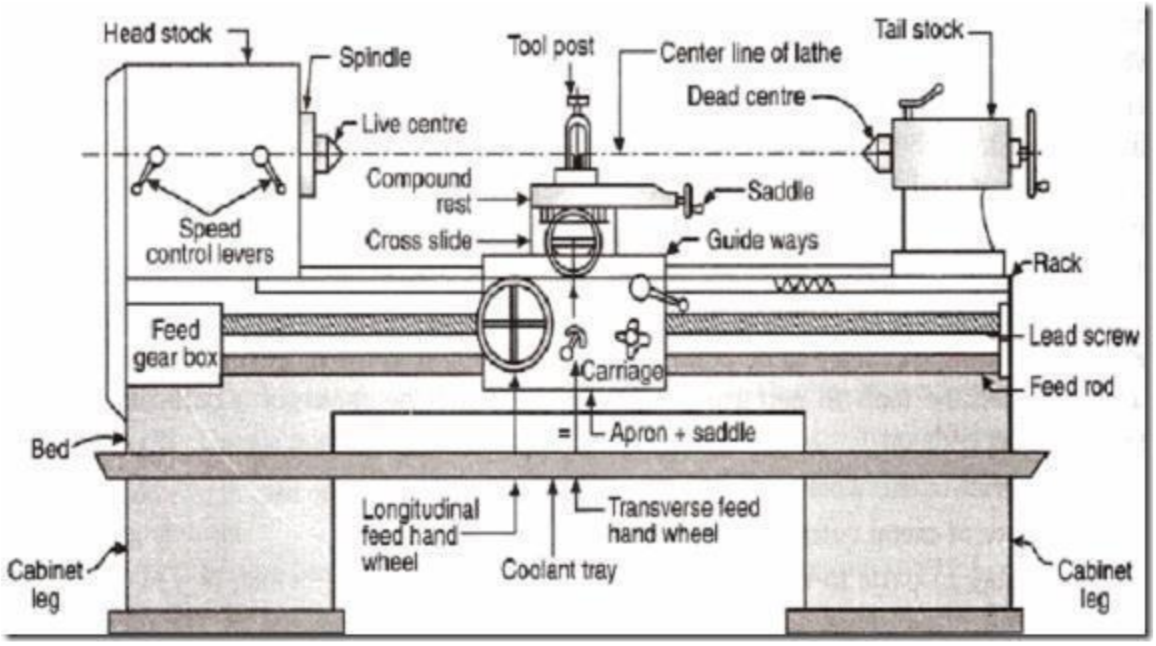
UNIT– II

Lathe removes undesired material from a rotating work piece in theform ofchips with the help of a tool which in traversed a cross the work and can be fed deep in work. The tool material should be harder than the work piece. The work piece in held securely and rigidly on the machine. The cutting tool is rigidly held and supported in a toolpost and is fed against the revolving work while the work revolves about its own axis the tool is made to move either parallel to it or at an inclination with their axis to cut the desired material. It produces cylindrical surface if it is fed at an inclination.



SpecificationofaLathe: Alatheisgenerallydesignedby

a) Swingi.e.thelargestworkdiameterthatcanbeswingoverthelathebed.

b) Distancebetweenheadstockcenters.

ClassificationofaLathe: Accordingto size,design, methodofdrive,arrangement ofgears, different precision classes and purpose.

i) Speed Lathe: It is so named because of the very high speed of head stock spindle. It is a simplest form of lathe and consists a simple head stock, a tail stock and tool post. It has no gear box, lead screw and carriage. Tools are hand operated. Cone-pulley is the only source providedfor the speedvariation of thespindle.Mainlyusedforwoodturnig,metal spinning andpolishing operations.

ii) Engine Lathe or Centre Lathe: It is most widely used one. Its name is derived from the fact that early machine tools were driven by a separate engine or from a central engine with over head belts and shafts. The stepped cone- pulley or geared headare oftenused for varying the speed of lathe spindle. A tail stock is provided to facilitate holding the work between the centers and permit the use of tools like drills and taps etc. The cutting tools are controlled either byhand or bypower and canbe fed bothincross and longitudinaldirections with ref to lathe axis with the help of a carriage feed rod and lead screw. A wide range of attachments can be fitted on it to increase its utility. These are available in sizes to handle up to 1 m dia jobs and 1 to 4 m long.

iii) Turret Lathe: It is a production machine used to perform a large number of operations simultaneously. Several tools are set on a revolving turret to facilitate doing large number of operations on a job in minimumtime. An index able square toolpost is provided on the cross slide for mounting the turning and parting off tools.

The turret usually accommodates six tools for different operationslikedrilling counter sinking, reaming, tapping etc, which can be successively brought in to working positions by indexing theturret. Some specialtoolholders to performsimultaneous multitool operations are also available. They are widely used be repetitive batch production.

iv) Capstan Lathe: It is similar to turret lathe and incorporate capstan slide which moves on an auxiliary slide and can be clamped in any position. It is best suited for fast production of small parts because of its light weight and short stroke of capstan slide.

v) Tool room Lathe: It is the modern engine lathe which is equipped with all necessary accessories foraccuratetoolroomwork. It is a geared head driven machine withconsiderable range in spindle speeds and feeds. It is suited for production ofsmalltools, dies, gauges etc.

vi) BenchLathe: It isasmall lathewhichcanbe mountedontheworkbenchfor doingsmall precision and light jobs.

vii) Gap bed Lathe: In these lathes, a gap is provided on the bed near the head stock with a view to handle jobs having flanges or some other producing parts. Very often q removable portion is provided in the bed so that when not required, it can be inserted.

viii) Hollow Spindle Lathe: These lathes are provided with spindles having large through bores in order to facilitate turning the ends of long tubular work pieces. The long jobs are supported on a steady or some other out board support.

ix) Vertical turret Lathes: These have vertical orientation and are use for turning large componentswhichcanbe convenientlymountedonthe machine table. Theturret head moves in two axes to enable turning, boring and facing.

x) Automatic Lathes: Theyare designed for allworking and job handling movements ofthe complete manufacturing a job are done automatically. Operator participation is not required during the operation. In semi-automatic lathes, mounting and removalofwork is done bythe operator and all other operations are performed by the machine automatically.

xi) Special purpose Lathes: These are desired to suit a definite class ofwork and to perform a specific operation only. They prove to be more efficient and effective as compared to the common engine lathe.

❖ WorkHolders

1. CHUCKS:

It is the most important device for holding the work pieces, particularly ofshortlength or larger diameter.

a) Independent or Four Jaw Chuck: It has four jaws and each jaw is independently actuated and adjusted by a key for holding the job. This type of chuck is used for irregular shapes, rough casting.

b) Three Jaw or Universal Chuck: In this all the three jaws move simultaneously by turning a key and thus the work piece may be automatically held in the centre of chuck-opening. It is used for holding round, hexagonal bar or other symmetrical work.

c) Collect Chuck: It is mostly used for holding bars of small sizes(below 63 mm) and is normally used where production work is required such on capstan lathe or automates.

d) MagneticChuck:Theyareeitherelectricallyoperatedorofpermanentmagnettype.

2. LATHECENTRES:

Lathe centers are used for work holding during turning operation. A centre hole of particular depth and shape is made at each end of work piece. The lathe centers acts as the supports for the work piece and take up the thrust due to metal cutting.These are made of very hard materials to with stand wear and resists the deflection. The included angle of the centre is 60^0 for general purpose work and 75^0 for heavy work.

<u>Thevarioustypesofcenters are:</u>

i. Ordinarycentre,whichisusedformostgeneralwork.
ii. Tippedcentre,whichcontainsahardalloytipbrazedintoasteelshank.
iii. Ball centre, which has a ball shape at the end ofthe centre, instead ofa sharp point andisusedto minimizethewearandstrainontheordinarycentrewhiletaperturning.
iv. Halfcentreinwhichcase lessthanhalfofthecentreisgroundaway, thusfacilitating facing of bar ends without removal of centers.
v. Rotatingdeadcentreisused intailstockforsupporting heavyworkrevolvingat high speed.

3. COLLETTS:

A collet is used for holding small semi finished or finished parts so that additional operations may be performed. It is a practical device for quickly and accurately chucking symmetrical work pieces. Collets are available in several shapes i.e. round, square and hexagonal holes to accommodate corresponding shapes of work pieces. The front portion is made conical and transverses slope is made in ¾ this length. The other end is threaded and was a keywayto prevent the collet from turning in the collet sleve

i) Drawintype: Whichexertsthegripoverthebarwhenitisdrawnin.

ii) Pushouttype: Whichexertsthegripoverthebarwhenitispushedoutwards.

4. FACEPLATE:

It is a circular cast iron dies having a threaded hole at its centre so that it can be screwed to the treaded nose of the spindle.It consists of holes and slots by means of which the workcanbe secured to it.Both,nutswashersclamping platesand metallic packing pieces etc. are required for holding the work properly on a face plate.

5. ANGLEPLATE:

It is used for holding work in conjunction with a face plate. When the size or a shape of the work is such that it is not possible to mount the work directly on the face plate, the angle plate is secured to the face plate and the work is mounted on it.

6. LATHEMANDRELS:

Mandrels are a solid shaft or spindle used for holding bored parts for machining their outside surface on lathe. The mandrel is fitted in to the holetightly and supports the job during machining of the outer surface. Mainly used for small jobs as bigger jobs will rotates over the mandrels. The solid or plain mandrel is ground to have a shape and a standard taper of 0.5 mm per meter is provided. The milled flat portions at the ends enable the screw of the dogto havea firmgrip. Boththeendsare madetohavecentres. Theabovetaper facilitatesan easy fitting of the mandrel in to the job hole and also allows for a little variation in the hole dimensions.

The collar mandrelenables a considerable reduction is weight. It is normallyused for job above 100 mm dia. The stepped mandrel facilitates use of the same mandrel for various jobs having different size of holes which correspond to the step dimensions.

7. RESTS:

When a very long job is to be turned between centres on a lathe, due to its ownweight it provides a springing action and carries a lot of bending movement which results in turning tool spoil and many even break. To avoid this, such jobs are always supported on an attachment knownassteadyrest or centrerest. Thispreventsthe deflectionofjoband enables the operator to take heavy cuts.

8. JIGSANDFIXTURES:

Theyare used inconjunctionwiththe face plate ona lathe for supporting and holding add shaped and eccentric jobs during the operation. Their specific use is in mass productionof identicalparts. Ifa single item is to be made the cost ofproduct onof jigs or fixtures itself will be too high, prevent their use.

9. DRIVINGPLATE:

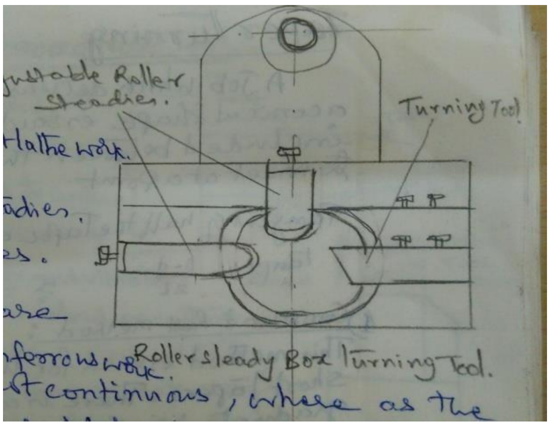
It is cast circular disc having a projected Boss at its rear. The boss carries internal threads so that it canbe screwed ontothe spindle nose. It also carries a hole to accommodate a pin which engages with the tail of lathe dog or carrier when the job is held in the lathe dog or carrier. When a bent tail dog is used their pin is taken out and the bent portion of tail insertedinthe hole, whichservesthe samepurpose, or elsethe bent tailcanbeengaged inthe slot made in the plate opposite to the pin hole.

<u>BOXTOOLS</u>

A large number of box tools are in application in capstan and turret lathe work. The common types are.

1. ThosehavingV-shapedsteadies.

2. ThosehavingRollersteadies.



V-shapes steadies are mainly used for brass and nonferrous work. Where chips producedarenot continuous, whereastherollersteadies is mainlyused forsteelwork, where continuouschipsareproduced.Exceptdifferenceinthetypesofsteadies,therestofthe mechanical features are same in both types of box tools.

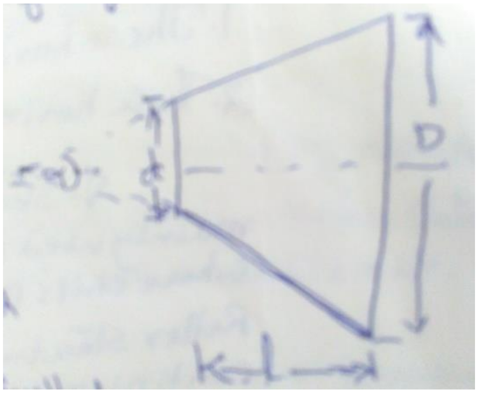
Roller-steady box turning tool consists of a strong body, fitted with two adjustable slides, which carry hardened roller each. By moving the slides, the rollers can be adjusted at any desired distance from the centre of the work to act as travelling steadies during the operation. a single cutting tool is mounted in front of the attachment. In case of heavier type of such tools a supporting bush is fitted at the top to accommodate the pilotbar. This bush can be fitted either in front or back of the body according to the requirement.Itis unavoidable when very heavy cuts are to be taken, to prevent vibrations.

Therollers, apart fromactingassteadies, provide aburnishingactiononthe machined surfaceto give fine finish. Theuseofthesetoolssometimeenablesthe jobto be finished ina single cut only. They facilitate the application of veryhigh speeds.

Some imported designs of box tools take use of ball bearings as steadiesin place ofthe rollers. These tools are normallyofV-shape. One armofthese carries the shank and other opposite to it, the ball bearing, which is concentric with the shank. A bush is fitted in the bearing, which is a sliding fit on the bar to be turned. The bush and inner race of the bearing rotate with the bar as the tool is moved forward. The tool is fitted inside the „V" construction to act radically on the job.

TaperTurning

A jobwhichdecreases indiameter graduallyso that assumesa conicalshape issaid to be tapered. Taper angle is the angle included between the tapering sides of the job when extended to meet at a point.



Tangentofhalfthetaperangle= $\frac{D-d}{2l}$

$$\tan\left(\frac{\alpha}{2}\right) = \frac{D-d}{2l}$$

$$\frac{\alpha}{2} = \tan^{-1}\left(\frac{D-d}{2}\right)$$

1. CompoundRestMethod:

This method is used for turning steep and short tapers. There is a circular base graduated in degrees which can be swiveled at any angle from the centre line of the lathe centers.

While turning a taper, the base of compound restis swiveled through an angle equal to the half of the taper angle. In this case, feed of the tool is given with thecompound rest feed handle. This method is used for internal tapers.

2. TailStockSetoverMethod:

This method is used for turning small tapers on long jobsis confined to externaltapers only. In this case tail stock may be set over by loosening the nut of the clamping bolt. Then by means of setscrews,providedon theboth thefrontandrear sides of the tail stock, the dead centre is shifted fromthe originalposition by a predetermined amount ofset over. If the larger dia. of the tapered part is to be obtained on the tail stock side, the centre will be shifted away from the operator and if the same is to be obtained on the head stock side the dead centre should be shifted towards the operator. Graduations provided on the flat surfaceofthe tail stock, facing the head stock help in adjusting the required set over. However in the absence of such graduations a steel rule can be used for this purpose.

Therequiredamountoftailstocksetovercanbecalculatedasfollows: Set

over = taper lengthsine of half the taper angle

$$\frac{D-d}{l} = l \times \sin\frac{\alpha}{2}$$

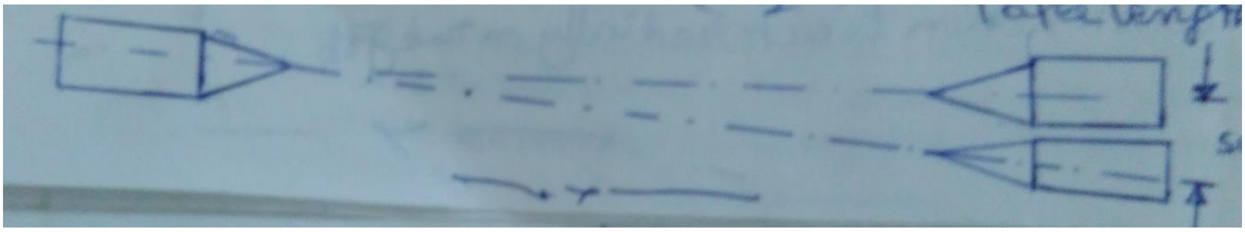
Where D=Lagerdia.

d = Smaller dia.

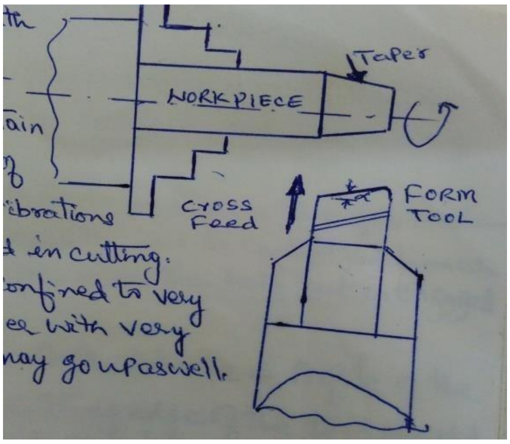
l=Lengthoftaper.

Whenapartoflengthofjob isto begiventape

$$\text{The tail stock set over} = \left(\frac{D-d}{2}\right) \times \frac{\text{Total length of Job}}{\text{Taper Length}}$$



TaperTurning byformorBroadNoseTool:



Very sharp tapers can easily be turned with a form or broad nose tool in which the cutting edge of the tool is ground to contain the half taper angle α. However use of this tool will cause a lot of chatter and vibrations because the full cutting edge of tool is involved incutting. Therefore this method of taper turning is confined to very short tapers of length max 20 mm. However with very heavy and rigid type of lathestheir limitmay go up as well.

Taperturningattachment:

This attachment is confined to give externaltapersonly. It is bolted onthe back ofthe lathe and has a guide bar which may be set atthe desired angle of taper. As the carriage moves along the lathe bed length, a slide over the bar causes the tool to move in and out according to the setting of the bar. i.e. the taper setting of the bar in duplicated on the work. The main advantage of this system is that the lathe centers are kept in alignment, and thesame taper may be turned on various pieces, even though they vary in length.

Advantagesofusingtaperturning attachment:

1. Itssettingisveryeasyand canbedone veryquickly.
2. Itsusedoesnotcallfortoomuchofskillonthe partoftheoperator.
3. Accuratetaperscanbereadilyobtainedinsinglesetting.
4. Normalsetup and alignmentoflathe anditsmain parts is notdisturbed during the operation.
5. Itisequallysuitableforexternalandinternaltapers.
6. Itgivesbettersurfacefinish andincreasedrate of production becauselongitudinal power feeds can easily be employed.

In some taper turning attachments instead of graduations in degrees, carries divisions in millimeters. Insuchcases it isrequired to find out,theno.ofmmdivisionsthroughwhichthe guide plate should be swiveled. These divisions can be found out from the formula.

$$M = \frac{D-d}{2} \times C$$

M=Requiredno.ofmmdivisions. D =

Larger dia.

d=Smallerdia.

L=LengthofTaper.

C=Halfthetotallengthofguide plateinmm

ThreadCuttingOnLathe

Internaland externalthreadsare cut either withthe help ofa threading toolor withthe help of tap and die respectively. While cutting threads with the help of a tool, the following requirement are fulfilled.

1. There should be a certain relation between the job revolutions and the revolutions of the lead screw to control the linear movement of the tool parallel to the job when the half nut is engaged with the lead screw.

2. The toolshould be ground to the proper shape or profile of the thread to be cut. i.e. the tip or cutting edge ofthe toolshould have an included angle corresponding to the included angle of the particular type of thread to be produced.

Irrespective of the shapes and sizes the common factor in all the threads is they are formed on the principle of helix and have a specified longitudinal movement of the cutting tool as the work revolves.

Both external and internal threads can be cut on the lathe. For both of these, the main requirement is to have a proper system of gearing between the lathe spindle and the leadscrew so as to establish the required ratio ofspeeds betweenthe two. For this some lathes are provided with quick-change gear box which provides required speed ratio quickly.This is done by simply shifting theposition of the gear change lever. Such gear boxes are madeto havea no. of gears inside them, mounted on two or three or more shifts and the different combinations of these gearsprovidedifferentspeedratios.Thesecombinationsareobtainedbyshiftingthegearchange lever to different positions. A chart is provided on the gear box which carries thecomplete information of speed and recommended feed corresponding to a particular position of the said lever.

In the absence of such gear box, the change gears, provided at the left hand side of the head stock are used to obtain the said ratio of speeds.

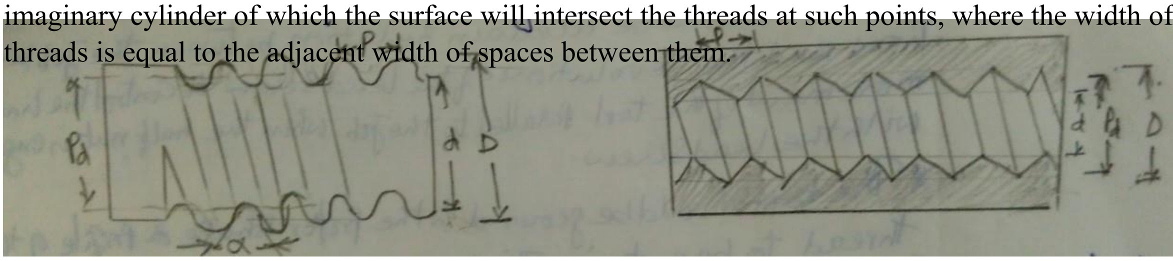
Thechiefelementsofallthescrewthreads are:

1. Pitch (P): It is the distance from the one point on one thread to the corresponding point on the adjacent thread. This distance is measured parallel to the axis of the job and is expressed in mms in metric threads and inches for other threads.

2. Major Diameter (D): it is the largest diameter of a screwed part, measured at right angle to the axis of the piece.

3. MinorDiameter(D): It is thesmallest diameter of thescrewedpart measurednormal totheaxis of the piece.

4. Pitch Diameter (P_d): For cylindrical screw parts this dimensions represents the diameter of the imaginary cylinder of which the surface will intersect the threads at such points, where the width ofthe threads is equal to the adjacent width of spaces between them.



5. Depth of threads (t): It is the distance, measured normal to the axis of the part, between the crest and root of the thread. Mathematically, it can be expresses as

$$t = \frac{D-d}{2}$$

6. Thread angle (α): It is the total included angle between the flanks of a thread or two adjacent flanks of two threads.

<u>RightAndLeft–HandThreads</u>

When we look at a screwed part in a direction normal to its axis its threads will be found sloping downwards fromtop, either from left to right or fromright to left. The former case represents the right handed threads and the latter left-hand threads.

A similar distinction can be observed and the hand of threads reckoned readily by observing the direction of movement when one member, out of the two mating screwed components is rotated. Hold a bolt in your lefthand and try to screw on a nut onthe same way by your right hand. Note the direction of rotating of the nut and its corresponding axial movement.Ifthe nut advancesaxiallywhenrotated ina clock wise direction it indicatesright hand threads.

If this advancement is attained byrotating the nut in an anticlock wise direction, presence of left-hand threads is indicated. Right hand threads are most commonly employed in engineering practice.

STARTOFTHREADS:

It is the no. of separate threads grooves running parallel to each otheralong thesurface of the screwed part. The threads can be single or multiple starts.In case of singlestart, the thread is cut with only one thread groove all along its length. When the threads are cut with two, three or more separatethread grooves, each having same dimensions and being equip distance from one another, they are known as double, triple or multiple starts respectively. The advancement forthe same amount ofrotationofthe screw part as compared to the single start threads. If the pitch in both cases remains the same, the axial advancement for the same amount of rotation will become as many times of the single start as the no. of start of the threads. The axial advancement in one rotation of the screwed part is known as lead of the threads or screw. It will obviously, be the distance measured parallel to the axis, betweentwocorrespondingpointsonthesamethread.Pitchinthecaseofmultiplestarts threads= $\frac{\text{lead}}{\text{no.of starts}}$ i.e.the pitchwillbe equaltotheleadincaseofsingle startthreads.

Lathesettingforscrewcutting:

When the lathe is not equipped with a quick change gearbox, a suitable set of gears have to be fondant and mounted at the proper position for cutting the threads of different pitches. Setting up of lathe for such work includes proper holding ofthe job, concentric with the lathe centers, setting oftoolat proper height and mounting ofthe calculated change gears at proper location.

For cutting threads it is necessarythat for everyrevolution ofthe spindle orthe work, the tool should move parallel to the axis of the job by a distance equal to the lead of the longitudinal feed of the tool and the speed of the spindle. The desired ratio is obtained with the help of lead screw by connecting it to the spindle through a train of gears.

The speed of the lead screw will be as many times lower than that of spindle as its pitch is greater than that of the screw to be cut.

To affect the variant on in speeds, change gears are employed and the amount by which the speed of the lead screw should be higher or lower than that of the work is determined by gear ratio.

$$\text{Gearing ratio} = \frac{\text{Speed of the lead screw}}{\text{Speed of the work}}$$

Thepitchofthescrewtobecut andthepitchofthe lead screwdeterminesthegear ratio of speeds.

$$\text{Gearingratio} = \frac{\text{Pitch of the screw to be cut}}{\text{pitch of lead screw}}$$

$$= \frac{\text{Lead of screw to be cut}}{\text{Lead of lead screw threads}}$$

$$= \frac{\text{No.of teeth of driver(slide grar)}}{\text{No.of teeth of driven(lead screw gear)}}$$

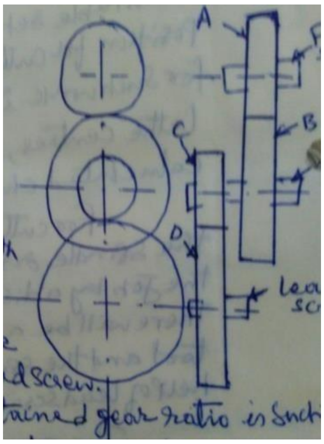
SimpleGeartrain:

It consists of a driving gear (mounted on the stud), A driven gear(mounted on the lead screw), and oneor two intermediate gears. The intermediate gears (idle gears) have no effect on the speed ratio but are used only

i) tofillthegapbetweenthedriver and drivengears,and

ii) toobtaindesireddirection ofrotationofthescrew.

Compoundgeartrain:



It consists of two studs instead of one. The second stud is suitably mounted on the bracket or quadrant carrying the change gears. The first driver A is mounted onthe first stud, which masher with the first driven Bonthe second stud. The second driver C is also mountedonthe second stud and it meshes withthe second drivenD mountedonthe lead screw. Such gear train is employed when the obtained gear ratio is such thatit is not possible to arrange a simple gear train out of the given set of gear trains. it isnot possible to arrange a simple geartrainoutofthe givenset of gear trains.

CuttingMetricthreadsonEnglishstandardLeadScreworVice-Versa:

WhenitisrequiredtocutmetricthreadsonalathehavingBritishstandardleadscrew i.e.pitchininches.Therelationforconversion

$$\frac{\text{Driver}}{\text{Driven}} = \frac{5}{127} \times \frac{\text{Lead of the screw to be cut in mm}}{\text{Lead of the threads on lead screw in inches}}$$

In case of reverse requirementi.e. when threads of British standard pitcher are to be cut on the lathe having leads screw of metric pitch.

$$\frac{\text{Driver}}{\text{Driven}} = \frac{127}{5} \times \frac{\text{Lead of the screw to be cut in inches}}{\text{Lead of the threads on lead screw in mm}}$$

$\frac{5}{127} = \frac{1}{25.4}$ *or* $\frac{127}{5} = 25.4$ isthemultipliedratioforconversionfrom Britishstandardtometricandvice-versa.

SettingToolsforThreading:

In cutting threads, the cutting tools should be carefully set exactly at the height ofthe centers and normalto the axis ofthe work. If it is incorrectlyset, the thread angle will not be correct andthe flanks formedwillnot beproper.This setting is essentialbothforexternaland internal threads. A centre gauge is always used for setting the threading tool correctly.

Feedingthetoolinthreadcutting:

Two methods are commonly used for feeding the tool in thread cutting. In one case, the tool is set normal to the axis of the work and is fed straight in to the job. Once a cut is complete, the tool is withdrawnfrom theformedgroove, the carriage returned to thestarting position and then the tool is fed forward for the next cut. The graduated dial provided on the crops feed screw helps in adjusting the required depth of each cut. The operation is repeatedtill full depth thread is obtained. In this case, the tool cuts the threads uniformly in each successive cut as both of its sides and its tip do the cutting. If this method is used for cutting coarse threads, the amount of material removed in the form of chips will be too much and it manyultimatelyjamming thetooland the flanks ofthe threads willbe rough. It is advisable to confine its use only to finishing cuts on coarse threads. However it can be safely used for threads having below 2 mm pitch.

The second method is to feed the tool at anyangle to the axis ofthe work. This angle is halfofthetotalincluded angle ofthethread. Thetoolis set asusualand required inclination is obtained byswiveling the compound rest to this angle. After everycut the toolis withdrawn bymeans ofcross slide and thenset forthe next cut. Inthis case mostofthe cutting is done by the left edge and tip of the tool.

When threading is to be done large scale, the cutting tool will be provided with top rake angle for easy flow of chips on the tool face and "digging-in" tenderly of the tool is required.

ProvidingUnderCut:

Under cuts are necessary when cutting threads on stepped work.When thejob has two different diametersandthethreads areto becutonsmaller dia. it isessentialto providean undercut where two steps meet. It allows for the over run of the tool after one cut is over.In the absence of this undercut there is always a likely hood of the tool running in to the larger dia. after finishing the cut. This will lead to tool to dig which result is riding of the job over tool, bending of job, breaking of job and breaking of tool.

ThreadCatching:

The complete depth of the thread can"t be obtained in a single cut. Several cuts haveto be taken, one after the other, till the required depth is obtained. For this, the tool has to be withdrawn from the thread groove after completing each cut and then brought to the starting position. Thenwe have to use some suitable methodto take thetoolfallow the previouslycut thread groove. In case it does not follow this path, the threads will be spoiled. The process of engaging the tool with the some groove in all the cuts is called thread catching or thread chasing. The following methods can be used for returning the tool to the starting position.

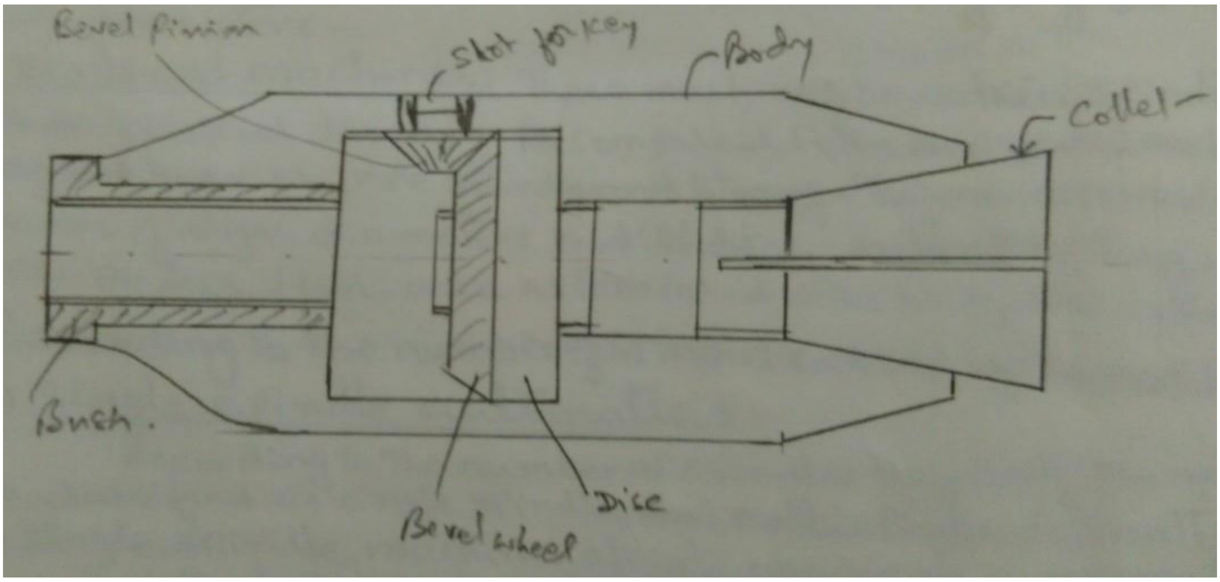
1. After a cut is over the tool is abruptly withdrawn and the machine stopped. The carriage is disengaged from the lead screw by disengaging the half nut and then brought to the starting point by hand. This is usually done in case of long threaded length.
2. When a very shortlength is tobe threaded an alternate method is that, at the end of the cut we do not disengage the carriage from the lead screw.At the end of the cutthe tool is withdrawn as usual and the machine stopped. Then the carriage is brought back to its starting position by reversing the direction of rotation of the lead screw. This method isveryadvantageouslyused forthreading blind holesorfor cutting such threads of which the pitch does not allow the use of chasing dial also. Since the carriage and lead screw are never disengaged, the tool automatically follows the previous path.

Correct engagement ofthetoolwiththe previouslycut thread groove is a must for cutting the threads successfully.

CollectChuck

It can be used with equal advantage on a centre lathe, capstan lathe or turret lathe for producing items from bar stock. It consists of the main body having a tapered inside surface which corresponds to the outside tapered surface of collet. Adisc is in corporate in the chuck which carries inside threads to receive the rear threaded end of the collet on the outside surface of the disc, teeth are cut to form a bevel wheel which meshes with the bevel pinion, operated by hand by means of a key. Usually an adopter bush is fitted to the rear side of the chuck whichcarries internalthreads. The assemblyis thenscrewed ontothe noseofthe lathe spindle.

In operation, when the key is rotated, the disc rotates and in doing so, it either drawsin or pushes out the collet, depending upon the direction of its rotation. When the collet is drawn in its spitted bodyinpressed against thetapered inside surface ofthe chuck, making a firm grip over the bar. When the collet is pushed out, the pressure on its bodyrelieved and it opens out, releasing the grip on bar, which can be then fed forward.



❖ AutomaticLathes

Automatic lathes are best suited for production of identical parts on mass scale. They require the application of large number of tools. Once they are properly set, they produce the components at 3 times the rate of the turret lathe of same capacity.

ClassificationofAutomaticLathes:

Classified according to the type of stock material they use, the operations performed on them, principleofoperationand number andpositionofspindlesetc. The mainclassifications are:

1. Accordingtothetypeofstockmaterialused:

- **a)** Bar Automatics: The machines designed to produce various components using bar or pipe stock are known as bar automatics.
- **b)** Chucking Machines: These machines are used for machining separate blanks like forgings and castings etc and are also known as magazine loaded automatics.

2. AccordingtothedirectionoftheaxisoftheMachineSpindle:

- **a)** Horizontal Machines: This classification is according to the arrangement of spindles. These machines have their spindles in a horizontal direction and are used for machining long job of small diameters.
- **b)** Vertical Machines: These machines have their spindles set in a vertical direction. As compared to the horizontal machines, they are heavier, more sturdy and strong. They can accommodate blanks of larger diameters but shorter in length. They occupy less floor area as compared to the horizontal lathes.

3. Accordingtothenumberofspindlescarried bytheMachine:

a) Single Spindle automatic: According to the no. of spindles they carry, the machines are classified as single spindle and multi spindles automatics. The single spindle machines are classified as single spindle machines operate on a single component at a time and include some cutting off machines and Swiss type automatic screw machines etc. The automatic cutting off machine is designed to produce short components, requiring turning, forming, drilling, threading, cutting off etc.

Two cross-slides are provided, which are operated by means of cams mounted on a cam shaft. A longitudinal slide is also mounted to carry tools for drilling,remaining, threading etc. All the operations are performed automatically.

The Swiss type automatically screw machines are used for machining slender partsof small diameter. They have a capacity to machine components of 2 to 25 mm dia. they differ from the above machine in that the longitudinal feed are obtained by moving the headstock with the bar instead of tools.

Automatic screw machine is fully automatic bar type turret lathe. They are used for manufacturing screw, both and pins etc from the bar stock. Ten different tools canbe mounted at a time. The collet, bar feed mechanism, cross slide and turret slides etc are controlled and operated automatically.

b) Multi-spindle automatics: They are the improved types of single of spindle automatics. Theyare made to have 2 to 8spindles, but 4 and 6 spindles are commonlyused. The spindles are arranged in a carrier which is periodically indexed from position.The indexing takes place through 90^0 or 60^0, depending upon whether there are 4 or 6spindles. A gear is centrally mounted in the carrier which drives all the spindles, which are free to rotate in the carrier. This gear rotates independent of carrier. Out of all the positions, one position of the bar forms, cutting off positions, where the finished component in cut off and the bar fed forward uptothe stopforthe neatoperationto beperformed atthe following positionstation. At each station(position)the work is machined by tools from two sides,i.e. the cross slide and themain or longitudinalslide.The spindles rotate atconstantspeedin allthepositions.

Operating parts of the machine are controlledby means of cams, mounted on a cam shaft. The rate of production increases with multi spindle machines but the machining accuracy of single spindle automatic lathe is much higher.

In automatic machines, cams play the important role and they operate various tool slides, turret and working features of automatic machines. The cams may bemade from circular discs or segmental form mounted on circular drums.

LATHEBED

The bed of the lathe acts as the base on which different fixed and operating partsof the lathe are mounted. It provides for locationoffixed parts and controlled movement ofthe operating part(carriage). It hasto withstandthe various forcesduring the cutting tooloperation. It must be very rigid and robust construction.

Lathe beds are made as single piece casting of semi-steel (i.e. toughened cast Iron) with the addition of small quantity of steel scrap to the cast Iron during melting. Cast Iron facilitates an easy sliding action & high vibration damping quality. In case of large machines the bed maybe made two or more pieces, bolted together. Bed castings usually made to have a box section with cross ribs.

During solidification of the casting, distortion takes place due to cooling stresses. To avoid this natural seasoning called ageing is done. For this the bed castings are rough machined to the required size for final assembly accurately and finely finished. The common bed casting are fine grained with a hardness of 200 ± 10% BHN.

Theadditionalstepstakentoimprovethewearresistanceare:

1. ChillingofCastings.

2. Increasingthehardnessofthewearingsurfacesbyflame hardening.

3. Superimposing separatelyhardened steelslide ways and prismatic (Inverted „V‟)ways over the top of the bed casting.

The prismatic ways are preferred over flat ways as their constructiontotallydisallows the entry of chips and dirt etc between the saddle and bed and thus preventing scratching. They provide very efficient guiding surfaces and the wear of the bed does not have any appreciable effect on the overall alignment to the lathe. In most cases the combination of the flat and prismatic shapes of bed ways are adopted. The flat ways acts as supports i.e. taking max load and stress and prismatic shapes act as guide ways. Tail stockis usually guidedalong the bed way bya combination of one prismatic and one flat way.

Proper leveling of the bed during installation and afterward is very important as this will affect the accuracy of the work very seriously. Therefore the bed should be tested for level both length wise as well as cross wise.

HeadStock:

The headstock serves as housing for the driving pulleys and back gears, provides bearing for the machine spindle and keeps alignment with bed.

Itconsistsofthefollowingmainparts:

1. Conepulley
2. Backgearsandbackgearlever
3. MainspindleorHeadstockspindle
4. LiveCentre
5. Feedreverselever

<u>Needforchangeofspeed</u>

There are several reasons due to which different spindle speeds are needed, because theworkpiecehasto berotatedat different speedsunder different machiningconditions. The main parameters are

1. Work material: Harder and tougher materials need slower speeds while softer materials are machined at faster speeds.

2. Cuttingtoolmaterial: The harder the cutting tool materialthe higher is the cutting speed, to take full advantage of higher hot hardness

3. Types of operation: Operations like external and internal threading by means of single point tools, tapping, dicing, remaining etc onlathe need muchslower speeds than manyother operations like turning, drilling boring, facing, under-cutting etc.

4. Work piece Size: Larger the dia. of work piece to be turned the slower is spindle speed required and smaller the work dia. the higher rotating speed.

5. Surface Finish: Rough machining, where the main requirement is to remove maximum amount ofmaterial, needsa deeper cut and slowerspeed. Against this in finish machining the depth of cut is less and a higher sped used.

6. Cutting Fluid: Use of proper cutting fluid, depending upon the cutting tool and work piece materials and other parameters, facilitates the use of higher cutting speeds and thus increased rate of production and reduction in machining time.

7. Rigidity of Machine Tool: A rigid machine tool in perfect running condition enables use of higher spindle speeds.

TOOL–LAYOUT(ForTurret&CapstanLathes**)**

Tools for Capstan and Turret Lathe are similar in construction to those of centre lathe tools, except material. The tools used are made of H.S.S or Tungsten Carbide because the machines are more rigid and also operated at higher cutting speeds. The tools mounted on cross slide are used for turning, facing, necking, parting etc, and those mounted onthe Turret head are used for drilling, boring remaining etc.

The toollayout for a jobconstitutesthe pre-determined plan for machining operations ofa particular component. The layout independent uponthe no. ofpieces to be manufactured i.e. lot size. As a general rule standard tools should be used as much possible and also for small batcher of work, the layout should be simple. For large quantities and long run special toolsshould beusedastheyminimize machiningtimeand retaintheircuttingqualities forthe maximum period. The accuracyand cost of component largely depends upon the tool layout.

For preparationoftoollayout, it is necessaryto have the finished drawings ofthe part to be machined and if it is a forging or casting, the forged or cast blank will determine, how much machining has to be done on various faces.

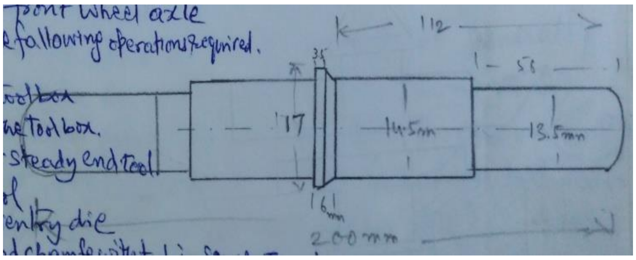
After preliminary list-giving the order of operations has been decided upon with details as the tools required, a tool layout to the scale is prepared on the tracing paper by super-imposing the layout of the machine capacity chart, drawn to the same scale with the component inposition. Asimple preliminarytrialis conductedonthe drawing board beforeit is put on the machine.

Ex:ToolLayoutforfrontwheelAxle.

Tool layout shows types of tools required and the sequence in which they are to be used. While preparing the tool layout the capacity chart of the machine shoeing the capabilities should not be lost sight of. It also ensures that tool movementsandturret indexing etc clear the various machine parts.Machining time canbe established bylisting the operations required systematically in the form of tool – layout.

Tomachinethefrontwheelaxlefrom18mmsteelbar,thefollowingoperationsrequired.

1. Feedoutthebar
2. Turn14.5mmdia.withtoolbox
3. Turn13.5mmdia.withthetoolbox
4. Roundendwithrollersteadyend tool
5. Centrewithcentretool
6. CutthreadwithCoventrydie
7. Form17mmdiameterandchamferwith tool in square turret
8. Partoffwithsteppedcutofftoolintherear toolpost



❖ ToolPosts

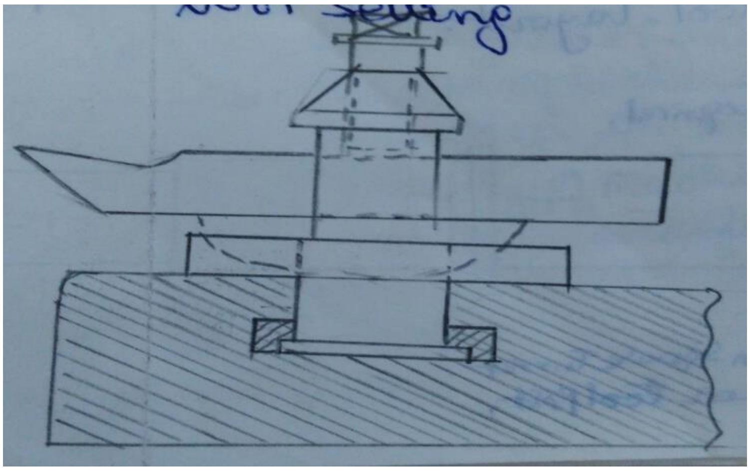
Toolpostsarethedeviceusedonvariousmachinesforholdingthetoolsinpositionand providing a rigid support to them during the operation.

American typesingle tool post is used for holding a single tool holder or a solid forged tool only. It is commonly used in light work.Itconsists of a vertical body having a slot to accommodate the tool shank and a flange at its bottom. The collar carries a spherical groove inwhicha rockerisplaced. Thisrockercanbe tilted to adjust the height ofthe cutting edge of the tool.

Open side tool post is a better form of a single tool post. The main clamping bolt is used for securing the tool post and the adjusting screws for gripping the tool in position. Height of the tool is adjusted by using flat packing pieces under the tool. This form of tool post used as rear tool post on lathes.

Another useful form of tool Post usually employed on heavy duty lathes. Itisprovided with 4 bolts, each carrying a coiled spring. Two tools can be simultaneously mounted on it. The tools are held between the bases and clamping barsand gripped firmly by tightening the bolts. The springs help in keeping the bars in position when the tools have been withdrawn.

A square tool post vastly used in mass production. I can accommodate 4 tools at a time. It is also called a turret tool post. It facilitates mounting of 4 different tools prior to starting the operation and bringing them to the desired position, oneafter the other, by rotating the handle. Such arrangement is an asset and a vital necessity in repetition work, because it saves a lot of time in tool setting.



LAYOUTOFSPINDLESPEEDS

Thefollowingfactorshavetobedecidedfordesigninganysteppeddrive:

a) Max.outputRPM(N_{max})
b) Min.outputRPM(N_{min})
c) No.ofstepsofthetransference(n)
d) No.ofsub-divisionsofsteps
e) No.ofstagesinwhichsteps aretobemounted

In multipurpose machines the selection of speeds in very complex, as correct speed depends upon various factors i.e. the proper toes of job material, shape of the cutting tools, wear resistance of tool material, type of operation to be performed and the process capability ofthe machine. However in single purpose machine the selectionofparticular speed depends upon the machining characteristics ofthat process only. In case ofcylindrical work piece, the cutting speed V_C is related to the diameter of the work (D) and the spindle speed(N) by the relation,

$V_C = \frac{\pi DN}{1000}$ Spindlespeed $N = \frac{1000V}{\pi D}$ ______________(1)

From the above equation the min. speed of the spindle in depend upon the max. dia of work that can be accommodated in the machine. Also depend upon the min. speed required for screw cutting and tapping.

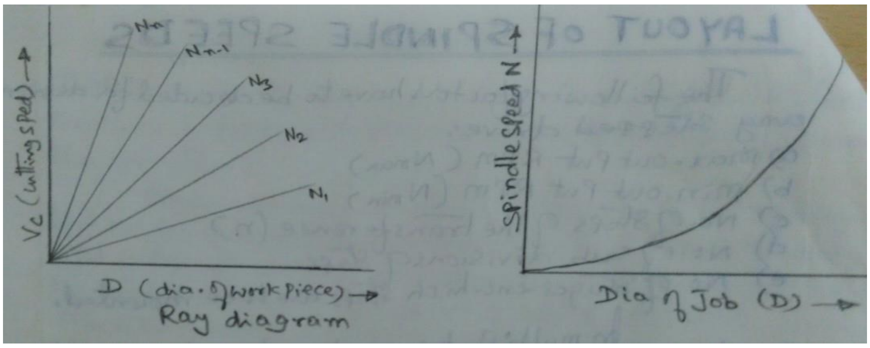
Againfromtheaboveequationthemax.Speed (N_{max}) depend upon

i) Thegreatestpossiblecuttingspeed(V_C)and

ii) Whenthediameter isminimumpossible.

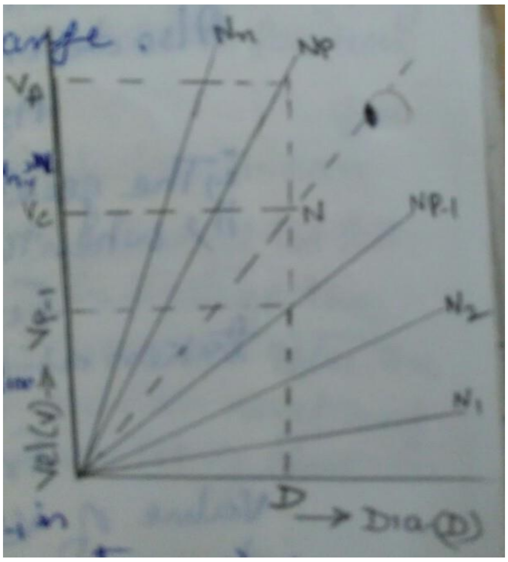
For design purpose the value of minimum diameter is taken as = (η/8) where η is the height of the centers above the bed.

From the above equation it is also obvious that for constant value of V_C as the diameter increases, the speed N should decrease and vice-versa. The output spindle speeds generally form a series which may be in arithmetical progression (A.P), Geometrical Progression(G.P) or Logarithmic Progression(L.P). It is now obvious that for constant Nthe relationbetweenV_C and D is a straight line. Graphically, the relationbetweenV_C, D and N is represented by Ray diagram.



Let us studythe most suited series in all respects for machine tools. Let us assume that a barin to be machined on a lathe and its diameter D varies from some min.dia to some max.dia. Assuming V_C to be constant, the variant on of spindle speed with change in job diameter is observed. Initially as the dia of job increases the speed change is not much, but after words, even for small changes in diameter the spindle speed changes rapidly. This condition is fulfilled by G.P. series. Whereas A.P. series follows a straight line an can"t fulfill this requirement. This G.P. series is preferred as it canprovide more number ofranges ofspeed at lower range.

KinematicAdvantagesofGeometricProgression:



The various speeds in some progression in several steps be N_1, N_2,- - - - - N_{n-1} ,V. Corresponding to certain dia D, the required RPM(N) foraccurate cutting velocity(V_C) is not available.

Wehaveselect lower speedV_{p-1}.Inthatcase

Loss of Speed = V_C- V_{p-1}

andpercentagelossofspeed = $\frac{V_c - V_{p-1}}{V_c} \times 100$

$$= \frac{\pi DN - \pi D N_{p-1}}{\pi DN} \times 100 = \left(1 - \frac{N_{p-1}}{N}\right) \times 100$$

Max.Possiblespeedlossin betweentwostepsNpand $N_{p-1}$is= $\left(1 - \frac{N_{p-1}}{N}\right) \times 100$. This loss should be constant for any two available ranges of speeds and for that $\frac{N_{p-1}}{N}$ should be a constant (Say =$\frac{1}{Q}$). This is possible if $\frac{N_{p-1}}{N} = Q$ or ifit follows G.P. If $N_{max}$and $N_{min}$are max. and min rotational speeds and these are achieved in stepsthen $\frac{N_{max}}{N_{min}} = \text{Range} \rightarrow$. Range Ratio40-60 for lathes, 80-100 for capstan lathe, 40 for shapes Range Ratio(R) =Q^{n-1} or $Q = \frac{1}{n-1}\log_e R$ further max. Loss = $1 - \frac{1}{Q} = \frac{Q-1}{Q}$ .20-30 for drillingmachines30-50millemachines1-10grindersforanefficiencyof50% $\frac{Q-1}{Q} = \frac{1}{2}$ or Q=2, for steps less output Q→1 and loss of velocityin that case=0. Thus for G.P. the useful valueofcommonratioliesbetween1and 2i.e.1<Q<2.Value ofQ 1.12,1.26,1.41,1.56&2 Automaticlathes1-10.

TOOLLAYOUTFORAUTOMATICLATHES

Tool layout is a definite schedule or sequence ofdifferent operations to be performed for producing a job and preparing a list and sequence of application of the tools to be used. The important points to be considered are

1. To minimize machining time, tryto put as manytools to operatesimultaneously. This can be done byover lapping the corresponding machining operators.
2. The job handling operations should also be over lapped with machining operations. This will reduce manufacturing time and increase rate of production.
3. Cutting tools should be planned that during the operation the cutting forcesare counter balanced by one another. This will increase tool life and surface finish on the job.
4. If several tools are used separately for roughturning a surface. This will minimize un evenness of the surface.
5. In order to maintain perfect concentricity between external and internal surfaces of a part, these surfaces should be finish machined out the same station.
6. To have a better finished component, avoid over lapping of roughing and finishing operations.
7. Inplanningthedrillingoperationsthefollowingpointstakencare
   a) Centre drill should always be used for spot drilling (centering) before hole is drilled.
   b) Deep holes should not be drilled continuously, it should be taken out of the hole many times during the operation in order to break the chips and allow the drill to cool. This will improve tool life and give better finish.
   c) When a hole of varying diameter is to be drilled, always use the drills in a descending order of their diameters. This will minimize total drilling time.
8. Cuttingofdeepgroovesandpastingoffshould invariablybethe last butoneand last operations respectively.
9. Theoperationsareplannedinsuchawaythatthemachiningtimetakenateach station is nearly the same and particularly in multi spindle automatics.
10. Extraordinarilylongsingleoperationshould bedivided intoomanysmalloperations in order to meet the requirement of proceeding point q.

Exp:<u>ProducingaCircularPinonaCapstanlathefrombarstock</u>

Thetoolinglayoutforproducingtheabovepartis

Procedure:

1. Feedthebaragainststop.
2. Roughturnthepinwithrollersteadyboxtool.
3. Finishturnsthepinwithrollersteadyboxtool.
4. Chamferthepinend.

5. Knurlwithconcentricknurlingtool
6. Cutoffbyusingthepartingofftoolinthereartoolpost.

Exp:<u>Makingahex.HeadboltonaCapstanlathefromhexagonalbarstock</u>

Thetoolinglayout for producingthegivenbolt.Theoperationsat station4and5canbedone simultaneously

Procedure:

1. Feedthebaragainststop.
2. Roughturntheboltdia.witharollersteadyboxtool.
3. Finishturnstheboltdia.witharollersteadybox tool.
4. Cutthreadswithselfopeningdia.head.
5. Faceandfromturntheheadbythetoolsmountedonthefronttoolpost.
6. Cutoffpartingofftoolheldinthereartoolpost.