accurate alignment of saddle and tailstock. The metal burrs resulting from turning operation automatically fall through. Flatbed guide ways can be found in older machine tools. It is useful in heavy machines handling large work pieces. But then the accuracy is not high.

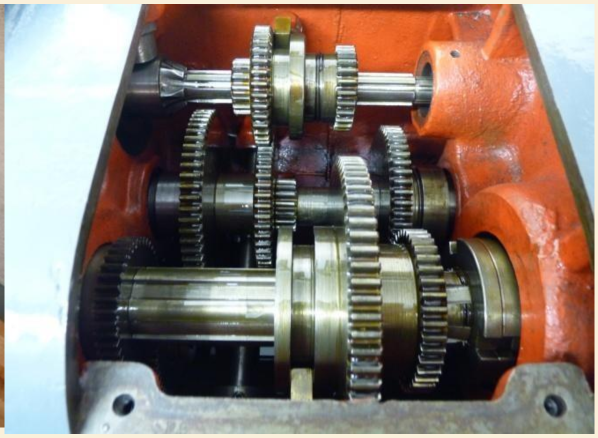


Headstock: Headstock is mounted permanently on the inner guide ways at the left hand side of the leg bed. The headstock houses a hollow spindle and the mechanism for driving the spindle at multiple speeds. The headstock will have any of the following arrangements for driving and altering the spindle speeds

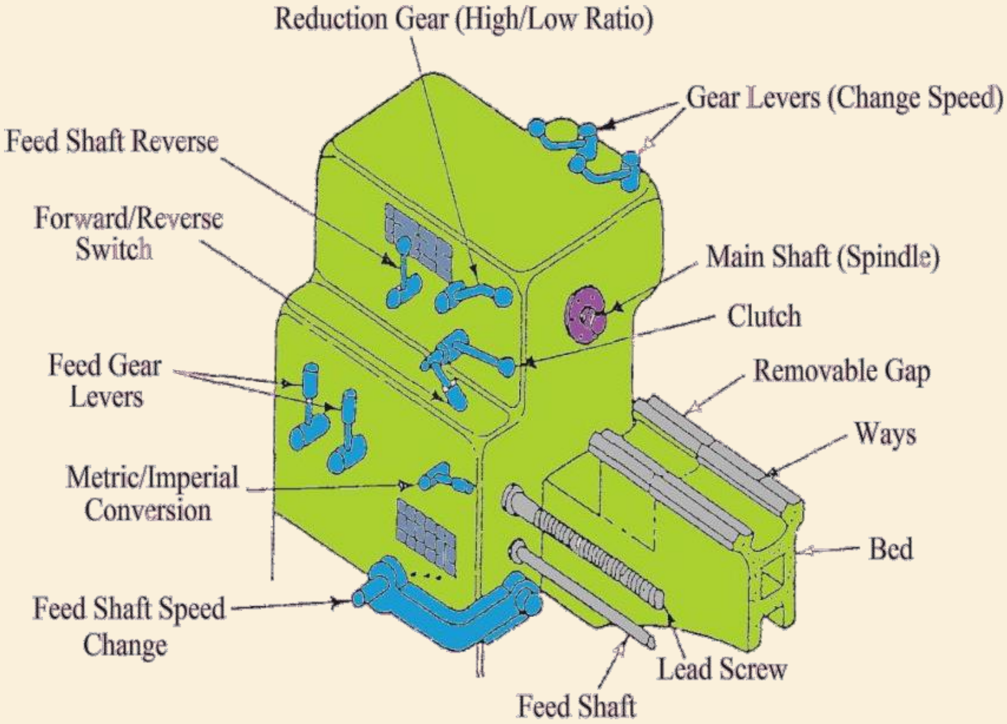
- Stepped cone pulley drive
- Back gear drive
- All gear drive



BELT DRIVE

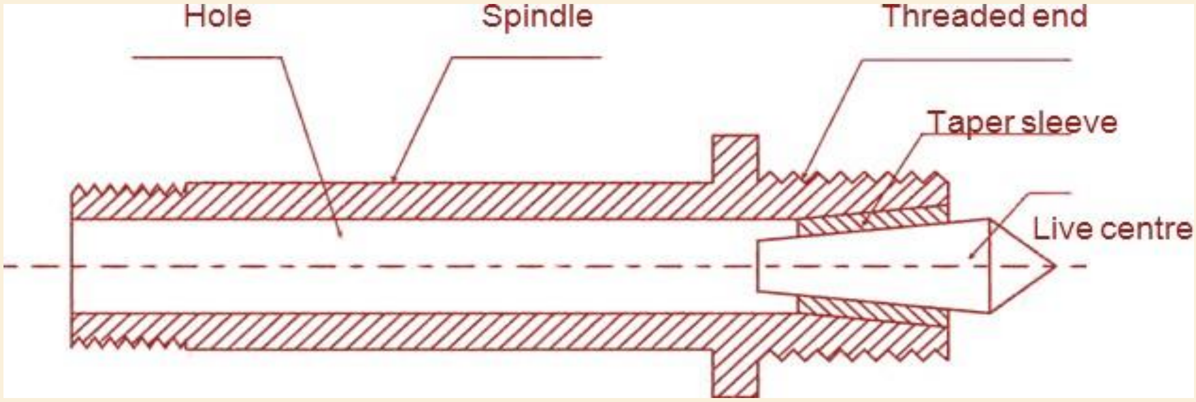


GEAR DRIVE

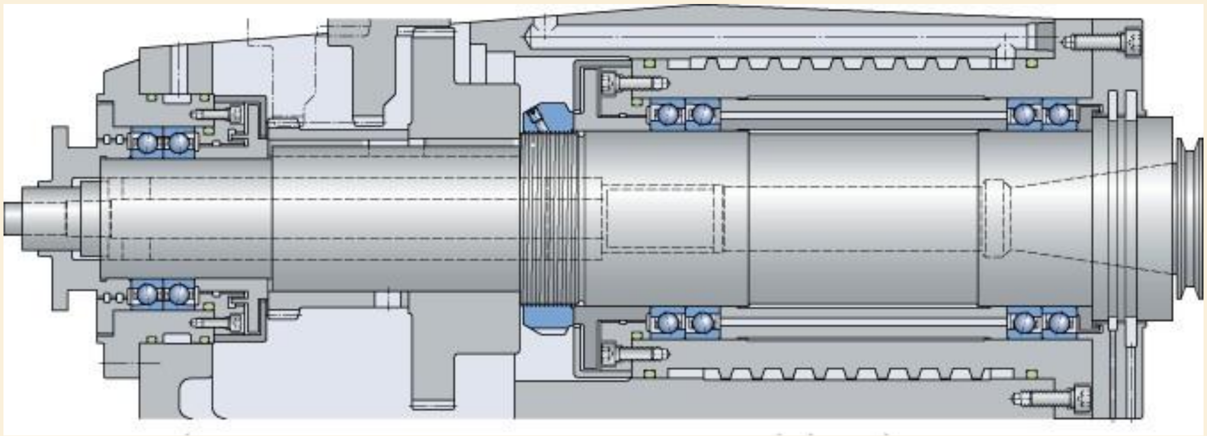


LATHE HEAD STOCK

Spindle: The spindle rotates on two large bearings housed on the headstock casting. A hole extends through the spindle so that a long bar stock may be passed through the hole. The front end of the spindle is threaded on which chucks, faceplate, driving plate and catch plate are screwed. The front end of the hole is tapered to receive live center which supports the work. On the other side of the spindle, a gear known as a spindle gear is fitted. Through this gear, tumbler gears and a main gear train, the power is transmitted to the gear on the lead screw. The construction of a lathe spindle is shown in Fig

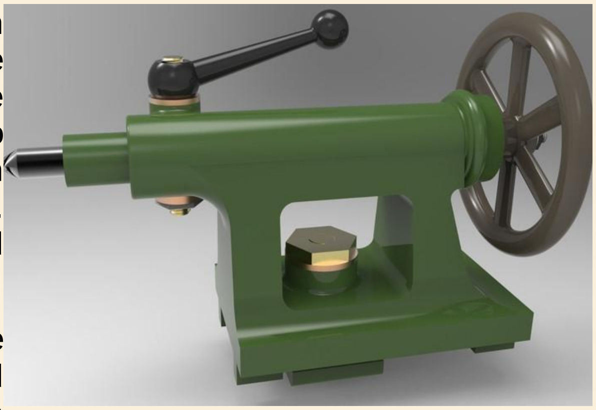


Spindle



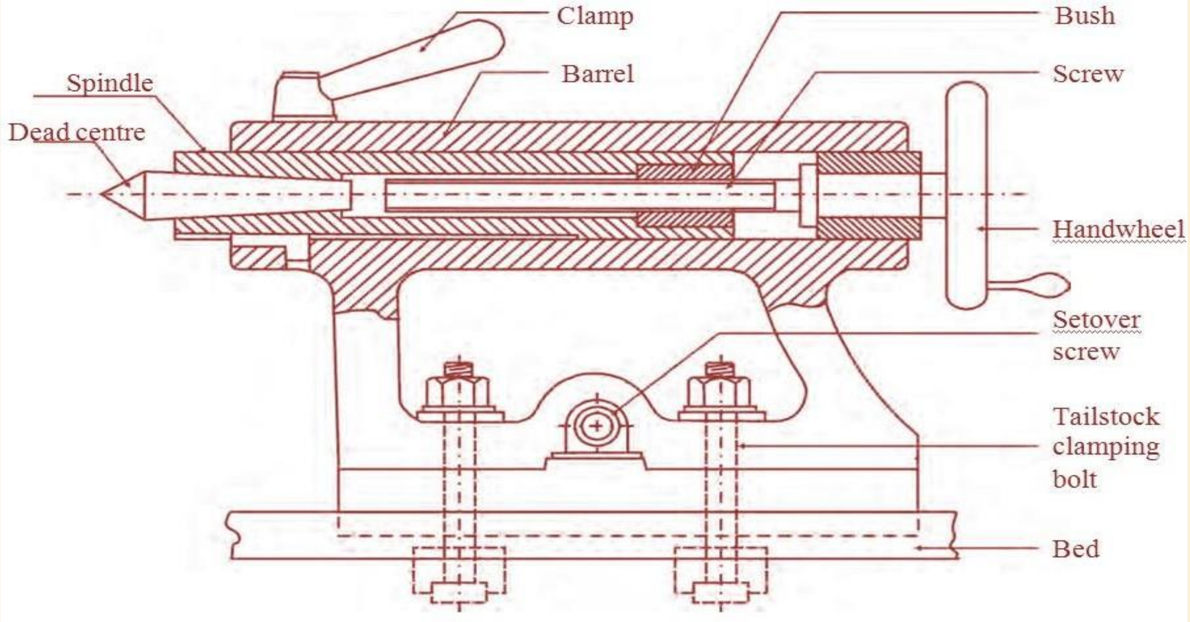
Tailstock:

Tailstock is located on the inner guide ways at the right side of the bed opposite to the headstock. The body of the tailstock is bored and houses the tailstock spindle or ram. The spindle moves front and back inside the hole. The spindle has a taper hole to receive the dead center or shanks of tools like drill or reamer. If the tailstock hand wheel is rotated in the clockwise direction, the spindle advances. The spindle will be withdrawn inside the hole, if the hand wheel is rotated in anti-clockwise direction. To remove the dead center or any other tool



from the spindle, the hand wheel is rotated in anticlockwise direction further. The movement of the spindle inside the hole may be locked by operating the spindle clamp located on top of the tail stock in order to hold work pieces of different lengths, the tailstock can be locked at any desired position on the lathe bed. Tailstock clamping bolts and clamping pates are used for this purpose.

Tailstock is designed to function as two units-the base and the body. The base of the tailstock is clamped to the bed. The body is placed on the base and can be made to slide sideways-perpendicular to the bed guide ways up to a certain distance. Fig shows a tailstock.

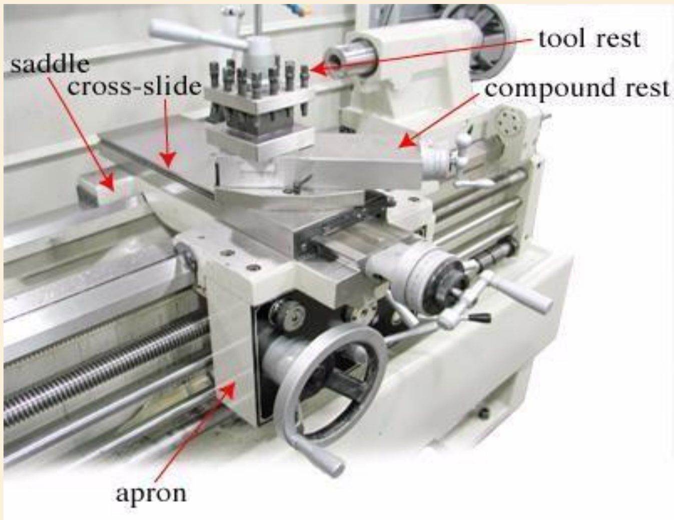


The uses of tailstock:

- It supports the other end of the long work piece when it is machined between centers.
- It is useful in holding tools like drills, reamers and taps when performing drilling, reaming and tapping.
- The dead center is offset by a small distance from the axis of the lathe to turn tapers by set over method.
- It is useful in setting the cutting tool at correct height aligning the cutting edge with

lathe axis.

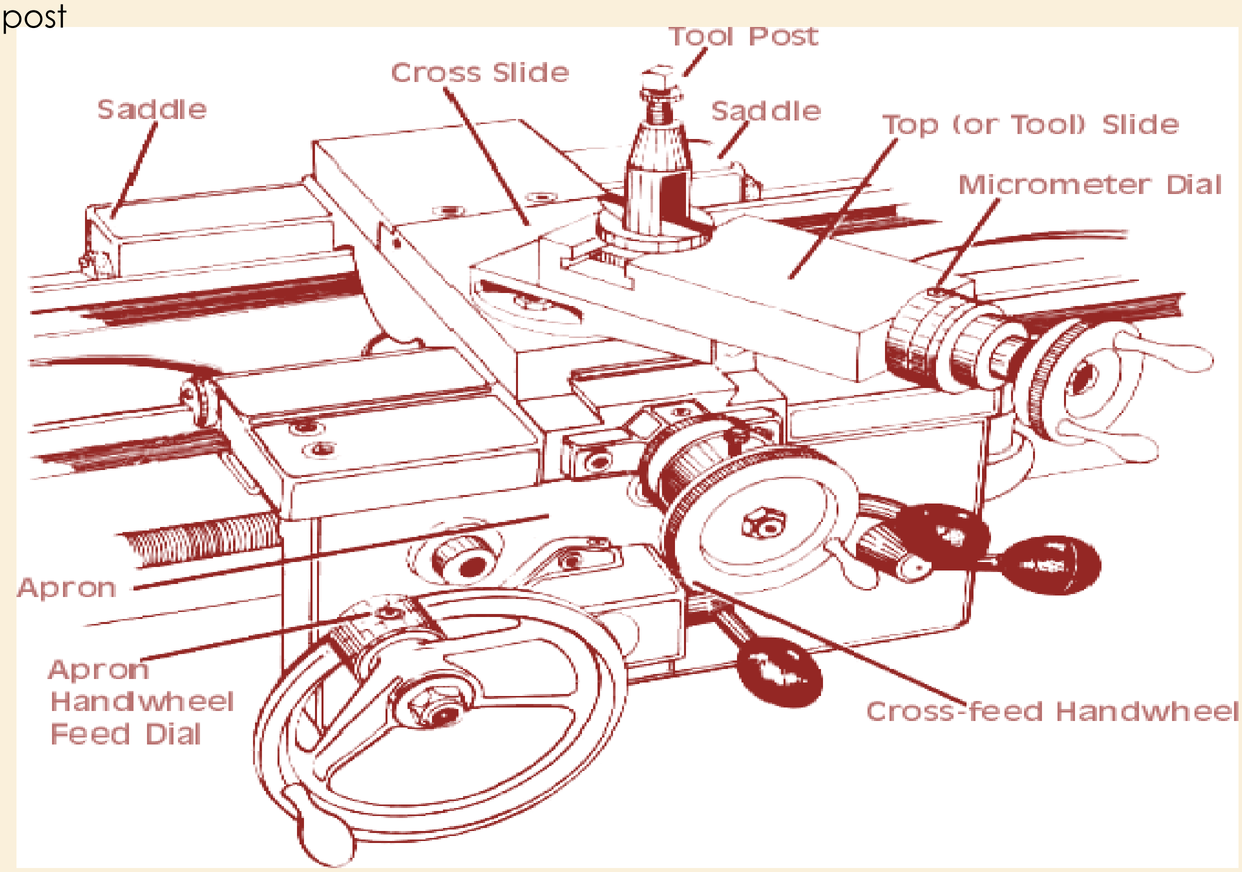
Carriage



Carriage is located between the headstock and tailstock on the lathe bed guide ways. It can be moved along the bed either towards or away from the headstock. It has several parts to support, move and control the cutting tool. The parts of the carriage are :

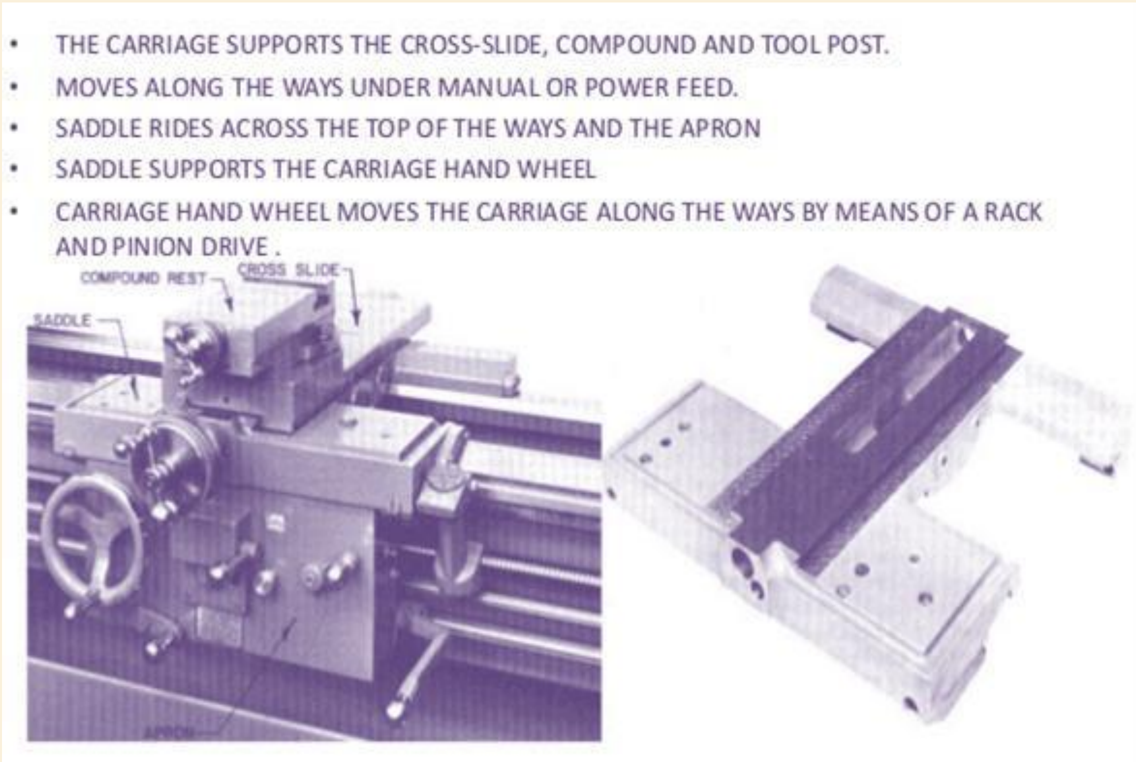
- Saddle
- Apron
- cross-slide
- compound rest

tool post



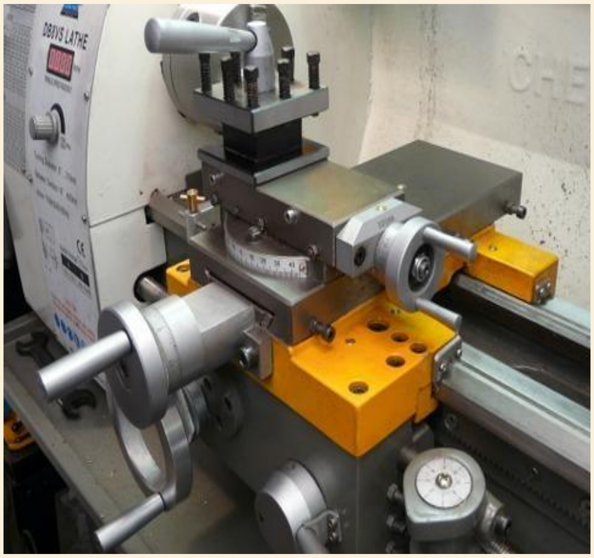
Saddle:

It is an ―H‖ shaped casting. It connects the pair of bed guide ways like a bridge. It fits over the bed and slides along the bed between headstock and tailstock. The saddle or the entire carriage can be moved by providing hand feed or automatic feed.



Cross slide:

Cross-slide is situated on the saddle and slides on the dovetail guide ways at right angles to the bed guide ways. It carries compound rest, compound slide and tool post. Cross slide hand wheel is rotated to move it at right angles to the lathe axis. It can also be power driven. The cross slide hand wheel is graduated on its rim to enable to give known amount of feed as accurate as 0.05mm.



Compound rest:

Compound rest is a part which connects cross slide and compound slide. It is mounted on the cross-slide by tongue and groove joint. It has a circular base on which angular graduations are marked. The compound rest can be swiveled to the required angle while turning tapers. A top slide known as compound slide is attached to the compound rest by dove tail joint. The tool post is situated on the compound slide.

Tool post:

This is located on top of the compound slide. It is used to hold the tools rigidly. Tools are selected according to the type of operation and mounted on the tool post and adjusted to a convenient working position. There are different types of tool posts and they are:

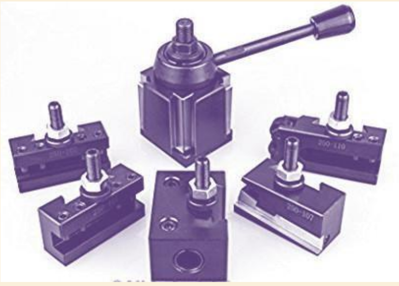
- Single screw tool post
- Four bolt tool post
- Four way tool post
- Open side tool post

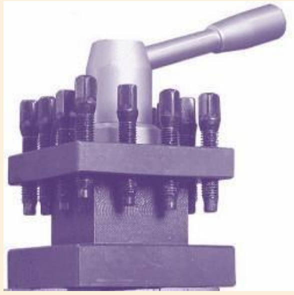
Single screw tool post

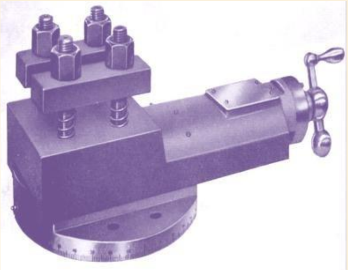
The tool is held by a screw in this tool post. It consists of a round bar with a slotted hole in the center for fixing the tool by means of a setscrew. A concave ring and a convex rocker are used to set the height of the tool point at the right position. The tool fits on the flat top surface of the rocker. The tool post is not rigid enough for heavy works as only one clamping screw is used to clamp the tool. A single screw tool post is illustrated in Figure.

Four-way tool post

This type of tool post can accommodate four tools at a time on the four open sides of the post. The tools are held in position by separate screws and a locking bolt is located at the center. The required tool may be set for machining by swiveling the tool post. Machining can be completed in a shorter time because the required tools are pre-set.

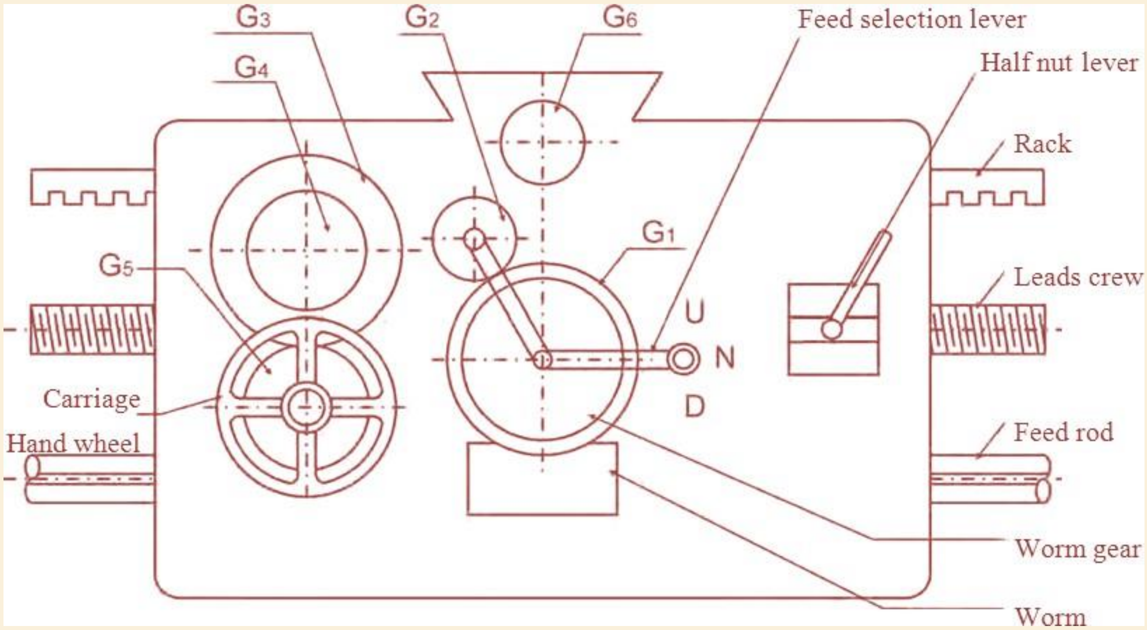






Apron Mechanism:

Apron is attached to the carriage and hangs over the front side of the lathe bed. It is useful in providing power and hand feed to both carriage and cross-slide. It is also used to provide power feed to the carriage during thread cutting through two half nuts. The construction of apron is shown in Fig



Construction

Power is transmitted from the spindle to the lead screw and feed rod through the spindle gear and tumbler gear arrangement. A worm is mounted on the feed rod by a sliding key. The worm meshes with a worm gear on whose axis another gear G1 is attached. Gear G1 is attached to a small gear G2 by a bracket as shown in the diagram. Gear G4 is positioned to be in mesh with the rack gear always. Another gear G3 is mounted on the same axis of gear G4. The carriage hand wheel meant for longitudinal feed is attached to the gear G5 on the same axis. The gears G3 and G5 are always in mesh. The gear G6 is attached to the cross slide screw.

The feed selection lever can be kept in neutral, up and down positions to obtain the following movements.

- Hand feed and power feed to the carriage
- Hand feed and power feed to the cross slide

Hand feed to the carriage

Feed selection lever is kept in neutral position and the carriage hand wheel is rotated. The gear G4 attached to the rack gets rotation through the gears G5 and G3. The carriage moves longitudinally.

Power feed to the carriage

When feed selection lever is kept in up position (U), the gear G2 will mesh with gear G3. Gear G4 gets rotation through gear G3 and the carriage gets automatic (power) feed.

Hand feed to the cross slide

Feed selection lever is kept in neutral position. The cross slide will move on rotation of the cross slide hand wheel.

Power feed to the cross slide

When the feed selection lever is kept in down position (D), gear G2 will be in contact with gear G6. The rotation of G6 will make the cross slide screw also to rotate and the cross-slide moves automatically.

Power feed to the carriage for thread cutting

When the two half nuts in the apron are made as one unit, lead screw makes the carriage to move automatically and cut threads of required pitch value.

Lead screw: The lead screw is a long threaded shaft used as master screw. It is brought into operation during thread cutting to move the carriage to a calculated distance. Mostly lead screws are Acme threaded.

The lead screw is held by two bearings on the face of the bed. A gear is attached to the lead screw and it is called as gear on lead screw. A half nut lever is provided in the apron to engage half nuts with the lead screw.

Lead screw is used to move the carriage towards and away from the headstock during thread cutting. The direction of carriage movement depends upon the direction of rotation of the lead screw. When the lead screw is kept stationary, the half nuts are engaged with the lead screw to keep the carriage locked at the required position.

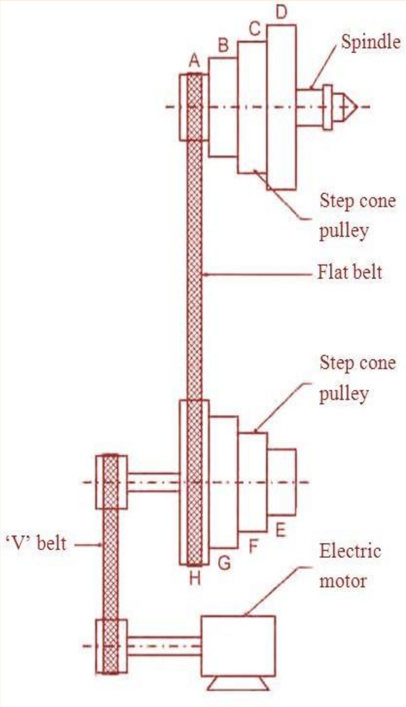
Feed rod: Feed rod is placed parallel to the lead screw on the front side of the bed. It is a long shaft which has a keyway along its length. The power is transmitted from the spindle to the feed rod through tumbler gears and a gear train. It is useful in providing feed movement to the carriage except for thread cutting and to move cross-slide. A worm mounted on the feed rod enables the power feed movements.

Spindle mechanism: The spindle is located in the headstock and it receives the driving power from the motor. The spindle speed should be changed to suit different machining conditions like type of material to be cut, the diameter and the length of the work, type of operation, the type of cutting tool material used, the type of finish desired and the capacity of the machine. In order to change the spindle speeds, any one of the following methods are employed.

- Step cone pulley drive
- Back geared drive
- All geared drive

Step cone pulley drive: It is simple in construction. The belt is arranged on the four different steps of the cone pulley to obtain four different speeds.

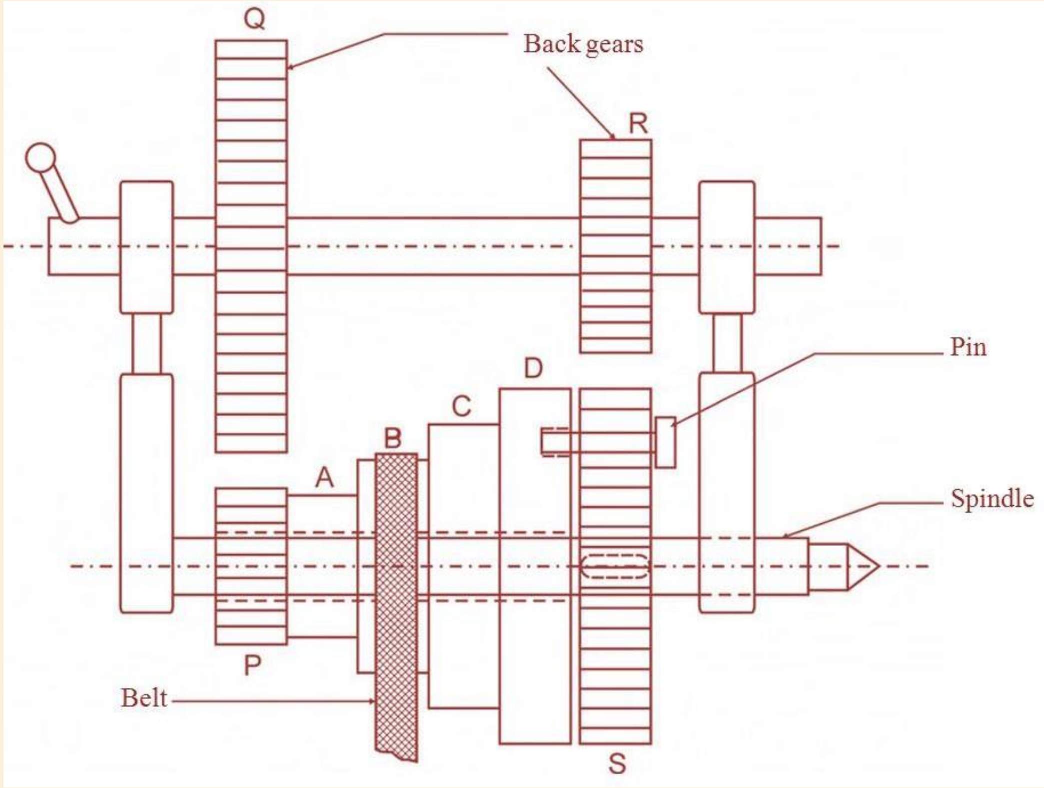
A step cone pulley is attached with the spindle contained within the headstock casting. The cone pulley has four steps (A, B, C & D). Another cone pulley having four steps (E, F, G and H) is placed parallel to the spindle cone pulley. Both the cone pulleys are connected by a flat belt. The belt can be arranged between the steps A & H, B & G, C & F and D & E. The cone pulley at the bottom is connected to the electric motor by a V belt. So the cone pulley at the bottom rotates at a particular speed.



Step cone pulley drive

The belt is arranged on any of the four steps to obtain different spindle speeds. The spindle speed is increased if the belt is placed on the smaller step of the driven pulley. The spindle speed will be maximum when the belt is arranged between A & H and the speed will be minimum when the belt is arranged between D & E.

Back gear mechanism: Back gear mechanism is housed within the headstock of the lathe. A step cone pulley having steps ABCD and a small pinion P are mounted on the spindle and rotates freely on it. The gear S is keyed to the headstock spindle. So, the spindle will rotate only when the gear S rotates.



Back gear drive

The step cone pulley ABCD and the gear S can be kept separately or made as one unit with the help of a pin T. When the pin is disengaged, the cone pulley along with the gear P will rotate freely on the spindle and the spindle will not rotate. There is another shaft parallel to the spindle axis having back gears Q and R mounted on it. These back gears can be made to mesh with gears P and S or kept disengaged from them. The spindle can get drive either from the cone pulley or through back gears.

Drive from step cone pulley: When the spindle gets drive from the cone pulley, the back gears Q and R are disengaged from the gears P and S. The pin _T is engaged with cone pulley. The belt can be arranged on the steps A, B, C or D to get four different direct speeds for the spindle.

Drive through back gears: Back gears Q and R are engaged with gears P and S. The pin T is disengaged from the cone pulley to make the cone pulley and the spindle separate units. When the cone pulley gets drive through the belt, the power is transmitted through the gears P Q and R to the gear S. Because of number of teeth on these gears, the spindle rotates at slower speeds. By arranging the belt on the different steps of the cone pulley, four different spindle speeds are obtained.

Uses of back gear arrangement: The spindle gets four direct speeds through the cone pulley and four slower speeds through the back gears. Slower speeds obtained by this arrangement are useful when turning on larger work pieces and cutting coarse threads.

All geared headstock: Modern lathes are equipped with all geared headstocks to obtain different spindle speeds quickly. Casting of the all geared headstock has three shafts (1,2& 3) mounted within it. The intermediate shaft (2) has got three gears D, E and F as a single unit and rotate at the same speeds. The splined shaft (1) which is above the intermediate shaft has got three gears A, B and C mounted on it by keys. These three gears can be made to slide on the shaft with the help of a lever. This movement enables the gear A to have contact with the gear D or the gear B with gear E or the gear C with the gear F.

Likewise, the spindle shaft (3) which is also splined has three gears G, H and I. With the help of a lever, these three gears can be made to slide on the shaft. This sliding movement enables the gear G to have contact with gear D or the gear H with the gear E or the gear I with the gear F. By altering the positions of the six gears namely A, B, C, G, H and I the following arrangements can be made within the headstock. Nine different spindle speeds are obtained.

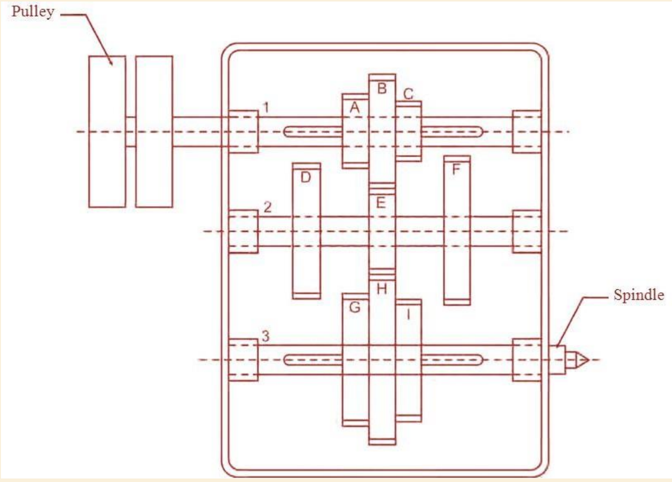


Fig .All geared drive

The gear combinations are

1. $\frac{A}{D} \times \frac{D}{G}$ 4. $\frac{B}{E} \times \frac{D}{G}$ 7. $\frac{C}{F} \times \frac{D}{G}$

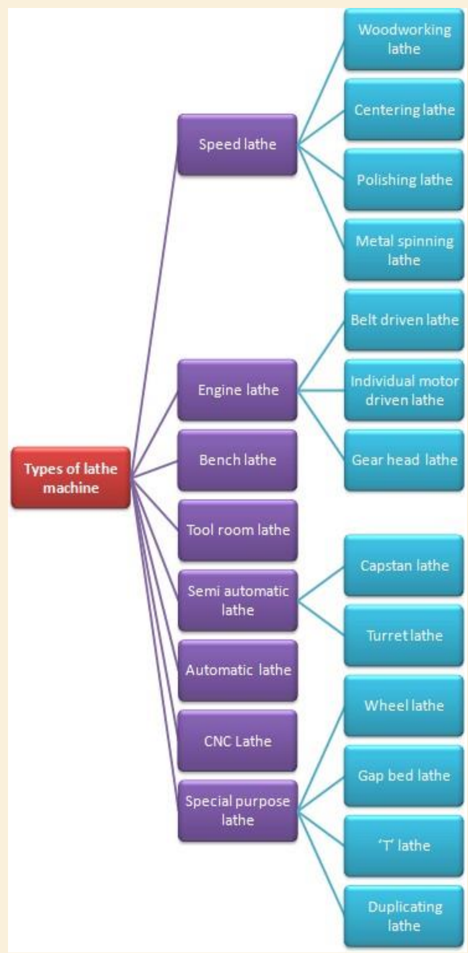
2. $\frac{A}{D} \times \frac{E}{H}$ 5. $\frac{B}{E} \times \frac{E}{H}$ 8. $\frac{C}{F} \times \frac{E}{H}$

3. $\frac{A}{D} \times \frac{F}{I}$ 4. $\frac{B}{E} \times \frac{F}{I}$ 9. $\frac{C}{F} \times \frac{F}{I}$

Types of lathe machine

Various designs and constructions of lathe have been developed to suit different machining conditions and usage. The following are the different types of lathe

- ❖ Speed lathe
  - ➢ Woodworking lathe
  - ➢ Centering lathe
  - ➢ Polishing lathe
  - ➢ Metal spinning lathe
- ❖ Engine lathe
  - ➢ Belt driven lathe
  - ➢ Individual motor driven lathe
  - ➢ Gear head lathe
- ❖ Bench lathe
- ❖ Tool room lathe
- ❖ Semi automatic lathe
  - ➢ Capstan lathe
  - ➢ Turret lathe
- ❖ Automatic lathe



- ❖ CNC Lathe

- ❖ Special purpose lathe

  - ➢ Wheel lathe
  - ➢ Gap bed lathe
  - ➢ T lathe
  - ➢ Duplicating lathe

Speed lathe

Spindle of a speed lathe operates at very high speeds (approximately at a range of 1200 to 3600 rpm) and so it is named so. It consists of a headstock, a tailstock, a bed and a tool slide only. Parts like lead screw, feed rod and apron are not found in this type of lathe.

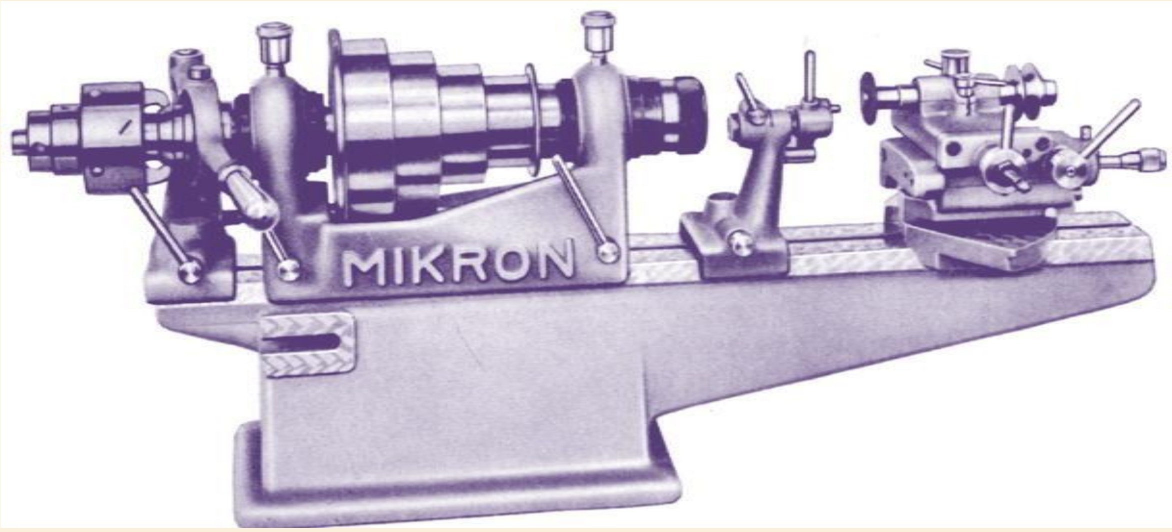
- ❖ Centering lathes are used for drilling center holes.
- ❖ The woodworking lathes are meant for working on wooden planks.
- ❖ Metal spinning lathes are useful in making tumblers and vessels from sheet metal.
- ❖ Polishing of vessels is carried out in polishing lathe.

Woodworking lathe: Complex forms made on a wood lathe develop from surprisingly few types of cuts: parting, planning, bead, cove, and hollowing. Parting separates the wood from the holding device, or establishes depth cuts. Planning is done with a tool in which the bevel below the cutting edge supports wood fibers, just as in a typical wood planer. Beads are a convex shape relative to the cylinder, and coves are a concave shape. Hollowing techniques are a combination of drilling and scooping out materials. The wood turner is at liberty to choose from a variety of tools for all of these techniques,

Most woodworking lathes are designed to be operated at a speed of between 200 and 1,400 revolutions per minute, with slightly over 1,000 rpm considered optimal for most such work, and with larger work pieces requiring lower speeds.

Polishing lathe

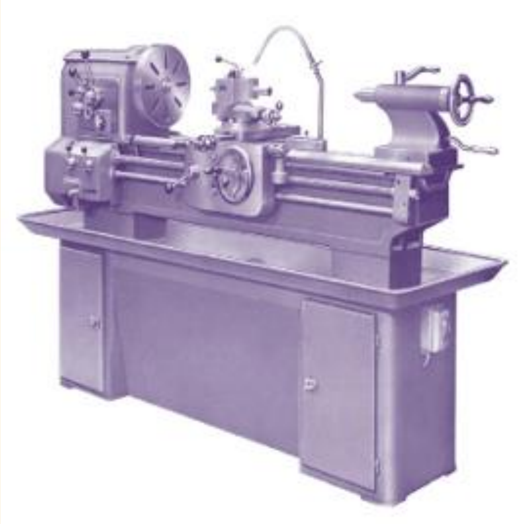
polishing lathes have features preferred by dentists, dental lab technicians, jewelers, lapidary, and others requiring precise trouble free polishing. The ball bearings in all lathes are lubricated for life and sealed to prevent entry of dust and debris.



Metal spinning lathe

Metal spinning, also known as spin forming or spinning or metal turning most commonly, is a metalworking process by which a disc or tube of metal is rotated at high speed and formed into an axially symmetric part. Spinning can be performed by hand or by a CNC lathe

Engine lathe or center lathe



Engine lathes are named so because the early lathes were driven by steam engines. As the turning operations are performed by holding the work piece between two centers, it is also known as center lathe. Engine lathes are widely used in industries. It consists of parts like headstock, tailstock and carriage. Parts like lead screw and feed rod which are useful in providing automatic feed are also found in this type of lathe.

Bench lathe

Bench lathe is a small lathe generally mounted on a bench. It consists of all the parts of an engine lathe. It is used for small works like machining tiny and precise parts and parts of measuring instruments.

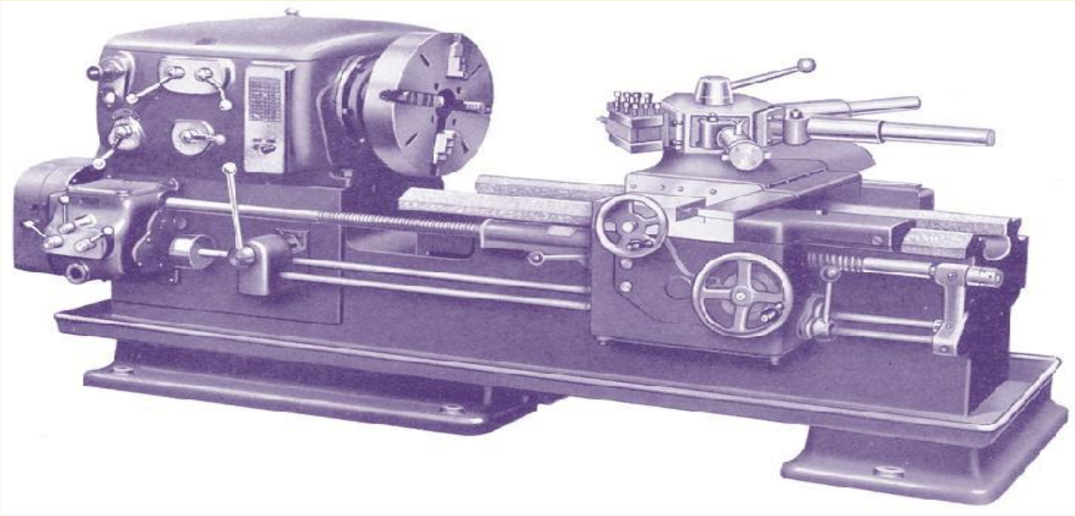
Tool room lathe

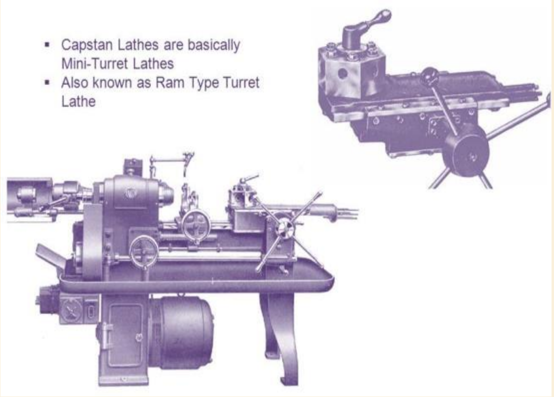
A tool room lathe has similar features of an engine lathe but is accurately built and has wide range of spindle speeds to perform precise operations and different feeds. It is costlier than a center lathe. This is mainly used for precision works like manufacturing tools, dies, jigs, fixtures and gauges.

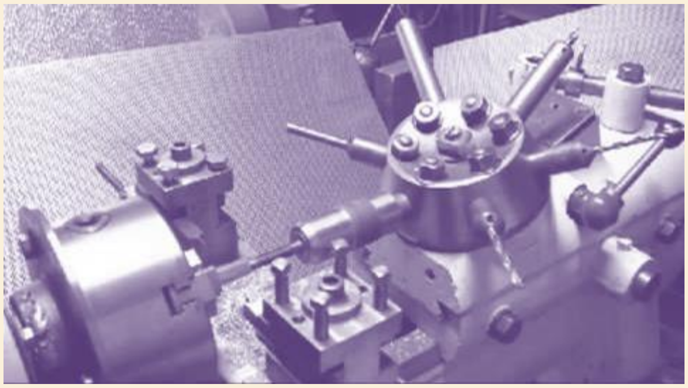
Semi-automatic lathe

Turret and Capstan lathes are known as semi-automatic lathes. These lathes are used for production work where large quantities of identical work pieces are manufactured. They are called semi-automatic lathes as some of the tasks are performed by the operators and the rest by the machines themselves.

A semi-skilled operator can do this at low cost and at shorter time. So, the cost of production is reduced. There are two tool posts in the machine namely four-way tool post and rear tool post. Four tools can be mounted on the four-way tool post and parting tool is mounted on the rear tool post. The tailstock of an engine lathe is replaced by a hexagonal turret. As many tools may be fitted on the six sides of the turret, different types of operations can be performed on a work piece without resetting of tools. The tool heads of a turret lathe and a capstan lathe are illustrated in Fig







Automatic Lathe Machines

An automatic lathe is a lathe (usually a metalworking lathe) whose actions are controlled automatically. Although all electronically controlled (CNC) lathes are automatic but they are usually not called by that name. The mechanically controlled lathes are called automatic lathe.

Automatic lathes are operated with complete automatic control. They are high speed, mass production lathes. An operator can look after more than one automatic lathe at a time. A lathe in which the work piece is automatically fed and removed without use of an operator. It requires very less attention after the setup has been made and the machine loaded.

- Once tools are set and the machine is started it performs automatically all the operations to finish the job.
- After the job is complete, the machine will continue to repeat the cycles producing identical parts.
- An operator can maintain five or six such a types of lathes at a time simply look after the general maintenance of the machine and cutting tools.
- It has heavier construction and provides wider range of speeds.
- The saddle carrying the turret head moves along the whole length of the bed. Much longer jobs can be machined.
- Turret head directly mounted on the saddle. The front tool post can carry 4 tools and rear tool post may have 1 or 2 tools. Turret may have4 to 6 tools.
- More than one tool may be set to operate simultaneously. There is no lead screw.

In this machine technology has been designed to make industrial tasks easier, faster and error free. Automatic Lathe Machines are extremely versatile machines that give big returns on small investment. Up to 80% of all turning jobs can be profitably handled by these automats with accuracy and precision. These automatic machines have proved economical for mass production of simple and complex turned parts for various engineering products. The simple design of these automats greatly reduces the time for changeover of tooling setup from one component to another.

Computer Numerical Controlled (CNC):

Computer numerical controlled (CNC) lathes are rapidly replacing the older production lathes (multi spindle, etc.) due to their ease of setting, operation, repeatability and accuracy. They are designed to use modern carbide tooling and fully use modern processes. The part may be designed and the tool paths programmed by the CAD/CAM process or manually by the programmer, and the resulting file uploaded to the machine, and once set and trialed the machine will continue to turn out parts under the occasional supervision of an operator.

The machine is controlled electronically via a computer menu style interface, the program may be modified and displayed at the machine, along with a simulated view of the process. The setter/operator needs a high level of skill to perform the process, however the knowledge base is broader compared to the older production machines where intimate knowledge of each machine was considered essential. These machines are often set and operated by the same person, where the operator will supervise a small number of machines (cell).

The design of a CNC lathe varies with different manufacturers, but they all have some common elements. The turret holds the tool holders and indexes them as needed, the spindle holds the work piece and there are slides that let the turret move in multiple axis simultaneously.

Special purpose lathe:

Special purpose lathes are used for special purposes and for jobs, which cannot be accommodated and conveniently machined on a standard lathe. Wheel lathe, “T” lathe, duplicating lathe are some examples of special purpose lathe.

Wheel lathe:

A wheel lathe is a machine tool used in the manufacturing and reconditioning of wheels for railway cars. Wheel lathes are used to re-cut the profile of the wheel in cases where the wheel has been worn down or compromised because of excessive use. Like other lathes, the wheel lathe works by gripping the work object in this case, the wheel in a piece called a chuck and rotating the object across a single fixed cutting point. As the wheel rotates across the axis of the cutting tool, strips of metal are shaved off its surface. The machine operator controls the lathe and shapes the wheel in a process known as turning.

“T” lathe

These lathes are used for production work where large quantities of identical work pieces are manufactured. These lathes are used for larger diameter facing of the work piece.

T lathe

Duplicating lathe

One type of specialized lathe is duplicating or copying lathe also known as Blanchard lathe after its inventor Thomas Blanchard. This type of lathe was able to create shapes identical to a standard pattern and it revolutionized the process of gun stock making in 1820's when it was invented.

Differences between a Engine lathe and turret lathe & capstan lathe

Engine lathe	Turret & Capstan lathe
1. There is only one tool post	1. There are two tool posts – four-way tool post and rear tool post
2. Tailstock is located at the right side of the bed	2. Tailstock is replaced by a hexagonal tool head called turret
3. Only one cutting tool can be held in the tailstock	3. A minimum of six tools can be held in the turret
4. No provision to control the tool movement (feed) automatically	4. Turret movement can be controlled automatically
5. Only one tool can be put into machining at a time. Tools have to be set every time according to the operation to be performed	5. More tools can be set on the turret and each of them can be set at the work one by one automatically
6. Setting of tools will take more time	6. Setting of cutting tool is easy
7. A skilled operator is necessary to work on the machine	7. After the initial settings are made, a semi-skilled operator can operate the machine
8. The machine has to be stopped to change the tool	8. Tools can be indexed even when the machine is on
9. The production cost is high	9. Production cost is reduced as the rate of production is more
10. Motors with 3 to 5 HP are used	10. Motors with 15 HP are used

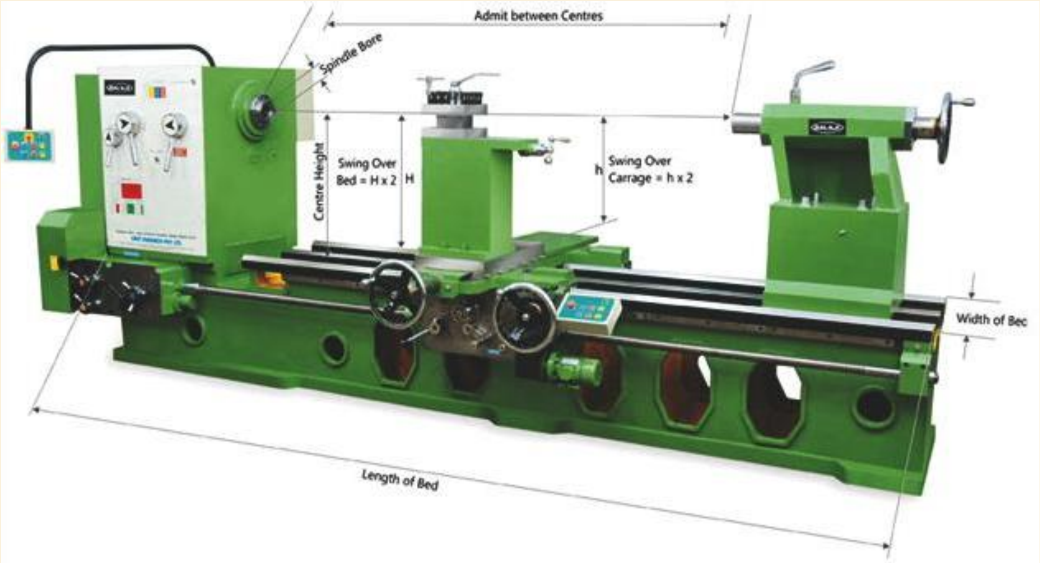
Differences between a turret lathe and a capstan lathe

Turret lathe	Capstan lathe
1. Turret tool head is directly fitted on the saddle and both of them appear like one unit.	1. Turret head is mounted on a slide called ram which is mounted on the saddle
2. Saddle is moved to provide feed to the tool	2. To provide feed to the tool, saddle is locked at a particular point and the ram is moved
3. It is difficult to move the saddle for feed	3. It is easy to move the ram for feed
4. As the saddle can be moved along the entire length of the bed, it is suitable for longer work pieces	4. As the movement of the ram is limited, it is suitable for machining shorter work pieces only
5. To index the turret tool head, a clamping lever is released and the turret is rotated manually	5. When the hand wheel for the ram is reversed, the turret tool head is indexed automatically
6. Limit dogs are used to control the distance of tool movement	6. To control the distance of tool movement, feed stop screws are provided at the rear side of the turret
7. Some turret lathes have the facility of moving the turret at right angles to the lathe axis	7. No such facility
8. Heavy and sturdy	8. Lighter in construction
9. Suitable for machining heavy and large work pieces	9. Only small and light work pieces are machined
10. Machining can be done by providing more depth of cut and feed	10. Only limited amount of feed and depth of cut are provided for machining

Size of a lathe

The size of a lathe is specified by the following points

- The length of the bed
- Maximum distance between live and dead center.
- The height of center from the bed
- The swing diameter
  - The swing diameter over bed - It refers to the largest diameter of the work that will be rotated without touching the bed
  - The swing diameter over carriage - It is the largest diameter of the work that will revolve over the saddle.
- The bore diameter of the spindle
- The width of the bed
- The type of the bed
- Pitch value of the lead screw
- Horse power of the motor
- Number and range of spindle speeds
- Number of feeds
- Spindle nose diameter
- Floor space required
- The type of the machine



Advantages of Lathe

- The single point cutting tool used in lathe is inexpensive.
- Single point cutting tool can be easily grounded to any desirable shape.
- The simplicity and ease of holding work.
- Easy adjustment and the simple tool give the lathe its great flexibility.
- lathe set up is very quick and easy and can be readily changed from one job to another.
- More productivity.
- Smaller to bigger diameter of jobs can be conveniently machined.
- Accurate job can be produced in lathe.
- Multiple operation can be performed at time (Ex; turning and drilling).
- Any types of job can be produced by using a different types lathe attachments.
- Mass production can be done by using a turning fixture.

Disadvantages of Lathe

- Highly skilled person is required to operate the lathe machine.
- Cost of the machine is high.
- Slower machining process due to single point cutting tooling used in lathe.
- Different types of lathe machine are required to manufacture the different types of jobs.
- Different types of lathe attachments are required to manufacture the different types of jobs.
- Complex shape jobs can to be produced in lathe.
- More safety precaution is required.

Application of Lathe

- Lathe machines are used in work shop, tool room, power plant, rolling mill, paper mill, textile, oil, mining, industries etc.
- Lathe machines are used for wood turning.
- Lathe machines are used for wood spinning.
- Lathe machines are used for polishing.
- Lathe machines are used to producing ornament.

Lathe machines are used for

- Facing
- Turning
- Chamfering
- Grooving
- Forming
- Knurling
- Undercutting
- Eccentric turning
- Taper turning
- Thread cutting (Internal & External)
- Drilling
- Reaming
- Boring
- Tapping

Work holding devices used in a lathe:

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

- Chucks
- Face plate

- Driving plate
- Carriers
- Mandrels
- Centers
- Rests

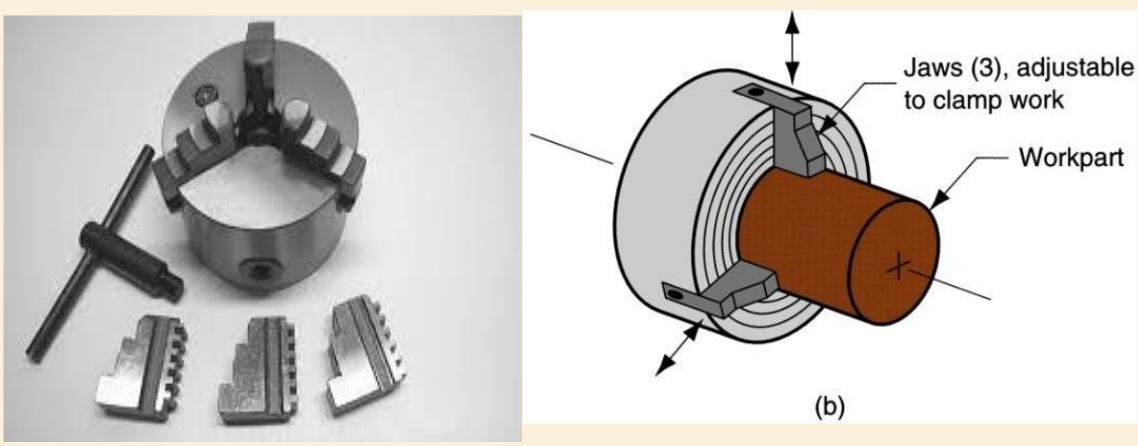
Chucks

Work pieces of short length, large diameter and irregular shapes, which cannot be mounted between centers, are held quickly and rigidly in chuck. There are different types of chucks namely, Three jaw universal chuck, Four jaw independent chuck, Magnetic chuck, Collet chuck and Combination chuck.

Three jaw self-centering chuck

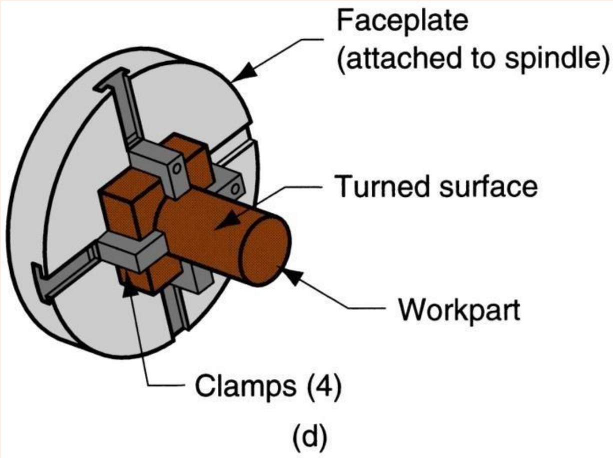
The three jaws fitted in the three slots may be made to slide at the same time by an equal amount by rotating any one of the three pinions by a chuck key. This type of chuck is suitable for holding and rotating regular shaped work pieces like round or hexagonal rods about the axis of the lathe. Work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

The work is held quickly and easily as the three jaws move at the same time. Fig 1.14 shows a three jaw chuck



Four jaw independent chuck

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

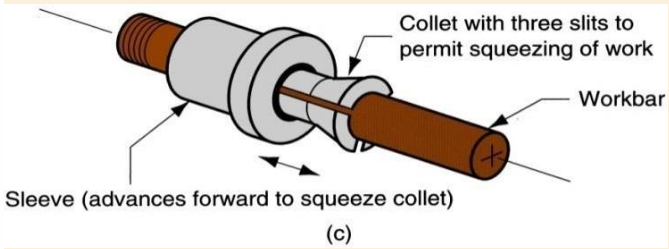


Magnetic chuck

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

Collet chuck

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



Face plate

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

Driving plate

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

Catch plate

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

Carrier

When a work piece is held and machined between centers, carriers are useful in transmitting the driving force of the spindle to the work by means of driving plates and catch plates. The work is held inside the eye of the carrier and tightened by a screw. Carriers are of two types and they are:

1. Straight tail carrier
2. Bent tail carrier

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

Mandrel

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

1. Plain mandrel
2. Step mandrel
3. Gang mandrel
5. Collar mandrel
6. Cone mandrel
7. Expansion mandrel

Plain mandrel

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

Gang mandrel

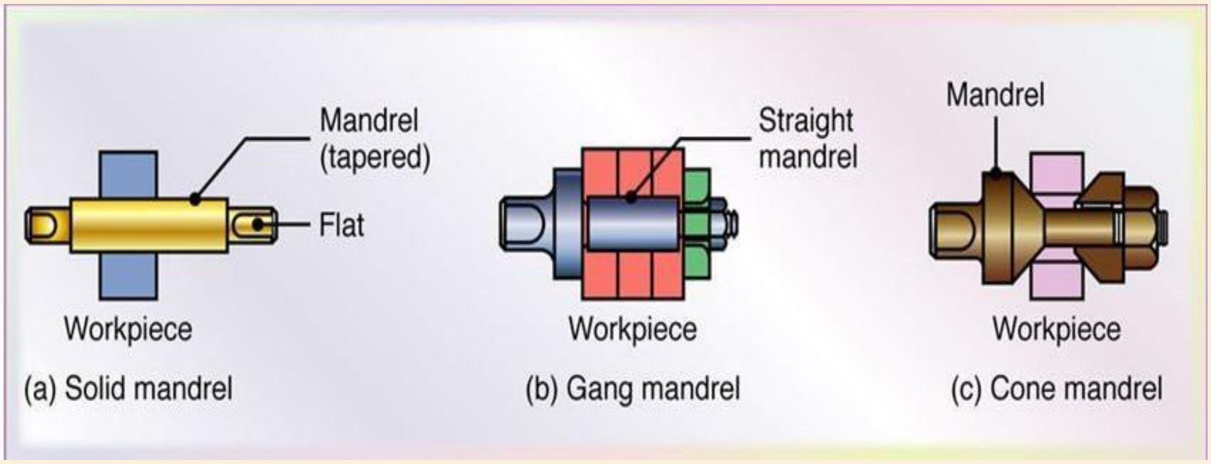
It has a fixed collar at one end and a movable collar at the threaded end. This mandrel is used to hold a set of hollow work pieces between the two collars by tightening the nut.

Screwed mandrel

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

Cone mandrel

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



Centers

Centers are useful in holding the work in a lathe between centers. The shank of a center has Morse taper on it and the face is conical in shape. There are two types of centers namely

- Live center
- Dead center

The live center is fitted on the headstock spindle and rotates with the work. The center fitted on the tailstock spindle is called dead center. It is useful in supporting the other end of the work. Centers are made of high carbon steel and hardened and then tempered. So the tip of the centers is wear resistant. Different types of centers are available according to the shape of the work and the operation to be performed. They are

1. Ordinary center
2. Ball center
3. Half center
4. Tipped center
5. Pipe center
6. Revolving center
7. Inserted type center

Rests

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

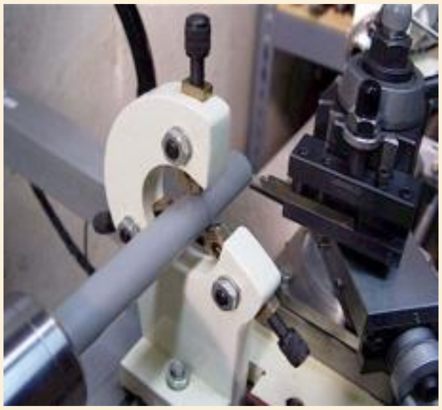
1. Steady rest
2. Follower rest

Steady rest

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

Follower rest

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



In order to reduce friction between the work and the jaws, proper lubricant should be used.

Cutting speed, feed and depth of cut

Cutting speed

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

$$\text{Cutting speed} = \frac{\Pi\ d\ n}{1{,}000}\ \text{m/min.}$$

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

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

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 the cutting time. But increased the feed greatly reduces the tool life. The feed depends on factors such as size, shape, strength and method of holding the component, the tool shape and its setting as regards overhang, the rigidity of the machine, depth of cut, power available, etc. Coarser feeds are used for roughing and finer feeds for finishing 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. It is expressed in millimeters.

In a lathe, the depth of cut is expressed as follows

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

Where

d_1 - Diameter of the work surface before machining

d_2 - Diameter of the machined surface

Machining Time:

The machining time in a lathe work can be calculated for a particular operation if the speed of the job, feed and length of the job.

If– s – is the feed of the job per revolution expressed in MM per revolution and – l – the length of the job in MM, then number of revolution of the job required for a complete cut will be – l/s ‖.

If the r p m of the work is – n – time taken to revolve the job through – l/s – number of revolution for a complete cut will be.

$$T = \frac{l}{S_r \times n}$$

Table showing cutting speed for various materials

Work material	Cutting tool material		
	High speed steel	Tungsten steel	Stellite
Mild steel	30 m/ min	80 m/ min	58 m/ min
High carbon steel	26 m/ min	65 m/ min	50 m/ min
Cast steel	15 m/ min	80 m/ min	42 m/ min
Cast iron	22 m/ min	80 m/ min	50 m/ min
Aluminium	90 m/ min	400 m/ min	330 m/ min
Brass	61 m/ min	200 m/ min	33 m/ min

EXAMPLE 1

Find the time required for one complete cut on a piece of work 350 mm long and 50mm diameter. The cutting speed is 35 meter per minute and the feed is 0.5 mm per revolutions.

$$\text{Cutting speed (v)} = \frac{\Pi \times d \times n}{1000}$$

$$35 = \frac{\Pi \times 50 \times n}{1000}$$

$$n = \frac{35 \times 1000}{\Pi \times 50}$$

$$n = 222.5 \text{ r p m}$$

$$\text{Machining time (T)} = \frac{l}{s_r \times n}$$

$$T = \frac{350}{0.5 \times 22.5}$$

$$T = 3.14 \text{ min.}$$

EXAMPLE 2

A steel shaft of 25 mm diameter is turned at a cutting speed of 50 meter per minute. Find the r p m of the shaft.

Solution,

Given date,

Diameter of work piece (d) =25 MM

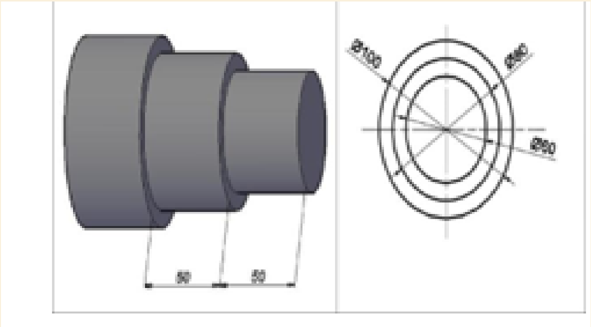
$$\text{Cutting speed (v)} = \frac{\Pi \times d \times n}{1000} \text{ m per min.}$$

$$= \frac{\Pi \times 25 \times n \; 50}{1000}$$

$$N = \frac{50 \times 1000}{\Pi \times 25} = 637 \text{ r p m.}$$

EXAMPLE 3

The part shown below will be turned in two machining steps. In the first step a length of (50 + 50) = 100 mm will be reduced from Ø100 mm to Ø80 mm and in the second step a length of 50 mm will be reduced from Ø80 mm to Ø60 mm. Calculate the required total machining time T with the following cutting conditions:



Cutting speed V=80 m/min,
Feed is f=0.8 mm/rev,
Depth of cut = 3 mm per pass.

SOLUTION: V = 80 m/min
f = 0.8 mm/rev

The turning will be done in 2 steps. In first step a length of (50 + 50) = 100 mm will be reduced from Ø100 mm to Ø80 mm and in second step a length of 50 mm will be reduced from Ø80 mm to Ø60 mm.

Introduction to Cutting Fluids

Cutting fluids are used in metal machining for a variety of reasons such as improving tool life, reducing work piece thermal deformation, improving surface finish and flushing away chips from the cutting zone. Practically all cutting fluids presently in use fall into one of four categories:

- Straight oils
- Soluble oils
- Semi-synthetic fluids
- Synthetic fluids

- Straight oils are non-emulsion and are used in machining operations in an undiluted form. They are composed of a base mineral or petroleum oil and often contains polar lubricants such as fats, vegetable oils and esters as well as extreme pressure additives such as Chlorine, Sulphur and Phosphorus. Straight oils provide the best lubrication and the poorest cooling characteristics among cutting fluids.
- Synthetic Fluids contain no petroleum or mineral oil base and instead are formulated from alkaline inorganic and organic compounds along with additives for corrosion inhibition. They are generally used in a diluted form (usual concentration = 3 to 10%). Synthetic fluids often provide the best cooling performance among all cutting fluids.
- Soluble Oil Fluids form an emulsion when mixed with water. The concentrate consists of a base mineral oil and emulsifiers to help produce a stable emulsion. They are used in a diluted form (usual concentration = 3 to 10%) and provide good lubrication and heat transfer performance. They are widely used in industry and are the least expensive among all cutting fluids.

Semi-synthetic fluids are essentially combination of synthetic and soluble oil fluids and have characteristics common to both types. The cost and heat transfer performance of semi-synthetic fluids lie between those of synthetic and soluble oil fluids.

Cutting Fluid Effects in Machining

The primary functions of cutting fluids in machining are:

- Lubricating the cutting process primarily at low cutting speeds
- Cooling the work piece primarily at high cutting speeds
- Flushing chips away from the cutting zone

Secondary functions include:

- Corrosion protection of the machined surface
- Enabling part handling by cooling the hot surface.

Process effects of using cutting fluids in machining include:

- Longer Tool Life
- Reduced Thermal Deformation of Work piece
- Better Surface Finish (in some applications)
- Ease of Chip and Swarf handling

Cutting Fluid Selection Criteria

The principal criteria for selection of a cutting fluid for a given machining operation are:

- Process performance:
    - Heat transfer performance
    - Lubrication performance
    - Chip flushing
    - Fluid mist generation
    - Fluid carry-off in chips
    - Corrosion inhibition
    - Fluid stability (for emulsions)
- Cost Performance
- Environmental Performance
- Health Hazard Performance

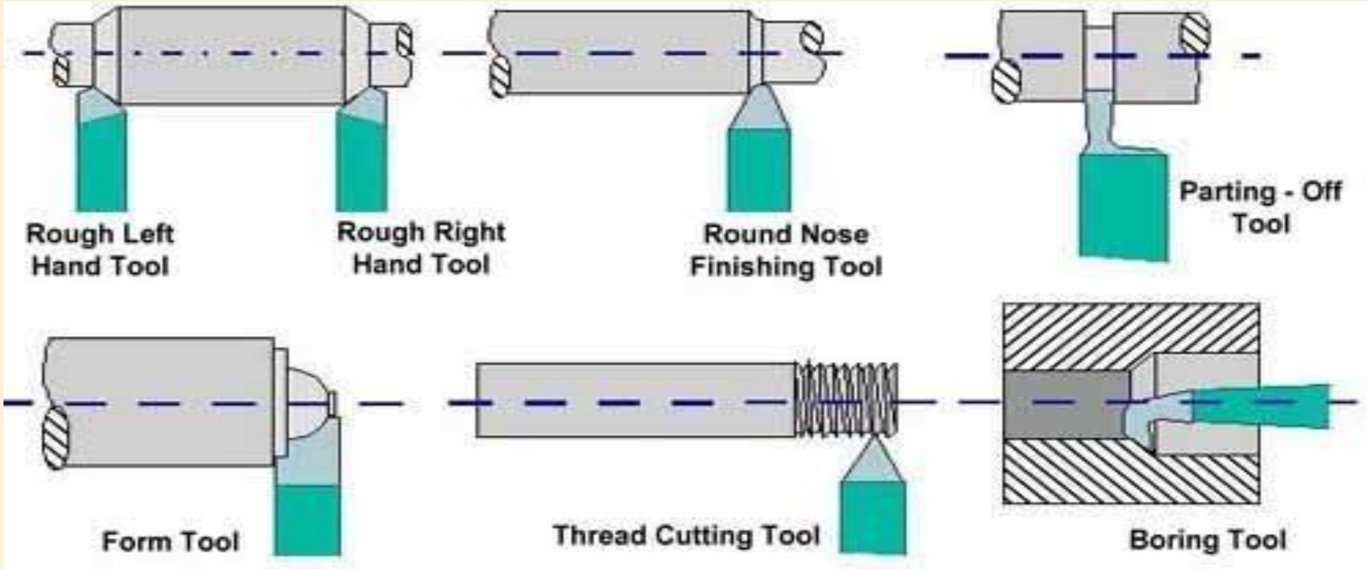
METAL	COOLANTS
Aluminum and its alloys	Soluble oil/ Kerosene and lard oil compounds/ Light non-viscous oil/ Kerosene and soluble oil mixtures.
Steel (M.S.)	Soluble oil/ Sulphurised mineral oil
Brass Dry	Soluble oil/ Kerosene and lard oil compounds/ Light non-viscous neutral oil
Copper	Soluble oil
Malleable iron	Soluble oil/ Sulphurised neutral oil
Stainless steel	Sulphurised oil/ High extreme pressure value mineral oil
Steel (hard)	Soluble oil / Sulphurised oil/ Turpentine
Wrought Iron	Soluble oil/ Sulphurised oil/ High animal oil content mineral oil
Cast Iron	Dry or with a jet of compressed air for cooling medium

Tools used in a lathe:

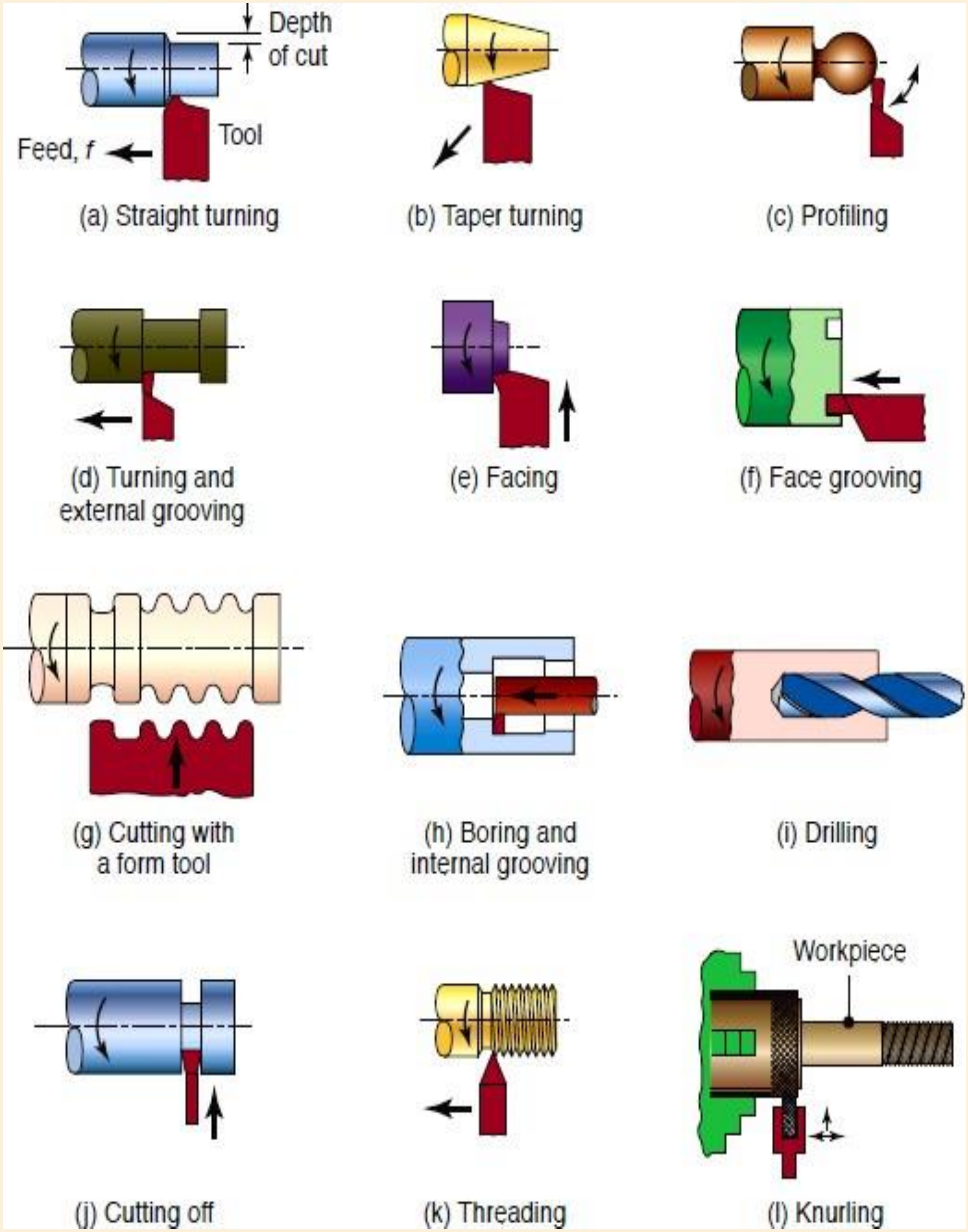
Tools used in a lathe are classified as follows

- According to the construction, the lathe tools are classified into three types
    - Solid tool
    - Brazed tipped tool
    - Tool bit and tool holders

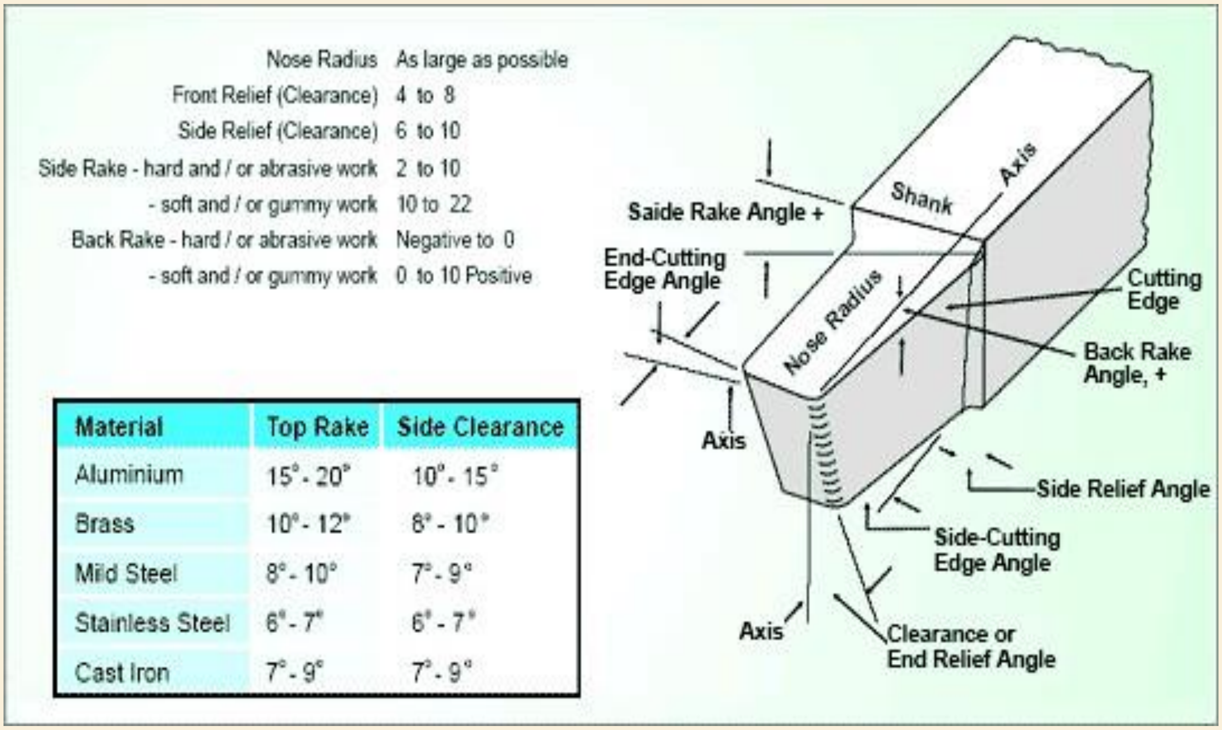
- According to the operation to be performed, the cutting tools are classified as
  - Turning tool
  - Thread cutting tool
  - Facing tool
  - Forming tool
  - Parting tool
  - Grooving tool
  - Boring tool
  - Internal thread cutting tool
  - Knurling tool
- According to the direction of feed movement, the following tools are used
  - Right hand tool
  - Left hand tool
  - Round nose tool



DIFFERENT TYPES OF OPERATION:



TOOL GEOMETRY AND NOMECLATURE



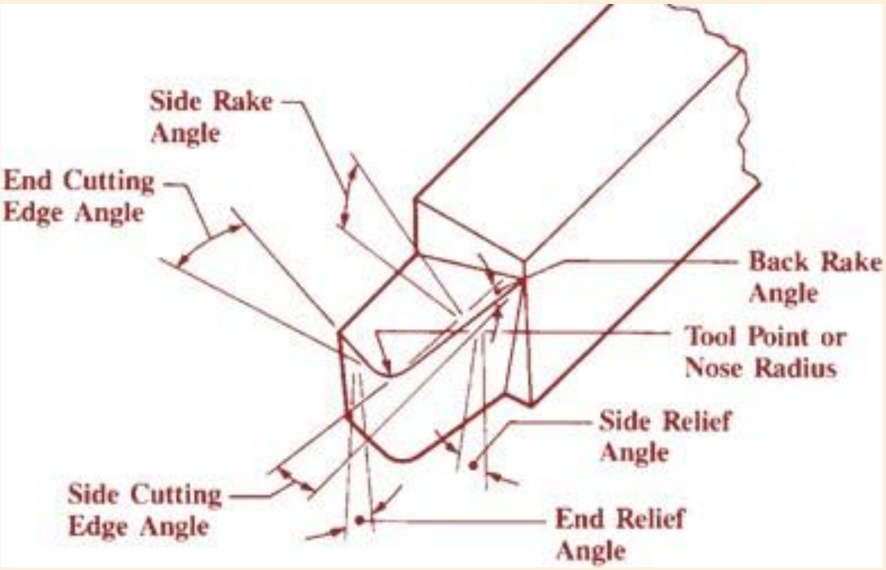
Material	Top Rake	Side Clearance
Aluminium	15°- 20°	10°- 15°
Brass	10°- 12°	8°- 10°
Mild Steel	8°- 10°	7°- 9°
Stainless Steel	6°- 7°	6°- 7°
Cast Iron	7°- 9°	7°- 9°

- **CLEARANCE:** The intentional relief provided on the faces of the cutting tool to give a sharp cutting edge and thereby preventing the other portions of the tool from rubbing the job is called as clearance. The tool may get heated up because of the friction caused by the rubbing action if a proper clearance for the cutting edge is not provided. The side adjacent to the cutting edge is ground and relieved. This is called as the Side clearance angle. Too much side clearance will weaken the cutting edge and cause the cutting edge to chip off. Similarly, the front portion is also ground at an angle and this is called the Front clearance angle. Too much front clearance will weaken the cutting edge. The common angles provided on a Right Hand Roughing tool.

- **Back Rake** is to help control the direction of the chip, which naturally curves into the work due to the difference in length from the outer and inner parts of the cut. It also helps counteract the pressure against the tool from the work by pulling the tool into the work.

- **Side Rake** along with back rake controls the chip flow and partly counteracts the resistance of the work to the movement of the cutter and can be optimized to suit the particular material being cut. Brass for example requires a back and side rake of 0 degrees while aluminum uses a back rake of 35 degrees and a side rake of 15 degrees.

- **Nose Radius** makes the finish of the cut smoother as it can overlap the previous cut and eliminate the peaks and valleys that a pointed tool produces. Having a radius also strengthens the tip, a sharp point being quite fragile.
- **All the other angles** are for clearance in order that no part of the tool besides the actual cutting edge can touch the work. The front clearance angle is usually 8 degrees while the side clearance angle is 10-15 degrees and partly depends on the rate of feed expected.
- **Minimum angles** which do the job required are advisable because the tool gets weaker as the edge gets keener due to the lessening support behind the edge and the reduced ability to absorb heat generated by cutting.
- **The Rake angles** on the top of the tool need not be precise in order to cut but to cut efficiently there will be an optimum angle for back and side rake.



Cutting Tool Materials

Principal categories of cutting tools include single point lathe tools, multi-point milling tools, drills, reamers, and taps. All of these tools may be standard catalog items or tooling designed and custom-built for a specific manufacturing need.

The number one error when selecting tooling is calculating monetary savings based on lowest cost per tool, rather than on maximized productivity and extended tool life. To effectively select tools for machining, a machinist or engineer must have specific information about:

- The starting and finished part shape
- The work piece hardness
- The material's tensile strength

- The material's abrasiveness
- The type of chip generated
- The work holding setup
- the power and speed capacity of the machine tool

Changes in any of these conditions may require a thorough review of any cutting tool selection.

Different machining applications require different cutting tool materials. The ideal cutting tool material should have all of the following characteristics:

- Harder than the work it is cutting
- High temperature stability
- Resists wear and thermal shock
- Impact resistant

Chemically inert to the work material and cutting fluid

No single cutting tool material incorporates all these qualities. Instead, trade-offs occur among the various tool materials. For example, ceramic cutting tool material has high heat resistance, but has a low resistance to shock and impact. Every new and evolving tool development has an application where it will provide superior performance over others. Many newer cutting tool materials tend to reduce, but not eliminate the applications of older cutting tool materials.

Basic properties that cutting must possess are:

- Tool material must be at least 30 to 50% harder than the work piece material.
- Tool material must have high hot hardness temperature.
- High toughness
- High wear resistance
- High thermal conductivity
- Lower coefficient of friction
- Easiness in fabrication and cheap

Different elements used in cutting tool materials and their properties are

Element	Properties
Tungsten	Increases hot hardness Hard carbides formed Abrasion resistance
Molybdenum	Increases hot hardness Hard carbides formed Improving resistance
Chromium	Depth hardenability during heat treat hard carbides are formed improving abrasion resistance some corrosion resistance
Vanadium	combines with carbon for wear resistance retards grain growth for better toughness
Cobalt	Increases hot hardness, toughness
Carbon	Hardening element forms carbides

Different cutting tool materials used for cutting operations in practice are high carbon steel, high speed steel, non -ferrous cast alloys, cemented carbides, ceramics and sintered oxides, cerements, diamond, cubic boron nitride, UCON and sialon.

1. High Carbon Steel tools

- Its composition is C = 0.8 to 1.3%, Si = 0.1 to 0.4% and Mn = 0.1 to 0.4%.
- It is used for machining soft metals like free cutting steels and brass and used as chisels etc.
- These tool loose hardness above 250°C.

- Hardness of tool is about Rc = 65.
- Used at cutting speed of 5m/min.

2. High speed steel (H.S.S)

- General use of HSS is 18-4-1.
- 18-- Tungsten is used to increase hot hardness and stability.
- 4 – Chromium is used to increase strength.
- Vanadium is used to maintain keenness of cutting edge.
- In addition to these 2.5% to 10% cobalt is used to increase red hot hardness.

3.Rest iron

H.S.S is used for drills, milling cutters, single point cutting tools, dies, reamers etc.

- It loses hardness above 600°C.
- Sometimes tungsten is completely replaced by Molybdenum.
- Molybdenum based H.S.S is cheaper than Tungsten based H.S.S and also slightly greater toughness but less water resistance.

4. Non – ferrous cast alloys

- It is an alloy of Cobalt – 40 to 50%,
- Chromium – 27 to 32%,
- Tungsten – 14 to 29%,
- Carbon – 2 to 4%

- It cannot heat treated and are used as cast form.
- It loses its hardness above 800°C
- It will give better tool life than H.S.S and can be used at slightly higher cutting speeds.
- They are weak in tension and like all cast materials tend to shatter when subjected to shock load or when not properly supported.

5. Cemented carbides

- Produced by powder metallurgy technique with sintering at 1000°C.
- Speed can be used 6 to 8 times that of H.S.S.
- Can withstand up to 1000°C.
- High compressive strength is more than tensile strength.
- They are very stiff and their young‘s modulus is about 3 times that of the steel.
- High wear resistance.
- High modulus of elasticity.
- Low coefficient of thermal expansion.
- High thermal conductivity, low specific heat, low thermal expansion.

According to ISO the various grades of carbide tool materials grouped as

- For cutting CI and non-ferrous metals are designated as K10 to K50
- For cutting steel are designated as p10 to p50
- For general purpose application are designated as M10 to M50.

The advantages of carbide tools are

- They have high productivity capacity.
- They produce surface finish of high quality.
- They can machine hardened steel.
- Their use leads to reduction in machining costs.

6. Ceramics and sintered oxides

- Ceramics and sintered oxides are basically made of Al_2O_3, These are made by powder metallurgy technique.
- Used for very high speed (500m/min).
- Used for continuous cutting only
- Can withstand up to 1200°C.
- Have very abrasion resistance.
- Used for machining CI and plastics.
- Has less tendency to weld metals during machining.

- Generally used ceramic is sintered carbides.
- Another ceramic tool material is silicon nitride which is mainly used for CI.

7. Cermet's

- Cermet's is the combination of ceramics and metals and produced by Powder Metallurgy process.
- When they combine ceramics will give high refractoriness and metals will give high toughness and thermal shock resistance.
- For cutting tools usual combination as Al_2O3 + W + Mo + boron + Ti etc.
- Usual combination 90% ceramic, 10% metals.
- Increase in % of metals reduces brittleness some extent and also reduces wear resistance.

8. Diamond

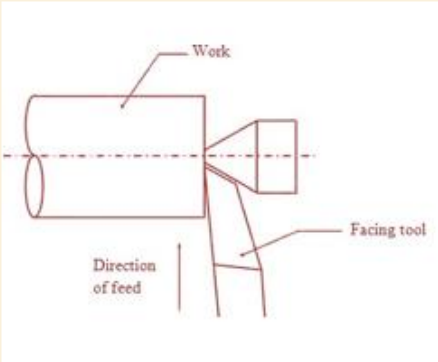
- Diamond has
  1. Extreme hardness
  2. Low thermal expansion.
  3. High thermal conductivity.
  4. Very low coefficient of friction.
- Cutting tool material made of diamond can withstand speeds ranging from 1500 to 2000m/min.
- On ferrous metals diamond are not suitable because of the diffusion of carbon atoms from diamond to work-piece.
- Can withstand above 1500°C.
- A synthetic (manmade) diamond with polycrystalline structure is recently introduced and made by powder metallurgy process.

Operations performed in a lathe

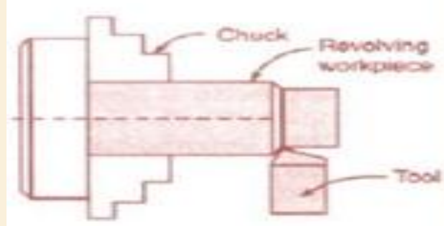
Various operations are performed in a lathe other than plain turning. They are

- Facing
- Turning
  - Straight turning
  - Step turning
- Chamfering
- Grooving
- Forming
- Knurling
- Undercutting
- Eccentric turning
- Taper turning
- Thread cutting
- Drilling
- Reaming
- Boring
- Tapping

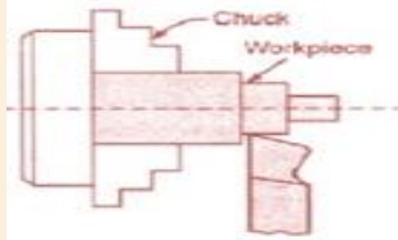
Facing: Facing is the operation of machining the ends of a piece of work to produce flat surface square with the axis. The operation involves feeding the tool perpendicular to the axis of rotation of the work.



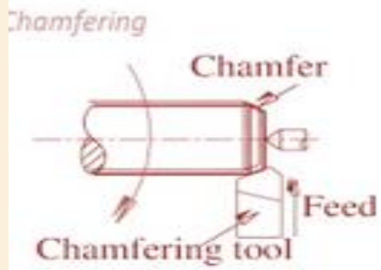
Turning: Turning in a lathe is to remove excess material from the work piece to produce a cylindrical surface of required shape and size.



Straight turning: The work is turned straight when it is made to rotate about the lathe axis and the tool is fed parallel to the lathe axis. The straight turning produces a cylindrical surface by removing excess metal from the work pieces.

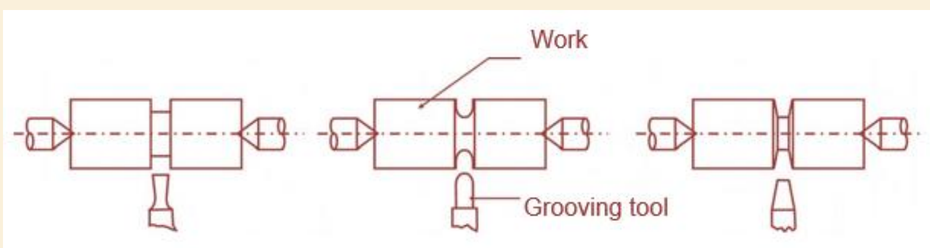


Chamfering: Chamfering is the operation of beveling the extreme end of the work piece. The form tool used for taper turning may be used for this purpose. Chamfering is an essential operation after thread cutting so that the nut may pass freely on the threaded work piece.



Grooving

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



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

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

Knurls are available in coarse, medium and fine pitches. The patterns may be straight, inclined or diamond shaped.

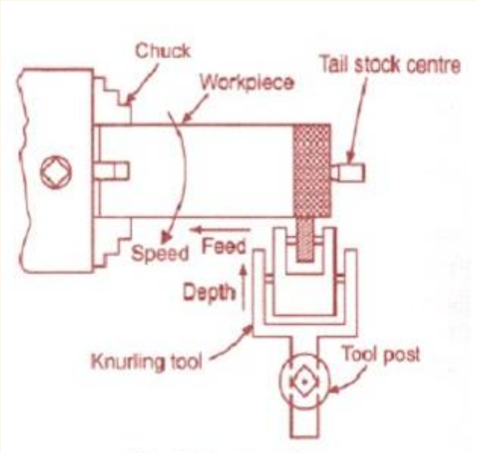


Fig. 7.17. Knurling

purpose of knurling;

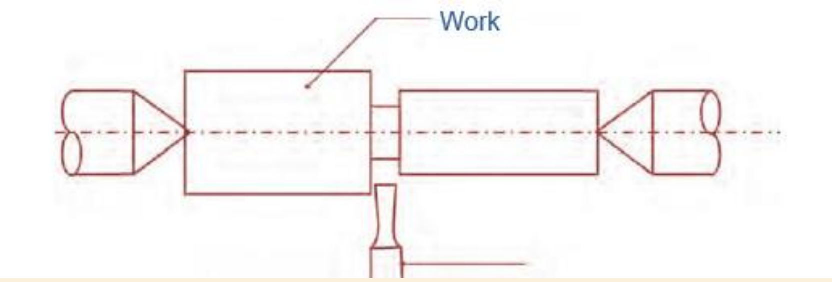
- to provide an effective gripping surface
- to provide better appearance to the work

to slightly increase the diameter of the work

Undercutting: Undercutting is done;

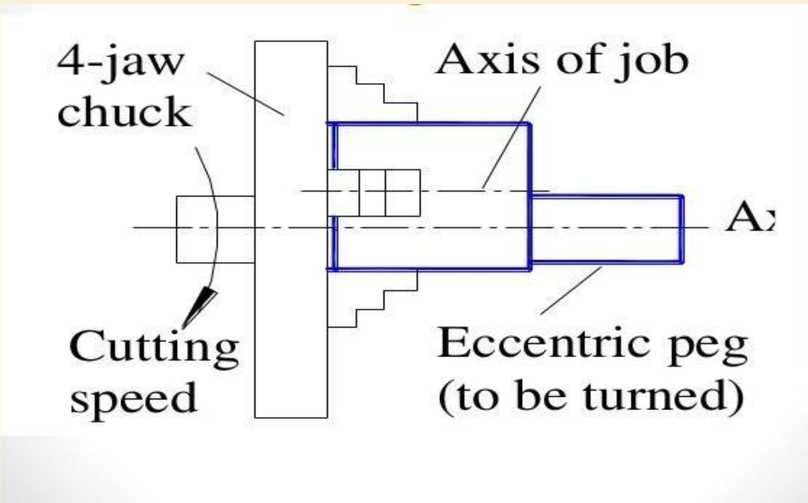
- at the end of a hole
- near the shoulder of stepped cylindrical surfaces
- at the end of the threaded portion in bolts

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



Eccentric turning

If a cylindrical work piece has two separate axes of rotating, one being out of center to the other, the work piece is termed as eccentric and turning of different surfaces of the work piece is known as eccentric turning. *Eccentric turning is shown in Fig. 1.37.* The distance between the axes is known as offset. Eccentric turning may also be done on some special machines. If the offset distance is more, the work is held by means of special centers. If the offset between the centers is small, two sets of centers are marked on the faces of the work. The work is held and rotated between each set of centers to machine the eccentric surfaces.



Taper turning:

Taper

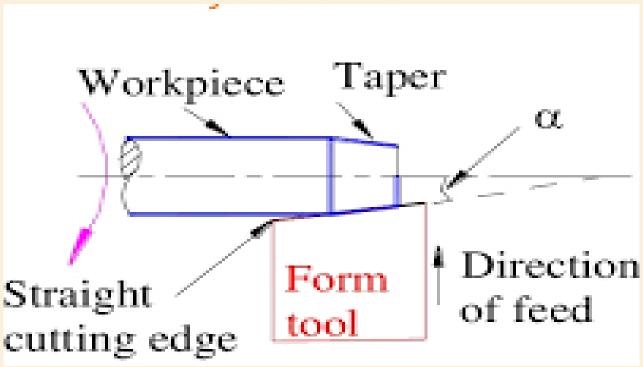
A taper may be defined as a uniform increase or decrease in diameter of a piece of work measured along its length.

Taper turning methods

- Form tool method
- Compound rest method
- Tailstock set over method
- Taper turning attachment method
- Combined feed method

Form tool method: A broad nose tool is ground to the required length and angle. It is set on the work by providing feed to the cross-slide. When the tool is fed into the work at right angles to the lathe axis, a tapered surface is generated.

This method is limited to turn short lengths of taper only. The length of the taper is shorter than the length of the cutting edge. Less feed is given as the entire cutting edge will be in contact with the work.



Compound rest method:

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

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

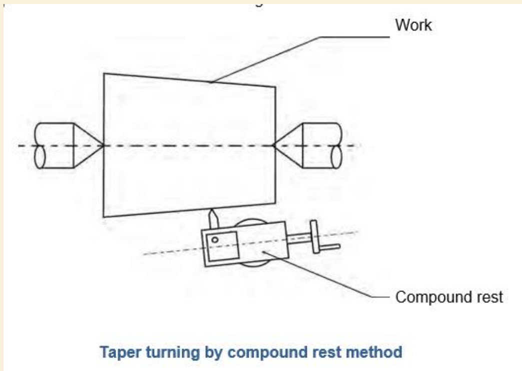


Fig. 1.39

Where

D – Larger diameter
d – Smaller diameter
l – Length of the taper
Ø - Half taper angle

The compound rest is swiveled to the angle calculated as above and clamped. Feed is given to the compound slide to generate the required taper. Taper turning by compound rest method is illustrated in Fig. 1.39

Taper turning by compound rest method Formula

$$\tan \text{Ø} = \frac{D - d}{2 \times l}$$

Where D – Larger diameter
d – Smaller diameter
l – Length of the taper, Ø - Half taper angle

The compound rest is swiveled to the angle calculated as above and clamped. Feed is given to the compound slide to generate the required taper. Taper turning by compound rest

Example

Determine the angle at which the compound rest will be swiveled when cutting a taper on a piece of work having the following dimension (i) outer diameter of rod 60 mm (ii) the length of tapered portion 80 mm (iii) smallest diameter on the tapered end of the rod 20 mm.

$$\tan \alpha = \frac{D - d}{2 \times l} = \frac{60 - 20}{2 \times 80} = \frac{40}{160} = \frac{1}{4} = 0.25$$

$\tan \alpha = 0.25$, $\alpha = \tan^{-1}(0.25)$, $\alpha = 14° 2'$

The compound rest should be swiveled at an angle of 14° 2'

2. The spindle end of a milling machine arbor has a taper of 7: 24. Determine the setting of the compound rest.

$$\tan \alpha = \frac{D - d}{2 \times l} = \ldots \quad \tan \alpha = \frac{k}{2}, \quad k = \frac{D - d}{l}$$

$$\tan \alpha = \frac{k}{2} = \frac{7}{2 \times 24} = \frac{7}{48} = 0.1458$$

$\tan \alpha = 0.1458$, $\alpha = \tan^{-1}(0.1458)$, $\alpha = 8° 18'$

Tailstock set over method

Turning taper by the set over method is done by shifting the axis of rotation of the work piece at an angle to the lathe axis and feeding the tool parallel to the lathe axis. The construction of tailstock is designed to have two parts namely the base and the body. The base is fitted on the bed guide ways and the body having the dead center can be moved at cross to shift the lathe axis.

The amount of set over - s, can be calculated as follows

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

where s - Amount of set over

D – Larger diameter

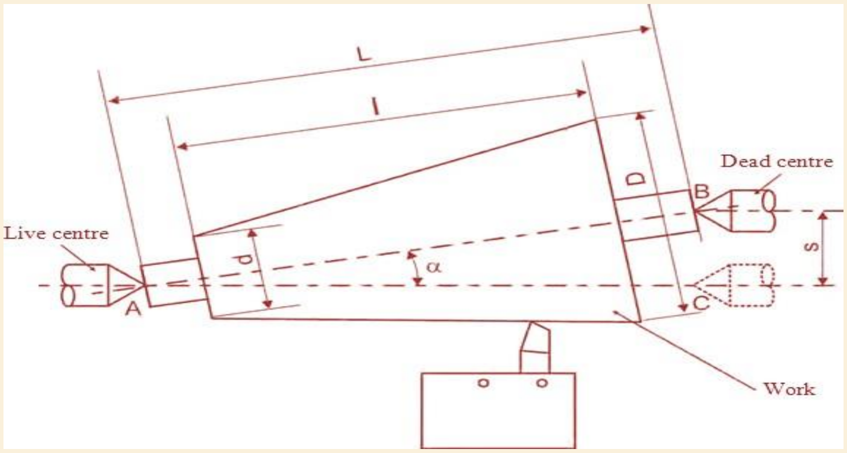
d – Smaller diameter

L - Length of the work

l – Length of the taper

The dead center is suitably shifted from its original position to the calculated distance. The work is held between centers and longitudinal feed is given by the carriage to generate the taper. The advantage of this method is that the taper can be turned to the entire length of the work. Taper threads can also be cut by this method.

The amount of set over being limited, this method is suitable for turning small tapers (approx. up to 8°). Internal tapers cannot be done by this method.



The amount of set over required to machine a particular taper may be calculated as; From right angle triangle ABC In Fig.

$$BC = AB \sin \alpha,$$

where

BC= Set over,
AB= L,

Set over= L Sin α.

If the angle α, the angle of taper, is a very small, for all practical purposes, sin α ≈ tan α or set over = L Tan α,

$$\text{Set over} = L \times \frac{D - d}{2 \times l}$$

If the taper is turned on the entire length of the work piece than l = L and the equation become;

$$\text{Set over} = L \times \frac{D - d}{2 \times L}, \qquad \text{Set over} = \frac{D - d}{2}$$

$\frac{D - d}{L}$ being termed as conicity or amount of taper, the

formula may be written in the following form

$$\text{set over} = \frac{\text{Entire length of the work x conicity}}{2}$$

The dead center is suitably shifted from its original position to the calculated distance. The work is held between centers and longitudinal feed is given by the carriage to generate the taper.

The advantage of this method is that the taper can be turned to the entire length of the work. Taper threads can also be cut by this method.

The amount of set over being limited, this method is suitable for turning small tapers (approx. up to 8°). Internal tapers cannot be done by this method.

Example;

1. The length of a work is 200MM the amount t a p e r is 1: 50, find the set Over required

$$\text{set over} = \frac{\text{Entire length of the work x conicity}}{2}$$

$$\text{set over} = \frac{200 \times 1/50}{2} = 2\ \text{MM}$$

2. Determine the amount set over required to turn a taper on the entire length of a work piece having diameter of lager end 30 MM a diameter of small end 20 MM.

$$\text{Set over} = \frac{D - d}{2} = \frac{30 - 20}{2} = 5\ \text{MM.}$$

3. A shaft 1200 mm long h. as a taper of 1: 200 for a length of 600 mm The maximum diameter of the shaft is 75 mm. Determine the minimum diameter of the shaft and the amount of set over.

Length of the taper = 600 mm

$$\text{Set over} = \frac{D - d}{L}$$

$$\frac{1}{200} = \frac{75 - d}{600}$$

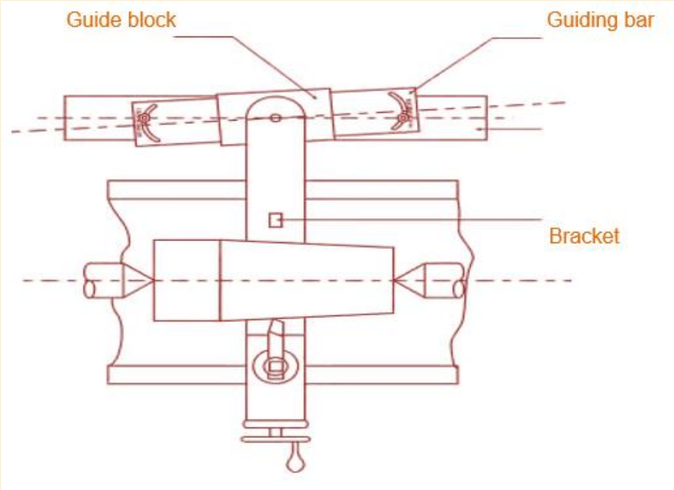
$$\frac{600}{200} = 75 - d, \qquad 3 = 75 - d \qquad d = 75 - 3\ d = 72\ \text{mm}$$

$$\text{Set over} = L \times \frac{D - d}{2 \times l}$$

$$\text{Set over} = 1200 \times \frac{75 - 72}{2 \times 600} = 3 \text{ mm}$$

Taper attachment method: The taper attachment consists of a bracket which is attached to the rear end of the lathe bed. It supports a guide bar pivoted at the center. The bar having graduation in degrees may be swiveled on either side of the zero graduation and set at the desired angle to the lathe axis. A guide block is mounted on the guide bar and slides on it. The cross slide is made free from its screw by removing the binder screw. The rear end of the cross slide is tightened with the guide block by means of a bolt. When the longitudinal feed is engaged, the tool mounted on the cross slide will follow the angular path as the guide block will slide on the guide bar set at an angle of the lathe axis. The depth of cut is provided by the compound slide which is set parallel to the cross-slide.

The advantage of this method is that long tapers can be machined. As power feed can be employed, the work is completed at a shorter time. The disadvantage of this method is that internal tapers cannot be machined. Taper turning by taper attachment method is illustrated in Fig.

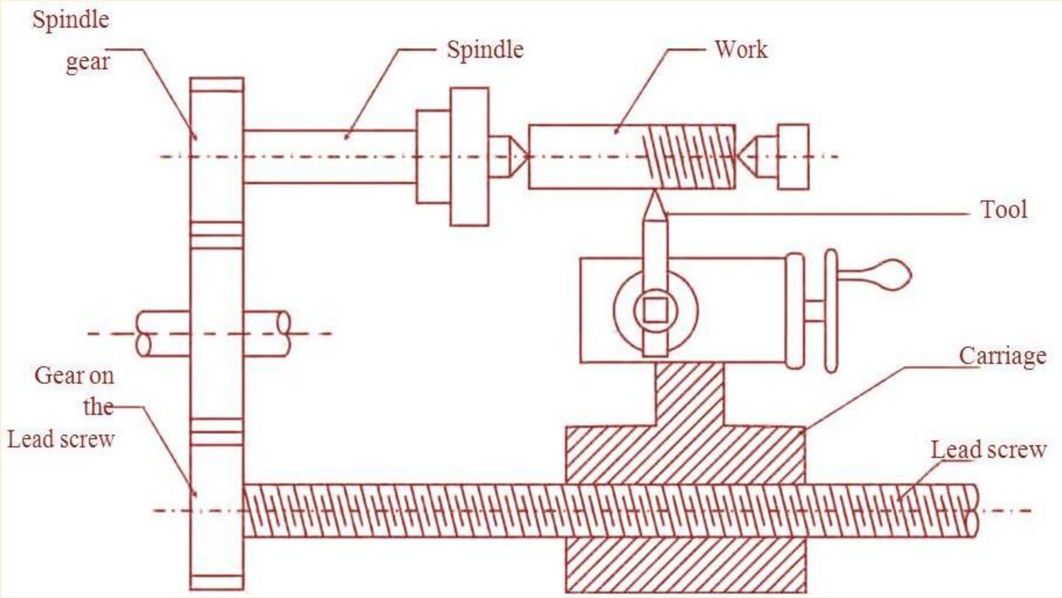


Combined feed method: Feed is given to the tool by the carriage and the cross-slide at the same time to move the tool at resultant direction to turn tapers.

Thread cutting: Thread cutting is one of the most important operations performed in a lathe. The process of thread cutting is to produce a helical groove on a cylindrical surface by feeding the tool longitudinally.

The job is revolved between centers or by a chuck. The longitudinal feed should be equal to the pitch of the thread to be cut per revolution of the work piece.

- The carriage should be moved longitudinally obtaining feed through the lead screw of the lathe.
- A definite ratio between the longitudinal feed and rotation of the headstock spindle should be found out. Suitable gears with required number of teeth should be mounted on the spindle and the lead screw.
- A proper thread cutting tool is selected according to the shape of the thread. It is mounted on the tool post with its cutting edge at the lathe axis and perpendicular to the axis of the work.
- The position of the tumbler gears is adjusted according to the type of the thread (right hand or left hand).
- Suitable spindle speed is selected and it is obtained through back gears.
- Half nut lever is engaged at the right point as indicated by the thread chasing dial.
- Depth of cut is set suitably to allow the tool to make a light cut on the work.
- When the cut is made for the required length, the half nut lever is disengaged. The carriage is brought back to its original position and the above procedure is repeated until the required depth of the thread is achieved.
- After the process of thread cutting is over, the thread is checked by suitable gauges.



Thread cutting calculation

Calculating for change wheel:

To calculate the wheel required for cutting screw of certain pitch it is necessary to know how the ratio obtained and exactly where the driving and driven wheel are to be obtained. Suppose the pitch of lead screw is 12 mm and it is required to cut a screw of 3 mm pitch, then the lathe spindle must rotate 4 times the speed of the lead screw, that is

$$\frac{\text{Spindle turn}}{\text{Lead screw turn}} = \frac{4}{1}$$

But $\frac{\text{Spindle turn}}{\text{Lead screw turn}} = \frac{4}{1}$ means that we must have

$$\frac{\text{Driver teeth}}{\text{Driven teeth}} = \frac{1}{4}$$

since a small gear rotates faster than a larger one with which it is connected.

Hence we may say $\frac{\text{Driver teeth}}{\text{Driven teeth}} = \frac{\text{lead screw turn}}{\text{spindle turn}}$

$$\boldsymbol{\frac{\text{Driver teeth}}{\text{Driven teeth}} = \frac{\text{pitch of the screw to be turn (work)}}{\text{pitch of the lead screw}}}$$

Often engine lathe is equipped with a set of gears ranging from 20 to 120 teeth in step of 5 teeth and one gear with 127 teeth.

Example.

1. The pitch of the lead screw is 6 mm and pitch of the thread to be cut is 1 mm find the change gear.

$$\frac{\text{Driver teeth}}{\text{Driven teeth}} = \frac{\text{pitch of the work}}{\text{pitch of the lead screw}}$$

$$\frac{\text{Driver teeth}}{\text{Driven teeth}} = \frac{1}{6}$$

$$\frac{\text{Driver teeth}}{\text{Driven teeth}} = \frac{1 \times 20}{6 \times 20} = \frac{20}{120}$$

The driver will have **20** T and the driven will have gear on the lead screw 120T

2. The pitch of the lead screw is 6 mm and pitch of the thread to be cut is 1.25 mm. Find the change gear.

$$\frac{\text{Driver teeth}}{\text{Driven teeth}} = \frac{\text{pitch of the work}}{\text{pitch of the lead screw}}$$

$$\frac{\text{Driver teeth}}{\text{Driven teeth}} = \frac{1.25}{6}$$

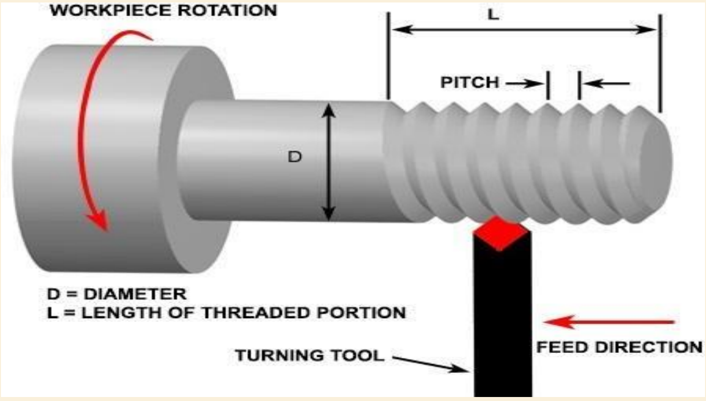
$$\frac{\text{Driver teeth}}{\text{Driven teeth}} = \frac{1.25 \times 4}{6 \times 4} = \frac{5}{24} = \frac{5 \times 1}{4 \times 6}$$

$$\frac{\text{Driver teeth}}{\text{Driven teeth}} = \frac{5}{4} \times \frac{10}{10} \times \frac{1}{6} \times \frac{20}{20}$$

$$\frac{\text{Driver teeth}}{\text{Driven teeth}} = \frac{50}{40} \times \frac{20}{120}$$

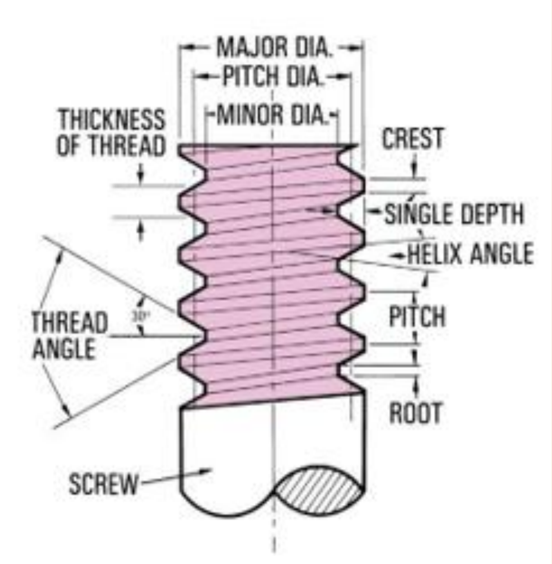
The driver gear will have 5**0** T and 20 T and the driven gear will have 40T and 120T

Threads and Thread Cutting:



- Used for hundreds of years for holding parts together, making adjustments, and transmitting power and motion
- Art of producing threads continually improved
- Massed-produced by taps, dies, thread rolling, thread milling, and grinding
- Thread
- Helical ridge of uniform section formed on inside or outside of cylinder or cone
- Used for several purposes:
    - Fasten devices such as screws, bolts, studs, and nuts
    - Provide accurate measurement, as in micrometer
    - Transmit motion
    - Increase force

Thread Terminology:

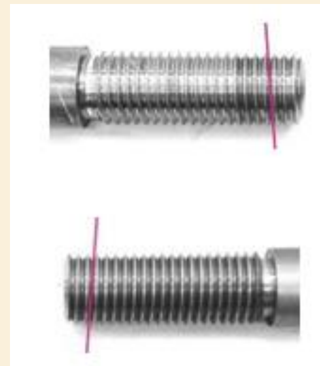


- Screw thread
  Helical ridge of uniform section formed on inside or outside of cylinder or cone
- External thread
  Cut on external surface or cone
- Internal thread
  Produced on inside of cylinder or cone

- Major diameter
  Largest diameter of external or internal thread
- Minor diameter
  Smallest diameter of external or internal thread

- Pitch diameter
  - Diameter of imaginary cylinder that passes through thread at point where groove and thread widths are equal
  - Equal to major diameter minus single depth of thread
  - Tolerance and allowances given at pitch diameter line
  - Number of threads per inch
    - Number of crests or roots per inch of threaded section (Does not apply to metric threads)
  - Pitch
    - Distance from point on one thread to corresponding point on next thread, measured parallel to axis
    - Expressed in millimeters for metric threads
  - Lead
    - Distance screw thread advances axially in one revolution (single-start thread, lead = pitch)
  - Root
    - Bottom surface joining sides of two adjacent threads
    - External thread on minor diameter
    - Internal thread on major diameter
  - Crest
    - Top surface joining two sides of thread
    - External thread on major diameter
    - Internal thread on minor diameter
  - Flank

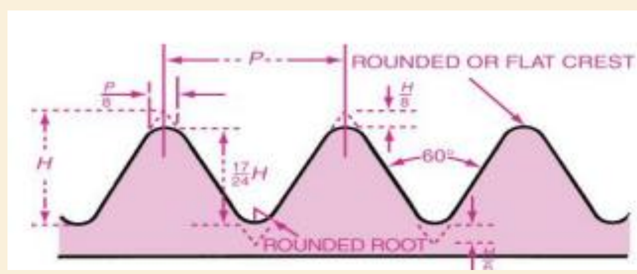
    - Thread surface that connects crest with root
  - Depth of thread
    - Distance between crest and root measured perpendicular to axis
  - Angle of thread
    - Included angle between sides of thread measured in axial plane
  - Helix angle
    - Angle that thread makes with plane perpendicular to thread axis
  - Right-hand thread
    - Helical ridge of uniform cross section onto which nut is threaded in clockwise direction
    - When cut on lathe, tool bit advanced from right to left
  - Left-hand thread
    - Helical ridge of uniform cross section onto which nut is threaded in counterclockwise direction
    - When cut on lathe, tool bit advanced from left to right



Thread Forms:

- April, 1975 ISO came to an agreement covering standard metric thread profile
  - Specifies sizes and pricthes for various threads in new ISO Metric Thread Standard
  - Has 25 thread sizes, range in diameter from 1.6 to 100 mm

– Identified by letter M, nominal diameter, and pitch



American National Standard Thread

- Divided into four main series, all having same shape and proportions
  - National Coarse (NC)
  - National Fine (NF)
  - National Special (NS)
  - National Pipe (NPT)
- Has 60º angle with root and crest truncated to 1/8th the pitch

Used in fabrication, machine construction

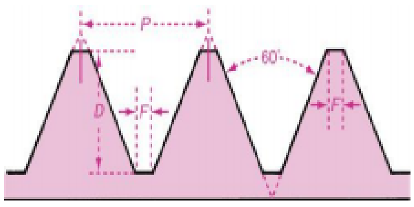
$$D = .6134 \text{ x } P \text{ or } \frac{.6134}{N}$$

$$F = .125 \text{ x } P \text{ or } \frac{.125}{N}$$

Unified Thread:

N

- Developed by U.S., Britain, and Canada for standardized thread system
- Combination of British Standard Whitworth and American National Standard Thread

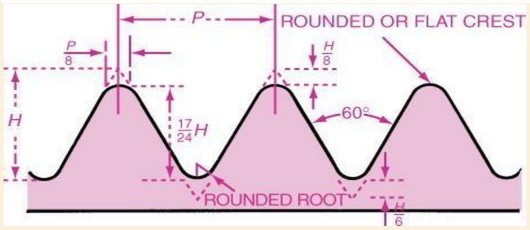


$$D \text{ (external thread)} = .6134 \times P \text{ or } \frac{.6134}{N}$$

$$D \text{ (internal thread)} = .5413 \times P \text{ or } \frac{.5413}{N}$$

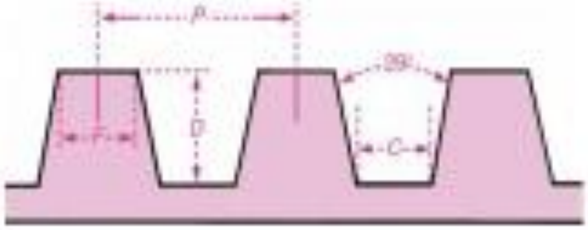
$$F \text{ (external thread)} = .125 \times P \text{ or } \frac{.125}{N}$$

$$F \text{ (internal thread)} = .250 \times P \text{ or } \frac{.250}{N}$$



American National Acme Thread

- Replacing square thread in many cases
- Used for feed screws, jacks, and vises



D = minimum $.500P$

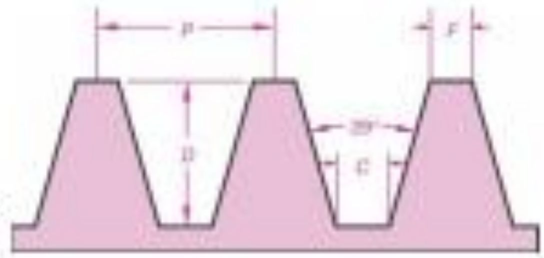
= maximum $.500P + 0.010$

$F = .3707P$

$C = .3707P - .0052$ (for maximum depth)

Brown & Sharpe Worm Thread

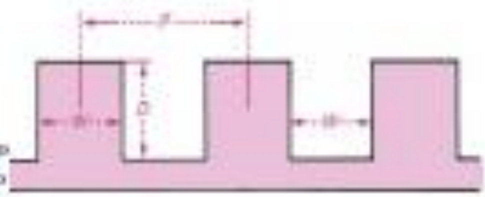
- Used to mesh worm gears and transmit motion between two shafts at right angles to each other but not in same plane



$D = .6866P$
$F = .335P$
$C = .310P$

Square Thread

- Being replaced by Acme thread because of difficulty in cutting it
- Often found on vises and jack screws



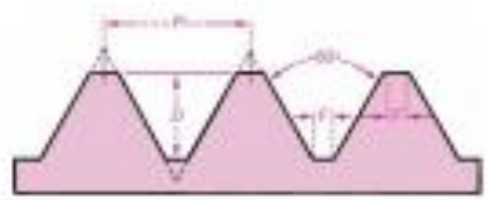
$D = .500P$
$F = .500P$
$C = .500P + .002$

International Metric thread

- Standardized thread used in Europe

$D = 0.7035P$ (maximum)
$= 0.6855P$ (minimum)

$F = 0.125P$
$R = 0.0633P$ (maximum)
$= 0.054P$ (minimum)



Thread Fits and Classifications

- Fit
  - Relationship between two mating parts
  - Determined by amount of clearance or interference when they are assembled
- Nominal size
  - Designation used to identify size of part
- Actual size
  - Measured size of thread or part
  - Basic size: size from which tolerances are set

Metric Tap & Clearance Drill Sizes		Tap Drill			
		75% Thread for Aluminum, Brass, & Plastics		50% Thread for Steel, Stainless, & Iron	
Screw Size (mm)	Thread Pitch (mm)	Drill Size (mm)	Closest American Drill	Drill size (mm)	Closest American Drill
M1.5	0.35	1.15	56	1.25	55
M1.6	0.35	1.25	55	1.35	54
M 1.8	0.35	1.45	53	1.55	1/16
M 2	0.45	1.55	1/16	1.70	51
	0.40	1.60	52	1.75	50
M 2.2	0.45	1.75	50	1.90	48
M 2.5	0.45	2.05	46	2.20	44
M 3	0.60	2.40	41	2.60	37
	0.50	2.50	39	2.70	36
M 3.5	0.60	2.90	32	3.10	31
M 4	0.75	3.25	30	3.50	28
	0.70	3.30	30	3.50	28
M 4.5	0.75	3.75	25	4.00	22
M 5	1.00	4.00	21	4.40	11/64
	0.90	4.10	20	4.40	17
	0.80	4.20	19	4.50	16
M 5.5	0.90	4.60	14	4.90	10
M 6	1.00	5.00	8	5.40	4
	0.75	5.25	4	5.50	7/32
M 7	1.00	6.00	B	6.40	E
	0.75	6.25	D	6.50	F
M 8	1.25	6.80	H	7.20	J
	1.00	7.00	J	7.40	L
M 9	1.25	7.80	N	8.20	P
	1.00	8.00	O	8.40	21/64
M 10	1.50	8.50	R	9.00	T
	1.25	8.80	11/32	9.20	23/64
	1.00	9.00	T	9.40	U
M 11	1.50	9.50	3/8	10.00	X
M 12	1.75	10.30	13/32	10.90	27/64
	1.50	10.50	Z	11.00	7/16
	1.25	10.80	27/64	11.20	7/16
M 14	2.00	12.10	15/32	12.70	1/2
	1.50	12.50	1/2	13.00	33/64
	1.25	12.80	1/2	13.20	33/64
M 15	1.50	13.50	17/32	14.00	35/64
M 16	2.00	14.00	35/64	14.75	37/64
	1.50	14.50	37/64	15.00	19/32
M 17	1.50	15.50	39/64	16.00	5/8
M 18	2.50	15.50	39/64	16.50	41/64
	2.00	16.00	5/8	16.75	21/32
	1.50	16.50	21/32	17.00	43/64
M 19	2.50	16.50	21/32	17.50	11/16
M 20	2.50	17.50	11/16	18.50	23/32
	2.00	18.00	45/64	18.50	47/64
	1.50	18.50	47/64	19.00	3/4

NEW DEVELOPMENT IN LATHE MACHINE (Benefits of Advanced Lathe)

- Lathe machine is development by using electronics and automation engineering
- Advanced Numerical controlled (NC) lathes have been developed.
- Advanced computer Numerical controlled (CNC) lathes have been developed.
- Advanced special purpose lathe has been developed.
- The advanced lathes have many benefits over the conventional lathes.
- In conventional lathes, the lathe operator checks the dimensions regularly to get perfect precision and the time taken to complete the work is more for high precision works.
- This is very important because if he removes excess metal from the work piece, the whole work piece will be a waste which will result in loss of money and time.
- In automated CNC lathes, the feedback system continuously monitors the dimensions and so they complete the operation in a short time with high accuracy.
- The loss is minimal in automated lathes, they are much faster and more efficient in terms of accuracy.
- Advanced tool holding devices & work holding devices are incorporated.
- They are equipped with one or two head stock and number of turrets.
- Multi cutting tool are used to increase the productivity.
- To Increased productivity and improved control of machine.
- The advanced lathes are used to superior repeatability.
- The advanced lathes are used to reduced machine downtime.
- The advanced lathes are used to Fast machining cycles.
- The advanced lathes are used to High accuracy& high feed-rate.
- The advanced lathes are used to Eliminate additional tooling cost.
- User friendly programming and simulation software enables 3D graphic representation of job with automatic generation of G-Code.
- The advanced horizontal & vertical lathes machines are developed with special features and application to fulfill the industrial requirement.
- The advanced lathes have compact marching with minimum floor space occupation.

Application in prevailing Marketing scenario

Lathe machines find its application mainly in engineering industry across the nation. The products should have good quality in order to meet international quality standards. Conduct R&D, market surveys regularly in order to understand the prevailing market trends and scenario. These surveys enable us in implementing new manufacturing techniques and tools in our process. Moreover, all the products should deliver at the client's end within the desired time limit. Contact with the customers in order to understand the ever growing needs and demands. Generally, work on the strict quality management policy so as to attain maximum client satisfaction and also test these machines on the set industry parameters and quality norms. Some of the key features of the product are as follows:

- High tensile strength
- More rigidity.
- Low cost.
- High efficiency.
- Longer service life.
- Less maintenance.
- High tolerance capacity.
- Easy to operate.

Usage in GTTC centers

- The lathe machine is used for training purpose.
- The lathe machine is used for manufacturing of Press tool parts.
- The lathe machine is used for manufacturing of Moulds parts.
- The lathe machine is used for manufacturing of Jigs & Fixture parts.
- The lathe machine is used for manufacturing of Die casting parts.
- The lathe machine is used for Production of Automobiles, Aerospace, Defense and other general work.

Summary: Lathe is a very important machine in engineering which is used in most of the fields. They are used for Diamond turning, ornamental turning, metal spinning, glass working, thermal spraying and many other operations. Lathe work is found in most of the products which we use in our day to day life. Lathe will remain as an important machine at all times

At the end of the subject, the trainee will be able to:

- Identify parts of lathe machine
- Identify different types of lathe machine.
- Identify different types of lathe operation
- Identify different types of tool holding devices.
- Identify different types of work holding devices.
- Identify the various types cutting tools and explain their geometry
- Identify different types of lathe attachment, auxiliary attachments and calculation.
- Calculate the cutting parameters and machining time.
- Define threads and their standards
- Explain safety precautions to be followed on the lathe machines.
- To understand present market trend.
- To understand Application in prevailing Marketing scenario.

QUESTIONS

FILL IN THE BLANKS

1. Lathe machine is known as.............. tool. (mother of machine tools)
2. In lathe, a.............point cutting tool is advanced radially into to the job /work piece
3. The bed of the lathe machine is usually made from............ (cast iron)
4. The bed of the lathe must be.........so that it can withstand, without being distorted, the........................forces transmitted to it while the lathe is in operation.
5. The lathe headstock is a ....like casting mounted permanently on the..........

6.operation is done on a shank for the purpose of gripping.

7. Thread on the lead screw of lathe is ....type.

8.chuck is used for holding hexagonal jobs.

9. Uniform increase or decrease in diameter is called.........

10.chuck is used for holding irregular and heavy jobs on lathe.

11. The included angle of metric tread is..........

12.is the common material for lathe bed?

13. The size of the lathe is specified by..........

14. 1micron =......... mm.

15. process is used to finish drilled hole to accurate size.

16. taper is generally used for drill bit shank.

17. Core drill for M10 tap is.............

18. 3-Jaw chuck is also called as...........

19. Is the included angle of acme thread?

20. The distance between two adjacent tread forms is called............
21. The unit of cutting speed is...........
22. taper is provided on the tailstock of a lathe.
23. Utensils are made from........... operation on lathe.
24. The normal ratio of cutting stroke to return stroke i the shaper is............
25. The material of the collet is................
26. operation is done on a shank for the purpose of gripping.
27. The general ratio of the soluble oil and water in coolant is............
28. The RPM during reaming is generally............ times than RPM during drilling.
29. Do not shift the levers, controlling the sliding gears when.............
30. The unit of feed in metric system is............
31. Changing of speed is easy in............ headstock.
32. For dressing the pedestal grinding wheel. ....is used. (abrasive stick)
33. The development of the lathe was from the tree .... (Lathe).
34. The first screw cutting lathe which is designed by............. In the year..........

    (HENRY MOUDSLAY, 1797).
35. The lathe machine bed is made of............grade.............. (High level grade cast

    iron).
36. In lathe machine, spindle and poppet of barrel of the tailstock are having internally

    to suit the headstock. (Morse taper)
37. The front face of the carriage is called .... (Apron)
38. Do not possess gear box, carriage and lead screw ....lathe (speed lathe)
39. Spindle speed up to 4000 rpm are common used...........(speed lathe)

40. Wood working lathes are ....type of lathe (speed lathe)
41. Bench lathe are used for.......... (small and light jobs)
42. Headstock is mounted on ....(right side of the lathe bed)
43. A tapered mandrel is used for components having ....(standard taper center hole)
44. Three jaw chuck is also called ....type of chuck (scroll self-cantering chuck)
45. Steel work piece can be easily hold in the ....chuck (magnetic chuck)
46. Air hydraulic chuck is operated by ....pressure (hydraulic pressure)
47. For tool holding device of lathe machine................ (tool post)
48. A compound slide mounted on the.............(cross slide)
49. A saddle is ....shaped (H shaped)
50. The tail stock also known as ....(loose head)
51. Steady rest are mounted on............. (lathe bed)
52. Mandrels are used for holding, rotating........work piece (hollow work piece)
53. Turret (4 –way tool post). ....type adjustment of the tool
54. Tapers attachments method tapers up to..................(20)
55. 1inch=...... mm.(25.4mm)
56. An engine lathe is used for producing................ jobs (cylindrical)
57. The lathe bed is usually made of ....(cast iron)
58. The ..is bolted at the front of the saddle(apron)
59. Independent chuck is also called as ....(four jaw chuck)
60. Lathe center is ....steel device(hardened)

61. Lathe centers are made of (carbon tool steel)
62. Collet chuck is used widely in ...... work (production work)
63. Head stock is mounted on ....(lathe bed)
64. English type of tool post is known as ....(clamp type tool post)
65. Chuck is.............. device (work holding)
66. Three jaw chuck is known as........(self-cantering chuck)
67. Tail stock is......... (non-rotate part)
68. Drive plate........... construction(light)
69. Engine lathe is a basic.............. machine(turning)
70. Chuck is attached to ....of the lathe (head stock spindle)
71. Face plate is ....shape of work piece hold (irregular)
72. Rest is used............ (support the long slender work)
73. Three jaw chuck............ type of work can be hold (cylindrical, horizontal)
74. Bench lathe is used for ....work (precision work)
75. Wood working and metal spinning operations are done by........... (speed lathe)
76. Cone pulley arrangement in head stock is provide.............in work piece (speed variation)
77. Common speed of spindle is up to......... (4000 rpm)
78. Speed lathe is............. driven (power)
79. Bench lathe is used for doing .... and.......... which requires precision work (small and light jobs)
80. A crank shaft lathe is used for.......... (turning long and crank shaft)

81. Tail stock is providing support to a end of the work piece both........... and......... be used (dead center and live center)
82. The saddle is provided with adjustable .... and ......(gibes and steps)
83. The cross feed used for facing the end of the work piece is called as ....(angular feed)
84. Lead screw can be long..........shaft (threaded)
85. Mandrels bar is ....degree (60)
86. Tail stock is a ....part which can be moved on hardened ways(non-rotating)
87. The ....is bolted to the front of the saddle(apron)
88. .... and........... are the main components of feed mechanism (feed rod and lead screw)?
89. The feed rod is also known as ....(feed shaft)
90. Catch plate is made up of ....(cast iron or steel)
91. chuck is simple, compact and reliable (collet)
92. .... is the kind of rest which is not fixed in one position (follower rest)?
93. .... turning tool is the kind of cutting tool which is frequently used (right hand)
94. ....turning implies cutting two or more diameters on a work piece(shoulder)
95. The tapering value of the taper pins is. ....(0.0208mm/min)
96. When the cutting tool moves at an angle to the axis of rotation of the work piece and produces a conical surface it is termed as ....(taper turning operation)
97. The carriage situated ....the head stock and tail stock (between)
98. A tool room lathe is more expensive than .... sizes of engine lathe(comparable)

99. Tail stock can also be offset about ....mm for cutting small angle tapers (25m

100. The train of gears through which the motion is transmitted from lathe spindle to lead screw is called (change gears)

101. The thread can be measured by______________(pitch)

MULTIPLE CHOICE QUESTIONS:

1. The usual ratio of forward and return stroke in a shaper is:

a) 2:1 b) 1:2 c) 2:3 d) 1:3

2. A mandrel is used in a lathe to held

a) An eccentric job b) a heavy job c) a thin job d) None of the above

3. The surface finish is improved by the increase in

a) Cutting speed b) Nose radius c) True rake angle d) all of the above

4) Threads are cut on a lathe with a single point tool

a) By making a series of cuts in the same groove

b) In one cut for the full depth of cut (Thread)

c) By moving the carriage by means of the rack that is located under front way.

d) By setting the correct feeds on the quick change gear box.

5) Which of the following material has highest cutting speed?

a) Carbon steel b) Tool steel c) High speed steel d) Carbide

6) The parting of operation must be carried out at

a) A high spindle speed b) Automatic speed

c) Reduced spindle speed d) Variable spindle speed

7) In a shaper

a) Tool is stationary and the work reciprocating

b) Work is stationary and tool is reciprocating

c) Tool moves over stationary work

d) Tool and work both reciprocating

8) High speed steel contains fallowing elements in the ratio of 18:4:1

a] Tungsten (W) chromium (cr)and vanadium(V) b) Cr, v, w c]

W, mn, cr d] W, cr, mn

9) The correct formula for the calculation of taper is

a] k=D-d/2l b] k=D-d/l c] K=D-d/2 d] k=D-d/2L

10] The correct formula to find out the RPM of a given job is

a] N=1000*cs/3142. *D b] N=c.s*3.142*D/1000 c] N=D*1000/c.s*3.142

d] N=3.142*c.s/1000*D

11] In lathe machine, the tool like drill and reamer are hold by

a] tool post b] head stock c] spindle d] tail stock

12] In lathe machine, the chuck is mounted on

a] carriage b] spindle c] tail stock d] apron **13]**

In lathe machine, the function of carriage is to a]

hold the work piece b] hold the tool

c] Support the tail stock d] change the speed

14] The following parameter cannot be used for specifying in the lathe machine

a] swing diameter over the bed b] work piece length c]

Height of lathe d] overall length of bed

15] in lathe machine, during drilling operation, drill bit is supported by

a] tool post b] spindle c] carriage d] none of the above

16] Eccentric turning on lathe requires

a] two-jaw chuck b] three-jaw chuck c] four-jaw chuck d] eccentric chuck

17] In lathe machine, the tool motion is perpendicular to the axis of the spindle during which of following operation

a] Perpendicular turning b] Taper turning c] Facing d] Finishing

18] The chamfering helps in

a] Metal saving

b] Avoiding the injuries to the persons handling the finished product c]

Giving aesthetic look to the finished product

d] Both (b) and (c)

19] The process of cutting a work piece into two parts on lathe machine is called as

a] Grooving b] Slitting c] Cutting d] Parting

20] The knurling helps in

a] Improving the strength of material b] Providing a non-slip grip on the surface c]

Saving the material d] Both (b) and (c)

21] In lathe machine the enlargement of the already existing hole in work piece is carried by the operation is known as

a] Drilling b] Enlarging c] Boring d] Finishing

22] In thread cutting operation on lathe machine the fallowing elements has to engage with lead screw

a] Tail stock b] Spindle c] Carriage d] Lathe bed

23] In thread cutting operation on lathe machine there has to be engagement between................

a] head stock and tail stock b] lead screw and tail stock
c] apron and cross slide d] lead screw and split nut

24]The fallowing operation cannot be performed on lathe machine

a] drilling b] milling c] boring d] none of the above

25] The fallowing is the metal cutting process

a] shaping b] grinding c] honing d] lapping

26] In lathe machine the function of lathe bed is

a] provide sliding surface for tail stock b] provide sliding surface for tail stock c] Support tail stock d] all of the above

27] In lathe machine the function of head stock is

a] support the carriage b] support the tail stock c] support the spindle d] both all (a) (b) &(c) **28] In lathe machine function of tail stock is**

a] support the spindle b] hold the main drive

c] hold the dead center d] both (b)&(c)

29] In lathe machine the function of main drive is a] drive an electric motor b] drive the spindle c] to change the spindle speed d] both (b)&(c) **30]in lathe machine function of carriage is** to

a] support the spindle b] hold and give feed to cutting tool c] to hold the dead center d] both(b)&(c)

31] in lathe machine, the mechanism used for mechanized movements of the carriage is known as

a] saddle b] apron c] cross slide d] compound rest

32] In lathe machine, the arrangement used for facilitating the taper turning is known as

a] compound rest b] saddle c] apron d] cross slide

33] In lathe machine, the component which helps in thread cutting is known as

a] cross slide b] compound slide c] apron d] lead screw

34] In lathe machine, the feed drive is placed between.............

a] head stock and tail stock b] tail stock and carriage

c] tool post and tail stock d] main drive and lead screw

35] In lathe machine, the unit used for transmitting the motion from the main drive to the lead screw is known as

a] apron b] feed drive c] electric motor d] gear box

36] In lathe machine the component used for engagement and dis- engagement of lead screw is known as

a] apron b] cross slide c] drive nut d] split nut

37] In thread cutting operation on lathe machine..............

a] the motion of carriage is manual

b] The motion of carriage is mechanized

c] The motion of carriage is perpendicular to the axis of work piece d]

Both (b) & (c)

38] In center lathe machine, the gear box or cone pulley is located in

a] carriage b] bed c] head stock d] tail stock

39] Turning tool is a..........

a] multi point cutting tool b] three point cutting tool c]

Line cutting tool d] single point cutting tool

40] The drill is a.............

a] multi point cutting tool b] two point cutting tool
c] line cutting tool d] single point cutting tool

Answer the following questions

1. What do you mean by lathe?
2. What are all the various operations can be performed on a lathe?
3. What are all the principle parts of the lathe?
4. Difference between three jaw chuck and four jaw chuck
5. State the various parts mounted on the carriage?
6. write four types of tool post
7. What is an apron?
8. State any two specification of lathe?
9. List any four types of lathe?
10. What do you mean by semi-automatic lathe?
11. State the various feed mechanisms used for obtaining automatic feed?
12. List any four holding devices?
13. What are the different operations performed on the lathe?
14. State any two specifications of capstan lathe & turret lathe?

15. Compare the advantage of capstan lathe & turret lathe?

16. Define tooling?

17. What are the three stage of a tool-layout?

18. What are the different drives used in copying lathe?

19. What are the components that can be turned on a copying lathe?

20. Define automatic lathes.

21. Explain the different components of a lathe with neat sketch.

22. What are the different operations that can be performed on a lathe? also, mention the tools required for each operation

23. What are the different machining operations that can be performed on a lathe?

    Explain any five in detail.

24. Explain the different work holding devices used in a lathe?

25. write short notes on

    a. universal scroll chuck   b. magnetic chuck   c. collet chuck   d. centers

23. Explain the different methods of holding the work piece in a lathe with suitable sketches.

REFERANCE BOOKS:

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- Workshop technology by Chapman
- Technology of Machine tools by Krar and Oswald
- All about machine tools
- Production Technology by Hazra Choudhary
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- Workshop Technology – S.K.Hazra Chowdhary
- Basic Shop theory – Chapmen
- R.Lizarralde, A. Azkarate and O. Zelaicta

  http://Google.com (for sketches and drawings)