THE LATHE

FUNCTION OF THE LATHE

The main function of a lathe is to remove metal from a piece of work to give it the required shape and size.

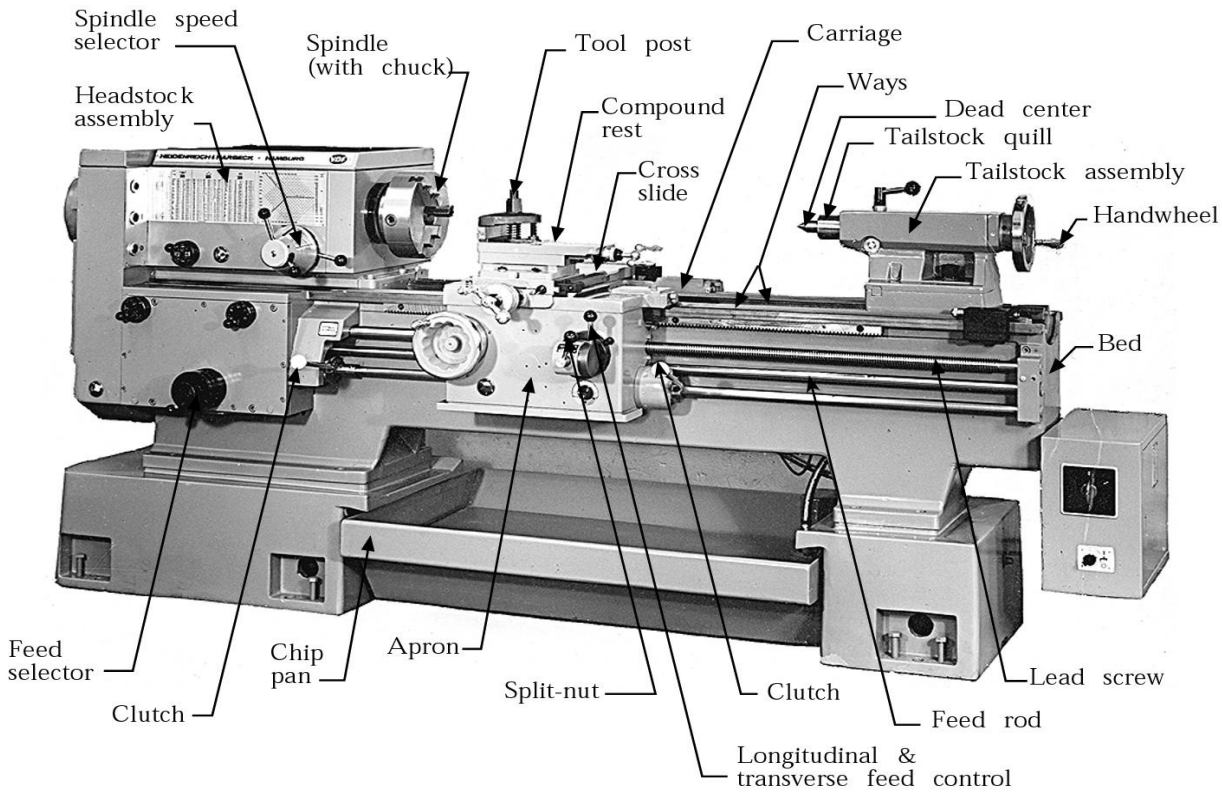
TYPES OF LATHE

Lathes of various designs and constructions have been developed to suit the various conditions of metal machining.

1. Speed lathe.
(a) Woodworking
(b) Centering.
(c) Polishing.
(d) Spinning.
2. Bench lathe.
3. Tool room lathe.
4. Capstan and Turret lathe.
5. Special purpose.
(a) Wheel lathe.
(b) Gap bed lathe.
(c) T-lathe.

6. Engine lathe.
(a) Belt drive.
(b) Individual motor drive.
(d) Duplicating lathe.
(c) Gear head lathe.
(d) Spinning.

7. Automatic lathe.



The Speed Lathe:

- ✓ The speed lathe, in construction and operation, is the simplest of all types of lathe. It consists of a bed, a headstock, a tailstock and a tool-post mounted on an adjustable slide.
- ✓ There is no feed box, lead screw or conventional type of carriage. The tool is mounted on the adjustable slide and is fed into work purely by hand control.
- ✓ This characteristic of the lathe enables the designer to give high spindle speeds which usually range from 1200 to 3600 r.p.m. As the tool is controlled by hand, the depth of cut and the thickness of chip is very small

The engine lathe or centre lathe :

- ✓ This lathe is the most important member of the lathe family and is the most widely used.
- ✓ The term "engines is associated with the lathe owing to the fact that early lathes were driven by steam engines. Similar to the speed lathe, the engine lathe has got all the basic parts

The bench lathe:

- ✓ This is a small lathe usually mounted on a bench. It has practically all the parts of an engine lathe or speed lathe and it performs almost all the operations, its only difference being in the size.
- ✓ This is used fur small and precision work.

The tool room lathe:

- ✓ A tool room lathe having features similar to an. engine lathe is much more accurately built and has a wide range of spindle speeds ranging from a very low to a quite high speed up to 2500 r.p.m.
- ✓ This is equipped, besides other things, with a chuck, taper turning attachment, draw in collet attachment, thread chasing dial, relieving attachment, steady and follower rest, pump for coolant, etc.
- ✓ This lathe is mainly used for precision work on tools, dies, gauges and in machining work where accuracy is needed. The machine is costlier than an engine lathe of the same size.

The capstan and turret lathe:

- ✓ These lathes are development of the engine lathe and are used for production work.
- ✓ The distinguishing feature of this type of lathe is that the tailstock of an engine lathe is replaced by a hexagonal turret, on the face of which multiple tools may be fitted and fed into the work in proper sequence.
- ✓ The advantage is that. several different types of operations can be done on a work piece without re- setting of work or tools, and a number of identical parts can be produced in the minimum time.
- ✓

Special purpose lathe:

- ✓ As the name implies, they are used for special purposes and for jobs which cannot be accommodated or conveniently machined on a standard lathe.
- ✓ Thewheel is made for finishing the journals and turning the tread on railroad car and locomotive wheels. Thegap bed lathe, in which a section of the bed adjacent to the headstock is recoverable, is used to swing extra-large diameter pieces.
- ✓ TheT-lathe, a new member of the lathe family, is intended for machining of rotors for jet engines.The axis of the lathe bed is at right angles to the axis of the headstock spindle is the form of a T.
- ✓ Theduplicating lathe is one for duplicating the shape of a flat. or round template on to the workpiece. Mechanical, air, and hydraulic devices are all used to coordinate the movements of the tool to reproduce accurately.

Automatic lathe :

- ✓ These are high speed, heavy duty, mass production lathes with complete automatic control. Once the tools are set and the machine is started it performs automatically all the operations to finish the job.

- ✓ The changing of tools, speeds, and feeds are also done automatically. After the job is complete, the machine will continue to repeat the cycles producing identical parts even without the attention of an operator.
- ✓ An operator who has to look after five or six automatic lathes at a time will simply look after the general maintenance of the machine and cutting tool, load up a bar stock and remove finished products from time to time.

THE SIZE OF A LATHE:

The size of a lathe is expressed or specified by the following items
1. Theheight of the centres measured from the lathe bed.
2. Theswing diameter overbed. This is the largest diameter of work that will

FEED MECHANISM

- ✓ The movement of the tool relative to the work is termed as "feed". A lathe tool may have three types of feed —longitudinal, cross, and angular.
- ✓ When the tool moves parallel to the lathe axis, the movement is termed asLongitudinal! feed and is effected by the movement of the carriage.
- ✓ When the tool moves at right angle to the lathe axis with the help of the cross slide the movement is termed ascross feed, while the movement of the tool by compound slide when it is swiveled at an angle to the lathe axis is termed asangular feed. Cross and longitudinal feed are both hand and power operated, but angular feed is only hand operated.

The feed mechanism has different units through which motion is transmitted from the headstock spindle to the carriage. Following are the units:
I. End of bed gearing.
2. Feed gearbox.
3. Feed rod and lead screw
4. Apron mechanism.

End of bed gearing:
This gearing serves the purpose of transmitting the drive to the lead screw and feed shaft, either direct or through a gear box. In modern lathes,tumbler gear mechanism or bevel gear feed reversing mechanism is incorporated to reverse the direction of feed.

Tumbler gear mechanism:.

- ✓ Tumbler gears are used to give the desired direction of movement to the lathe carriage, via lead screw or the feed shaft.
- ✓ Apron mechanism Different designs of apron mechanism for transforming rotary motion of the feed rod and the lead screw into feed motion of the carriage are constructed by different makers of the lathe

THREAD CUTTING MECHANISM

The rotation of the lead screw is used to transverse the tool along the work to produce screw thread. The half-nut mechanism illustrated in Fig makes the carriage to engage or

disengage with the lead screw. it comprises a pair of half nuts 7 capable of moving in or out of mesh with the lead screw.

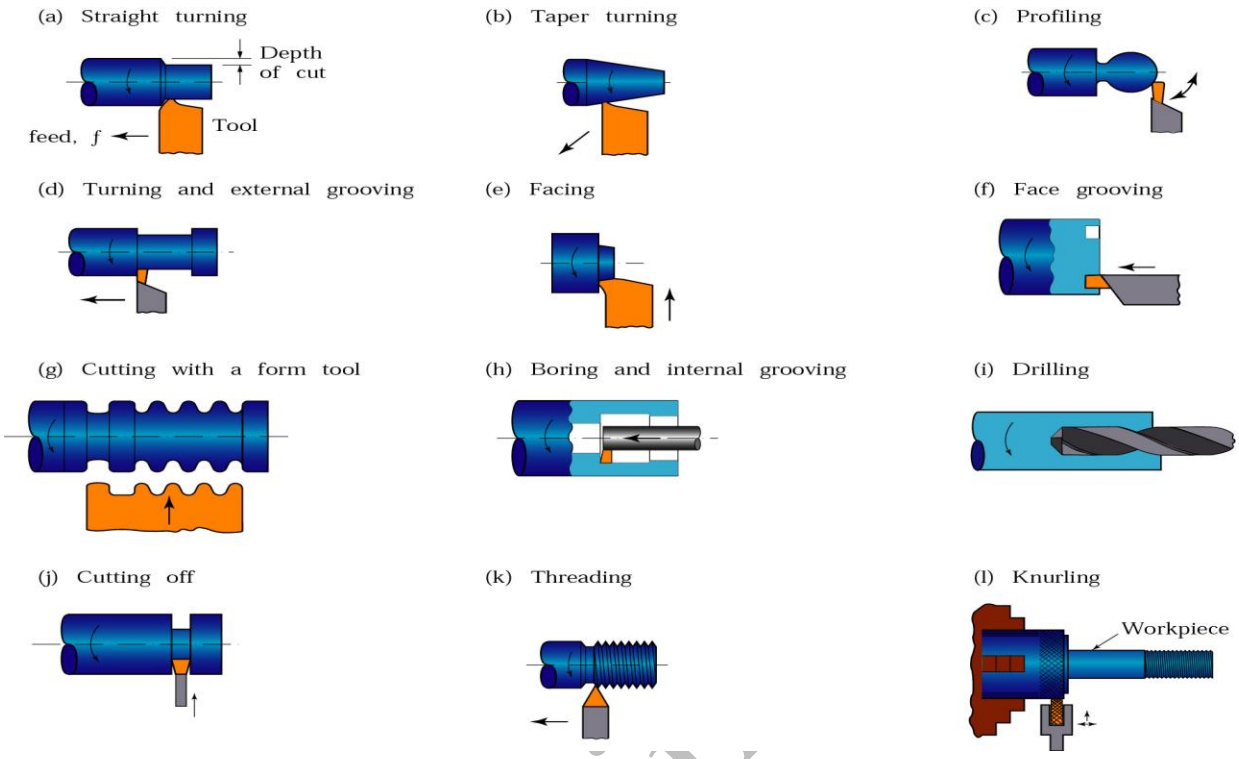
LATHE ACCESSORIES AND ATTACHMENTS

- ✓ Lathe accessories include centers, catch plates and carriers, chutes, collets, face plates, angle plates, mandrels, and rests.
- ✓ They are used either for holding and supporting the work or for holding the tool. Attachments are additional equipment used for specific purposes.
- ✓ They include stops, ball turning rests, thread chasing dials, and taper turning, milling, grinding, gear cutting, turret, cutter, relieving a id crank pin turning attachments.

LATHE OPERATIONS

Operations which are performed in a lathe either by holding the workpiece between centres or by a chuck are:

1. Straight turning.
2. Shoulder turning.
3. Chamfering.
4. Thread cutting.
5. Facing.
6. Knurling.
7. Filing.
8. Taper turning.
9. Eccentric turning.
10. Polishing.
11. Grooving.
12. Spinning.
13. Spring winding.
14. Forming.

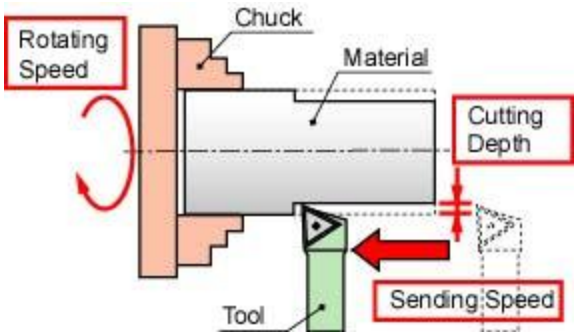


Operation which are performed by holding the work by a chuck era faceplate or an angle plate are:

1. Drilling
2. Reaming
3. Boring
4. Counterboring
5.Taperboring
6. Internal thread cutting
7. Tapping
8. Undercutting
9.Parting-off

Operations which are performed by using special attachments

1.Grinding
2. Milling



Work Holding Devices:

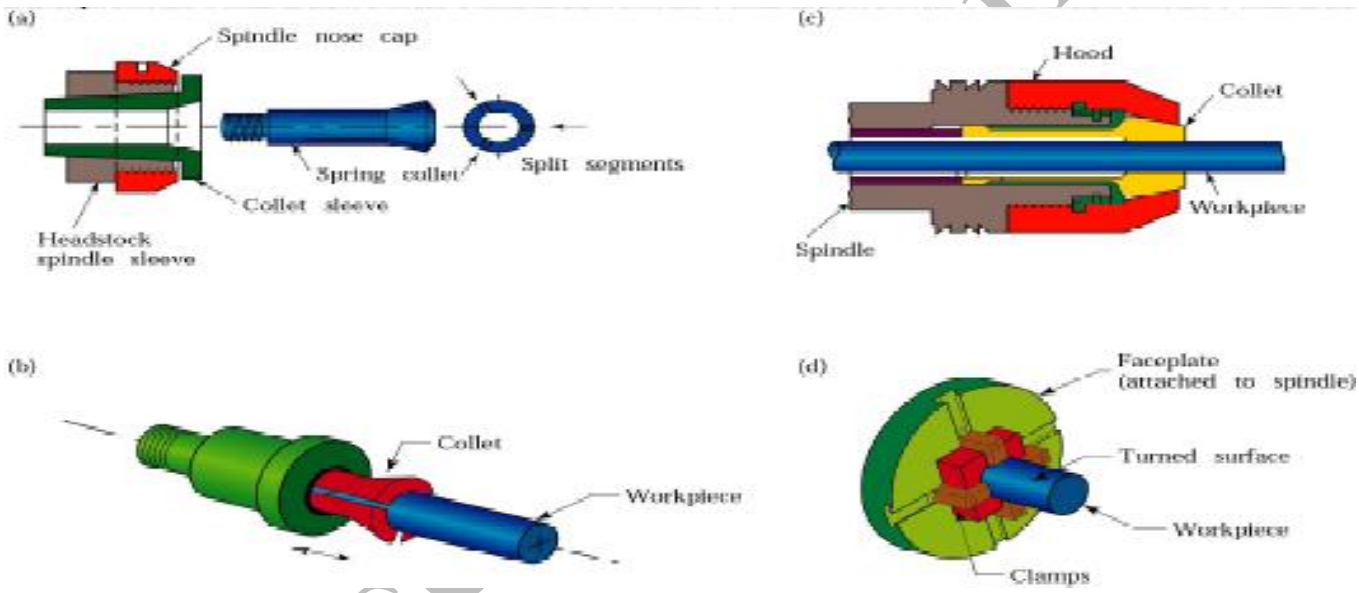


Fig : (a) and (b) Schematic illustrations of a draw-in-type collets. The workpiece is placed in the collet hole, and the conical surfaces of the collet are forced inward by pulling it with a draw bar into the sleeve. (c) A push-out type collet. (d) Workholding of a part on a face plate.

Three jaw chuck:

- For holding cylindrical stock centered.
- For facing/center drilling the end of your aluminum stock

Four-Jaw Chuck

- This is independent chuck generally has four jaws , which are adjusted individually on the chuck face by means of adjusting screws

Collet Chuck:

Collet chuck is used to hold small workpieces

Magnetic Chuck:

Thin jobs can be held by means of magnetic chucks

CENTERING
Where the work is required to be turned between centres or between a chuck and a centre, conical shaped holes must be provided at the ends of lbs workpiece to provide bearing surface for lathe centres. Centering is the process of producing conical holes in workpieces.

TURNING:
Turning in a lathe is to remove excess material from the workpiece to produce a cone-shaped or acylindrical surface. The various types of turning made in lathe work for various purposes are described
below.

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 workpiece.

TAPER TURNING METHODS:

A taper may be turned by any one of the following methods:
1. By a broad nose form tool.
2. By setting over the tailstock centre.
3. By swivelling the compound rest.
4. By a taper turning attachment.
5.By combining longitudinal and cross feed in a special lathe.

Taper Turning by a form tool:.

- ✓ A broad nose tool having straight cutting edge is set on to the work at half taper angle, and is fed straight into the work to generate a tapered surface
- ✓ The half angle of taper will correspond to 90 minus side cutting edge angle of the tool. In this method the tool angle should be properly checked before use.
- ✓ This method is limited to turn short length of taper only. This is due to the reason that the metal is removed by the entire cutting edge, and any increase in the length of the taper will necessitate the use of a wider cutting edge.
- ✓ This will require excessive cutting pressure, which may distort the work due to vibration and spoil the work surface.
- ✓

Taper turning by setting over the tailstock:

- ✓ The principle of turning taper by this method is to shift the axis of rotation of the workpiece, at an angle to the lathe axis, feeding the tool parallel to the lathe axis.
- ✓ The angle at which the axis of rotation of the workpiece is shifted is equal to half angle of the taper. This is done when the body of the tailstock is made to slide on its base towards or away from the operator by a setover screw as illustrated

- ✓ The amount of setover being limited, this method is suitable for turning small taper on long jobs.
- ✓ The main disadvantage of this method is that the live and dead centres are not equally stressed and the wear is not uniform. Moreover, the lathe carrier being set at an angle, the angular velocity of the work is not constant.
- ✓

Taper turning by swiveling the compound rest:

- ✓ This method employs 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 mounted on the compound rest is attached to a circular base, graduated in degree, which may be swivelled and clamped at any desired angle.
- ✓ Thesetting of the compound rest is done by swivelling the rest at the half taper angle, if this is already known. If the diameter of the small and large end and length of taper are known.
- ✓

Taper turning by a taper attachment:

- ✓ The principle of turning taper by a taper attachment is to guide the tool in a straight path set at an angle to the axis of rotation of the workpiece, while the work is being revolved between centres or by a chuck aligned to the lathe axis. consists essentially of a bracket or frame which is attached to the rear end of the lathe bed and supports a guide bar pivoted at the centre.
- ✓ The bar having graduations in degrees may be swivelled on either side of the zero graduation and is set at the desired angle with the lathe axis.

CAPSTAN AND TURRET LATHE

- ✓ A capstan or a turret lathe is a production lathe used to manufacture any number of identical pieces in the minimum time. These lathes are development of engine lathes.
- ✓ The capstan or turret lathe consists of a bed, all geared headstock, and a saddle on which a four station tool post is mounted to hold four different tools. A tool post fitted at the rear of the carriage holds a parting tool in an inverted position.
- ✓ The tool post mounted on the cross-slide is indexed by hand. In a capstan or turret lathe there is no tailstock, but in its place a hexagonal turret is mounted on a slide which rests upon the bed. All the six faces of the turret can hold six or more number of different tools.
- ✓ The turret may be indexed automatically and each tool may be brought in line with the lathe axis in a regular sequence. The workpieces are held in collets or in chucks.
- ✓ The longitudinal and cross feed movement of the turret saddle and cross-slide are regulated by adjustable stops.
- ✓ These stops enable different tools set at different stations to move by a predetermined amount for performing different operations on repetitive

workpieces without measuring the length or diameter of the machined surface in each case.

DIFFERENCE BETWEEN A CAPSTAN AND TURRET AND AN ENGINE LATHE

Although a capstan and a turret lathe is a development of an engine lathe they possess certain basic differences as regards their construction, operation and use. The differences are:

1.The headstock of a turret lathe is similar to that of an engine lathe in construction but possess wider range of speeds, and is of heavier in construction. For similar sizes of capstan and turret lathe and engine lathe, when an engine lathe will require a motor of 3 h.p. to drive its spindle and other parts, a capstan and turret lathe will demand power as high as 15 h.p. for high rate of production.

2. The tool post mounted on the cross-slide of a turret lathe is a four way tool post which holds four tools that may be indexed by 900 and each tool may be brought into operation in a regular order. In addition to this, there is a rear tool post mounted upon the carriage which holds another tool, whereas in the case of an engine lathe the usual practice is to hold only one tool on the tool post, and for different operations the tool must be changed and will require too much of setting time in repetitive works.

3. In a turret lathe, the tailstock of an engine lathe is replaced by a turret. This is a six sided block each side of which may carry one or more tools. Thus, in place of tailstock in a centre lathe which can accommodate only one tool of limited size, the six faces of the turret hold six or more tools. These tools may be indexed one after the another to perform different operations in a regular order. This is a decisive advantage in mass production work.

4. The feed movement of each tool set on square or hexagonal turret may be regulated by stops and feed trips. They enable the same tool to perform operation on each workpiece to a predetermined amount making duplication of work without further measurement.

5. In a turret lathe, combination cuts can .be taken. Two or more tools may be mounted on the same face of the turret, making it possible to machine more than one surface at a time. This feature reduces total operational time. In a centre lathe, this type of arrangement is quite uncommon.

6. The labour cost required to operate a capstan or turret lathe is less than that required in a centre lathe. Once the tools have been set in the turret holders to perform different operations and the stop and feed trips have been adjusted to determine the correct machining lengths, the operation of the machine becomes very simple. A semiskilled operator can operate a capstan or turret lathe after the machine has been set up by a skilled machinist. A skilled machinist may be requisitionedforsetting up only for a large number of machines, whereas actual production may be given by a semiskilled operator.

7. Capstan and turret lathes are not usually fitted with leadscrews for cutting threads similar to an engine lathe. The threads are usually cut by dieheads and taps. A short length of leadscrew, called “chasing screw” are sometimes provided for cutting threads by a chaser in a turret lathe.

8. The capstan or turret lathe is fundamentally a production machine, capable of producing large number of identical pieces in a minimum time. The special feature of holding eleven or more tools which may be brought into operation in a regular sequence

and the use of feed trips and stops justifies its use as a production machine. On the other hand, the centre lathe is suitable for odd jobs having different shapes and sizes.

DIFFERENCE BETWEEN A CAPSTAN AND A TURRET LATHE

The capstan and turret lathes although appear to be identical in the first sight, present lot of differences in construction, operation and use. The following are the difference between capstan and turret lathes:

1. The turret of a capstan lathe is mounted on a short slide or ram which slides on the saddle. The saddle is clamped on bed ways after adjusting the length of the work piece. Thus in a capstan lathe, the travel of the turret is dependent upon the length of the travel of the ram. This limits the maximum length of the work to be machined in one setting. The turret of a turret lathe is mounted on a saddle which slides directly on the bed. This feature enables the turret to be moved on the entire length of the bed and can machine longer work.
2. In the case of a turret lathe, the turret is mounted on the saddle which slides directly on the lathe bed ways. This type of construction provides utmost rigidity to the tool support as the entire cutting load is taken up by the lathe bed directly. In the case of a capstan lathe as the ram feeds into the work, the overhanging of the ram from the stationary saddle presents a non-rigid construction which is subjected to bending, deflection or vibration under heavy cutting load. For this reason the turret lathe can operate under severe cutting conditions, accommodating heavier work pieces with high cutting speeds, feeds, and depth of cuts. Turret lathes are capable of turning bars 125 to 200 mm in diameter and absorbing upto 50 h.p. in the main drive, whereas maximum size of bar that a capstan lathe can accommodate is 60 mm in diameter.
3. Larger and heavier chucking works are usually handled on a turret lathe, whereas a capstan lathe is suitable for bar work.
4. On the capstan lathe, the hexagonal turret can be moved back and forth much more rapidly without having to move the entire saddle unit. Thus capstan lathes are particularly handy forsmall articles which require light and fast cuts. While operating the machine by hand, the cuts are sensitive and there is less fatigue to the operator due to the lightness of the ram, whereas in the case of a turret lathe, the hand feeding is a laborious process due to the movement of the entire saddle unit.
5. Some turret type lathes are equipped with crosswise movement of the hexagonal turret. The crosswise movement may be effected by hand or power. This feature enables turning of large diameters, facing, contour turning and many other operations on the lathe.
6. Heavier turret lathes are equipped with power chucks like air operated chucks for holding larger sizes of work quickly.
7. In the case of a capstan lathe, the cross-slide is mounted on a carriage which rests on bedways between headstock and the ram. The carriage rests on both the front and rear ways on the top of the bed. Some turret type lathes are equipped with side hung type carriage. The carriage of this type does not require support from the rear bed ways but slides on the top and bottom guide ways provided at the front of the lathe. This construction enables larger diameter of work to be swung above the lathe bed ways. There is no rear tool post on this type of the machine as the carriage does not extend up to the rear bed ways.

BAR FEEDING MECHANISM:

The capstan and turret lathes while working for bar work require some mechanism for bar feeding. The long bars which protrude out of the headstock spindle require to be fed through the spindle upto the bar stop after the first piece is completed and the collet chuck is opened. Thus bar feeding may be without stopping the machine.

- ✓ They accurately locate the work.
- ✓ They grip the work properly, preventing it from bending o slipping during machining operations.
- ✓ They permit rapid loading and unloading of workpieces.

TOOL HOLDING DEVICES

- ✓ The wide variety of work performed in a capstan or turret lathe in mas production necessitated designing of many different types of tool holder for holding tools for typical operations.
- ✓ The tool holders may be mount on turret faces or on cross-slide tool post and may be used for holding tools for bar and chuck work.
- ✓ Certain tool holders are used for holding tools for both bar and chuck work while box tools are particularly adapts in bar work.
- ✓ In capstan or turret lathe practice the whole assembly o holder and its tool is designated according to the type of the holder.
- ✓ Thus slide tool holder with the tool mounted in it is called a ‘ slide tool’ and knee tool holder with the tool fitted into it is called a “knee tool”. Special tool holders are also sometimes designed forspecial purposes. The important and widely used tool holders are listed below:

1. Straight cutter holder.
2. Plain or adjustable angle cutter holder.
3. Multiple cutter holder.
4. Offset cutter holder.
5. Combination tool holder or multiple turning head.
6. Slide tool holder. 7. Knee tool holder. 8. Drill holder.
9. Boring bar holder or extension holder or flanged tool holder.
10. Reamer holder.
11. Knurling tool holder.
12. Recessing tool holder.
13. Form tool holder : (a) straight, (b) circular.
14. Tap holder.
15. Die holder.
16. Balanced tool holder (box tool).
17. V-steady box tool holder.
18 . Roller steady box tool holder.

ANNA UNIVERSITY IMPORTANT QUESTION

Part A (Two marks Questions)

1. What are the principle parts of a lathe?
2. What is the main difference between live center and dead center?
3. What are all the various parts mounted on the carriage?
4. What is compound rest?
5. What are the different types of lathe?
6. What is semi automatic lathe?
7. What are the two types of semi automatic lathe?
8. What are the various feed mechanisms used for obtaining automatic feed in lathe?
9. What is all the work holding devices in lathe?
10. What is the different between semi automatic lathe and automatic lathe?
11. What are the different operations that can be performed on a lathe?
12. What is thread catching?
13. What are the possible different operations that can be performed on a lathe?
14. What is the difference between the turret lathe and capstan lathe?
15. What are the four major parts of Swiss type automatic lathe?
16. What are all the advantages of Swiss type screw cutting machine?
17. What is the principle of multi-spindle automats?
18. What are the purposes of using cam?
19. What is a hollow mill?
20. What is the advantage of automation in machining?

PART B

1. Explain in details the various types of lathes with suitable sketches.
2. Explain in details the various parts of the lathe.
3. Explain the feed mechanism used in the lathe.
4. Explain thread cutting mechanism in the lathe.
5. Explain the various types of mandrels used in lathe.
6. Explain thread cutting operation in the lathe.
7. Explain the differences between capstan lathe and turret lathe.
8. Explain in details capstan lathe and turret lathe mechanism.
9. Explain various tool holding devices used in turret and capstan lathe.
10. Explain the tooling layout for the production of a hexagonal bolt in turret and capstan lathe.