RTU SYLLABUS

Basic machine tools: Constructional configuration, estimation of machining time on lathe, drilling, shaping, milling, grinding, Gear cutting on milling, Gear hobbling. Special Purpose Machine Tools: Automatic lathes, capstan and turret lathe machines, operational planning and turret tool layout, sequence of operations.

UNIT - III

CENTRE LATHE AND SPECIAL PURPOSE LATHES

CENTRE LATHE

Lathe is the oldest machine tool invented, starting with the Egyptian tree lathes. It is the father of all machine tools. Its main function is to remove material from a work piece to produce the required shape and size. This is accomplished by holding the work piece securely and rigidly on the machine and then turning it against the cutting tool which will remove material from the work piece in the form of chips. It is used to machine cylindrical parts. Generally single point cutting tool is used. In the year 1797 Henry Maudslay, an Englishman, designed the first screw cutting lathe which is the forerunner of the present day high speed, heavy duty production lathe.

Classification of lathes

Lathes are very versatile of wide use and are classified according to several aspects:

According to configuration:

- Horizontal - Most common for ergonomic conveniences.
- Vertical - Occupies less floor space, only some large lathes are of this type.

According to purpose of use:

- General purpose - Very versatile where almost all possible types of operations are carried out on wide ranges of size, shape and materials of jobs; e.g.: centre lathes.
- Single purpose - Only one (occasionally two) type of operation is done on limited ranges of size and material of jobs; e.g.: facing lathe, roll turning lathe etc.
- Special purpose - Where a definite number and type of operations are done repeatedly over long time on a specific type of blank; e.g.: capstan lathe, turret lathe, gear blanking lathe etc.

According to size or capacity:

- Small (low duty) - In such light duty lathes (up to 1.1 kW), only small and medium size jobs of generally soft and easily machinable materials are machined.
- Medium (medium duty) - These lathes of power nearly up to 11 kW are most versatile and commonly used.
- Large (heavy duty)
- Mini or micro lathe - These are tiny table-top lathes used for extremely small size jobs and precision work; e.g.: Swiss type automatic lathe.

According to configuration of the jobs being handled:

- Bar type - Slender rod like jobs being held in collets.
- Chucking type - Disc type jobs being held in chucks.
- Housing type - Odd shape jobs, being held in face plate.

According to precision:

Ordinary

Precision (lathes) - These sophisticated lathes meant for high accuracy and finish and are relatively more expensive.

According to number of spindles:

- ➢ Single spindle - Common.
- ➢ Multi-spindle (2, 4, 6 or 8 spindles) - Such uncommon lathes are suitably used for fast and mass production of small size and simple shaped jobs.

According to type of automation:

- ➢ Fixed automation - Conventional; e.g.: single spindle automat & Swiss type automatic lathe
- ➢ Flexible automation - Modern; e.g.: CNC lathe, turning centre etc.

According to degree of automation:

Non-automatic - Almost all the handling operations are done manually; e.g.: centre lathes. Semi-automatic - Nearly half of the handling operations, irrespective of the processing operations, are done automatically and rest manually; e.g.: copying lathe, relieving lathe etc.

- ➢ Automatic- Almost all the handling operations (and obviously all the processing operations) are done automatically; e.g.: single spindle automat, Swiss type automatic lathe, etc.

CONSTRUCTIONAL FEATURES

Major parts of a centre lathe

Amongst the various types of lathes, centre lathes are the most versatile and commonly used.

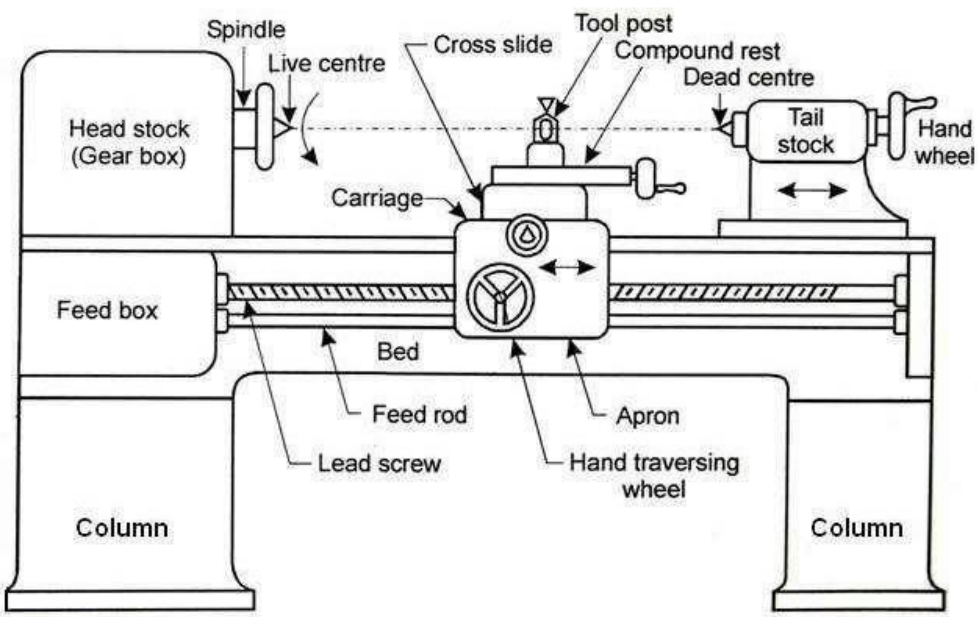


Fig. 2.1 shows the basic configuration of a center lathe. The major parts are:

Fig. 2.1 Schematic view of a center lathe

Headstock It holds the spindle and through that power and rotation are transmitted to the job at different speeds. Various work holding attachments such as three jaw chucks, collets, and centres can be held in the spindle. The spindle is driven by an electric motor through a system of belt drives and gear trains. Spindle rotational speed is controlled by varying the geometry of the drive train.

Tailstock The tailstock can be used to support the end of the work piece with a center, to support longer blanks or to hold tools for drilling, reaming, threading, or cutting tapers. It can be adjusted in position along the ways to accommodate different length work pieces. The tailstock barrel can be fed along the axis of rotation with the tailstock hand wheel.

Bed Headstock is fixed and tailstock is clamped on it. Tailstock has a provision to slide and facilitate operations at different locations. The bed is fixed on columns and the carriage travels on it.

Carriage It is supported on the lathe bed-ways and can move in a direction parallel to the lathe axis. The carriage is used for giving various movements to the tool by hand and by power. It carries saddle, cross-slide, compound rest, tool post and apron.

Saddle It carries the cross slide, compound rest and tool post. It is an H-shaped casting fitted over the bed. It moves alone to guide ways.

Cross-slide It carries the compound rest and tool post. It is mounted on the top of the saddle. It can be moved by hand or may be given power feed through apron mechanism.

Compound rest It is mounted on the cross slide. It carries a circular base called swivel plate which is graduated in degrees. It is used during taper turning to set the tool for angular cuts. The upper part known as compound slide can be moved by means of a hand wheel.

Tool post It is fitted over the compound rest. The tool is clamped in it.

ApronLower part of the carriage is termed as the apron. It is attached to the saddle and hangs in front of the bed. It contains gears, clutches and levers for moving the carriage by a hand wheel or power feed.

Feed mechanism The movement of the tool relative to the work piece is termed as “feed”. The lathe tool can be given three types of feed, namely, longitudinal, cross and angular.

When the tool moves parallel to the axis of the lathe, the movement is called longitudinal feed. This is achieved by moving the carriage.

When the tool moves perpendicular to the axis of the lathe, the movement is called cross feed. This is achieved by moving the cross slide.

When the tool moves at an angle to the axis of the lathe, the movement is called angular feed. This is achieved by moving the compound slide, after swiveling it at an angle to the lathe axis.

Feed rod The feed rod is a long shaft, used to move the carriage or cross-slide for turning, facing, boring and all other operations except thread cutting. Power is transmitted from the lathe spindle to the apron gears through the feed rod via a large number of gears.

Lead screw The lead screw is long threaded shaft used as a master screw and brought into operation only when threads have to cut. In all other times the lead screw is disengaged from the gear box and remains stationary. The rotation of the lead screw is used to traverse the tool along the work to produce screw. The half nut makes the carriage to engage or disengage the lead screw.

Kinematic system and working principle of a centre lathe

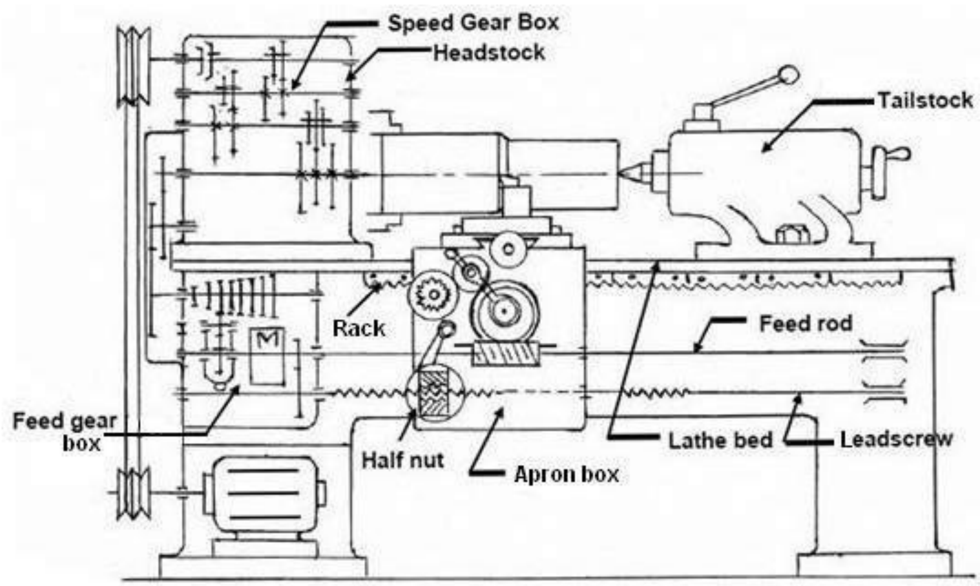


Fig. 2.2 schematically shows the kinematic system of a 12 speed centre lathe.

Fig. 2.2 Kinematic system of a 12 speed centre lathe

For machining in machine tools the job and the cutting tool need to be moved relative to each other. **The tool-work motions are:**

Formative motions: - cutting motion, feed motion.
Auxiliary motions: - indexing motion, relieving motion.

In lathes: Cutting motion is attained by rotating the job and feed motion is attained by linear travel of the tool either axially for longitudinal feed or radially for cross feed.

It is noted, in general, from Fig. 2.2. The job gets rotation (and power) from the motor through the belt-pulley, clutch and then the speed gear box which splits the input speed into a number (here 12) of speeds by operating the cluster gears.

The cutting tool derives its automatic feed motion(s) from the rotation of the spindle via the gear quadrant, feed gear box and then the apron mechanism where the rotation of the feed rod is transmitted:Either to the pinion which being rolled along the rack provides the longitudinal feed. Or to the screw of the cross slide for cross or transverse feed.While cutting screw threads the half nuts are engaged with the rotating lead screw to positively cause travel of the carriage and hence the tool parallel to the lathe bed i.e., job axis.

The feed-rate for both turning and threading is varied as needed by operating the Norton gear and the Meander drive systems existing in the feed gear box (FGB). The range of feeds can be augmented by changing the gear ratio in the gear quadrant connecting the FGB with the spindle.

As and when required, the tailstock is shifted along the lathe bed by operating the clamping bolt and the tailstock quill is moved forward or backward or is kept locked in the desired location. The versatility or working range of the centre lathes is augmented by using several special attachments.

Headstock driving mechanisms

There are two types of headstock driving mechanisms as follows:

Back geared
headstock. All geared
headstock.

Back geared headstock

Back gear arrangement is used for reducing the spindle speed, which is necessary for thread cutting and knurling. The back gear arrangement is shown in Fig.2.3.

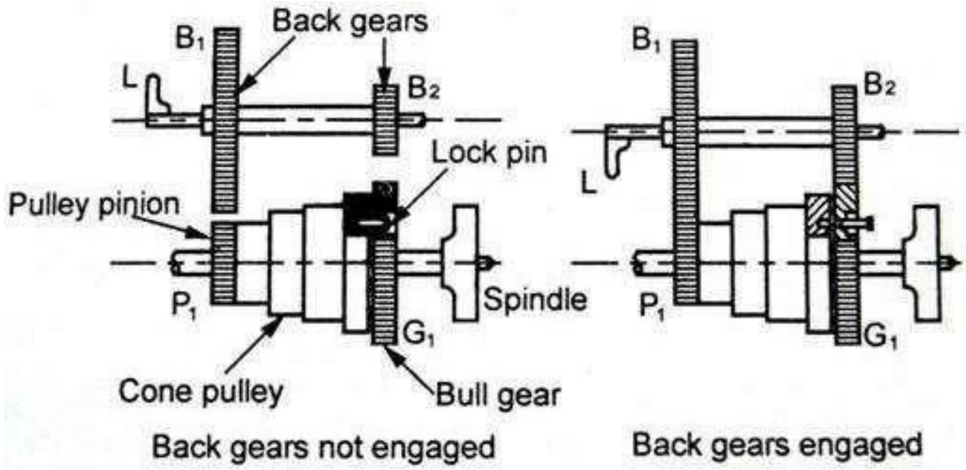


Fig. 2.3 Back gear arrangement

There is one stepped cone pulley in the lathe spindle. This pulley can freely rotate on the spindle. A pinion gear P_1 is connected to small end of the cone pulley. P_1 will rotate when cone pulley rotates. Bull gear G_1 is keyed to lathe spindle such that the spindle will rotate when Gear G_1 rotates. Speed changes can be obtained by changing the flat belt on the steps. A bull gear G_1 may be locked or unlocked with this cone pulley by a lock pin.

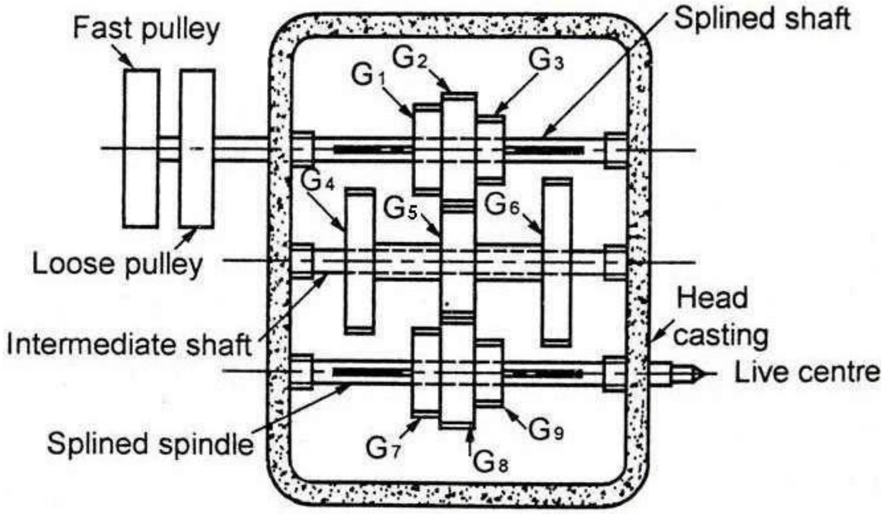
There are two back gears B_1 and B_2 on a back shaft. It is operated by means of hand lever L; back gears B_1 and B_2 can be engaged or disengaged with G_1 and P_1. For getting direct speed, back gear is not engaged. The step cone pulley is locked with the main spindle by using the lock pin. The flat belt is changed for different steps. Thus three or four ranges of speed can be obtained directly.

For getting slow or indirect speeds, back gear is engaged by lever L and lock pin is disengaged. Now, power will flow from P_1 to B_1. B_1 to B_2 (same shaft), B_2 to G_1 to spindle. As gear B_1 is larger than P_1, the speed will further be reduced at B_1. B_1 and B_2 will have the same speeds. The speed will further be reduced at G_1 because gear G_1 is larger than B_2. So, the speed of spindle is reduced by engaging the back gear.

All geared headstock

All geared headstock is commonly used in modern lathes because of the following advantages:

It gives wider range of spindle speeds.
It is more efficient and compact than cone pulley mechanism.
Power available at the tool is almost constant for all spindle
speeds. Belt shifting is eliminated.
The vibration of the spindle is
reduced. More power can be
transmitted.



The all geared headstock is shown in Fig 2.4.

The power from the constant speed motor is delivered to the spindle through a belt drive. Speed changing is made by levers. The different spindle speeds are obtained by shifting the levers into different positions to obtain different gear combinations. This mechanism has a splined spindle, intermediate shaft and a splined shaft. The splined shaft receives power from motor through a belt drive.

This shaft has 3 gears namely G_1, G_2 and G_3. These gears can be shifted with the help of lever along the shaft. Gears G_4, G_5 and G_6 are mounted on intermediate shaft and cannot be moved axially. Gears G_7, G_8 and G_9 are mounted on splined headstock spindle and can be moved axially be levers. Gears G_1, G_2 and G_3 can be meshed with the gears G_4, G_5 and G_6 individually. Similarly, gears G_7, G_8, G_9 can be meshed with gear G_4, G_5 and G_6 individually. Thus, it provides nine different speeds.

Feed mechanisms

The feed mechanism is used to transmit power from the spindle to the carriage. Therefore, it converts rotary motion of the spindle into linear motion of the carriage. The feed can be given either by hand or automatically. For automatic feeding, the following feed mechanisms are used:

Tumbler gear reversing
mechanism. Quick-change
gearbox.
Tumbler gear quick-change
gearbox. Apron mechanism.
Bevel gear feed reversing mechanism.

Tumbler gear reversing mechanism

Tumbler gear mechanism is used to change the direction of lead screw and feed rod. By engaging tumbler gear, the carriage can be moved along the lathe axis in either direction during thread cutting or automatic machining. Fig. 2.5 shows the schematic arrangement of tumbler gear reversing mechanism.

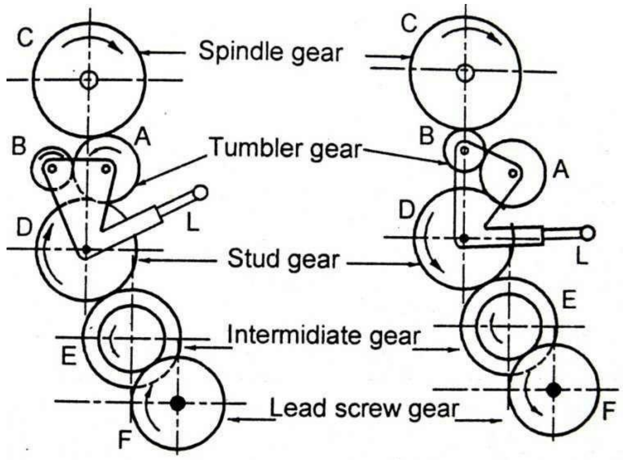


Fig. 2.5 Tumbler gear reversing mechanism

The tumbler gear unit has two pinions (A and B) of same size and is mounted on a bracket. The bracket is pivoted at a point and can be moved up and down by a lever L. The bracket may be placed in three positions i.e., upward, downward and neutral. Gear 'C' is a spindle gear attached to the lathe spindle. Gear 'D' is the stud gear. The stud gear is connected to the lead screw gear through a set of intermediate gears.

When the lever is shifted upward position, the gear 'A' is engaged with spindle gear 'C' and the power is transmitted through C-A-D-E-F. During this position, lead screw will rotate in the same direction as spindle rotates (i.e. both anticlockwise). Now, the carriage moves towards the headstock. When the lever is shifted downward, the gear 'B' is engaged with spindle gear 'C' and the power is transmitted through C-B-A-D-E-F. Hence, the lead screw will rotate in the opposite direction of the spindle. Now, the carriage moves towards tailstock.

When the bracket is in neutral position, the engagement of tumbler gears is disconnected with the spindle gear. Hence, there is no power transmission to lead screw.

Quick-change gear box

Quick-change gearbox is used to get various power feeds in the lathe. Fig. 2.6 shows the schematic arrangement of quick-change gear box.

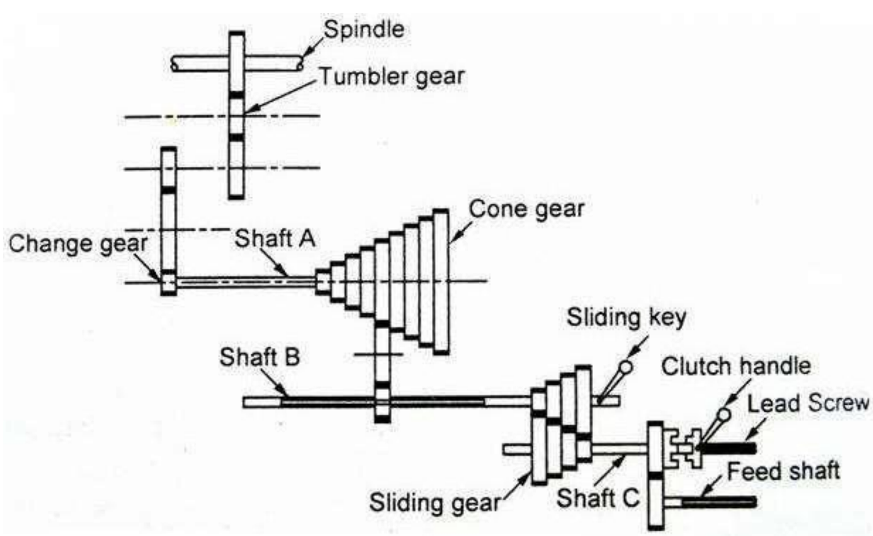


Fig. 2.6 quick-change gear box

Power from the lathe spindle is transmitted to feed shaft through tumbler gear, change gear train and quick-change gearbox. Shaft A (Cone gear shaft) contains 9 different sizes of gears keyed with it. Shaft B (Sliding gear shaft) has a gear and it receives 9 different speeds from shaft A by the use of sliding gear. Shaft B is connected to shaft C (Driven shaft) through 4 cone years. Therefore, Shaft C can get 9 X 4 = 36 different speeds. The shaft C is connected to lead screw by a clutch and feed rod by a gear train. Lead screw is used for thread cutting and feed rod is used for automatic feeds.

Tumbler gear quick-change gear box

The different speed of the driving shaft is obtained by a tumbler gear and cone gear arrangement.

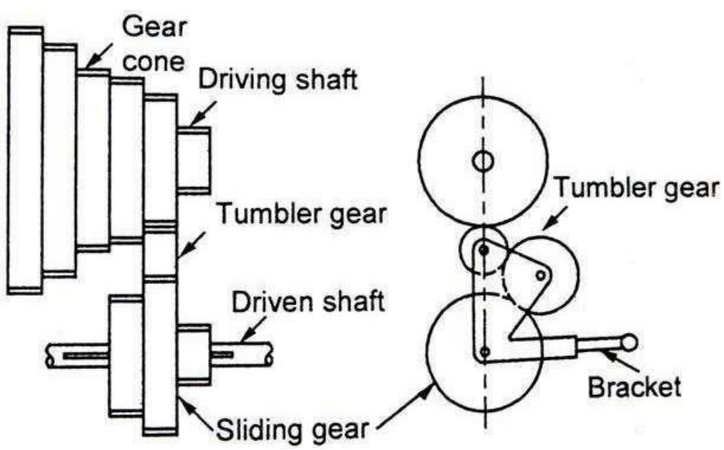


Fig. 2.7 shows the schematic arrangement of tumbler gear quick-change gear box.

Fig. 2.7 Tumbler gear quick-change gearbox

It is simpler than quick-change gearbox. A tumbler gear and a sliding gear are attached to the bracket as shown in Fig. 2.7. Driving shaft has a cone gear made up of different sizes of gears. The sliding gear is keyed to the driven shaft which is connected by the lead screw or feed rod. The sliding gear can be made to slide and engaged at any desired position. By sliding the sliding gear to various positions and engaging the tumbler gear, various speeds can be obtained.

Apron mechanism

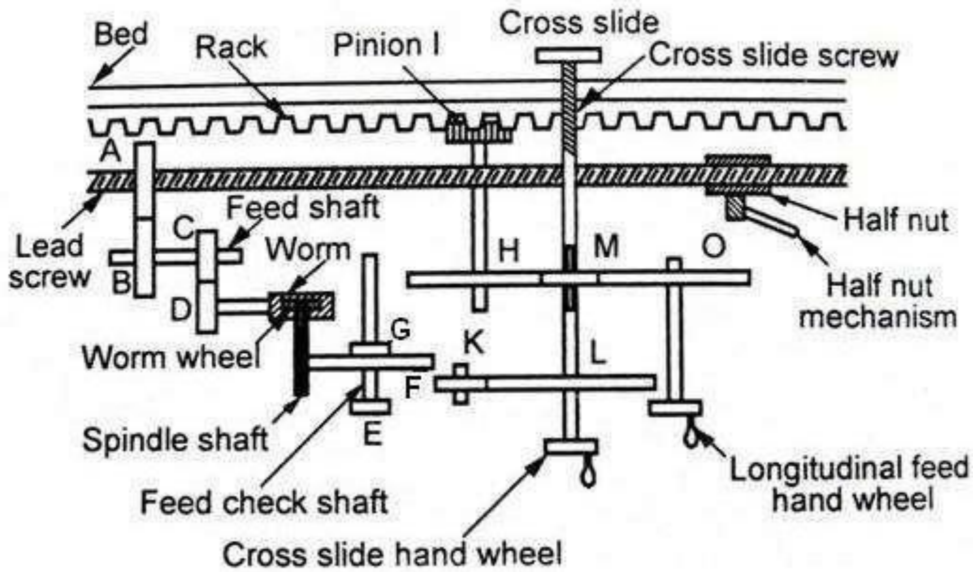


Fig. 2.8 shows the schematic arrangement of apron mechanism.

Lead screw and feed rod is getting power from spindle gear through tumbler gears. Power is transmitted from feed rod to the worm wheel through gears A, B, C, D and worm.

A splined shaft is attached with worm wheel. The splined shaft is always engaged with the gears F and G which are keyed to the feed check shaft. A knob 'E' is fitted with feed check shaft. Feed check knob 'E' can be placed in three positions such as neutral, push-in and pull-out.

When the feed check knob 'E' is in neutral position, power is not transmitted either to cross feed screw or to the carriage since gears F and G have no connection with H and K. Therefore, hand feed is given as follows. When the longitudinal feed hand wheel rotates, pinion I will also be rotated through I and H. pinion I will move on rack for taking longitudinal feed. For getting cross feed, cross slide screw will be rotated by using cross slide hand wheel.

When the feed check knob 'E' is push-in, rotating gear G will be engaged to H. then the power will be transmitted to pinion I. pinion I will rotate on rack. So, automatic longitudinal feed takes place. When the feed check knob 'E' is pulled-out, the rotating gear F will be engaged to K. Hence, the power will be transmitted to cross feed screws through L. This leads to automatic cross feed.

For thread cutting, half nut is engaged by half nut lever after putting knob 'E' neutral position. Half nut is firmly attached with the carriage. As the lead screw rotates, the carriage will automatically move along the axis of the lathe. Both longitudinal and cross feed can be reversed by operating the tumbler gear mechanism.

Bevel gear feed reversing mechanism

The tumbler gear mechanism being a non-rigid construction cannot be used in a modern heavy duty lathe. The clutch operated bevel gear feed reversing mechanism incorporated below the head stock or in apron provides sufficient rigidity in construction. Fig. 2.9 shows the schematic arrangement of bevel gear feed reversing mechanism.

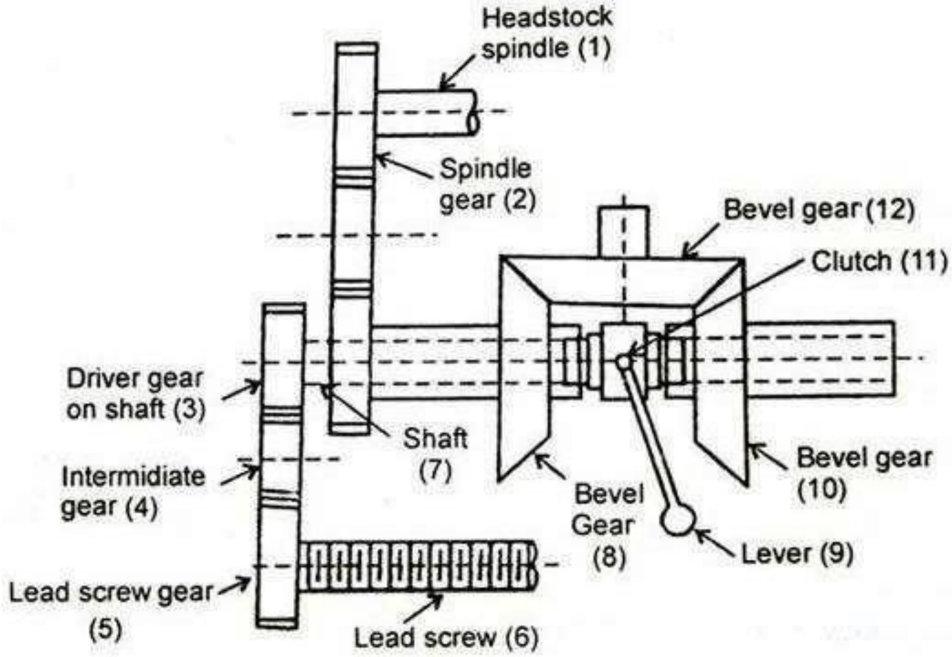


Fig. 2.9 Bevel gear feed reversing mechanism

The motion is communicated from the spindle gear 2 to the gear on the stud shaft through the intermediate gear. The bevel gear 8 is attached to the gear on the stud shaft and both of them can freely rotate on shaft 7. The bevel gear 8 meshes with bevel gear 12 and 12 mesh with 10. 12, 10 and 8 are having equal number of teeth. The bevel gear 10 can also rotate freely on shaft 7.

A clutch 11 is keyed to the shaft 7 by a feather key and may be shifted to left or right, by the lever 9 to be engaged with the gear 8 or 10 or it remains in the neutral position. When the clutch engages with bevel gear 8, gear 3 which is keyed to the shaft 7 and the lead screw, rotates in the same direction as the gear 2. The direction of rotation is reversed when the clutch 11 engages with gear 10.

Mounting of jobs in centre lathe

Without additional support from the tailstock

Chucks - 3 jaw self centering chuck or universal chuck and 4 jaw independent chuck

Fig. 2.10 (a and b) visualizes 3-jaw and 4-jaw chucks which are mounted at the spindle nose and firmly hold the job in centre lathes. Premachined round bars are quickly and coaxially mounted by simultaneously moving the three jaws radially by rotating the scroll (disc with radial threads) by a key as can be seen in the diagram 2.10 (a)

The four jaw chucks, available in varying sizes, are generally used for essentially more strongly holding non-circular bars like square, rectangular, hexagonal and even odder sectional jobs in addition to cylindrical bars, both with and without pre machining at the gripping portion. The jaws are moved radially independently by rotating the corresponding screws which push the rack provided on the back side of each jaw as can be seen in the diagram 2.10 (b).

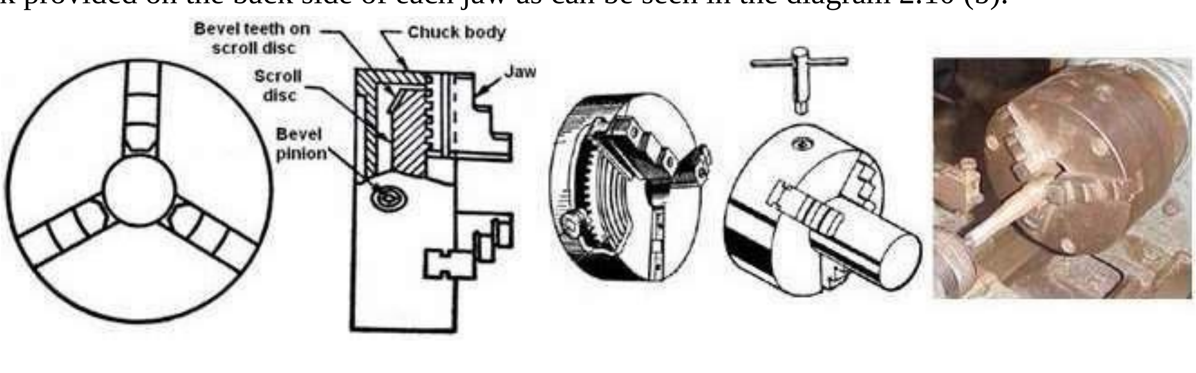


Fig. 2.10 (a) 3-jaw self centring chuck or universal chuck

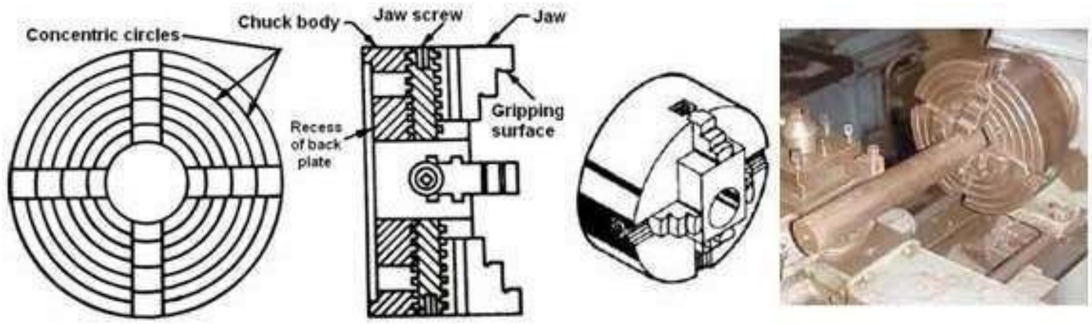


Fig. 2.10 (b) 4-jaw independent chuck

Magnetic chuck

This is used for holding thin jobs. When the pressure of jaws is to be prevented, this chuck is used. The chuck gets magnetic power from an electro-magnet. Only magnetic materials can be held on this chuck. Fig. 2.11 shows the magnetic chuck.

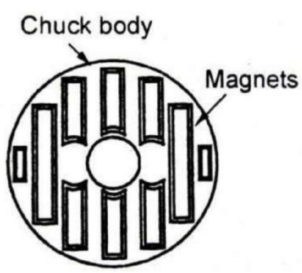


Fig. 2.11 Magnetic chuck

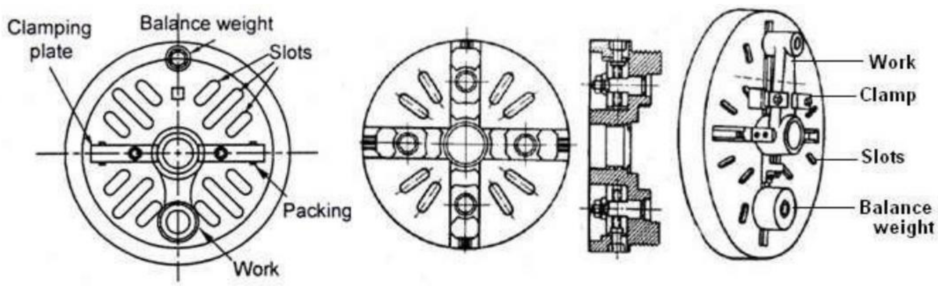


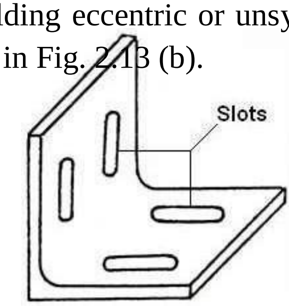
Fig. 2.12 Face plate

Face plate

A face plate as shown in Fig. 2.12 consists of a circular disc bored out and threaded to fit the nose of lathe spindle. This has radial, plain and T slots for holding work by bolts and clamps. Face plates are used for holding work pieces which cannot be conveniently held between centres or by chucks.

Angle plate

Angle plate is a cast iron plate that has two faces at right angles to each other. Holes and slots are provided on both faces as shown in Fig. 2.13 (a). An angle plate is used along with the face plate when holding eccentric or unsymmetrical jobs that are difficult to grip directly on the face plate as shown in Fig. 2.13 (b).



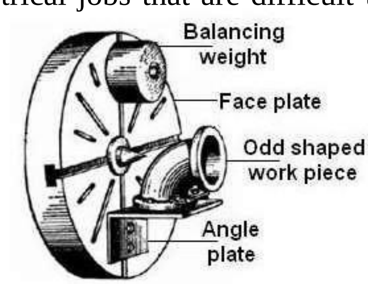


Fig. 2.13 (a) Angle plate   Fig. 2.13 (b) Angle plate used along with face plate

With additional support from the tailstock Catch plate or driving plate

It is circular plate of steel or cast iron having a projected boss at its rear. The boss has a threaded hole and it can be screwed to the nose of the headstock spindle. The driving is fitted to the plate. It is used to drive the work piece through a carrier or dog when the work piece is held between the centres. Fig. 2.14 shows the catch plate.

Carriers or Dogs

It is used to transfer motion from the driving plate to the work piece held between centres. The work piece is inserted into the hole of the dog and firmly secured in position by means of set screw. The different types of carriers are shown in Fig 2. 15.

Mandrels

A mandrel is a device used for holding and rotating a hollow work piece that has been previously drilled or bored. The work revolves with the mandrel which is mounted between two centres. The mandrel should be true with accurate centre holes for machining outer surface of the work piece concentric with its bore. To avoid distortion and wear it is made of high carbon steel.

The ends of a mandrel are slightly smaller in diameter and flattened to provide effective gripping surface of the lathe dog set screw. The mandrel is rotated by the lathe dog and the catch plate and it drives the work by friction. Different types of mandrels are employed according to specific requirements. Fig. 2.16 shows the different types of mandrels in common use.

In-between centres (by catch plate and carriers)

Fig. 2.17 schematically shows how long slender rods are held in between the live centre fitted into the headstock spindle and the dead centre fitted in the quill of the tailstock. The torque and rotation are transmitted from the spindle to the job with the help of a lathe dog or catcher which is again driven by a driving plate fitted at the spindle nose.

Depending upon the situation or requirement, different types of centres are used at the tailstock end as indicated in Fig. 2.18. A revolving centre is preferably used when desired to avoid sliding friction between the job and the centre which also rotates along with the job.

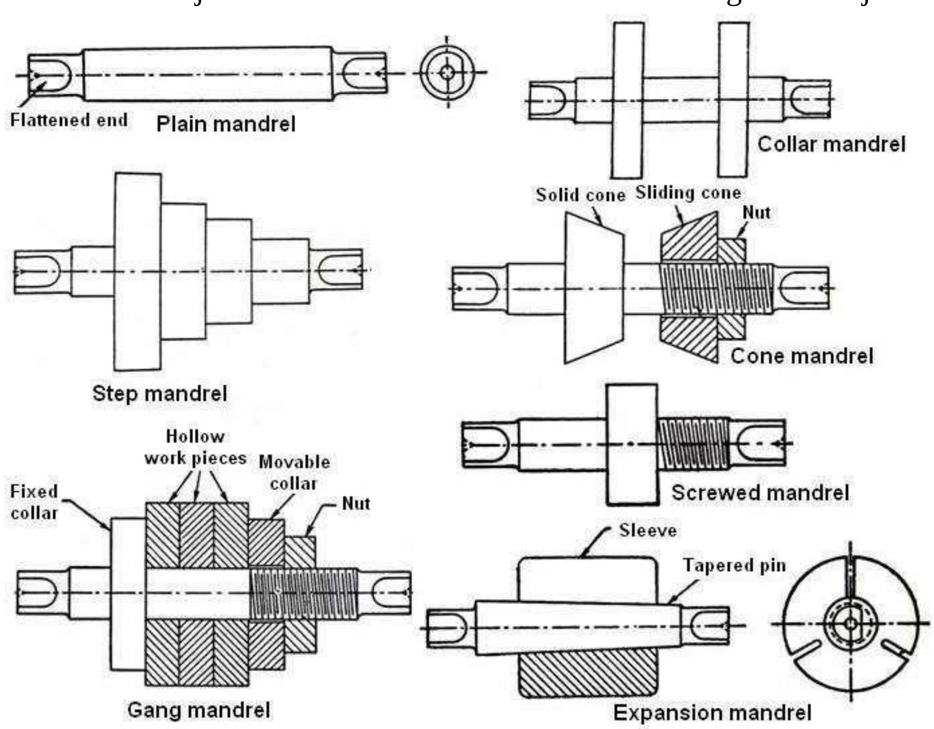


Fig. 2.17 Work held between centres

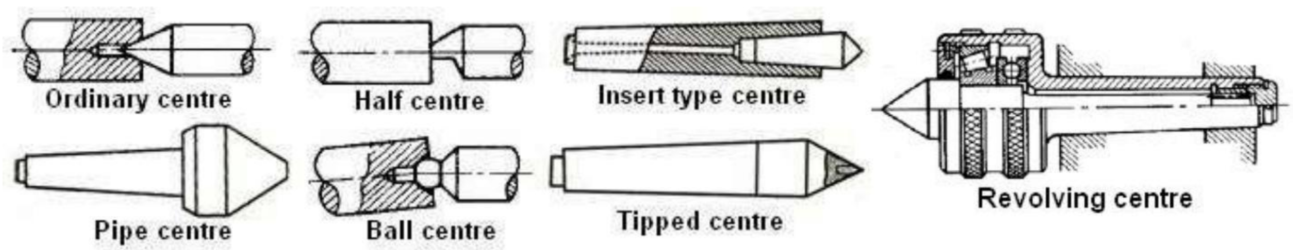


Fig. 2.18 Types of centres

Ordinary centre: It is used for general works.

Insert type centre: In this the steel “insert” can be replaced instead of replacing the whole centre. Half centre: It is similar to ordinary centre and used for facing bar ends without removal of the centre. Pipe centre: It is used for supporting pipes and hollow end jobs.

Ball centre: It has ball shaped end to minimize the wear and strain. It is suitable for taper turning.

Tipped centre: Hard alloy tip is brazed into steel shank. The hard tip has high wear resistant. Revolving centre: The ball and roller bearings are fitted into the housing to reduce friction and to take up end thrust. This is used in tail stock for supporting heavy work revolving at a high speed.

In-between chuck and centre

Heavy and reasonably long jobs of large diameter and requiring heavy cuts (cutting forces) are essentially held strongly and rigidly in the chuck at headstock with support from the tailstock through a revolving centre as can be seen in Fig. 2.19.

Fig. 2.19 Work held between chuck and revolving centre

In-between headstock and tailstock with additional support of rest

To prevent deflection of the long slender jobs like feed rod, lead screw etc. due to sagging and cutting forces during machining, some additional supports are provided as shown in Fig. 2.20. Such additional support may be a steady rest which remains fixed at a suitable location or a follower rest which moves along with the cutting tool during long straight turning without any steps in the job’s diameter. Fig. 2.21 (a and b) shows the steady rest and follower rest.

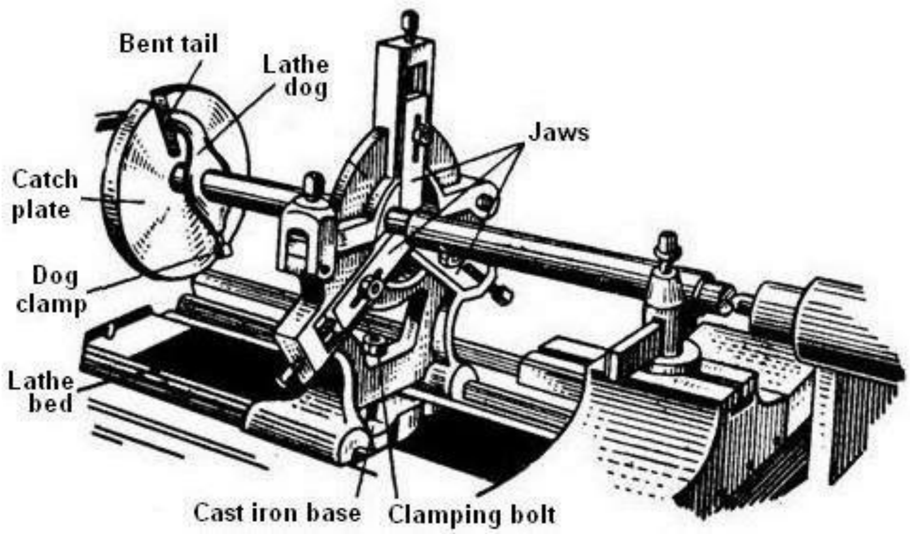


Fig. 2.20 Slender job held with extra support by steady rest

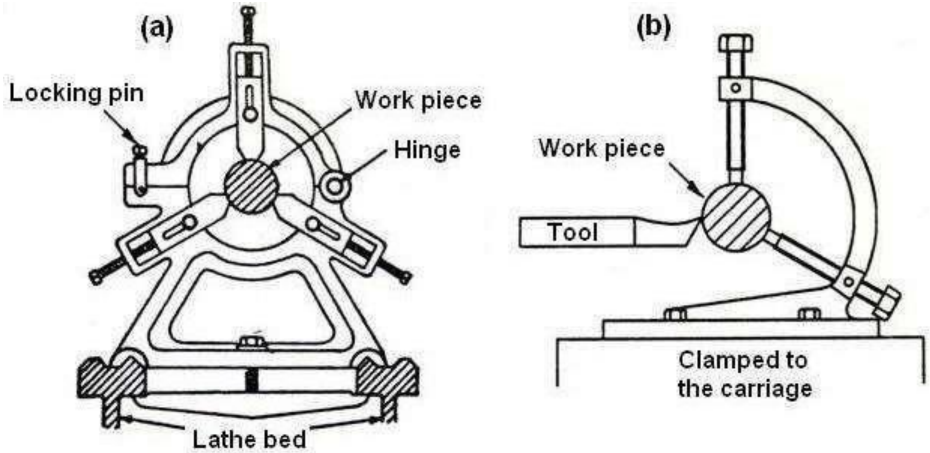


Fig. 2.21 (a) Steady rest and (b) Follower rest

Mounting of tools in centre lathe

Different types of tools, used in centre lathes, are usually mounted in the following ways:

HSS tools (shank type) in tool post.
HSS form tools and threading tools in tool post. Carbide and ceramic inserts in tool holders.
Drills and reamers, if required, in tailstock. Boring tools in tool post.

Fig. 2.22 (a and b) is typically showing mounting of shank type HSS single point tools in rotatable (only one tool) and indexable (up to four tools) tool posts. Fig. 2.22 (c) typically shows how a circular form or thread chasing HSS tool is fitted in the tool holder which is mounted in the tool post.

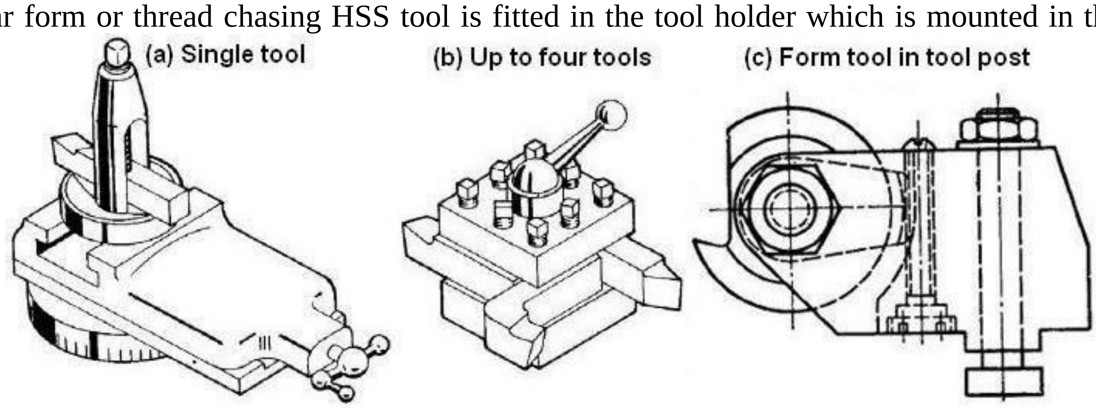


Fig. 2.22 Mounting of (a and b) shank type tools in tool post and (c) form tool in tool post

Carbide, ceramic and cermet inserts of various size and shape are mechanically clamped in

the
seat of rectangular sectioned steel bars which are mounted in the tool post. Fig. 2.23 (a, b, c and d) shows the common methods of clamping such inserts. After wearing out of the cutting point, the insert is indexed and after using all the corner tips the insert is thrown away.

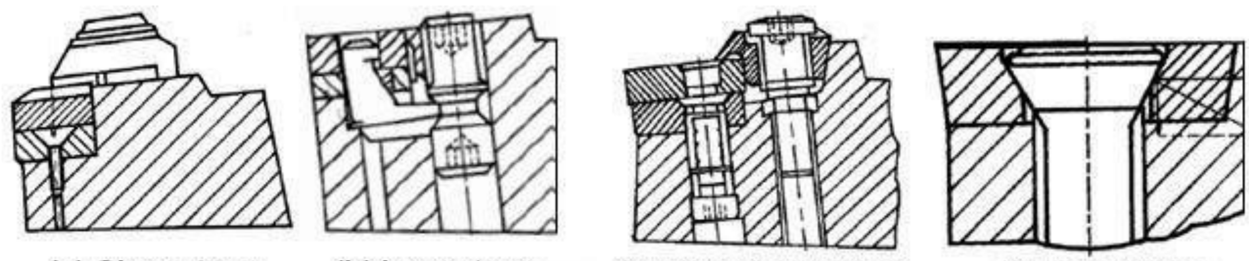


Fig. 2.23 Mounting of tool inserts in tool holders by mechanical clamping

For originating axial hole in centre lathe, the drill bit is fitted into the tailstock which is slowly moved forward against the rotating job as indicated in Fig. 2.24. Small straight shank drills are fitted in a drill chuck whereas taper shank drill is fitted directly into the tailstock quill without or with a socket.

Fig. 2.24 Holding drill chuck and drill in tailstock

Often boring operation is done in centre lathe for enlarging and finishing holes by simple shank type HSS boring tool. The tool is mounted on the tool post and moved axially forward, along with the saddle, through the hole in the rotating job as shown in Fig. 2.25 (a). For precision boring in centre lathe, the tool may be fitted in the tailstock quill supported by bush in the spindle as shown in Fig. 2.25 (b).

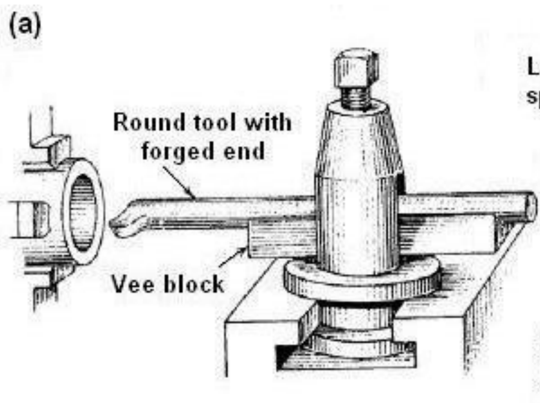


Fig. 2.25 (a) Boring tool mounted in the tool post

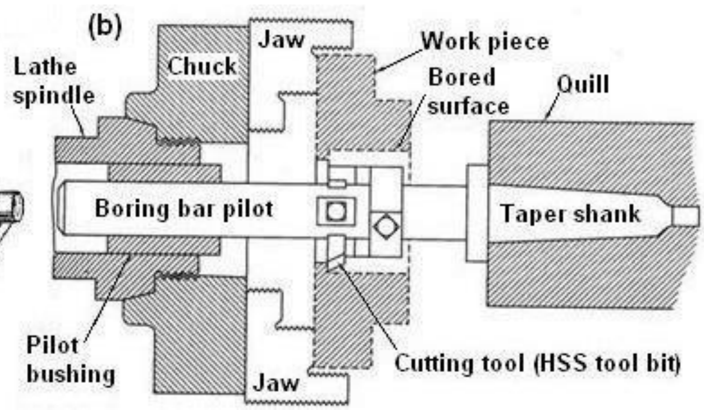


Fig. 2.25 (b) Precision boring in centre lathe

CUTTING TOOLS

For general purpose work, a single point cutting tool is used in centre lathes. But for special operations multi point tools may be used. Single point lathe tools are classified as follows:

According to the method of manufacturing the tool

Forged tool.
Tipped tool brazed to the carbon steel shank.
Tipped tool fastened mechanically to the carbon steel shank.

According to the method of holding the tool

Solid tool.
Tool bit inserted in the tool holder.

According to the method of using the tool

Turning tool, facing tool, forming tool, chamfering tool, finishing turning tool, round nose tool, external threading tool, internal threading tool, boring tool, parting tool, knurling tool, etc.

According to the method of applying feed

Right hand tool.
Left hand tool.
Round nose tool.

According to the method of manufacturing the tool

Forged tool

These tools are manufactured from high carbon steel or high speed steel. The required shape of the tool is given by forging the end of a solid tool steel shank. The cutting edges are then ground to the shape to provide necessary tool angles. Fig. 2.26 (a) shows a forged tool.

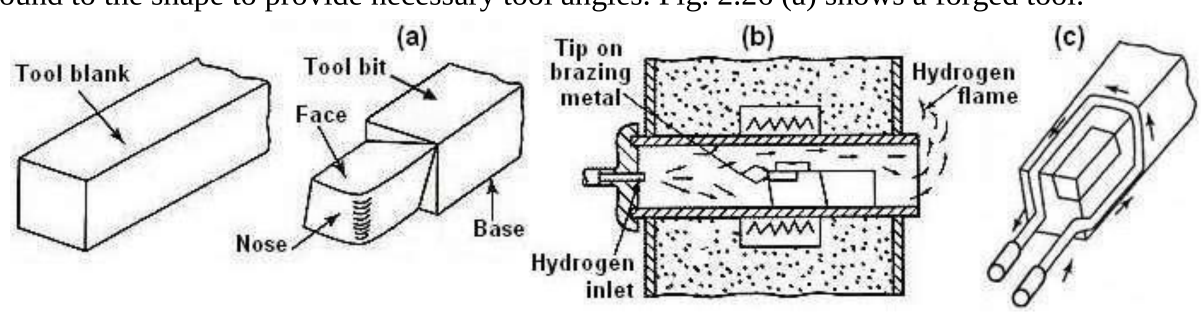


Fig. 2.26 (a) Forged tool (b) Furnace bracing of a tool tip (c) Induction brazing of a tool tip

Tipped tool brazed to the carbon steel shank

Stellite and cemented carbide tool materials, in view of the very high cost, brittleness, and low tensile strength, are used in the form of small tips. They are made to the various shapes to form different types of tools and are attached permanently to the end of a carbon steel shank by a brazing operation. High speed steel due to its high cost is also sometimes used in the form of tips brazed on carbon steel shank. Fig.

2.26 (b and c) shows the furnace and induction brazing of a tool tip on carbon steel shank.

Tipped tool fastened mechanically to the carbon steel shank

To ensure rigidity that a brazed tool does not offer, tips are sometimes clamped at the end of a tool shank by means of a clamp and bolt. Ceramic tips which are difficult to braze are clamped at the end of a shank. Fig. 2.27 shows a mechanically fastened tipped tool.

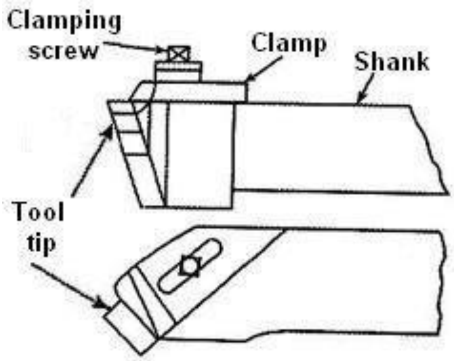


Fig. 2.27 Mechanically fastened tool tip

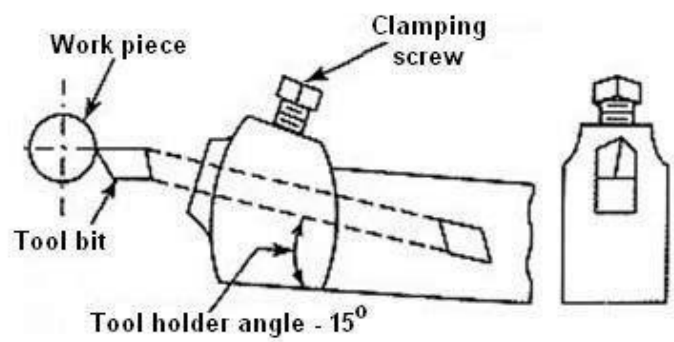


Fig. 2.28 Tool holder and tool bit

According to the method of holding the tool

Solid tool

Solid tools are made of high carbon steel forged and ground to the required shape. They are mounted directly on the tool post of a lathe. Fig. 2.26 (a) shows a solid tool.

Tool bit inserted in the tool holder

A tool bit is a small piece of cutting material having a very short shank which is inserted in a forged carbon steel tool holder and clamped in position by bolt or screw. A tool bit may be of solid type or tipped one according to the type of the cutting tool material. Tool holders are made of different designs according to the shape and purpose of the cutting tool. Fig. 2.28 illustrates a common type of tool holder using high speed steel tool bit.

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According to the method of using the tool

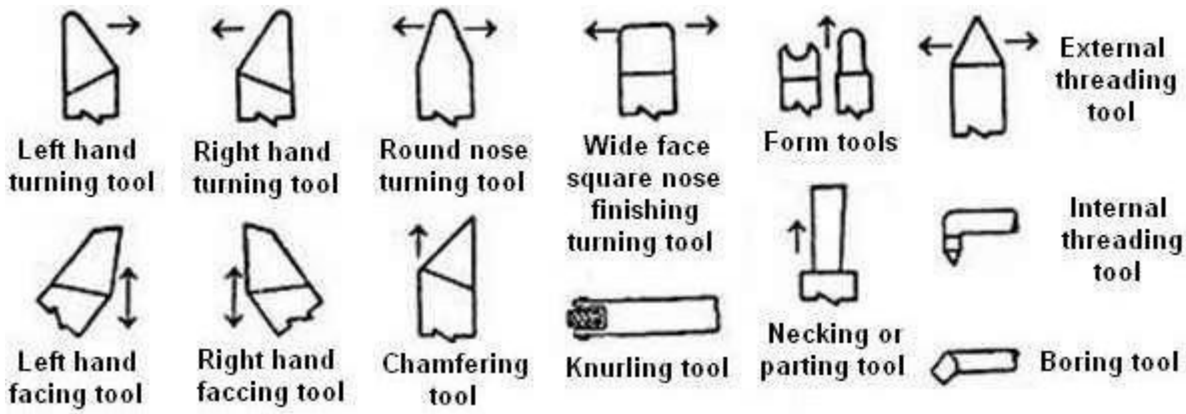


Fig. 2.29 shows the various tools used in centre lathe according to the method of using the tool.

Fig. 2.29 Various tools used in centre lathe according to the method of using the tool

VARIOUS OPERATIONS

The machining operations generally carried out in centre lathe are:

Rough and finish turning - The operation of producing cylindrical surface. Facing - Machining the end of the work piece to produce flat surface.

Centering - The operation of producing conical holes on both ends of the work piece.

Chamfering - The operation of beveling or turning a slope at the end of the work piece.

Shouldering - The operation of turning the shoulders of the stepped diameter work piece.

Grooving - The operation of reducing the diameter of the work piece over a narrow surface. It is also called as recessing, undercutting or necking.

Axial drilling and reaming by holding the cutting tool in the tailstock barrel. Taper turning by.

Boring (internal turning); straight and taper – The operation of enlarging the diameter of a hole. Forming; external and internal.

Cutting helical threads; external and internal.

Parting off - The operation of cutting the work piece into two halves.

Knurling - The operation of producing a diamond shaped pattern or impression on the surface. In addition to the aforesaid regular machining operations, some more operations are also occasionally done, if desired, in centre lathes by mounting suitable attachments available in the market. Some of those common operations carried out in centre lathe are shown in Fig. 2.30.

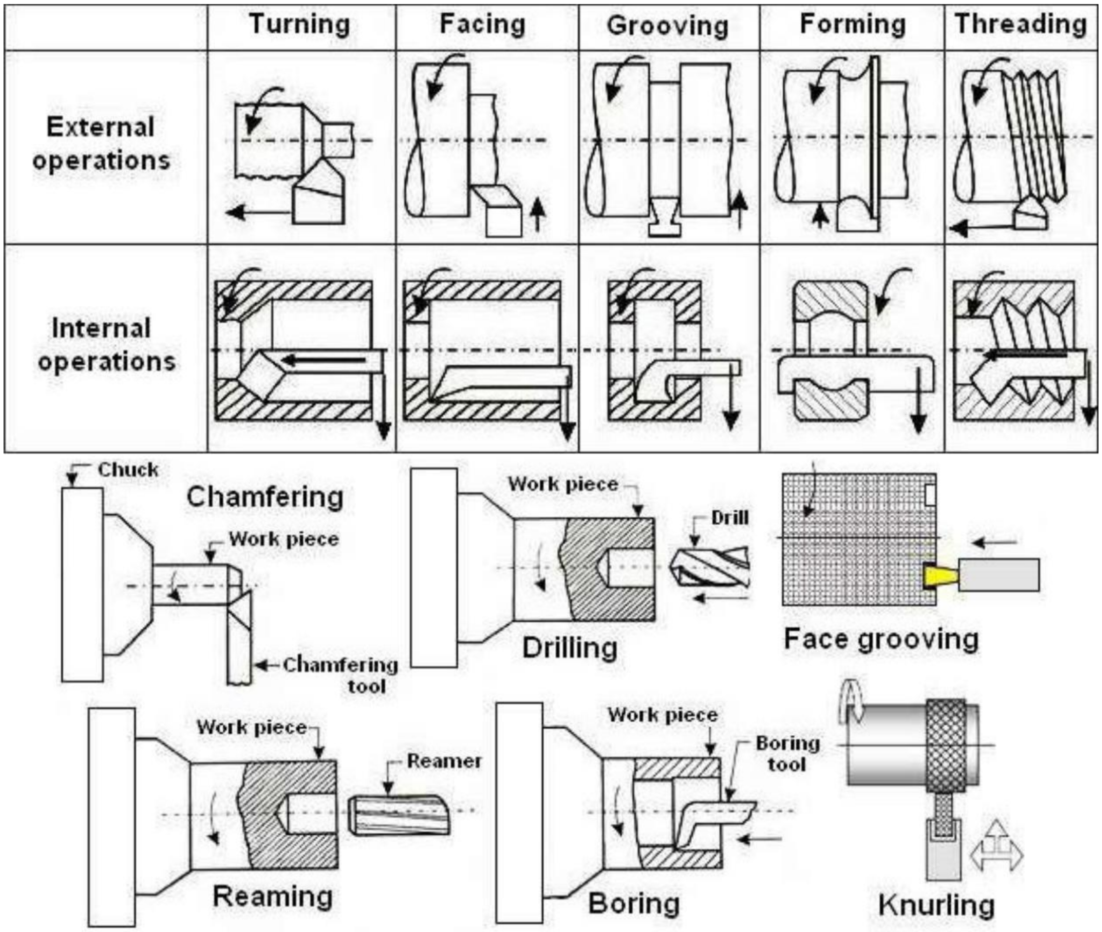
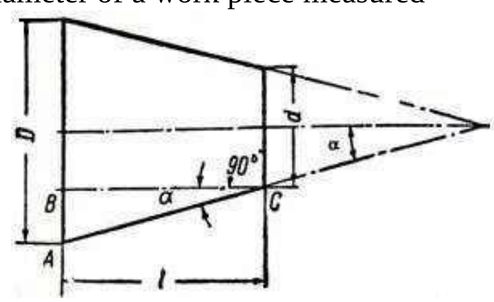


Fig. 2.30 Some common machining operations carried out in a centre lathe

TAPER TURING METHODS

A taper may be defined as a uniform change in the diameter of a work piece measured along its length. Taper may be expressed in two ways:



Ratio of difference in diameter to the length. In degrees of half the included angle.

Fig. 2.31 shows the details of a taper.

D - Large diameter of the taper. d - Small diameter of the taper. l - Length of tapered part.

α - Half angle of taper. Fig. 2.31 Details of a taper Generally, taper is specified by the term conicity. Conicity is defined as the ratio of the difference in

diameters of the taper to its length. Conicity, **K=—** 2.1

Taper turning is the operation of producing conical surface on the cylindrical work piece on lathe.

Taper turning by a form tool

Fig. 2.32 illustrates the method of turning taper 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. 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 will require excessive cutting pressure, which may distort the work due to vibration and spoil the work surface.

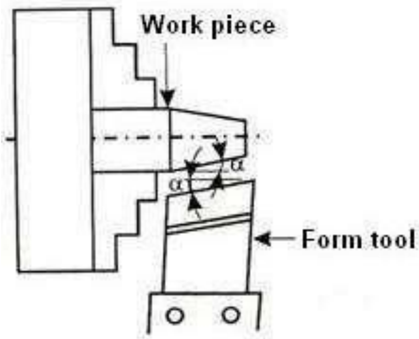


Fig. 2.32 Taper turning by a form tool

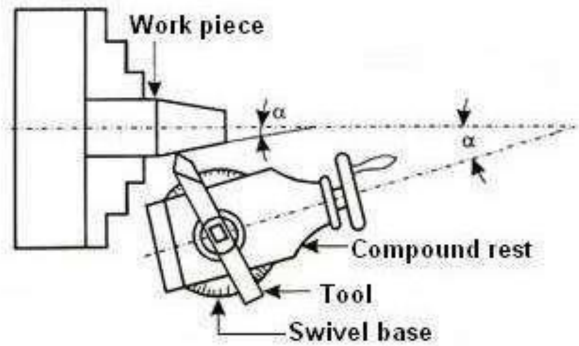


Fig. 2.33 Taper turning by swiveling the compound rest

Taper turning by swiveling the compound rest

Fig. 2.33 illustrates the method of turning taper by swiveling the compound rest. This method is used to produce short and steep taper. In this method, work is held in a chuck and is rotated about the lathe axis. The compound rest is swiveled to the required angle and clamped in position.

The angle is determined by using the formula, **tan**α = —   2.2

Then the tool is fed by the compound rest hand wheel. This method is used for producing both internal and external taper. This method is limited to turn a short taper owing to the limited movement

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of the compound rest. The compound rest may be swiveled at 45 on either side of the lathe axis enabling it to turn a steep taper. The movement of the tool in this method being purely controlled by hand, this gives a low production capacity and poorer surface finish.

Taper turning by offsetting the tailstock

Fig. 2.34 illustrates the method of turning taper by offsetting the tailstock. The principle of turning taper by this method is to shift the axis of rotation of the work piece, at an angle to the lathe axis, which is equal to half angle of the taper, and feeding the tool parallel to the lathe axis.

This is done when the body of the tailstock is made to slide on its base towards or away from the operator by a set over screw. The amount of set over being limited, this method is suitable for turning small taper on long jobs. The main disadvantage of this method is that 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.

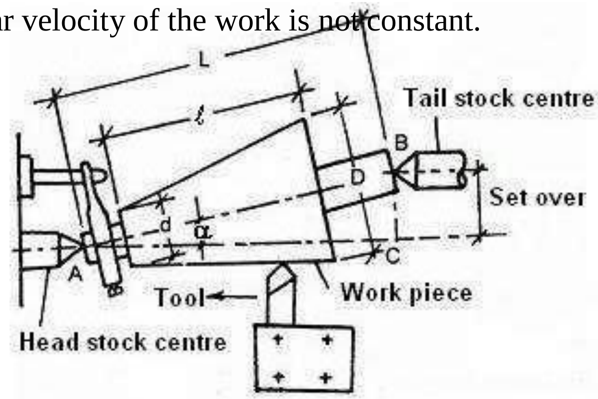

Fig. 2.34 Taper turning by offsetting the tailstock

The amount of set over required to machine a particular taper may be calculated as:

From the right angle triangle ABC in Fig.2.34; BC =AB sinα, where BC = set over

Set over = L sinα 2.3

If the half angle of taper (α), is very small, for all practical purposes, sinα = tanα

Set over = L tanα **= L x** —— in mm. 2.4

If the taper is turned on the entire length of the work piece, then l= L, and the equation (2.4) becomes:

Set over = L x —— = —— 2.5

—— being termed as the conicity or amount of taper, the formula (2.4) may be written in the following form:

Set over = 2.6

Taper turning by using taper turning attachment

Fig. 2.35 schematically shows a taper turning attachment. It consists 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 guide bar having graduations in degrees may be swiveled on either side of the zero graduation and is set at the desired angle with the lathe axis. When this attachment is used the cross slide is delinked from the saddle by removing the binder screw. The rear end of the cross slide is then tightened with the guide block by means of a bolt. When the longitudinal feed is engaged, the tool mounted on the cross slide will follow the angular path, as the guide block will slide on the guide bar set at an angle to the lathe axis.

The required depth of cut is given by the compound slide which is placed at right angles to the lathe axis. The guide bar must be set at half taper angle and the taper on the work must be converted in degrees. The maximum angle through which the guide bar may be swiveled is 10^0 to 12^0 on either side of the centre line. The angle of swiveling the guide bar can be determined from the equation 2.2.

The advantages of using a taper turning attachment are:

The alignment of live and dead centres being not disturbed; both straight and taper turning may be performed on a work piece in one setting without much loss of time.

Once the taper is set, any length of work piece may be turned taper within its limit.

Very steep taper on a long work piece may be turned, which cannot be done by any other method.

Accurate taper on a large number of work pieces may be turned. Internal tapers can be turned with ease.