WORKSHOP TECHNOLOGY

Unit-3 **Lathe and Grinding machines**	**Lathe Machine:** Introduction, working principle, its construction and specifications. *Lathe classification;* Bench, Tool room, Capstan and Turret, Automatic and Special purpose lathes. *Lathe Operations:* Plain and step turning, Taper turning; taper calculations, methods of taper turning, parting off, drilling, boring, knurling. Screw cutting on lathe-introduction to right and left threads, lathe setting for screw cutting-simple and compound gear trains. Cutting parameters- Speed, feed and depth of cut, machining time. *Lathe Accessories*: Centres; live and dead centre, Chucks; three jaw universal chuck, four jaw independent chuck, magnetic chuck, air or hydraulic chuck, Lathe carriers or dogs. Driving plate, Face plate, angle plate, mandrels, rests; steady and follower. Lathe Attachments; Grinding attachment, milling attachment, Taper turning attachment **Grinding Machine:** Introduction- Abrasive tools, stones and sticks, grinding wheels– materials, specifications, selection of grinding wheels Trucing and dressing of grinding wheels, abrasives-natural and artificial, speed, feed and depth of cut, use of coolants. Types of grinding machines; cylindrical grinders, surface grinders, centreless grinders, special grinding machines

INTRODUCTION:

In the Mechanical Engineering field Lathe plays an important role in Manufacturing.

- Lathe machine refers to a machine tool which used to remove **unwanted metals** from the work piece to give desired shape and size.
- Lathe machine is one of the most important machine tools which is used in the **metalworking industry.**
- It operates on the **principle of a rotating** work piece and a fixed cutting tool.
- The cutting tool is feed into the work piece which rotates **about its own axis** causing the workpiece to form the desired shape.
- It is also known as **" the mother/father of the entire tool family"**.
- It was invented by **DAVID WILKINSON (05 Jan. 1771 – 03 Feb. 1852).**

Definition of Lathe Machine:

- The machine tool that's used to remove **unwanted metals** from the workpiece to give the desired shape and size so-called **Lathe machine**.

- Lathe machine is also known as " **Center Lathe** " because of two centers between which the job can be held and rotated.

CONSTRUCTION OF LATHE MACHINE

The main parts of lathe machine are:

A. Bed

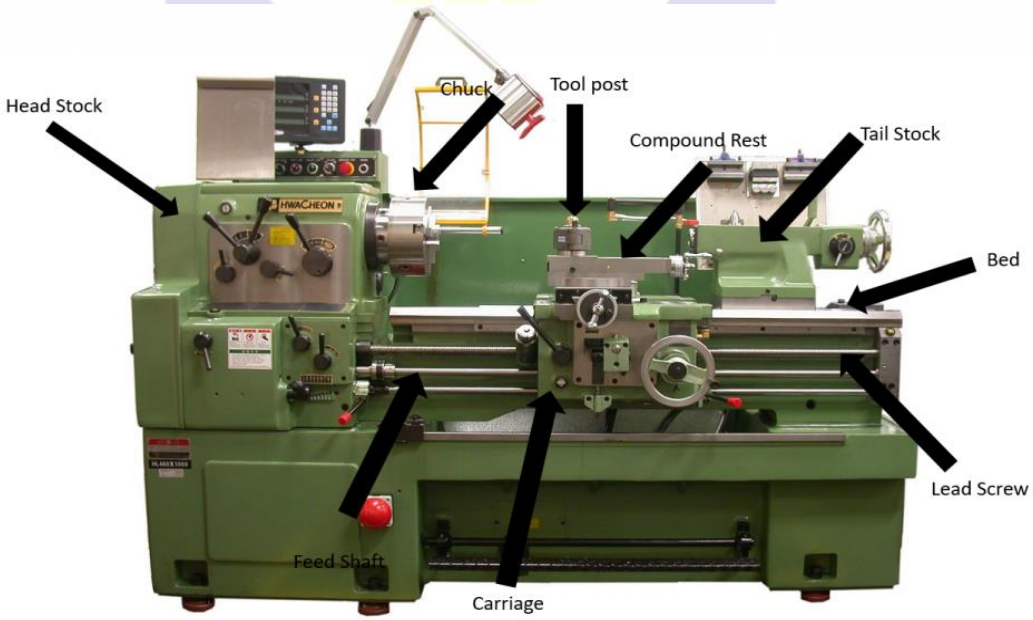
- The bed is the **main body of** a lathe which provides supports to all parts of the machine.
- The bed is heavy, rugged casting which is **mounted** on the working parts of the lathe.

B. Head Stock

- They having spindle shaft and support **bearings, speed shift levers,** and **gear trains.**
- The headstock spindle is a **hollow cylindrical shaft** that provides a drive from the motor to work holding devices.
- The headstock is **hidden** in a box and spindle is hidden in a gear cover.

C. Tail Stock

- The main **function** of the tailstock to support the job.
- The tailstock is situated in bed.
- It can be **offset for taper** turning operations.



Main Parts of Lathe Machine

D. Lead Screw

- It is used to **transmit power to** carriage through gear and clutch arrangement in the **carriage apron**.

E. Carriage and Saddle

- Carriage **supports** cross – slide, compound rest and tool post and it **moves** along the ways under manual or power feed.
- It comprises the **saddle a casting,** which rides across the top of the ways and the apron.
- Compound slide **permits angular** tool movement for taper turning.

F. Cross Slide and Compound slide

- Cross slide is a **dovetail** slide that assembles on the top of the saddle and moves at a right angle to the ways.
- Compound slide **supports** the tool post and cutting tool in its **various positions** and it is above the cross slide and it can be rotated to set the tool to advance cutting of workpiece.

G. Feed Mechanism

- The feed mechanism is used to **transmit** power to the carriage.
- **The gear train** system is provided.

H. Tool Post

- Tool Post is using to **hold** the tool in the correct position.
- It's **bolt-on** the carriage.
- It may set at any **desired angle**.

I. Apron

- It situated on the **carriage.**
- It consists of all-controlling **and moving** mechanisms of carriage.

J. Spindle

- It is the **main part** of the lathe which holds and rotates the chuck.

K. Live Center

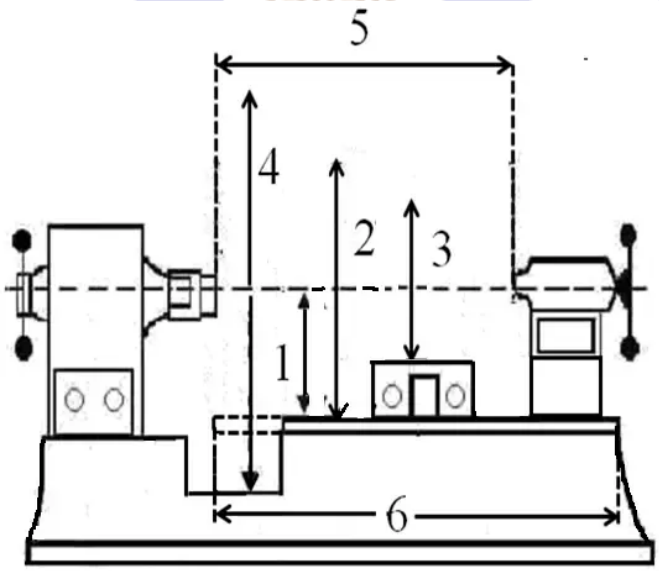
- A Live Center is mounting on bearings and rotates with the work.
- Live centers are using to hold or support a work-piece.

L. Dead Center

- A **dead center** may be used to support the workpiece at either the fixed or rotating end of the machine.
- Dead centers are typically fully hardened to **prevent damage** to the important mating surfaces of the taper and to preserve the **60° angle** of the nose.

SPECIFICATIONS OF LATHE MACHINE:

1) Height of centers over bed
2) Maximum swing over bed
3) Maximum swing over carriage
4) Maximum swing over Gap
5) Maximum distance b/w centers
6) Length of bed
7) Motor horsepower in **RPM (Revolution per minute).**



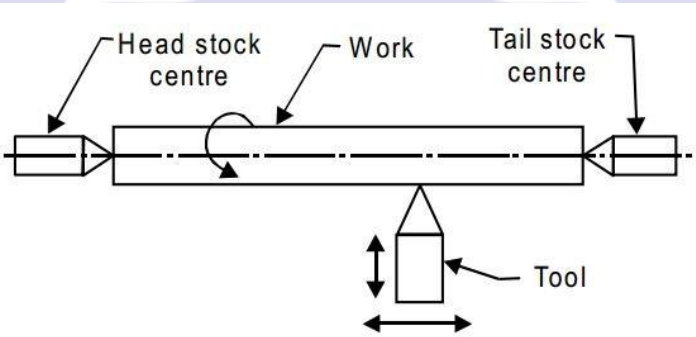
Functions of lathe machine:

- To producing **cylindrical** jobs.
- **Flats** surface and holes.
- It's used for producing **different types** of surfaces, cutting threads, cutting grooves.

Working Principle of lathe machine:

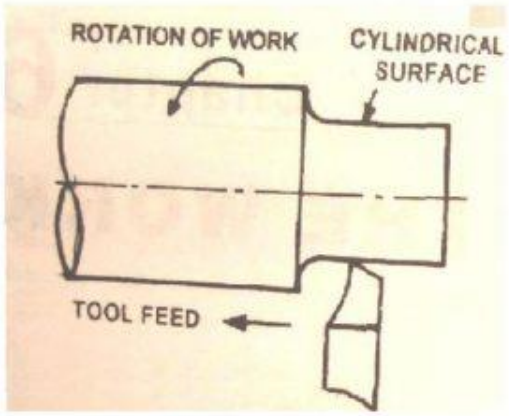
Principle

- A lathe is a machine tool which use to removes unwanted materials from a workpiece in the **form of chips** with the **help of a tool** that travels across the workpiece and can be **fed deep** in work.



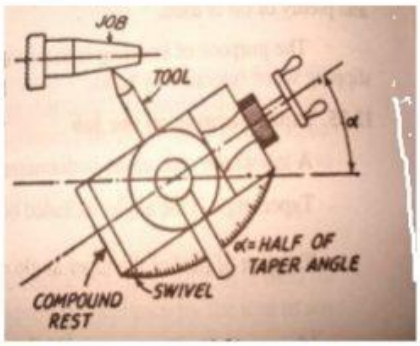
Principle diagram of lathe

- When the tool is **moved parallel** to the workpiece then **the cylindrical surface** is formed**.**



WORKING PRINCIPLE OF LATHE

- If the tool is **moved inclined** to the axis then it produces a **tapered surface** and so calls as taper turning.



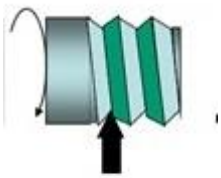
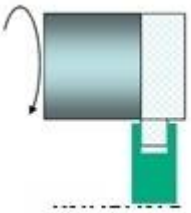
WORKING PRINCIPLE OF LATHE

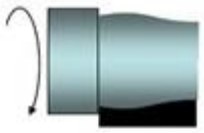
Working

- It holds the work between **two supports** so call as centers.
- **Faceplate or Chuck** are using for holding the work.
- Faceplate or Chuck are mounted **on the machine spindle**.
- The **cutting tool** is holding with the help of Tool post.
- The movement of the job is rotating about the **spindle axis**.
- Against the revolving work, the tool is feed.
- The **tool** moves either **parallel or inclination** to the work axis.

Lathe Operations & Machine Tools

OPERATIONS	DIAGRAM	MACHINE TOOL
Tapper **T**urning	 Taper turning	**T**urning **T**ool

Facing	 Facing	**F**acing **T**ool
Drilling	 Drilling	**D**rilling **T**ool
Boring	 Boring	**B**oring **T**ool
Internal & **E**xternal **T**hreading	 Threading	**T**hreading **T**ool
Knurling	 Knurling	**K**nurling **T**ool
Grinding	 Grinding Wheel	**T**ool Post **G**rinding

Parting	 Parting Tool	**P**arting **T**ool

Operations of Lathe Machine:

1. TURNING

- Turning is an operation in which **the diameter of the work piece** is removed as shown in the above table.

Tapers and taper turning

A taper is defined as a uniform increase or decrease in diameter of a piece of work measured along its length. In a lathe machine, taper turning means to produce a conical surface by gradual reduction in diameter from a cylindrical job. Taper in the British System is expressed in taper per foot or taper per inch.

$$\textbf{Taper per inch} = (D - d) / l$$

$$\textbf{Taper Angle, } \tan\alpha = (0.5 \times \text{Taper})$$

Where,
D = is the diameter of the large end of cylindrical job,
d = is the diameter of the small end of cylindrical job, and
l = is the length of the taper of cylindrical job, all expressed in inches,

Example
A 20-inch taper with small and large diameter as 5 inch and 10 inch has a taper length of 0.25 inch.
The angle formed by a 0.25-inch taper.

$\tan\alpha = (0.5 \times 0.25)$
$\tan\alpha = (0.125)$

Taper angle=**0.124** radians,**7.125** in degrees.

When the taper is expressed in taper per foot, the length of the taper l is expressed in foot, but the diameters are expressed in inches.

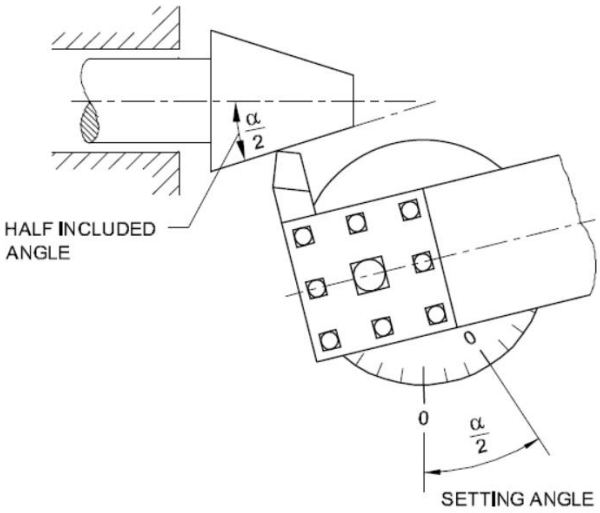
A taper is generally turned in a lathe by feeding the tool at an angle to the axis of rotation of the workpiece. The angle formed by the path of the tool with the axis of the workpiece should correspond to the half taper angle. A taper can be turned by anyone of the following methods:

1. By swivelling the compound rest,
2. By setting over the tailstock centre.
3.By a taper turning attachment,
4. By using numerical control lathe

Some of the important taper turning methods are discussed as under.

1. By swivelling the compound rest

This method uses the principle of turning taper by rotating the workpiece on the lathe axis and feeding the tool at an angle to the axis of rotation of the workpiece. The tool is mounted on the compound rest which is attached to a circular base, graduated in degrees. The compound rest can easily be swivelled or rotated and clamped at any desired angle

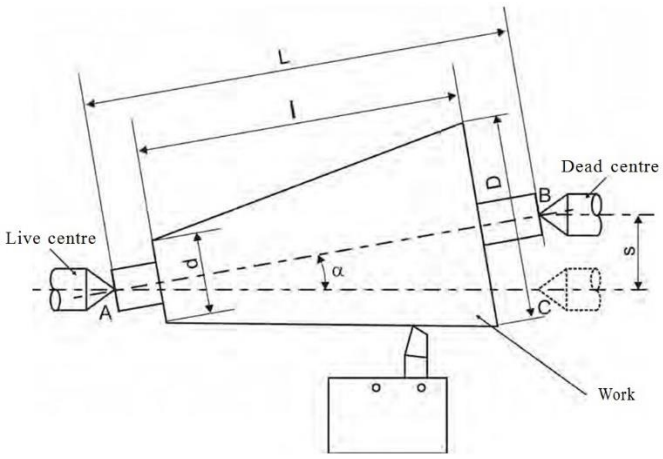


Taper Turning by Swivelling Compound Rest Method

2. Taper Turning with Tailstock set over Method

This method is basically employed for turning small tapers on longer jobs and is confined to external tapers only. In this method, the tailstock is set over is calculated by formula

Tail stock set over = Taper length × Sine of half of taper angle



Taper turning by tailstock setover method

2. FACING

- Facing is an operation in which **the length of the work piece** reduced as shown in the table.
- The turning tool is useful.

a. Feed

- The rate at which the cutting tool crosses the work piece in the direction **perpendicular to the work piece axis** so calls as feed.

b. Depth of cut

- It is the perpendicular distance measured from the machined surface to the **UN – cut** surface of the work piece.

3. DRILLING

- Drilling is an operation to **produce a hole** in the work piece.

4. BORING

- Boring is done to **enlarge a hole** or cylindrical cavity to produce circular internal grooves.

5. KNURLING

- Knurling is done to produce **regular pattern type** roughness on the work piece.

Types of lathe machine:

Lathe machines are classified according to their construction and design. Some of them are:

1. Bench lathe
2. Speed lathe
3. Engine lathe or centre lathe
4. Tool room lathe
5. Capstan and turret lathe
6. Special purpose lathe
7. Automatic lathe

1. BENCH LATHE

- Bench lathe is a **small lathe** usually mounted on a bench.
- This is using for **small and precision work**.

2. SPEED LATHE

- Speed lathe is the **simplest of all types of lathe** in construction and operation.
- It consists of a **bed, a head stock, a tail stock and a tool** – post mounted on an adjustable slide.
- The spindle speed is about **4000 rpm**.
- They named because of very **High Speed** of head stock spindle.

3. ENGINE LATHE (CENTRE LATHE)

- The term" **engine"** is associated with the lathe which is early driven by steam engines.
- An engine lathe is also known as a **reproductive machine** because of its production **capabilitie**s.
- Engine lathes are an **excellent tool,** which aids in the creation of many modern tools.

Advantages

- It is using for **mass production** of products.
- It is using for manufacturing **cylindrical shapes** like steels and plastics.

Disadvantages

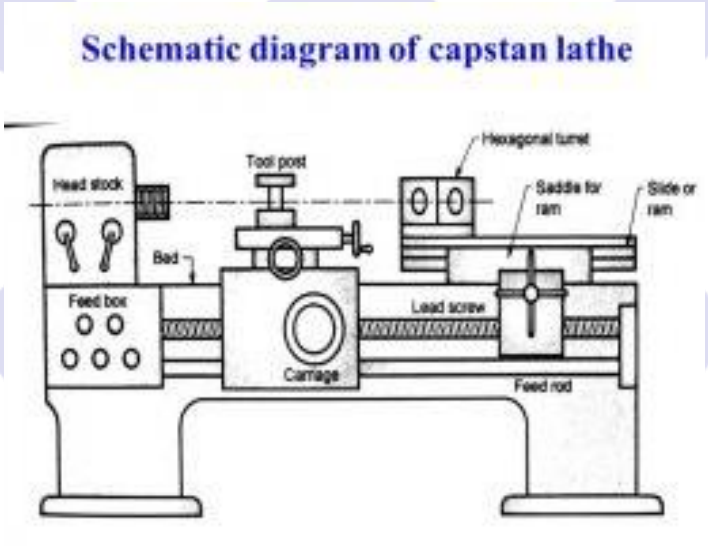
- It is very difficult to **program** in machine language
- poor service, and racial issues.

4. TOOLROOM LATHE

- Toolroom lathe is similar to an engine lathe.
- This lathe is mainly using for precision work on tools, Dies, Gauges and in making work where accuracy is needed.
- It is used for making precision components in the tool room.

5. CAPSTAN AND TURRET LATHE

a. **Capstan Lathe**



- They having features of the basic lathe and have short slide tail stock.
- A Capstan machine is a processing machine uses for making the same parts again and again.

Advantages

- The production rate is high.

Disadvantages

- The heavier workpiece cannot machine by capstan lathe.

b. TURRET LATHE

- The turret lathe is a form of metalworking lathe.
- It is used for repetitive production of duplicate parts.

- In a turret lathe, a longitudinally feed able, hexagon turret replaces the tail stock.

Advantages

- Turret lathe is using to machine the long and heavy workpieces.
- They having hexagonal tool post or head.
- There is no need of changing the tool.

Disadvantages

- They have manual indexes.

6. SPECIAL PURPOSE LATHE

- Special Purpose lathe are using for special purposes and for jobs which cannot be accommodated or conveniently machined on a standard lathe.

7. AUTOMATIC LATHE

- In the automatic lathe, the various operations are automating like the change of the work piece.
- The working cycle is fully automatic that is repeated to produce duplicate parts without participation of operator.

Advantages

- During machine operation operator is free to operate another machine.
- More economy in floor space.

Disadvantages

- Lots of consideration are taking on fixing the setup.

LATHE ACCESSORIES

Lathe accessories are generally divided into two categories :-

1. Work Holding device and
2. Cutting Tool Holding device

1. WORK HOLDING DEVICE

- The work holding devices are the device that is using to hold and rotate the work pieces along with the spindle.

- The different work holding devices are using, according to the shape, length, diameter and weight of the work piece and the location of turning on the work. They are as follows: -

A. Chucks

- A chuck is a specialized type of clamp used to hold the work piece.
- Chuck is mounted on the spindle which rotates within the head stock.

THREE JAW CHUCK

Types of chucks:

a. Three Jaw Chuck
b. Four Jaw chuck
c. Collect Chuck
d. Spindle Chuck
e. Magnetic Chuck
f. Combination Chuck
g. Air Operated Chuck

B. Face plate

Face plate

- Face plate is a circular disc and thread to fit to the nose of the lathe spindle.
- They having radial plain and **'T' – slots** for holding the work by bolts and clamps.

C. Mandrels

Mandrel

- Mandrel is a device which uses for holding a hollow work piece.
- Mandrel is mounting between centers and work revolves with it.

D. Centers

- A lathe center is a tool that has ground to a point to accurately position a work piece.
- There are two centers :-

a. Live center

- A live center is a center which fits into the head stock spindle and revolves with the work.
- A live center is constructed so that the **60** degree center runs in its own bearing .

b. Dead center

- Dead center is the center which uses a tail stock spindle and doesn't revolve .

c. Half center

- Half center is the center which is often used in the tail stock for facing up to or for Turning close to the end of the work .
- It cuts away almost to its point .

E. Driving plate or catch plate

Driving plate/Catch plate

- Catch plate is plane disc which is made up of cast iron or steel .
- They having a central

F. Carriers

- Carrier is a device that Clamps around the work piece .
- They allow the rotary motion of the machines spindle to transmit the work piece .
- There are two types of carrier: -

Carrier

a. Straight Tail Carrier

- This is using for driven the work by means of the pin provided in the driving plate .

b. Bent Tail Carrier

- It fits into the slot of the catch plate to drive the work .

c. Angle Vise

Angle vise

- Angle vise is an angular adjustment on base to allow operator to drill holes at an angle without tilting table.

2. CUTTING TOOL HOLDING DEVICE

- The cutting tool holding device is a device which is using to hold the cutting tools .
- The different cutting tool holding devices are as follows:-

A. Tool Post

Tool post

- Tool Post is a device which holds the cutting tool on a lathe and some other machine.

B. Collect

- Collect is a device which is using to hold a cutting tool in the spindle of a milling machine.

Collect

C. Drill Chucks

Drill chuck

- It is the most common devices which are using for holding straight-shank cutting tools.
- There are two common types:-

a. Key Type

- It has loosened or tightened by key.

b. Keys Less Types

- It has loosened or tightened by hand without the key.

D. Drill Sleeves

Drill sleeve

- Drill sleeves are used to adapt smaller Morse taper shank tools to larger machine spindles.

E. Drill Socket

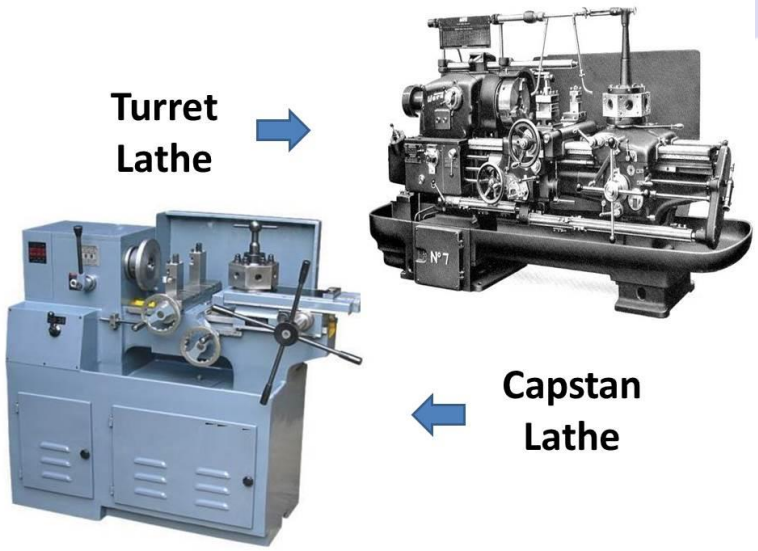
Drill socket

- Drill socket is used to hold twist drills with shanks.
- They have used often an extension socket.

F. Straight Tool Holders

- Straight is using for taken cuts in either direction and for general machining operations.

DIFFERENCE BETWEEN CAPSTAN AND TURRET LATHE



Sr. No.	Capstan lathe	Turret lathe
1.	The turret head is mounted on the ram and the ram is mounted on the saddle.	The turret head is directly mounted on the saddle and the saddle slides over the bed ways.
2.	The saddle is fixed during machining.	The saddle is moved along with the turret head during machining.
3.	The turret head can't be moved crosswise.	The turret head can be moved crosswise.
4.	The lengthwise movement of turret is less.	The lengthwise movement of turret is more.
5.	Maximum bar size is up to **60 mm.**	Maximum bar size is up to **200 mm.**
6.	Collect is used to hold the work piece.	Jaw chuck used to hold the work piece.
7.	Rate of tool feeding relatively faster.	Rate of tool feeding relatively slower.
8.	It is a light weight machine.	It is a heavier machine.
9.	It has a simple tool head.	It has hexagonal tool head.
10.	Automatic indexing.	Manual indexing.

Grinding machines

Grinding machines produce flat, cylindrical and other surfaces by means of high-speed rotating abrasive wheels. Grinding is a means of giving a more accurate finish to a part already machined, but is also a machining process in its own right.

Abrasives

Abrasives are used for grinding and polishing operations. It should have uniform physical properties of hardness, toughness and resistance to fracture. Abrasive may be classified into two principal groups.

1. Natural abrasives

2. Artificial abrasives

Natural abrasives

The natural abrasives are obtained from the Earth's crust. They include sandstone, emery, corundum and diamond. Sandstone is used as abrasive to grind softer materials only. Emery is natural alumina. It contains aluminium oxide and iron oxide. Corundum is also a natural aluminium oxide. It contains greater percentage of aluminium oxide than emery. Both emery and corundum have a greater hardness and abrasive action than sandstone. Diamond is the hardest available natural abrasive. It is used in making grinding wheels to grind cemented carbide tools.

Artificial abrasives

Artificial abrasives are of two types.

1. Silicon carbide abrasives

2. Aluminium oxide abrasives

Silicon carbide

Silicon carbide is manufactured from 56 parts of silica, 34 parts of powdered coke, 2 parts of salt and 12 parts of sawdust in a long rectangular electric furnace of the resistance type that is built of loose brick work. There are two types of silicon carbide abrasives - green grit and black grit. Silicon carbide is next to diamond in the order of hardness. But it is not tough enough as aluminium oxide. It is used for grinding materials of low tensile strength such as cemented carbides, ceramic materials, grey brass, bronze, copper, aluminium, vulcanized rubber etc. This is manufactured under trade names of carborundum. It is denoted by the letter 'S'.

Aluminium oxide

Aluminium oxide is manufactured by heating mineral bauxite, silica, iron oxide, titanium oxide, etc., mixed with ground coke and iron borings in arc type electric furnace. Aluminium oxide istough and not easily fractured, so it is better adapted to grinding materials of high tensile strength such as most steels, carbon steels, high speed steels, and tough bronzes. This is denoted by the letter 'A'.

Specifications for Grinding Machine

The grinding machine manufacturers use various specifications for manufacturing. A few main specifications for such machines are:

1. Grinding wheel size
2. No-Load speed
3. Frequency and volt-rating of machines

4. Input power needed for operating the various grinding machines
5. Horizontal or vertical spindle
6. Kind of control existing for grinding head
7. Hand – operated or CNC controlled machine

Types of grinding machines

1. **Belt Grinding**– Belt grinding conducts the process of edge breaking, finishing, and removing stock.
2. **Bench Grinding**– Bench grinder hand grinds the cutting tools. We also use grinding machines for other sorts of rough grinding functions.
3. **Surface Grinding**– These grinding machines work on the surface of the workpiece to make it extra smooth. This process led to the refined look of the workpiece.
4. **Jig Grinding Machine**– It is generally used for the processes, which need an extreme level of accuracy and finish. This grinding machine is best for grinding complex shapes.
5. **Cylindrical Grinding Machine**– This grinding machine uses the central axis of rotation to grind the workpieces.
6. **Gear cutting Machine**– It is another common type of grinding machine. It performs many other functions like casting, hobbling, machining, forging and others.