4

CAPSTAN AND TURRET LATHES

4.1 INTRODUCTION

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 lathe was first developed in the United States of America by Pratt and Whitney sometimes in 1860.

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. These special characteristics of a capstan or turret lathe enables it to perform a series of operations such as turning, drilling, boring, thread cutting, reaming, necking, chamfering, cutting-off and many other operations in a regular sequence to produce a large number of identical pieces in a minimum time.

4.2 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 90° 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 requisitioned for

setting 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.

In short, an engine lathe is a versatile machine capable of machining any or every type of jobs within its limit. The machine is unsuitable as a production unit as considerable time is taken to set different tools on the tool post of the lathe after each operation and for each job. On the other hand, the capstan or turret lathe is a mass production machine. They are unsuitable where only one or few jobs are to be machined. The high initial setting time compared to an engine lathe does not justify its use in a single or few number of jobs.

4.3 TYPES OF MACHINE

The two main types of horizontal lathes of this family are :

1. The capstan or ram type lathe.
2. The turret or saddle type lathe.

The capstan or ram type lathe : The ram type turret lathe or capstan lathe as shown in Fig.4.1 carries the hexagonal turret on a ram or a short slide. The ram slides longitudinally on a saddle positioned and clamped on lathe bedways. This type of machine is lighter in construction and is suitable for machining bar of smaller diameter. The tools are mounted on the square turret and six faces of the hexagonal turret. The feeding movement is obtained when the ram moves from left to the right, and when the ram is moved backward the turret indexes automatically and the tools mounted on the next face comes into operation.

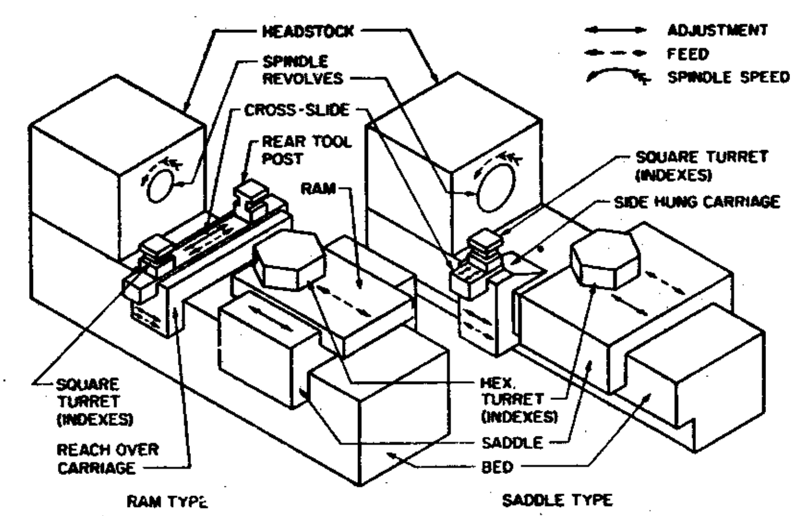

Figure 4.1 Ram type (capstan) and saddle type (turret) lathes
(Reproduced from Doyle *et al*)

The turret or saddle type lathe: The hexagonal turret as shown in Fig.4.1 is mounted directly on a saddle and the whole unit moves back and forth on the bedways to apply feed. This type of turret lathe is heavier in construction and is particularly adapted for larger diameter barwork and chucking work. The machine can accommodate longer workpieces than that in a capstan lathe.

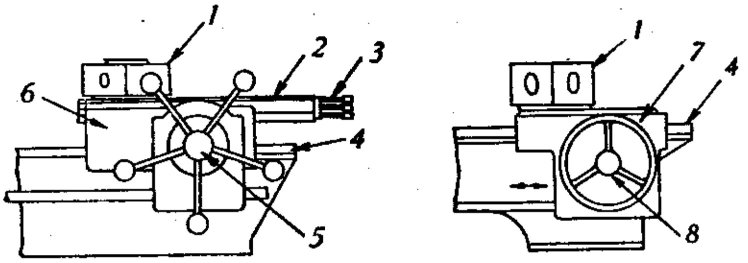

Figure 4.2 Capstan and turret lathe to show their difference
1. Hexagonal turret, 2. Auxiliary slide, 3. Feed stop rod, 4. Lathe bed, 5. Handwheel for auxiliary slide, 6. Saddle, 7. Turret saddle, 8. Handwheel for saddle.

4.4 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 bedways after adjusting the length of the workpiece. 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 ènables 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 bedways. 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 workpieces 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 for small 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 headsock 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 bedways but slides on the top and bottom guideways provided at the front of the lathe. This construction enables larger diameter of work to be swung above the lathe bedways. There is no rear tool post on this type of the machine as the carriage does not extend upto the rear bedways.

4.5 PRINCIPAL PARTS OF CAPSTAN AND TURRET LATHES

The turret lathe has essentially the same parts as the engine lathe except the turret and complex mechanism incorporated in it for making it suitable for mass production work. Fig. 4.3 illustrates the different parts of a capstan lathe and Fig. 4.4 shows the different parts of a turret lathe. The following are the principal parts of a capstan and turret lathe :

Bed : The bed is a long box like casting provided with accurate guideways

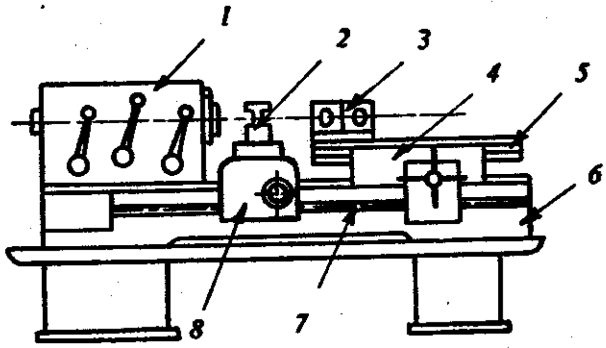

Figure 4.3 Capstan lathe parts

1. Headstock, 2. Cross-slide toolpost, 3. Hexagonal turret, 4. Saddle for auxiliary slide, 5. Auxiliary slide, 6. Lathe bed, 7. Feed rod, 8. Saddle for cross-slide.

upon which are mounted the carriage and turret saddle. The bed is designed to ensure strength, rigidity and permanency of alignment under heavy duty services. Like engine lathe precission surface finishing methods must be applied to keep it resistant to wear during service period.

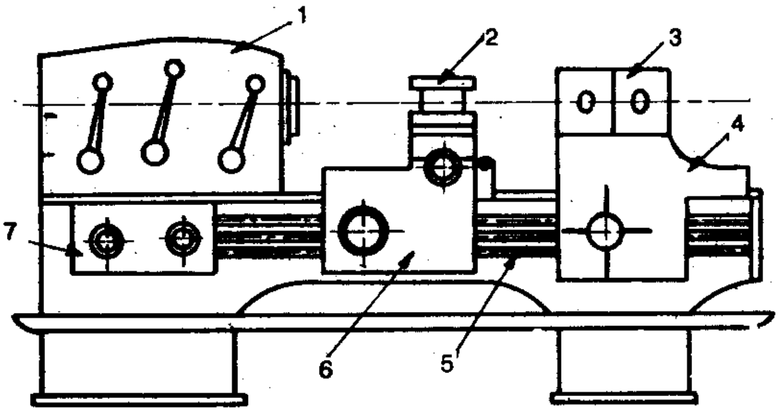

Figure 4.4 Turret lathe parts
1. Headstock, 2. Cross-slide toolpost, 3. Hexagonal turret, 4. Turret saddle, 5. Feed rod, 6. Saddle for cross-slide.

Headstock : The head stock is a large casting located at the left hand end of the bed. The headstock of a capstan or turret lathe may be of the following types :

1. Step cone pulley driven headstock.
2. Direct electric motor driven headstock.
3. All geared headstock.
4. Preoptive or preselective headstock.

Step cone pulley driven headstock : This is the simplest type of headstock and is fitted with small capstan lathes where the lathe is engaged in machining small and almost constant diameter of workpieces. Only three or four steps of pulley can cater to the needs of the machine. The machine requires special countershaft unlike that of an engine lathe, where starting, stopping and reversing of the machine spindle can be effected by simply pressing a foot pedal.

Electric motor driven headstock : In this type of headstock the spindle of the machine and the armature shaft of the motor are one and the same. Any speed variation or reversal is effected by simply controlling the motor. Three or four speeds are available and the machine is suitable for smaller diameter of workpieces rotated at high speeds.

All geared headstock : On the larger lathes, the headstocks are geared and different mechanisms are employed for speed changing by actuating levers. The speed changing may be effected without stopping the machine.

Preoptive or preselective headstock : It is an all geared headstock with provisions for rapid stopping, starting and speed changing for different operations by simply pushing a button or pulling a lever. For different operations and for turning different diameters, the speed of the spindle must change. The required speed for next operation is selected beforehand and the speed changing lever is placed at the selected position. After the first operation is complete, a button or a lever is simply actuated and the spindle starts rotating at the selected speed required for the second operation without stopping the machine. This novel mechanism is effected by the friction clutches.

Cross-slide and saddle : In small capstan lathes, hand operated cross-slide and saddle are used which are clamped on the lathe bed at the required position. The larger capstan lathes and heavy duty turret lathes are equipped with usually two designs of carriage.

1. Conventional type carriage.
2. Side hung type carriage.

The conventional type of carriage bridges the gap between the front and rear bedways and is equipped with four station type tool post at the front, and one rear tool post at the back of the cross-slide.

The side-hung type carriage is generally fitted with heavy duty turret lathes where the saddle rides on the top and bottom guideways on the front of the lathe bed. The design facilitates swinging of larger diameter of workpieces without being interfered by the cross-slide. The saddle and the cross-slide may be fed longitudinally or crosswise by hand or power. The longitudinal movement of each tool may be regulated by using stopbars or shafts set against the stop fitted on the bed and carriage. These stops are set so that each tool will feed into the work to the desired length for the purpose of duplicating the job without checking the machining lengths for different operations each time. These stops first trip out the feed and then serve as a deadstop for small hand operated movements of the tool to complete the cut. The stopbars are indexed by hand to synchronize with the indexing of the tool.

The tools are mounted on the tool post and correct heights are adjusted by using rocking or packing pieces.

The turret saddle and auxiliary slide : In a capstan lathe, the turret saddle bridges the gap between two bedways, and the top face is accurately machined to provide bearing surface for the auxiliary slide. The saddle may be adjusted on lathe bedways and clamped at the desired position. The hexagonal turret is mounted on the auxiliary slide. In a turret lathe, the turret is directly mounted on the top of the saddle and any movement of the turret is effected by the movement of the saddle. The movement of the turret may be effected by hand or power. The turret is a hexagonal-shaped tool holder intended for holding six or more tools. Each face of the turret is accurately machined. Through the centre of each face accurately bored holes are provided for accommodating shanks of different tool holders. The centre line of each hole coincides with the axis of the lathe when aligned with the headstock spindle. In addition to these holes, there are four tapped holes on each face of the turret for securing different tool holding attachments. At the centre of the turret on the top of it there is a clamping lever which locks the turret on the saddle. Six stop bars are mounted on the saddle which restrict the movement of each tool mounted on each face of the turret to be fed to a predetermined amount for duplicating workpieces. After one operation is completed, as the turret is brought back away from the spindle nose, the turret indexes automatically by a mechanism incorporated on the bed and in turret saddle, so that the tool mounted on the next face is aligned with the work.

4.6 CAPSTAN AND TURRET LATHE MECHANISM

The carriage, cross-slide, turret slide, and the saddle holding the turret may be fed into the work by hand or power. Separate feed rods transmit power to the carriage and turret saddle for this purpose. In addition to the apron mechanism and complicated geared headstock, a capstan or turret lathe incorporates a novel device by virtue of which the turret indexes automatically when it is brought back away from the spindle nose after the first operation is completed. The mechanism is explained below.

Turret indexing mechanism : A simple line sketch of the mechanism is shown in the Fig.4.5. The Fig.4.5 illustrates an inverted plan of the turret assembly. The turret *1* is mounted on the spindle *5*, which rests on a bearing on the turret saddle (not shown in the sketch). The index plate *2*, the bevel gear *3* and an indexing ratchet *4* are keyed to the spindle *5*. The plunger *14* fitted within the housing and mounted on the saddle locks the index plate by spring *15* pressure and prevents any rotary movement of the turret as the tool feeds into the work. A pin *13* fitted on the plunger *14* projects out of the housing. An actuating cam *10* and the indexing pawl *7* are attached to the lathe bed *9* at the desired position. Both the cam and the pawl are spring loaded. As the turret reaches the backward position, the actuating cam *10* lifts the plunger *14* out of the groove in the indexplate due to the riding of the pin *13* on the beveled surface of the cam *10* and thus unlocks the indexplate *2*. The spring loaded pawl *7* which by this time engages with a groove of the ratchet plate *4*, causes the ratchet to rotate as the turret head moves backward. When the indexplate or the turret rotates through one sixth of revolution, the pin *13* and the plunger *14* drops out of the cam *10* and the plunger locks the indexplate at the next groove. The turret is thus indexed by one sixth of revolution and again locked into the new position automatically. The turret holding the next tool is now fed

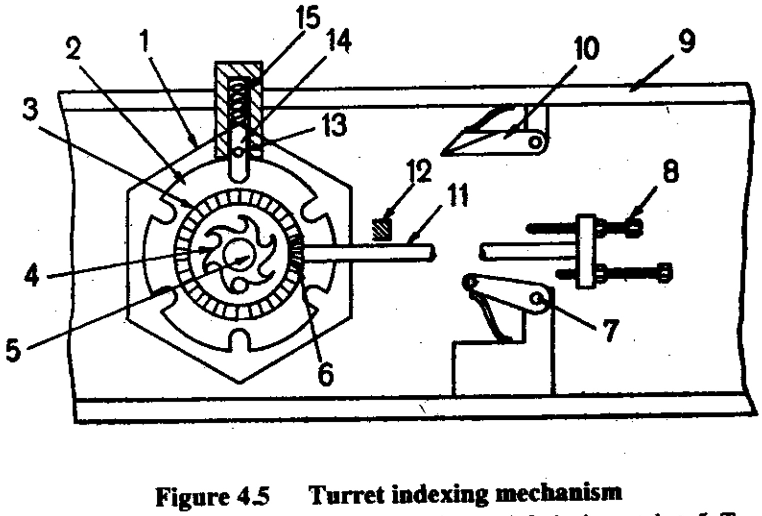

Figure 4.5 Turret indexing mechanism

1. Hexagonal turret, 2. Index plate, 3. Beveled gear, 4. Indexing ratchet, 5. Turret spindle, 6. Beveled pinion, 7. Indexing pawl, 8. Screw stop rods, 9. Lathe bed, 10. Plunger actuating cam, 11. Pinion shaft, 12. Stop, 13. Plunger pin, 14. Plunger, 15. Plunger spring.

forward and the pawl is released from the ratchet plate by the spring pressure.

The synchronized movement of the stop rods with the indexing of the turret can also be understood from Fig.4.5. The bevel pinion *6* meshes with the bevel gear *3* mounted on the turret spindle. The extension of the pinion shaft carries a plate holding six adjustable stop rods *8*. As the turret rotates through one sixth of the revolution, the bevel gear *3* causes the plate to rotate. The ratio of the teeth between the pinion and the gear are so chosen that when the tool mounted on the face of the turret is indexed to bring it to the cutting position, the particular stop rod for controlling the longitudinal travel of the tool is aligned with the stop *12*. The setting of the stop rods *8* for limiting the feed of each operation may be adjusted by unscrewing the lock nuts and rotating the stop rods on the plate. Thus six stop rods may be adjusted for controlling the longitudinal travel of tools mounted on six faces of the turret.

Bar feeding mechanism : The capstan and turret lathes while working on 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. In simple cases, the bar may be pushed by hand. But this process unnecessarily increases the total operational time, because the spindle and the long bar must come to a dead stop before any adjustment can be made. Thus in each case unnecessarily long time is wasted in stopping, setting, and starting the machine. Various types of bar feeding mechanism have, therefore, been designed which push the bar forward immediately after the collet releases the work without stopping the machine, enabling the setting time to be reduced to the minimum. Fig.4.6 illustrates a simple bar feeding mechanism. The bar *6* is passed through the bar chuck *3*, spindle of the machine and then through the collet chuck. The bar chuck *3* rotates in the sliding bracket body *2* which is mounted on a long slide bar. The bar chuck *3* grips the bar centrally by two set screws *5* and rotates with the bar in the sliding bracket body *2*. One end of the chain *8* is connected to the pin *9* fitted on the sliding bracket *10* and the other end supports a weight *4*, the chain running over two fixed pulleys *7* and *11* mounted on the slide bar. The weight *4* constantly exerts endthrust on the bar chuck while it revolves on the sliding bracket and forces the bar through the spindle, the moment the collet chuck is released. Thus bar feeding may be accomplished without stopping the machine.

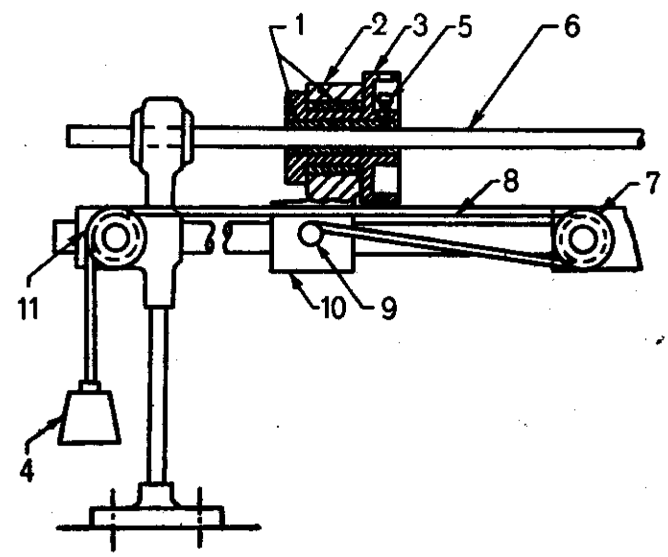

Figure 4.6 Bar feeding mechanism

1. Chuck bush, 2. Sliding bracket body, 3. Bar chuck, 4. Weight, 5. Bar chuck set screw, 6. Bar, 7, 11, Pylley, 8. Chain, 9. Pin on the sliding bracket, 10. Sliding bracket

4.7 CAPSTAN AND TURRET LATHE SIZE

The size of a capstan or turret lathe is designated by the maximum diameter of rod that can be passed through the headstock spindle and the swing diameter of the work that can be rotated over the lathe bed ways. In order to specify the lathe fully, other important particulars such as number of spindle speeds, number of feeds available to the carriage and turret saddle, net weight of the machine, floor space and power required, etc. should also be stated.

4.8 WORK HOLDING DEVICES

The standard practice of holding work between two centres in an engine lathe finds no place in a capstan or turret lathe as there is no dead centre to support the work at the other end. Work is, therefore, supported at the spindle end by the help of chucks and fixtures. The usual methods of holding work in a capstan or turret lathe are :

1. Jaw chucks.
   (a) Self centering chuck.
   (b) Independent chuck.
   (c) Combination chuck.
   (d) Air operated chuck.
2. Collet chucks.
   (a) Push out type
   (b) Draw in type
   (c) Dead length type

Jaw chucks : The jaw chucks are used in capstan lathes having two, three or four jaws depending upon the shape of the work. The jaw chucks are used to support odd sized jobs or jobs having larger diameter which cannot be introduced through the headstock spindle and gripped by collet chucks.

Self centering chuck : The chuck has been described in Art.3.12 and illustrated in Fig.3.25. The three jaws operate simultaneously by the rotation of the scroll and grips the job quickly while centering it. The chuck is suitable for gripping larger diameter bars, circular castings, forgings, etc.

Four jaw independent chuck : This type of chuck is used occasionally for gripping irregular shaped workpieces, where the number of articles required does not justify the manufacture of special fixtures. Each jaw can be operated independently and is reversible. The chuck has been described in Art.3.12 and illustrated in Fig.3.24.

Combination chuck : The combination chuck is used to hold a variety of work following the principle of self-centering and independent jaw chuck. The chuck has been described and illustrated in Art.3.12 and Fig.3.26.

Air operated chuck : Heavy duty turret lathes and capstan lathes engaged in mass production work are equipped with air operated chucks for certain distinct advantages. The chuck grips the work quickly and is capable of taking powerful grip with least manual exertion. The chucks are operated by air at a pressure of 5.5 kg/cm^2 to 7 kg/cm^2. The working of the chuck has been detailed in Art.3.12 and illustrated in Fig.3.30.

Soft jaws : To ensure long life, chuck jaws are normally hardened. For gripping certain classes of work the chuck jaws are made of soft steel. Certain jobs which have been machined previously are required to be gripped on chuck jaws on the machined surface for subsequent operations. The soft jaws prevent any damage to the machined surfaces by the serration of the jaws. For gripping a very irregular shaped work, soft jaws are used which grip the contoured profile efficiently. Tapered components are also suitably held by soft jaws.

Collet chucks : The collet chucks are used for gripping bars introduced through the headstock spindle of a capstan or turret lathe and is one of the most common method of holding work. They are much more suitable than a self centering chuck in mass production work due to its quickness in action and accurate setting. The chucks may be operated by hand or by power. The working of a collet chuck has been described in Art.3.12 and illustrated in Fig.3.29. Different sizes of spring collets having square, hexagonal, round or any other shaped bore are fitted in the chuck body for holding different sizes of bar having different sections. Collets grip the work by the spring action of its split jaws. The collets are classified by the methods used to close the jaws on the work.

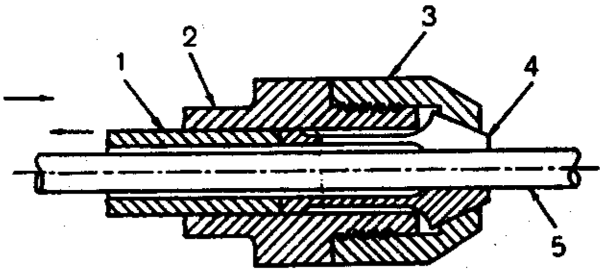

Figure 4.7 Push-out type collet chuck
1. Push tube, 2. Headstock spindle, 3. Hood, 4. Collet, 5. bar.

Push out type : To grip the work, the tapered portion of the spring collet is pushed into the mating taper of the chuck. There is a tendency of the bar to be pushed slightly outward when the collet is pushed into the chuck body for gripping. If the bar is fed against a stop bar fitted on the turret head, this slight outward movement of the bar ensures accurate setting of the length for machining, Fig.4.7 illustrates a push type collet in use.

Draw in type : To grip the work, the tapered portion of the spring collet is pulled back into the mating taper of the chuck which causes the split end of the collet to close in and grip the bar. The machining length of the bar in this type of chuck cannot be accurately set as the collet while closing will draw the bar slightly inward towards the spindle. Fig.4.8 illustrates a *draw in type* collet chuck.

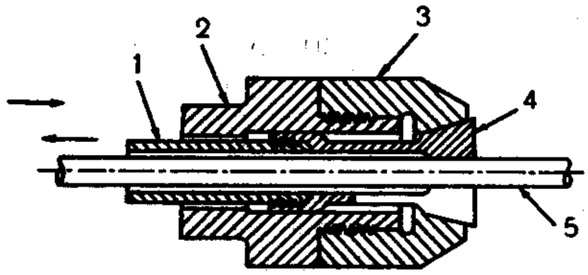

Figure 4.8 Draw in type collet chuck
1. Draw tube, 2. Headstock spindle, 3. Hood, 4. Collet, 5. bar.

Dead length type : For accurate positioning of the bar, both the push out and draw in type collet present some error due to the movement of the bar along with the collet while gripping. This difficulty is removed by using a stationary collet on the bar. A sliding sleeve closes upon the tapered collet which is prevented from any end movement by the shoulder stop. Fig.4.9 illustrates a *dead length type* collet chuck.

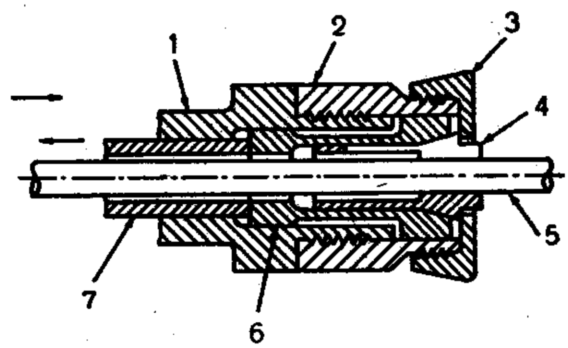

Figure 4.9 Dead length type collet chuck
1 Headstock spindle, 2. Chuck body, 3. Hood, 4. Collet, 5. bar, 6. Sliding sleeve, 7. Push tube.

Fixture : A fixture may be described as a special chuck built for the purpose of holding, locating and machining a large number of identical pieces which cannot be easily held by conventional gripping devices. Fixtures also serve the purpose of accurately locating the machining surface. The main functions of a fixture are as follows :

1. They accurately locate the work.
2. They grip the work properly, preventing it from bending or slipping during machining operations.
3. They permit rapid loading and unloading of workpieces.

4.9 TOOL HOLDING DEVICES

The wide variety of work performed in a capstan or turret lathe in mass production necessitated designing of many different types of tool holders for holding tools for typical operations. The tool holders may be mounted 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 adapted in bar work. In capstan or turret lathe practice the whole assembly of holder and its tool is designated according to the type of the holder. Thus a slide tool holder with the tool mounted in it is called a 'slide tool' and a knee tool holder with the tool fitted into it is called a "knee tool". Special tool holders are also sometimes designed for special 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.
19. Bar ending tool holder.

Straight cutter holder : This is a simple tool holder constructed to take standard section tool bits. The shank of the holder can be mounted directly into the hole of the turret face or into a hole of a multiple turning head. In this type of holder, the tool is held perpendicular to the shank axis. The tool is gripped in the holder by three set screws. Different operations like turning, facing, boring, counterboring, chamfering, etc. can be performed by holding suitable tools in the holder. Fig.4.10 illustrates a straight cutter holder.

Adjustable or plain angle cutter holder : The holder has an angular slot cut into the body into which the tool is fitted. The front face of the holder is also beveled. This type of setting of the tool and construction of the holder body allows the tool to maintain a permanent clearance with the work and permits turning or boring operations close to the chuck jaws or upto a shoulder without any interference. In plain type of holder, the setting of the cutting edge relative to the work is effected by opening the set screws and then adjusting the tools by hand. In adjustable type of holder, the accurate setting of the tool can be performed by rotating a micrometer screw. Fig.4.11 illustrates an angular cutter holder.

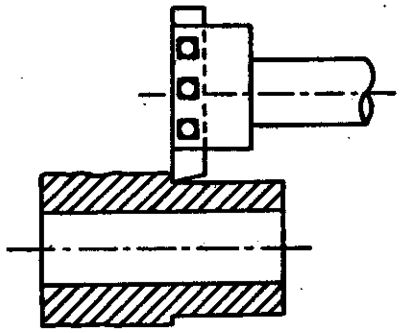

Figure 4.10 Straight cutter holder

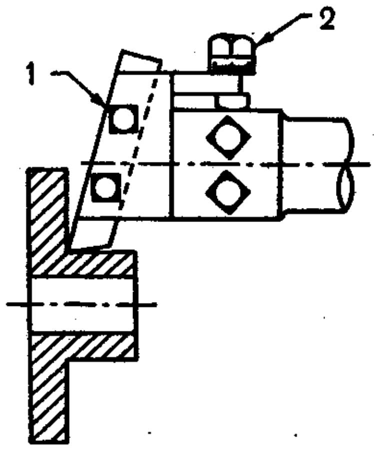

Figure 4.11 Adjustable angle cutter holder

1. Tool, 2. Adjustable micrometer screw.

Multiple cutter holder : The multiple cutter holder can accommodate double tools in its body. This feature enables turning of two different diameters simultaneously. Turning and boring tools or turning and facing tools can also be set in the holder to perform two operations at a time Fig.4.12 illustrates a multiple cutter holder.

Offset cutter holder : In this type of holder, the holder body is made offset with the shank axis. Larger diameter of work may be turned or bored by this type of holder. Fig.4.13 illustrates an offset holder.

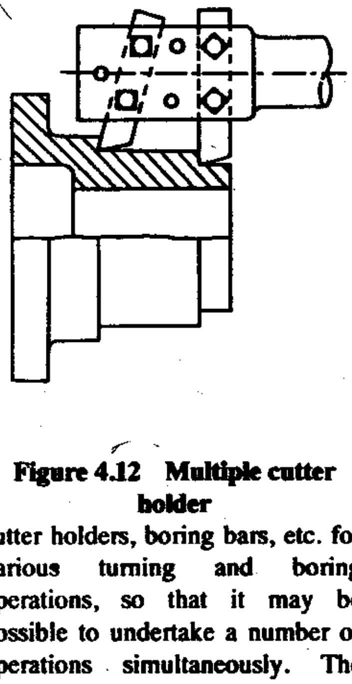

Figure 4.12 Multiple cutter holder

Combination tool holder or multiple turning head : Multiple turning heads are used for holding straight, angular, multiple or offset cutter holders, boring bars, etc. for various turning and boring operations, so that it may be possible to undertake a number of operations simultaneously. The tools are set at different positions on the work surface by inserting the shank of tool holders in different holes of the multiple head body, and they are secured to it by tightening separate set screws. A boring bar is held at the central hole of the head which is aligned with the axis of the supporting flange. The head is supported on the turret face by tightening four bolts passing through the holes of the flange. Fig.4.14 illustrates a combination tool holder.

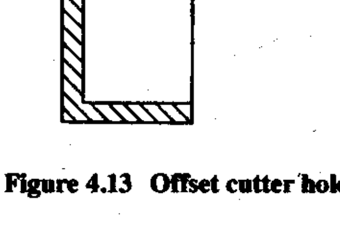

Figure 4.13 Offset cutter holder

Overhead pilot bar : To ensure utmost rigidity to the multiple turning head which supports different tools and holders, a pilot bar is clamped on the headstock casting which passes through the topmost hole of the turning head. As the tool approaches the work and cutting action continues, the pilot bar lends additional support to the tool and prevents any vibration or

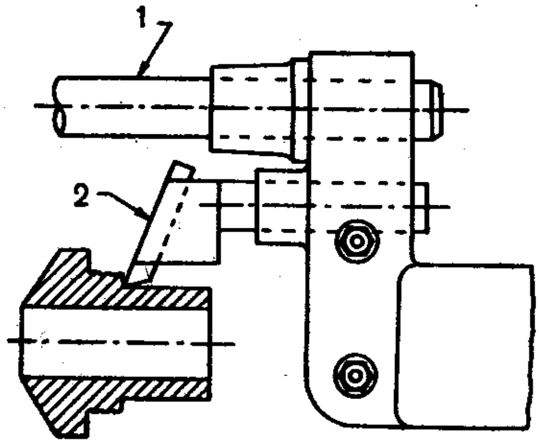

Figure 4.14 Combination tool holder
1. Pilot bar, 2. Turning tool,

deflection. This construction permits machining with deeper cuts and heavier feeds. Fig.4.14 illustrates a pilot used in conjunction with the turning head.

Slide tool holder : The slide tool holder is one of the most important tool support for mass production work in capstan or turret lathes for small or medium sized parts. The holder is very much useful for rough and finish boring, recessing , grooving, facing, etc. The holder consists of a vertical base on which a slide is fitted.

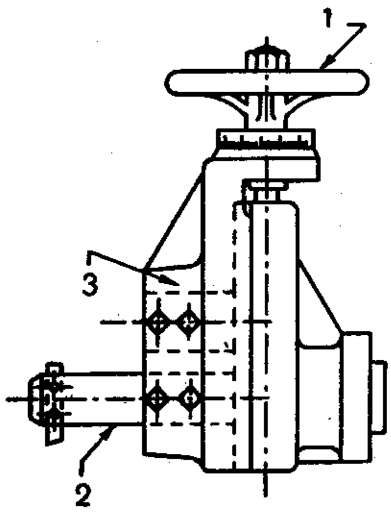

Figure 4.15 Slide tool holder
1. Handwheel, 2. Boring bar, 3. Upper hole for inserting tool holder.

The slide may be adjusted up or down accurately by rotating a hand wheel provided with a micrometer dial. The rotation of the hand wheel causes a screw to be rotated in a fixed nut fitted on the base and imparts vertical movement to the slide. Two holes are provided on the sliding unit for holding tools. The lower hole when aligned with the lathe axis is used for holding boring bars, drills, reamers, etc. The upper hole accommodates a turning tool holder. After necessary adjustments the slide is clamped to the base by a clamping lever for turning or boring operations. For facing or recessing operations, the crosswise movement of the tool is obtained in the vertical plane. The slide is equipped with two adjustable stops for facing or similar operations in order to be able to duplicate the workpiece. The holder base is clamped directly on the turret face by studs. Fig.4.15 illustrates a slide tool holder.

Knee tool holder : The knee tool holders are useful for simultaneous turning and boring or turning and drilling operations. The knee holder is bolted direct on the turret face. The axis of the lower hole coincides with the lathe axis and is used for holding boring bars, drills, etc. The turning tool holder is fitted into the hole of an adjustable block which slides in the knee tool holder body. The adjustment of the turning tool holder may be effected either by hand or by rotating a calibrated micrometer screw. A guide bush is provided at the top of the holder for running of the pilot bar. Fig.4.16 illustrates a knee tool holder.

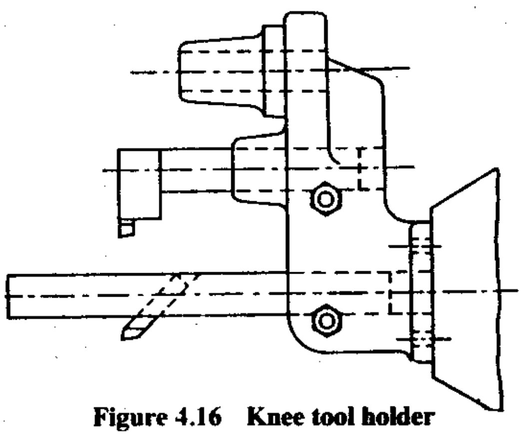

Figure 4.16 Knee tool holder

Drill holder : The twist drills having Morse taper shanks are usually held in a socket which is parallel outside and tapered inside. These sockets are introduced in the bracket of a flange tool holder and clamped to it by set screws. Straight shank drills are mounted on Jacob's chuck. Fig.4.17 illustrates a flange tool holder into which a drill socket is fitted to hold a twist drill.

Boring bar holder : This holder is also called extension holder or flange tool holder. The holders are intended for holding drills, reamers, boring bars, etc. The flanged end of the holder is bolted direct to the face of the turret and is accurately centered by means of a circular boss extending from the flanged end and fitting into the turret face bore. The holder can also be used to extend the length of shanked tools or bars by fitting into the bore of the holder and then adjusting its length. This arrangement is particularly useful in machining longer work in capstan lathes where the length of travel of the turret is short. Fig.4.17 illustrates an extension holder or flange tool holder.

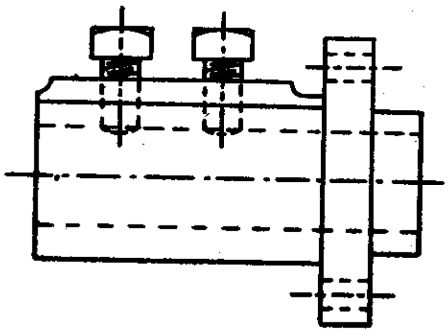

Figure 4.17 Flange tool holder

Reamer holder : The standard practice of holding reamers in a capstan or turret lathe is in some form of floating holder which permits some amount of end movement of the reamer to align itself with the work. The reamer holder has been described in Art.5.15 and illustrated in Fig.5.25.

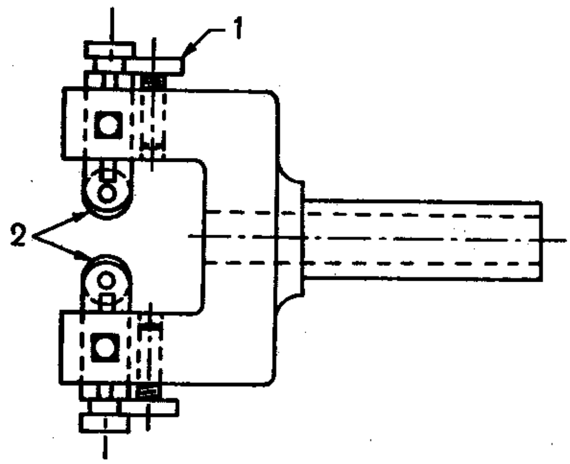

Figure 4.18 Knurling tool holder
1. Adjustable screw, 2. Knurls.

Knurling tool holder : A knurling tool holder may be mounted on the turret face or on the tool posts of the cross-slide. The knurling holder mounted on the cross-slide is similar to that described in Art.3.21 and illustrated in Fig.3.61. The holders with knurls mounted on the cross-slide can perform knurling operation on any diameter work. Fig.4.18 illustrates a knurling tool holder which is fitted on the turret face. The position of knurls can be adjusted in a vertical plane to accommodate different diameters of work, while the relative angle between them can also be varied to produce different patterns of knurled surface.

Recessing tool holder : The recessing tool holder is provided with an adjustable slide for producing a recess inside a bore. The tool holder is clamped directly on the face of the turret. Mounted on the short slide, there is a cylindrical extension having a bore into which the round shank of a recessing tool is fitted and clamped. The adjustable slide with the tool may be moved perpendicular to the lathe axis by turning a lever or a handwheel. While recessing, the tool is fed into the bore to the required distance being guided by the stop of the turret, and then the tool is fed perpendicular to the axis of rotation of the work by the adjustable slide to produce a recess. The tool is guided to the required depth of the recess by a stop mounted on the holder slide. Fig.4.19 illustrates a recessing tool holder.

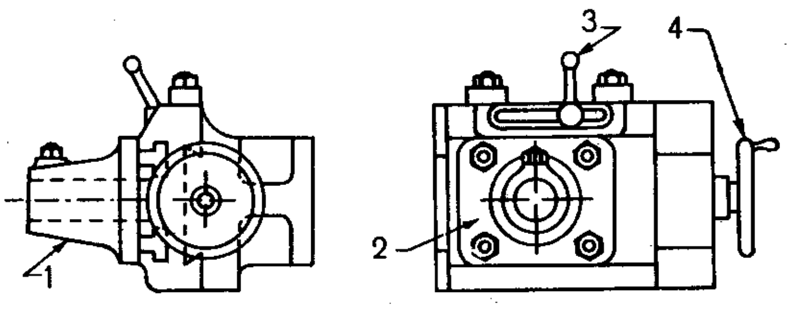

Figure 4.19 Recessing tool holder
1. Tool holder, 2. Adjustable slide, 3. Adjustable slide clamp, 4. Adjustable slide handwheel.

Form tool holder : Two sets of form tool holders have been designed for holding straight and circular form cutters. The usual procedure of holding a form tool holder is on the cross-slide. In the straight form tool holder, the tool is mounted on a dovetail slide and the height of the cutting edge may be adjusted by moving the tool within the slide. The height of the circular form tool may be adjusted by rotating the circular cutter. Fig.4.20(a) illustrates straight form cutter holder and Fig.4.20(b) illustrates circular form cutter holder.

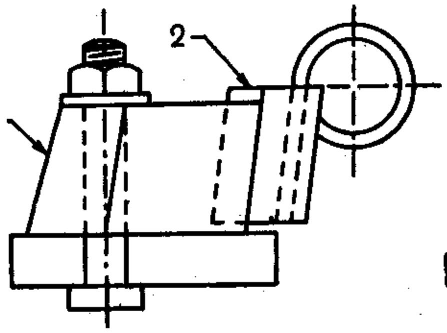

Figure. 4.20(a) Straight form cutter holder

1. Holder, 2. Straight from cutter

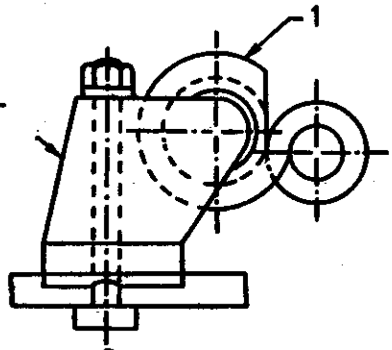

Figure 4.20(b) Circular form cutter holder

1. Circular form cutter, 2. Holder.

Tap holder : Taps are usually used for cutting internal threads. They are mounted on tap holders clamped on the turret face. For holding taps of finer sizes, manually gripped tap holders are used. The tap is prevented from rotation by the hand pressure given to the knurled sleeve which grips the tap with the holder. The pressure on the sleeve can be released when the tap gets stuck up or reaches the end of the job. Fig.4.21 illustrates a solid tap holder of this type.

Taps may also be rotated in clutch driven tap holders as described and illustrated in Art.5.15 and Fig.5.24. Slipping occurs when the tap gets stuck up. A combination tap or die holder of self releasing type may also be used.

Die holder : Dies are used for cutting external threads. Dies may be fitted in: (1) solid or non-releasing type of holders, (2) releasing type of holders, and (3) collapsible or self opening type of holders.

Solid or non-releasing type of die holders are used for finer threads in capstan lathes. The cutting action is purely sensitive and depends upon the skill of the operator.

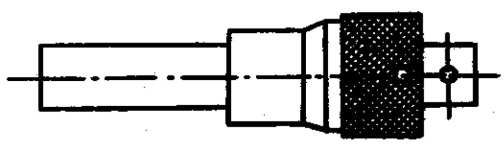

Figure 4.21 Solid tap holder

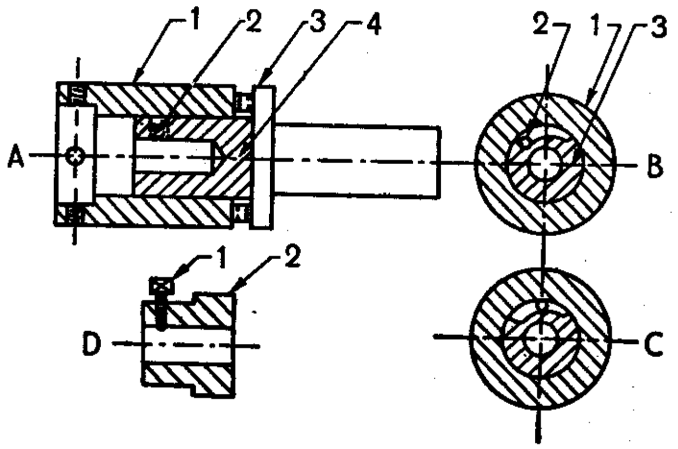

Figure 4.22 Releasing type die holder
(a)-1. Sleeve, 2. Ball in ball pocket, 3. Projecting pin, 4. Shank body.
(b)-1. Sleeve, 2. Ball in ball pocket, 3. Shank body.
(c)-1. Set screw, 2. Tap adapter.

Releasing type of die holders are used for releasing the dies after cutting threads through the required length of cut. A releasing type of die head has been illustrated in Fig.4.22.(a). The dies are fitted within the sleeve *1* and clamped to it by set screws. The shank 4 of the die head fitted on the turret face prevents the sleeve from rotating by the help of dog clutch *3* or projecting pins fitting into the groove of the sleeve body *1* as the dies feed into the work. As the dies progress on the rotating work, the thread is produced. At the end of cutting thread to the desired length, the turret stop prevents any further movement of the shank, but the sleeve *1* holding the dies continues to screw forward due to the rotation of the work. This forward movement of the sleeve relative to the shank *4* clears the dog clutch *3* from engagement and the sleeve with the dies rotates along with the work without cutting any further threads. To remove the dies, the rotation of the work is reversed and the sleeve starts rotating in the same direction as the spindle. Immediately a ball operated clutch engages with the shank body preventing the dies from rotating, and the die head simply screws itself off the job. The ball clutch system for reversal can be understood from the Fig.4.22(b). When the sleeve *1* rotates freely with the work at the end of the cut, the ball 2 lies in the ball pocket of the shank body *3*. When the work is reversed the ball 2 locks the shank body *3* with the sleeve *1* arresting its further rotation with the work. This type of die holder can also be used to hold a tap by using a tap adapter, shown in Fig.4.22(c).

Self opening type die holder : The self opening type die holder illustrated in Fig.4.23 is used for cutting an exact length of thread, and where quick removal of die head is necessary to reduce the production time. When the desired length of thread has been cut the dies or chasers spring open, thus clearing the dies from the thread and permitting the die holder to be withdrawn without stopping or reversing the spindle rotation. The self opening of the die head at the end of cutting desired length may be effected by any one of the following methods :

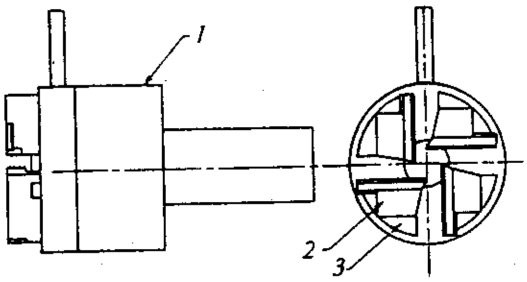

Figure 4.23 Self opening type die holder
1. Die holder body, 2. Dies, 3. Die holder.

By pulling off: The nose end of the die head is pulled off from the shank when the stop prevents any further movement of the turret face. The principle of action is similar to that which has been explained in releasing type die holder. This causes the nose end of the die head to rotate with the work as it is pulled apart from the shank and a pin is released which causes a scroll plate to rotate and the dies fitted on the scroll plate are pushed outward releasing them from the work.

By outside trip: When the length of the thread to be cut is short, there is not much of provision left for pulling the head off the shank, and release of the locking pin of the scroll is triggered by a stop fitted on the rear toolpost.

By inside trip: For more accurate positioning of the thread length, an inside trip triggers off the locking pin.

Box tool : The first operation to be performed in a capstan or turret lathe engaged in bar work is to turn different diameters of the work from the end of the workpiece. A box tool fitted on the turret face is employed for this purpose. As the tool, mounted on the tool holder, is fed into the work from the unsupported end, some sort of support is supplied by the holder on to the work to prevent any deflection or vibration set up by the heavy cutting action of the tool. The holders containing the tool and the support practically encloses the work as the metal cutting progresses. Hence this class of tool holders are named as box tool holders and the tools as box tools.

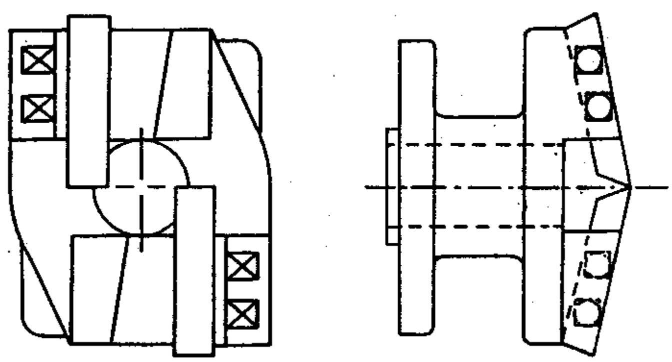

Figure. 4.24 Balanced tool holder

Balanced tool holder : Its name is derived from the fact that the tools mounted on the holder are so arranged that the cutting thrust exerted by one of the tools on the work is balanced by the cutting thrust developed by the other tool fitted on the holder. This prevents any bending of the work and obviates the use of any other work support. The tools may be set radially or tangentially at the opposite ends of the work, the position of one being slightly advanced than the other along the axial-length. Both the tools may take full depth of cut or the depth of cut may be divided. Fig.4.24 illustrates a balanced tool holder.

V-steady tool holder : The V-steady box tool holders are used for lending support to the workpiece while cutting action progresses from the end of a bar stock. Both the tool and V-steady are mounted on the adjustable slide in order to set the required diameter of the machined part and to position the tool relative to the V-steady. The tool is set slightly in advance than the V-steady. The two faces of the V-steady are so arranged that the top face is parallel to the shank and the bottom face is perpendicular to the tool axis allowing it to take both the up and side thrust of the tool. The steady block is provided with another size of V on the other end and the block may be reversed for supporting different diameter of work. The V-steady tool holder is mainly used in brass work. Fig.4.25 illustrates a V-steady tool holder.

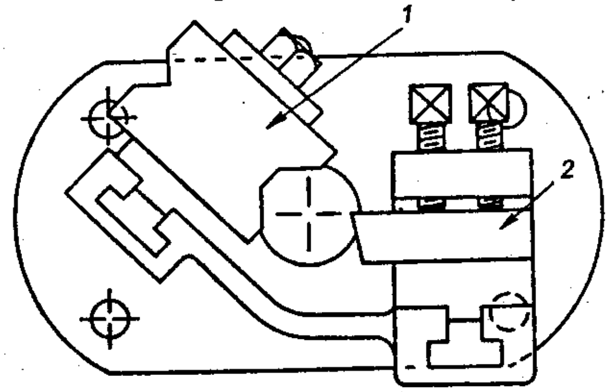

Figure 4.25 V-steady box tool holder
1. V-steady, 2. Tool.

Roller steady box tool holder : This type of tool holder illustrated in Fig.4.26 is commonly used in bar work for turning steel rods. In construction, it replaces V-steady and in its place two rollers are used to provide support to the work. The tool may be mounted radial or tangential to the workpiece. When the tool is mounted radial to the workpiece, the cutting pressure acts through the weakest section of the tool cutting edge. The tangential type of setting enables the cutting pressure to be borne by the entire shank. So this type of setting is widely used with cemented carbide tipped tool where the rate of metal removal is very high. The tool and the rollers can be adjusted in the holder for proper setting. A high class finish is obtained by using roller steady box tool on the work surface due to burnishing action of the rollers on the work. The rollers acting against the cutting pressure remove the feed marks on the workpiece. The deeper the cut the better is the surface finish. This is due to the fact that as the cutting pressure increases, equal and opposite pressure is exerted on the workpiece by the rollers improving the surface finish. The usual defects that may occur while using roller steady box tool are :

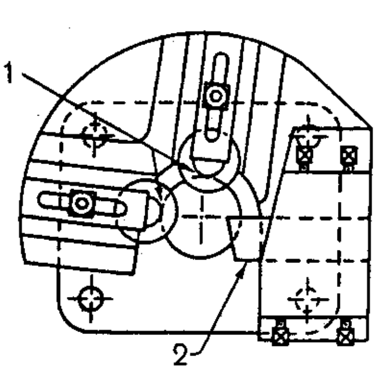

Figure 4.26 Roller steady box
1. Roller, 2. Tool

1. Production of uneven surface at the beginning of the cut due to too much of setting pressure of the rollers on the work.
2. Production of tool withdrawal mark at the end due to improper setting of the tool and rollers.
3. Productions of poor surface finish due to the application of light cuts.
4. Continuous chips may get entangled with the rollers and interfere with its working.

Bar ending tool holder : These holders are used for finishing the ends of bolts, pins, rods, etc. The rollers are set slightly in advance to the tool cutting edge, which centre the work and take up cutting pressure. Different types of tools are fitted on the holder for shaping different types of bar ends. The box tool may be adjustable or of one unit type. Fig.4.27 illustrates a bar ending tool holder.

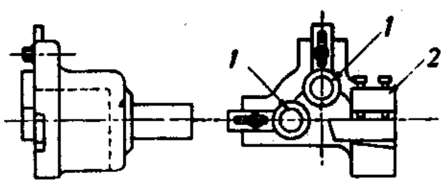

Figure 4.27 Bar ending tool holder
1. Roller, 2. Tool holder

4.10 CAPSTAN OR TURRET LATHE TOOLS

The different types of tools mounted on tool holders on the turret face and tools mounted on the cross-slide are similar in construction as that of centre lathe tools. The tools mounted on the cross-slide loosely perform turning, facing, necking and parting off operations. The standard tools listed for different operations are:

1. Turning tool.
2. Facing tool.
3. Parting tool.
4. Chamfering tool.
5. Bar ending tool.
6. Grooving and recessing tool.
7. Forming tool.
8. Drill.
9. Boring tool.
10. Counterbore.
11. Reamer.

12. External thread cutting tool.
13. Internal thread cutting tool.
14. Workstop.

Turning tool : Fig.4.28 (A) illustrates a heavy duty turning tool which is mounted on the cross-slide or knee holder. Fig.4.28 (B) is a knife edged bar turning tool which may be mounted on the box tool holder or on the cross-slide tool post.

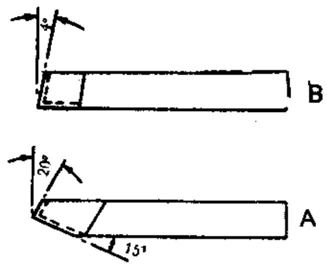

Figure 4.28 Turning tool
A. Heavy duty turning tool
B. Knife edge turning tool

Another special type of turning tool used in capstan and turret lathe is a hollow mill. Three teeth on the hollow mill are provided with cutting edges. The tool is hollow, through which portion of the job which has been machined passes through. The tool itself guides the work and prevents it from bending. This type of tool is suitable for turning smaller diameter of brass or steel. The chief disadvantage of using this type of tool is the difficulty in regrinding. Moreover, each regrind changes the diameter of the work being machined. Fig.4.29 illustrates a hollow mill.

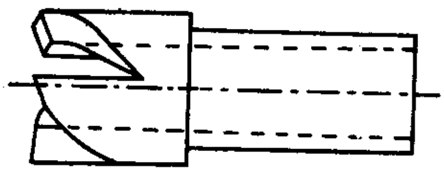

Figure 4.29 Hollow mill

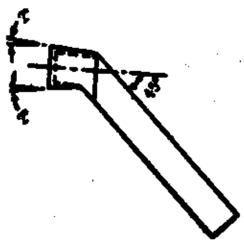

Figure 4.30 h.s.s. facing tool

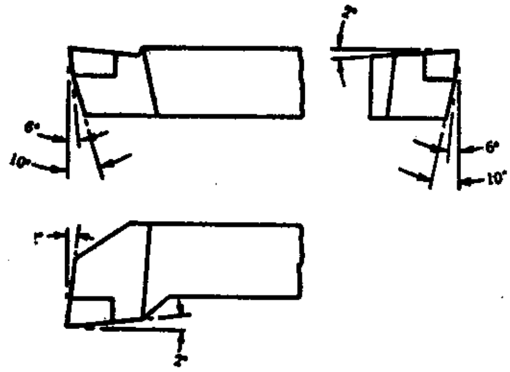

Figure 4.31 Cemented carbide tipped facing tool

Facing tool : Fig.4.30 illustrates a combined facing and turning tool. The rake is provided in different directions for turning or facing operations. The tool may be mounted on the cross-slide or on the knee tool holder. Fig.4.31 illustrates a combined turning and facing cemented carbide tipped tool.

Parting off tool : Fig.4.32 illustrates a parting off tool. All round clearance is given on the tool to clear the work while cutting. The tool is usually mounted on the rear tool post.

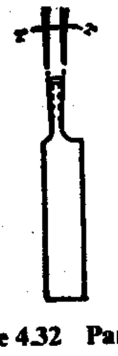

Figure 4.32 Parting off tool

Bar ending tool and chamfering tool : For forming the ends of a work, different formed tools are mounted on the bar ending tool holder. Fig. 4.33 A and B illustrate different bar ending tools.

Grooving or recessing tool : This is similar to that described in Art. 3.45.

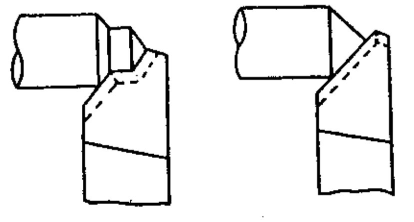

Figure 4.33 Bar ending tool
A. Form ending tool, B. Chamfering tool

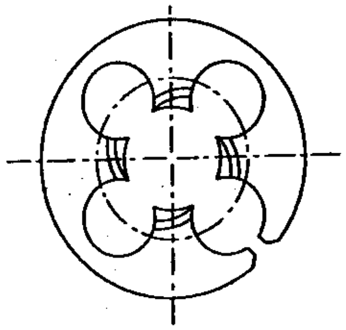

Figure 4.34 Solid button die

Forming tool : The forming tools may be straight or circular type. A forming tool has been described and illustrated in Art. 3.45 and Fig.3.64.

Drill : The twist drill mounted on the turret face holders are the standard tools used for drilling holes. Different types of drills may be used for different purposes. A twist drill has been described in Art.5.17 and illustrated in Fig.5.43.

Boring tool : The boring tools mounted on boring bars are used for enlarging a hole in a capstan or turret lathe. Boring tools mounted on different boring bars have been described in Art.3.45.

Counterbore : The counterbores are used for enlarging the drilled hole from one end. The working of a counterbore has been described in Art.5.24.

Reamer : The reamers are used for sizing and finishing a hole. Different types of reamers have been described in Art.5.22.

External thread cutting tool : External threads are cut on a job in a capstan or turret lathe by using any one of the following tools:

1. Solid button dies
2. Chasers
3. Single point tools

Solid button dies : The button die is actually an adjustable split nut in which teeth have been machined and hardened to provide cutting edges. The cutting edges are pressed on the work by tightening the body of the die by two set screws. The pressure can be released by allowing a third screw to enter into the split portion to expand. As the die is non-releasing type, it must be backed off after the thread is cut by reversing the machine spindle. Button dies can cut thread close to the shoulder of the work. Fig. 4.34 illustrates a button die.

Chasers : All self opening die holders are fitted with four chasers for cutting a thread. The chasers may be considered as a forming tool equally spaced on the circumference of the work. The shape and pitch of the cutting edges of the chaser conform to the solid button dies due to the following reasons :

1. The chasers not being a solid unit can open up at the end of the cut by the mechanism incorporated in the self opening die head. This permits quick removal of the die head from the work.
2. The chasers may be separately removed and reground with ease.

The following three types of chasers are used in die heads :

1. Radial chaser
2. Tangential chaser
3. Circular chaser

Radial chaser: Fig.4.35 shows cutting edges of a radial chaser. The chamfered portion of the chaser enables the tool to enter and cut gradually up to the full depth of the thread. The circular opening of the dies at the beginning due to the chamfer is called the *throat*. The included angle of the dies at the throat is usually 50° or less. Three or four threads are chamfered at the throat. The advantages of radial chasers are :

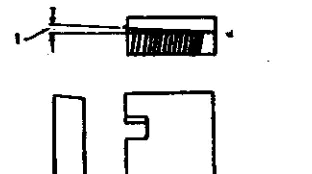

Figure 4.35 Radial chaser
1. Centre line overlap, 2. Throat angle, 3. Cutting face.

1. They are more rigidly mounted on the holder.
2. Wider chamfer can be kept at the throat which permits smoother cutting action.

On the other hand, the radial chasers are difficult to regrind. Breaking of one of the threads on the chaser will spoil the whole unit. Fig.4.36 illustrates the position of a radial chaser.

Tangential chaser : Fig.4.37 shows cutting edges of a tangential chaser. The tangential chaser has the thread ground on the face of a flat block. The starting edge of the chaser is chamfered and the rake angle is provided on the top face. The first full thread is on the centre line, and the entire cutting action is performed by the chamfered portion and the first thread. The remaining teeth are ground in a different way with a negative rake, so that they simply follow the thread cut by the first thread, and act as a guide. The regrinding of the chaser is easier as the top face of the chaser is ground from time to time. The long length of formed cutting edge ensures long tool life. Fig.4.38 illustrates the position of a tangential chaser mounted on a self opening die head.

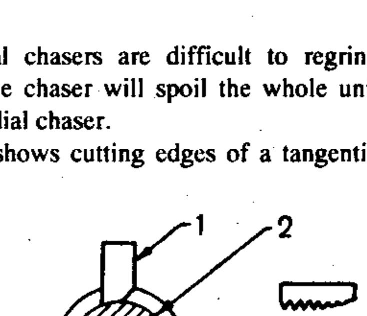

Figure 4.36 Position of radial chasers in a die head.
1. Radial chaser, 2 . Work.

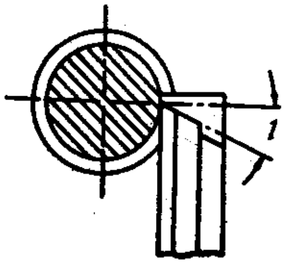

Figure 4.37 Tangential chaser
1. Rake

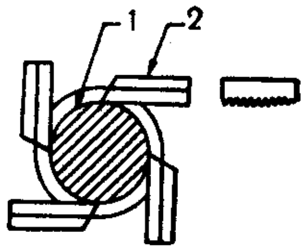

Figure 4.38 Position of tangential chasers in a die head.
1. Work, 2. Tangential chaser.

Circular chaser : Fig.4.39 shows cutting edges of a circular chaser. The circular chaser may be considered as a circular formed tool having the form of the thread cut on its circumference. The cutting action is similar to the tangential chaser. This type of chaser ensures long tool life due to long cutting edges. Fig.4.40 illustrates the position of a circular chaser mounted on a die holder.

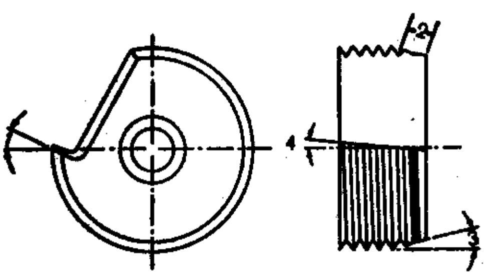

Figure 4.39 Circular chaser
1. Rake, 2. Chamfered face, 3. Throat angle, 4. Centre line overlap.

Thread cutting by single point tool and chaser : While cutting thread on a workpiece of larger diameter, single point tool or chaser conforming to the form and pitch of the thread is mounted on the cross-slide and the thread is cut in a similar manner as that in a centre lathe.

Internal thread cutting tool : The internal thread may be cut in a capstan or turret lathe by using any one of the following tools: (1) Solid tap, (2) collapsible tap, and (3) single point tool or chaser.

Solid tap : The solid tap has been described and illustrated in Art.5.26 and Fig.5.55. The solid tap may be mounted on a solid or self releasing holder.

Collapsible taps : Similar to the working of a self opening die head, collapsible taps are used for quick withdrawal of the tap after the thread has been cut on the job. Adjustable chasers are placed in the tap body which collapses at the end of the cut, so that the overall diameter of the tap is reduced enabling quick removal. This type of tap can only be used for cutting thread in holes of larger diameter due to the presence of collapsible mechanism.

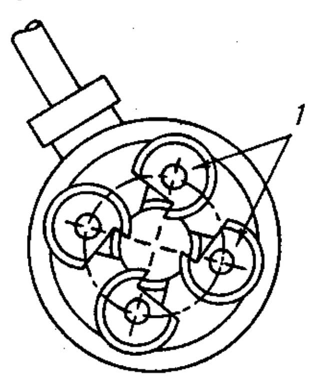

Figure 4.40 Position of circular chasers in a die head.
1. Circular chaser.

Single point tool or chaser : Single point tool or chaser is used for cutting thread on work having larger bore diameter in a manner similar to that described in the centre lathe.

Workstop : In bar work, workstops are mounted on the turret face for maintaining correct length of bar for machining after it has been pushed through the collet chuck. In construction, it is a cylindrical bar whose position can be adjusted relative to the spindle nose by the turret stop. For accurate setting, the length of the stops are adjustable so that by unscrewing the lock nut *2* and rotating the knurled knob *1* the exact length of the work can be adjusted. In some workstops, micrometer graduations are provided for accurate setting. Fig.4.41 shows a workstop.

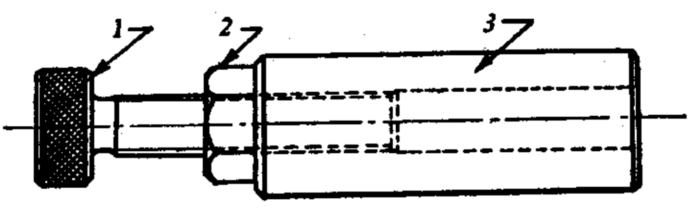

Figure 4.41 Workstop
1. Knurled knob, 2. Locknut, 3. Workstop body.

4.11 CAPSTAN AND TURRET LATHE OPERATIONS

The operations performed in a capstan or turret lathe are similar to that in a centre lathe. The usual operations performed in a capstan or turret lathe are: straight turning, shoulder turning, taper turning, chamfering, thread cutting, facing, knurling, forming, drilling, reaming, boring, counterboring, tapping, undercutting, and parting off. These operations are done in the same way as in a centre lathe besides the use of special type of tool holders. The operations which are particularly special in a capstan or turret lathe are given below.

Turning with a box tool : The setting and working of the box tools for turning operations should be performed in the following order :

1. The bar is first turned to a length of 20 mm approximately from one end.
2. The rollers are adjusted on the work in a manner so that it may be rotated freely.
3. The tool is brought forward and set slightly in advance than the rollers.
4. The bar is now finish turned to the required dimension.
5. The diameter of the finished bar is measured. If the finished diameter is slightly larger than the desired size, the tool is brought forward and the cut is taken to obtain the correct size. If the diameter of the bar is smaller than the finished size by a very small amount, the nose of the tool is ground to bring it to the correct size.
6. The work is then finished to the desired length by using the turret stop after setting properly the speed and feed of the machine.

External thread cutting: The external threads on bars may be cut by using solid button dies, solid adjustable dies, self opening die heads, single point tools or chasers. The working of dies for cutting a thread have been explained in Art.4.10. A single point tool or chaser is used for cutting thread on a larger diameter work. For cutting threads, leaders or leadscrews similar to these used in an engine lathe are provided in front of the bed. The leaders are short threaded shafts which rotate at definite ratios with the headstock spindle, such as 1:1, 1:2, 1:3 or 1:4. This arrangement enables different pitches to be cut by using different leaders. Fig. 3.58 illustrates thread cutting by using a single point tool or chaser.

Internal thread cutting: Internal threads are cut by solid taps, collapsible taps or single point tools or chasers. While cutting thread by a single point tool or chaser, leaders are used. Fig. 4.42 illustrates thread cutting by a chaser.

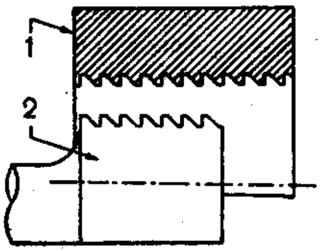

Figure 4.42 Internal thread cutting chaser.
1. Work, 2. Thread chaser.

Taper turning : The usual methods of turning taper in a capstan or turret lathe are as follows :

1. By a forming tool
2. By a taper turning attachment
3. By a taper forming tool box.

While turning taper by a forming tool, the tool cutting edge is set at half angle of taper and the work is finished by giving cross feed.

The principle of taper turning by using taper turning attachment is similar to that described in Art.3.16. A guide block *2* attached to the cross-slide *1* is allowed to follow an angular path set by the guide bar *3* when the longitudinal feed is applied. This causes the tool mounted on the cross-slide to trace an angular path with the lathe axis to produce a taper. Fig.4.43 illustrates a taper turning attachment for turning taper.

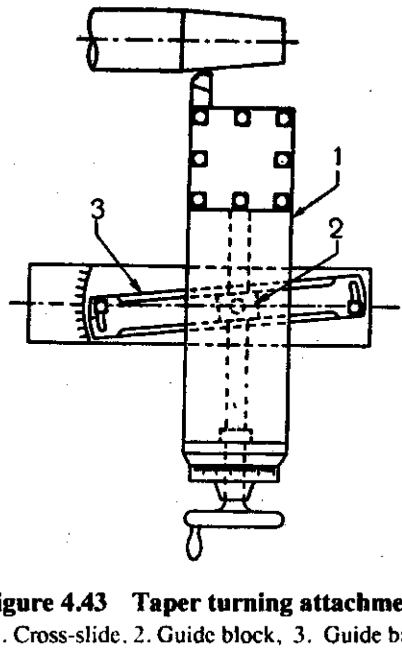

Figure 4.43 Taper turning attachment
1. Cross-slide. 2. Guide block, 3. Guide bar

A taper can also be turned by introducing a bar into a taper forming tool box having a long cutting edge and a V-steady set at an angle to each other according to the taper being turned.

4.12 TURRET TOOLING LAY OUT

In order to perform any work in a capstan or turret lathe, proper planning for systematic operations should be carried out in advance before setting the work on the lathe. The following procedures should be adopted to plan and execute a work.

1. For effective planning and control, for each capstan or turret lathe, an upto-date capacity chart is an essential requirement. The chart supplied by the manufacturers contains every working details of the machine such as the maximum and minimum diameter of the work that can be mounted, maximum length of stroke of the turret and saddle, maximum length of cross-slide movement, tools available, swing diameter over the carriage, bore diameter on the turret face, bore diameter of the spindle, and the maximum size of the collet chuck that can be mounted on the machine, number of spindle speeds and feeds available, h.p. input, etc.
2. For tooling layout, a drawing of the finished part is also needed.
3. The proper tool selection for different operations should be made from the available tools and tool holders. Standard tools are preferred for a small number of works. Where large number of identical pieces are to be manufactured, special tools and tool-holders may be designed for reducing setting and machining time.
4. Once the proper tool selection is made, the finished drawing of the workpiece is superimposed on the capacity chart supplied and the tools to be used are drawn out at the respective positions on the turret face and on the cross-slide toolposts in a regular sequence. The length of travel of tools for each turret face is now calculated from the chart and position of stops decided. Any difficulty in setting and operation is worked out on the paper.
5. The proper spindle speed, feed and depth of the cut are now worked out for each operation.

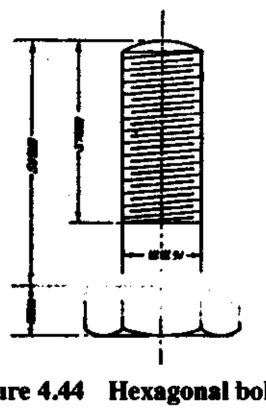

Figure 4.44 Hexagonal bolt

6. The work and the tools are then set on the machine according to the planned chart.

4.13 PRODUCTION OF A HEXAGONAL BOLT

The planning production of a hexagonal bolt is given below :

1. The capacity chart of the machine is made available.
2. The drawing of the finished hexagonal bolt is taken into consideration. (See Fig.4.44)
3. The tools and equipment such as bar stop, roller steady turning tool holder, roller steady bar ending tool holder, self opening die head, chamfering tool, parting tool are collected.
4. The sketch of the work and tools are superimposed on the capacity chart to decide the length of travel of the tool and the position of stops. Fig.4.45 shows a typical tooling layout.
5. Proper speeds and feeds for each operation are next calculated.
6. Setting and machining operations are performed in the following order :

(a) *Setting of the bar stops* : The bar stop is set at a distance of 70 mm from the collet face by using a slip gauge. An extra length

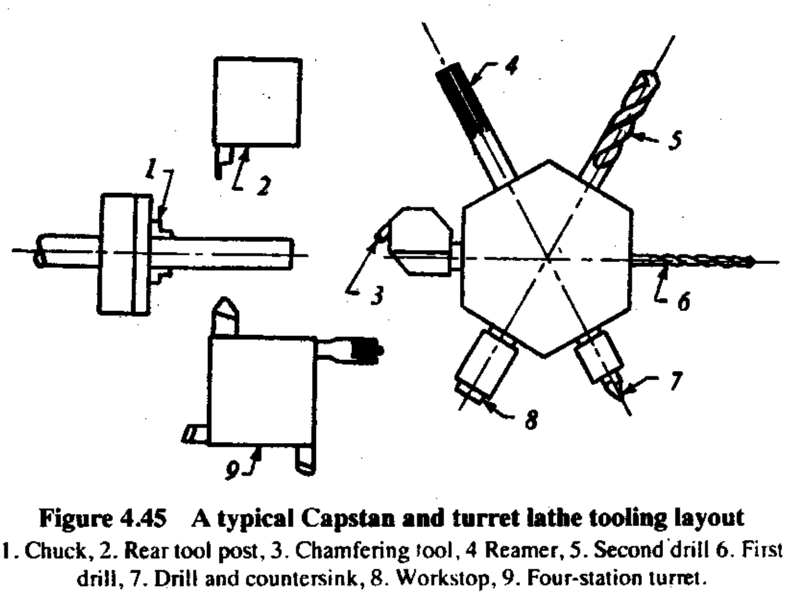

Figure 4.45 A typical Capstan and turret lathe tooling layout

1. Chuck, 2. Rear tool post, 3. Chamfering tool, 4 Reamer, 5. Second drill 6. First drill, 7. Drill and countersink, 8. Workstop, 9. Four-station turret.

of 10 mm than the bolt length is allowed, 4 mm for parting off and 6 mm for clearance off the collet face so that the parting off tool may penetrate deep into the work without any interference (See Fig. 4.46).

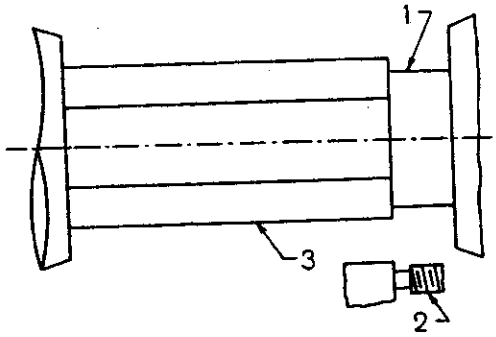

Figure 4.46 Setting of bar stop
1. Workstop, 2. Position of bar stop, 3. Hexagonal bar.

(b) *Setting of the roller steady box turning tool:* The roller steady box turning tool is set on the next turret face for turning a diameter of 16 mm. The procedure adopted for setting the box tool has been explained in Art. 4.11. The stop for turning the tool is set 20 mm from the collet face by a slip gauge. The rollers are set slightly behind the cutting edges, approximately 1.5 mm. (See Fig. 4.47)

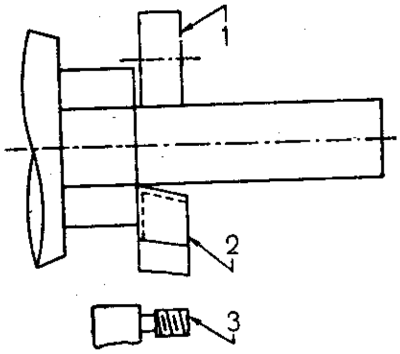

Figure 4.47 Setting of box turning tool
1. Roller, 2. Turning tool, 3. Position of stop rod.

(c) *Setting of bar ending tool:* The bar ending tool is set on the next turret face and is brought into operation after turning the bar. The stop is adjusted in the position by using a slip gauge (See Fig. 4.48)

(d) *Setting of self opening die head :* The self opening die head is mounted on the next face of the turret and the dies are fitted into it to cut a thread of 16 mm diameter. The stop is adjusted in a position keeping in view the pulling out length of the die head for self releasing. (See Fig. 4.49)

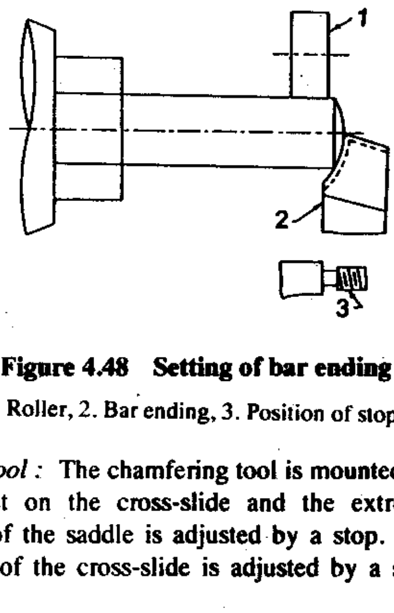

Figure 4.48 Setting of bar ending tool
1. Roller, 2. Bar ending, 3. Position of stop rod.

(e) *Setting of chamfering tool :* The chamfering tool is mounted on the four station turret on the cross-slide and the extreme longitudinal position of the saddle is adjusted by a stop. The cross feed movement of the cross-slide is adjusted by a stop (See Fig. 4.50)

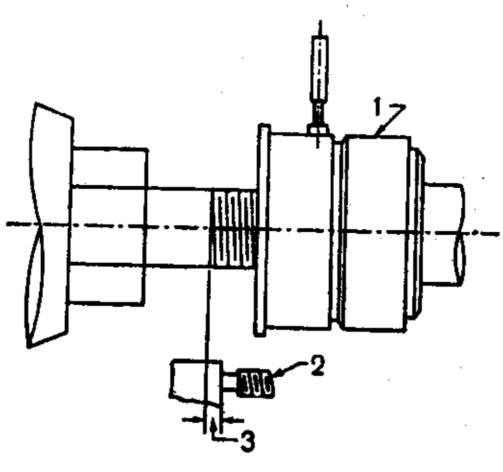

Figure 4.49 Setting of self opening die head
1. Die head 2. Position of stop rod, 3. Pulling out length.

(f) *Setting of parting off tool* : The parting off tool is set on the rear tool post on the cross-slide and the longitudinal position of the parting off tool is adjusted by the stop set at a distance of 6 mm from the turret face (See Fig.4.51)

Tooling schedule chart : A tooling schedule chart for each workpiece is of great importance in a capstan or turret lathe work for ready reference. A tooling schedule chart for the above operations is given below.

See Fig. 4.52 for tooling layout of a bush bearing along with Table 22.2.

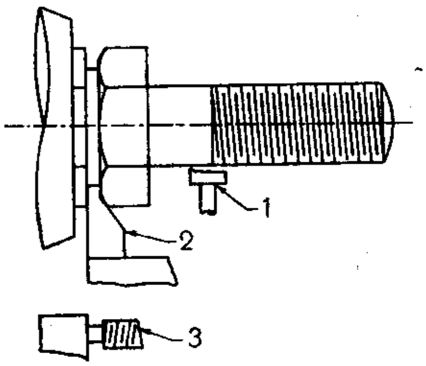

Figure 4.50 Setting of chamfering tool.
1. Position of stop on cross-slide, 2. Chamfering tool. 3. Turret saddle stop.

TOOLING SCHEDULE CHART

MACHINE - A 75 mm Capstan lathe MATERIAL - A hexagonal mild steel bar

Operation No.	*Description of operation*	*Tool positions*	*Tools*
1.	Hold in collet	Ist turret position	Bar stop
2.	Turn to 16 mm dia	2nd turret position	Roller steady box turning tool
3.	Form end of the bolt	3rd turret position	Roller steady bar ending tool
4.	Screw 16 mm	4th turret position	Self opening die head with chasers for 16 mm
5.	Chamfer	Front cross-slide tool post	Chamfering tool
6.	Parting off	Rear tool post	Parting off tool

4.14 CUTTING SPEED, FEED AND DEPTH OF CUT

Cutting speed : Similar to a centre lathe, the cutting speed in a capstan or turret lathe is the rate at which any point on the work passes over the tool. This is expressed in metres per minute.

Feed : It is the amount the tool moves per revolution of the work. This is expressed in mm per revolution.

Depth of cut : It is the perpendicular distance measured between a machined and an unmachined surface.

Tables 4.1 and 4.2 indicate the suggested cutting speed and feed for a high speed steel tool for different operations.

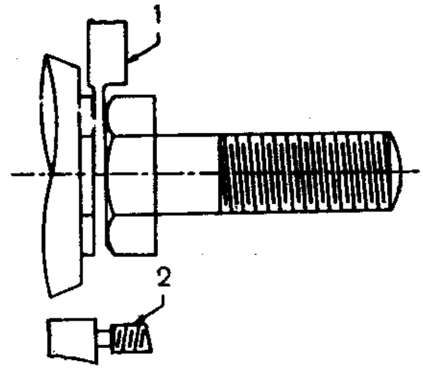

Figure 4.51 Setting of parting off tool
1. Parting off tool, 2. Position of stop rod.

TABLE 4.1 FEEDS FOR HIGHSPEED STEEL TOOLS, MM PER REV.

Material	*Straight turning*	*Form turning, cutting off*	*Drilling and centering*	*Boring*
Steel 50 kg/mm^2	0.05–0.18	0.02–0.05	0.04–0.14	0.10–0.30
Steel 70 kg/mm^2	0.05–0.15	0.015–0.04	0.03–0.10	0.08–0.18
Free cutting steel	0.06–0.19	0.02–0.05	0.04–0.12	0.10–0.30
Stainless steel	0.03–0.08	0.005–0.03	0.03–0.08	0.06–0.15
Brass	0.10–0.22	0.02–0.10	0.08–0.25	0.15–0.35
Aluminium	0.10–0.22	0.02–0.08	0.03–0.18	0.18–0.45

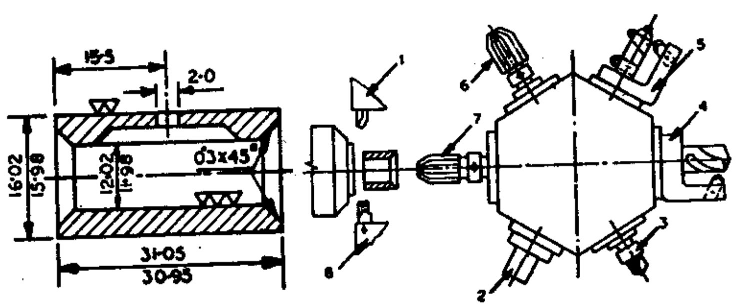

Figure 4.52 Tooling layout for a plain bush bearing

TABLE 4.1 SUGGESTED CUTTING SPEEDS (M. PER MIN) FOR HIGH SPEED STEEL TOOLS

Workpiece Material	*Operations*																
	Straight turning	Form turning cutting off	Drilling	Core drilling	Reaming	Thread cutting											
						With taps						With dies					
						Pitches											
						0.25	0.5	0.7	1.0	1.5	1.75	0.5	0.7	1.0	1.5	1.75	2.0
Steel 50 kg/mm²	45-55	30-40	40-50	25-30	10-15	2.5	3.3	4.2	5.2	7.2	10.0	2.1	2.6	3.2	4.6	6.4	7.5
Steel 70 kg/mm²	35-50	30-40	25-35	18-20	7-10	2.2	2.9	3.5	3.9	4.9	7.0	1.9	2.2	2.8	4.3	4.8	6.1
Free cutting steel	40-65	35-45	40-45	28-45	13-15	4.1	5.0	6.7	7.2	8.5	12.0	3.2	3.9	5.2	5.8	6.5	6.8
Stainless steel	15-30	10-12	16-30	10-15	5-6	1.9	2.5	3.2	4.8	5.0	5.4	1.5	1.9	2.5	3.2	4.0	–
Brass	70-150	70-150	50-100	45-80	25-40	6.3	8.5	10.5	12.3	17.5	20.0	5.5	6.8	7.5	8.5	10.4	10.8
Aluminium	200-250	200-250	150-200	60-80	20-30	7.5	10.0	13.2	14.5	19.5	22.5	6.5	7.4	8.5	9.2	10.8	11.5

REVIEW QUESTIONS

1. Differentiate between a capstan, a turret and an engine lathe.
2. What are the differences between a capstan and a turret lathe ?
3. Describe the features of turret lathe headstock. List also different types of headstocks.
4. Describe in brief various parts of capstan and turret lathes.
5. Name the different work holding devices / methods in capstan / turret lathe. Describe one method briefly with sketch.
6. What are various collet chucks ? List the names of various collet chucks. Describe one in brief.
7. List the various tool holding devices, used in capstan / turret lathes.
8. What is a box tool ? Describe in brief.
9. What is a hollow mill ? Discuss its utility and operation.
10. Sketch the tooling layout for production of simple bush by a turret lathe.