MACHINE TOOLS

7.1 Introduction

A machine tool may be defined as a power driven machine which accomplishes the cutting or machining operations in it. When machines perform the metal cutting operations by the cutting tools mounted on them, they are called "machine tools". The examples for such machine tools may be lathe, milling machine, grinding machine, drilling machine, planning machine etc.

Objectives:

After studying this unit, you will be able to:

- Explain working of Lathe, Lathe Specification and its functions
- Explain Taper turning methods
- Explain different operations can be carried out on Lathe
- Explain working of Bench and radial drilling machine
- Explain Drilling Operations can be carried out on drilling machine

7.2 Lathe

A lathe is a machine tool generally employed produce circular objects. Almost all the operations that can be performed on other machine tools like drilling machine, milling machine, shaping machine etc. can be performed on a lathe. A lathe is a machine tool, which holds the work piece in a work holding device and rotating it against a suitable cutting tool to remove the excess metal from the work piece.

Lathes are classified as:

- Engine Lathe
- Speed Lathe
- Capstan and Turret Lathe
- Bench Lathe
- Automatic Lathe
- CNC Lathe

7.3 Principle of working

A lathe works on the principle that cutting tool can remove material in the form of chips from rotating work pieces to produce circular objects.

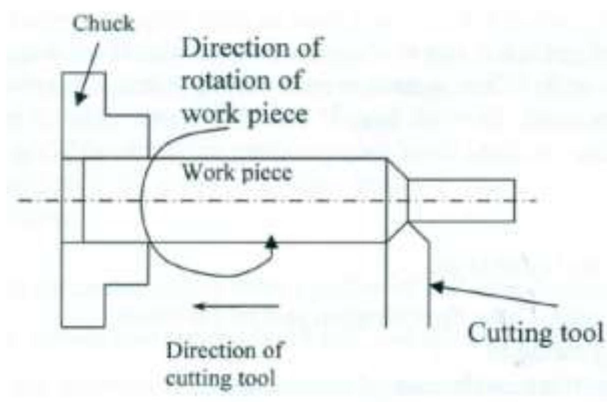


Fig. 7.1

The figure 7.1 shows work piece held rigidly by one of the work holding devices, known as chuck and rotated at high speeds. A V - shaped cutting tool (which is stronger and harder than the work piece) held against the work piece opposite to the direction of rotation of the work piece produces circular surfaces as shown in the figure.

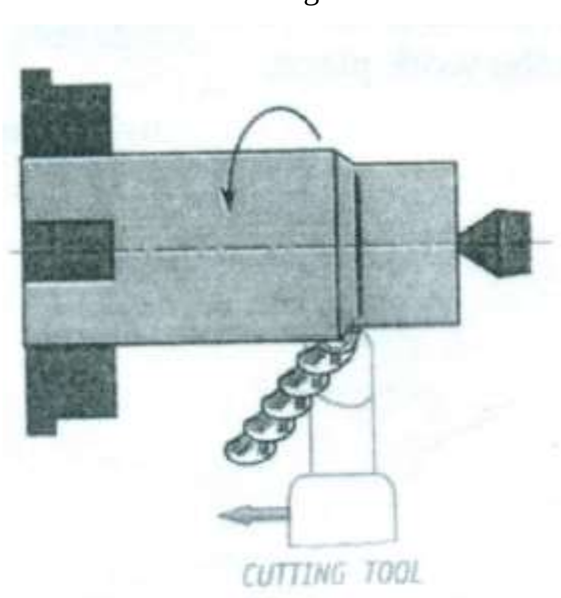


Fig. 7.2

7.3 Major parts of a Lathe and their functions

The figure 7.3 shows major parts of a lathe. They are:

Bed: The bed is a foundation part of a lathe and supports all its other parts. There are two precision machined guide ways formed on the top of the bed viz., outer guide ways and inner guide ways.

Headstock: The housing comprising of the feed gear box and the stepped cone pulley is called headstock of the lathe. The headstock will be rigidly mounted on the inner guide ways of lathe bed at its left end.

Tailstock: Tailstock is the movable part of the lathe that carries the dead centre in it. Tailstock is also used to clamp tools like twist drills and reamers for making holes, taps and dies for cutting threads. The tailstock will be mounted loosely on the inner guide ways of lathe bed and can be moved and locked in any position.

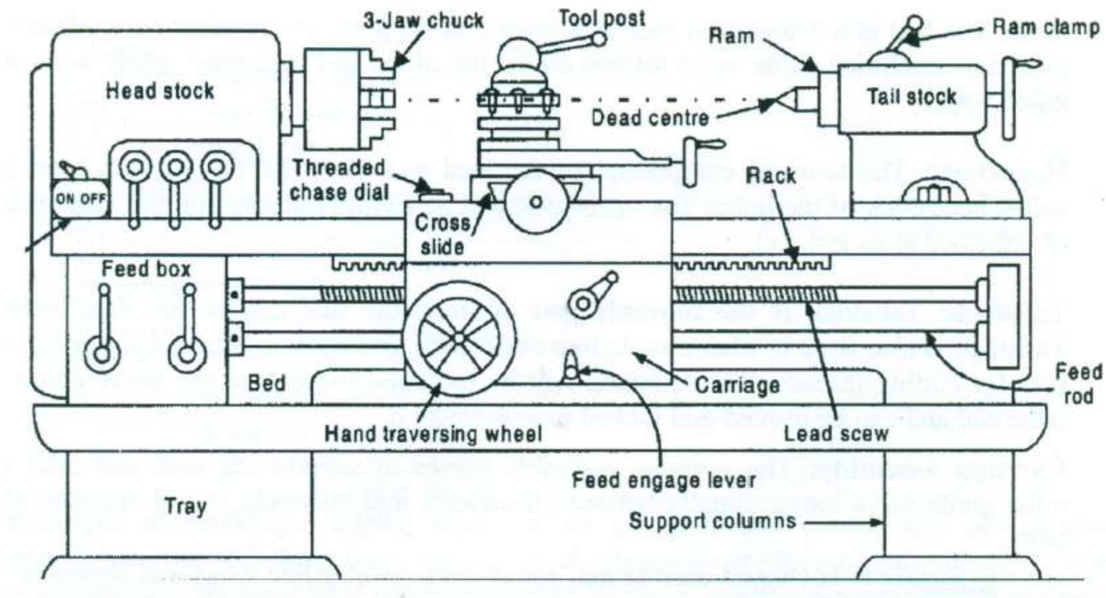


Fig: 7.3

Carriage assembly: The carriage assembly serves to support the tool and rides over the outer guide ways longitudinally between headstock and tailstock. It is composed of 5 main parts.

i. Saddle is H shaped casting that slides over set of guide ways and serves as the base for the cross slide.

ii. Cross slide is mounted on the saddle and enables the movement of the cutting tool laterally across the lathe bed by means of cross feed hand wheel.

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

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

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

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

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

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

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

7.4 Lathe Specification.

The size of the lathe is specified by the following as shown in the Fig. 7.4

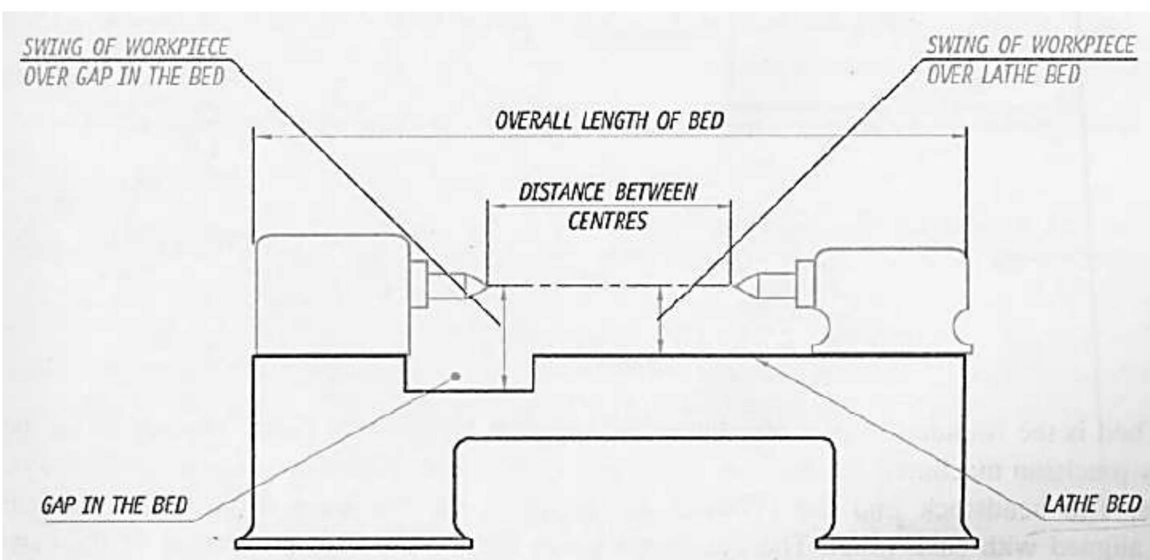


Fig: 7.4

1. Distance between centers: It is the maximum distance that can be obtained between the lathe centers. It hence represents the maximum length of the work piece that can be held between centers.
2. Overall length of the bed: It is the maximum length of the bed starting from the headstock end to tailstock end.
3. Swing diameter over the bed: It is the largest diameter of the work piece that can be rotated without touching the bed.
4. Swing diameter over a gap in the bed: It is the maximum diameter and the width of a work piece that can be mounted between the centers.

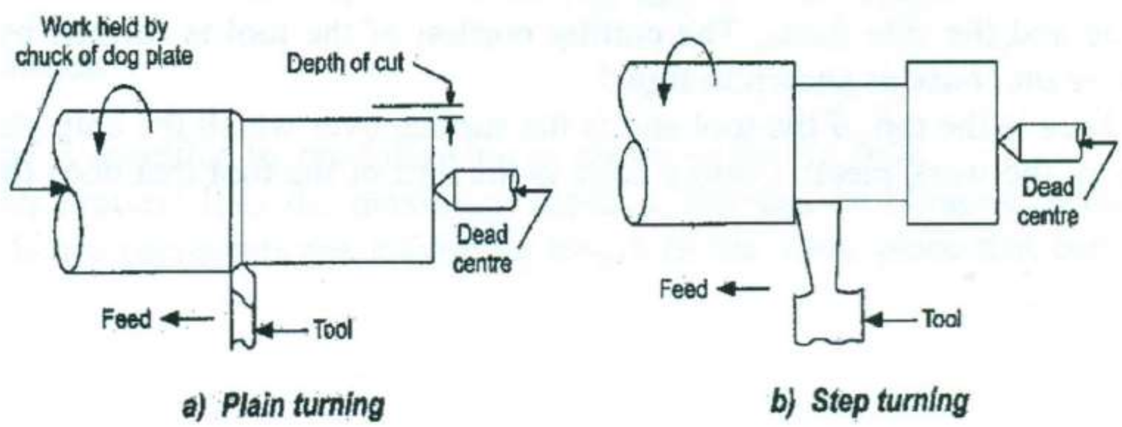
7.5 Lathe Operations

All most all the basic machining operations can be performed on a lathe. The various operations that can be conducted on a lathe are

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

1. Plain Turning: The process of metal removal from the cylindrical jobs is called straight or plain turning. Cross slide and the carriage are used to perform turning operations. Plain turning operation is performed in two steps. Fig 7.5

i) Rough turning (Roughing): is usually done on rolled, cast or forged parts to remove uneven, sandy or rough surface from the work pieces. Roughing is done by a roughing tool (2-4 mm feed) and excess stock is removed.



Turning operations

Fig: 7.5

ii) Finish turning (Finishing): For finishing, a tool with slightly round cutting edge a tool with slightly round cutting edge is used. The depth of cut ranges between 0.2 to 1mm and the feed rate between 0.1 to 0.3mm.

Step turning: A step turning operation is illustrated in the figure. A step turning operation is performed using a wide tool after the plain turning operation. The work is held in between the lathe centers or with the chuck and the tool is held at the height of the axis of the work. The depth of cut to obtain the step on the cylinder is provided by cross slide movement and feed by the carriage movement. This operation is performed manually.

Facing: Facing is the operation of producing a flat surface on the ends of work piece perpendicular to the axis. This can also be used to reduce the lengths of the work piece to required lengths.

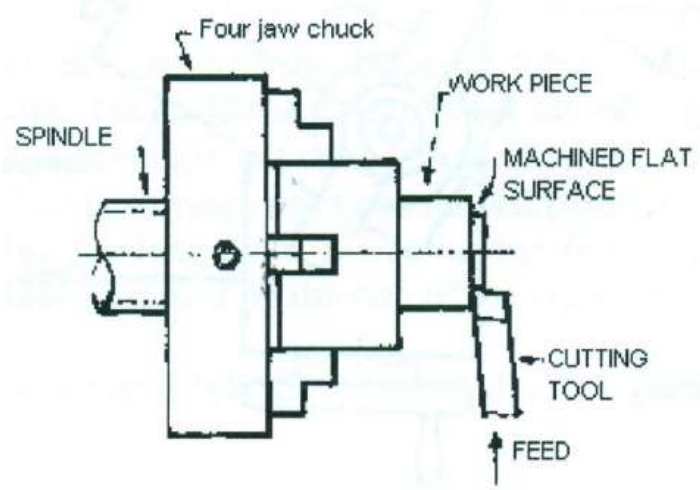


Fig: 7.6

To perform this operation the tool tip is set at same height as the work piece axis and fed gradually moving the cross slide in the direction perpendicular to the axis of the work piece. For large and rough surfaces facing also can be performed in roughing and finishing cycles.

2. Taper turning: involves producing a conical surface on a cylindrical surface in lathe. A taper surface can be produced either by rotating the job normally and feeding the tool at some angle (like in compound rest swivel method) or by rotating the job at an off - set angle and feeding the tool normally (like in tail stock set - over method).

Methods of taper turning:

i. Swiveling the compound rest.
ii. Tailstock set over method.
iii. Taper turning attachment method.
iv. By using form tool.

i. Taper Turning by Swiveling Compound Tool rest method:

The principle of taper turning operation by swiveling the compound rest method is as shown in the figure 7.7.

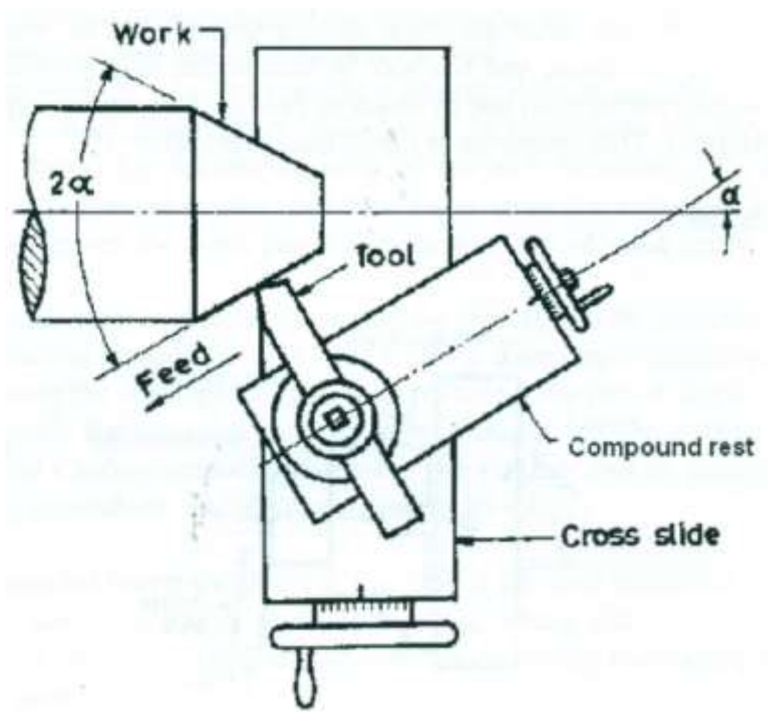


Fig: 7.7

In this method the job is rotated on the lathe axis, while tool feeding is done at an angle, by the swiveled compound rest. To assist in swiveling at particular angle, the base of the compound rest is graduated in degrees. The taper angle i.e. the angle at which the compound rest to be rotated is calculated as below.

$$\tan \alpha = \frac{D-d}{L}$$

where,

α = half taper angle (simply taper angle) in degrees.

D = larger diameter of the taper in mm.

d = smaller diameter of the taper in mm.

L = length of the taper in mm.

By calculating the taper angle, the compound rest can be swiveled to the angle. The tool feeding is done only by the compound rest handle so that the tool moves at the set angle only.

ii. Taper turning by Tail stock Set over method (Offset method):

This method is known as offsetting the Tailstock as shown in fig 7.8.

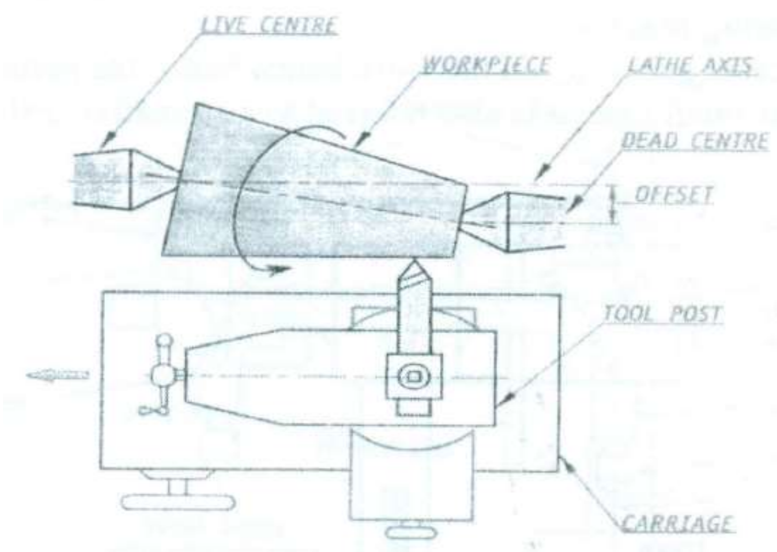


Fig: 7.8

It is most commonly employed for taper turning. The tailstock centre is set out of alignment, as a result, axis of the work piece gets inclined at an angle with the longitudinal movement of the tool which will be parallel to the lathe bed. Entire carriage has to be moved parallel to the lathe bed to cut the taper. This method most suitable for long work pieces having less taper, only external tapers can be produced. Amount of offset is limited by the size of the tailstock.

Set Over = $\frac{L(D-d)}{2l}$

$= \frac{D-d}{2}$ (when $L=l$).

7.6 Drilling

Drilling is the operation of making holes in a work piece using drill bit. The stationary work is held in a fixture and the rotating tool is fed vertically down. Drilling Machine is a power operated machine tool, which holds the drill in its rotating spindle and produces a hole when moved linearly against the work piece.

Drilling machines may be classified as

i. Portable drilling machine-12mm hole can be drilled
ii. Bench or sensitive drilling machine-15mm hole can be drilled
iii. Upright drilling machine-50mm hole can be drilled.
iv. Radial drilling machine.
v. Gang drilling machine.
vi. Multiple spindle drilling machine.

7.7 Radial Drilling Machine

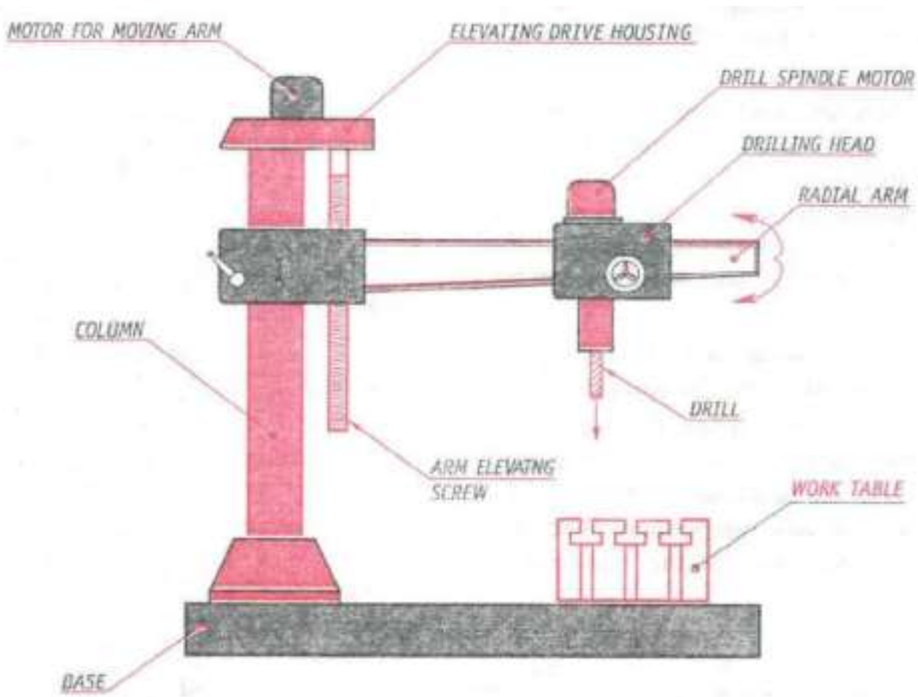


Fig. 7.9: Radial Drilling Machine

Radial drilling machine is used for medium and heavy duty applications. The Construction of a radial drilling machine is illustrated in figure 7.9. It consists of a heavy, circular column mounted on a very strong base. A radial arm that can swing around is mounted on the column and the radial arm can be raised and lowered. A drill head with drive and feed mechanism is fitted on to the radial arm, and the drill head can move horizontally along the slides of the arm and can be locked at any desired position. These movements of the arm and the drill head make it easier and faster to locate the drill centre on the work. All the motions can be clamped at necessary positions.

7.8 Drilling machine Operations

The different machining operations that can be performed operation performed on a drilling machine are as follows:

1. Drilling 2. Reaming 3. Boring. 4. Counter Boring 5. Counter sinking
6. Spot facing 7. Lapping. 8. Trepanning.

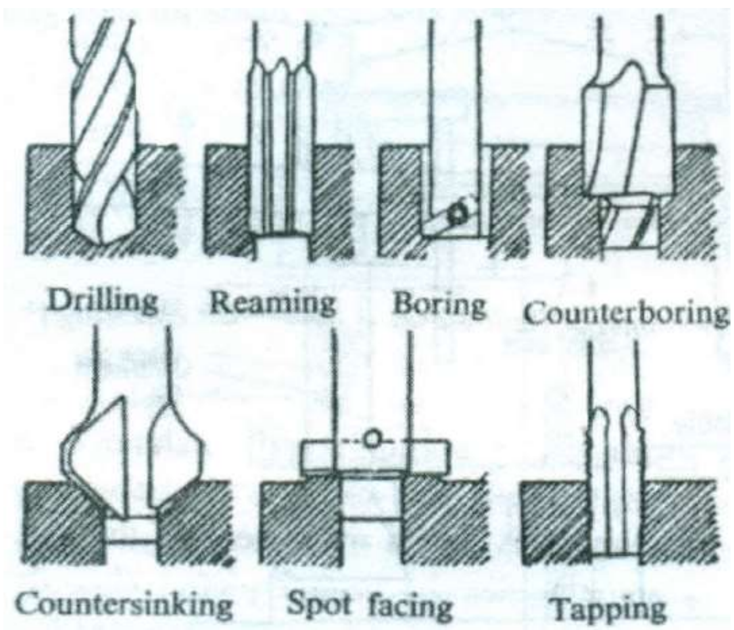


Fig. 7.10: Drilling Operations

1. Reaming is the accurate way of sizing and finishing a previously drilled. Tool used: Reamer

2. Boring: Boring is done on a drilling machine to increase the size of an already drilled hole. When a suitable size drill is not available, initially a hole is drilled to the nearest size and using a single point cutting tool, the size of the hole is increased to required size as shown in the fig. 7.11. By lowering the tool while it is continuously rotating, the size of the hole is increased entire depth.

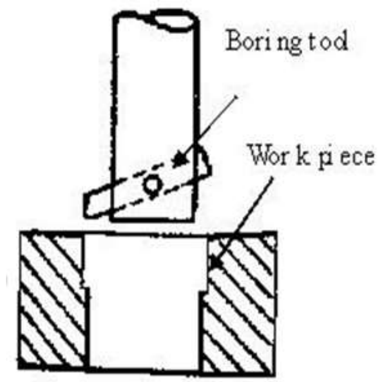


Fig. 7.11: Boring Operation

3. Counterboring: Counterboring is to increase the size of a hole at one end only through a small depth as shown in fig. 7.12.The counterboring forms a larger sized recess or a shoulder to the exiting hole. The cutting tool will have a small cylindrical projection known as pilot to guide the tool while counterboring. The diameter of the pilot will always be equal to the diameter of the previously drilled hole. The speed for this operation must be two-third of the drilling speed. The counterboring is done on the hole to accommodate the socket head screw, or grooved nuts, or round head bolts.

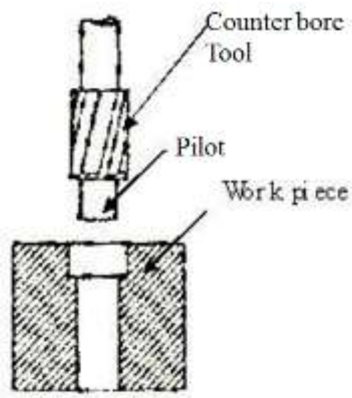


Fig. 7.12: Counterboring Operation

4. Counter sinking: Countersinking is the operation of making the end of the hole into a conical shape. It is done using countersinking tool as shown in fig. 7.13. This process may also be employed for deburring the holes. The cutting speed for this operation must be about one - half of that used for similar size drill. The countersunk holes are used when the countersunk screws are to be screwed into the holes so that top faces have to be in flush with the top surface of the work piece.

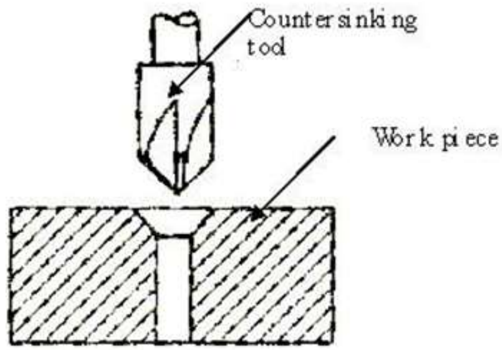


Fig. 7.13: Countersinking Operation

5. Spot-facing is operation of removing enough materials to provide a flat surface around a hole to accommodate the head of a bolt.

6. Tapping operation of producing internal threads in a hole.