THE LATHE OPERATIONS AND APPLICATIONS

The most common center or engine lathe is used for preparing of various turning parts by different turning process.

The work pieces are given cylindrical shapes by:

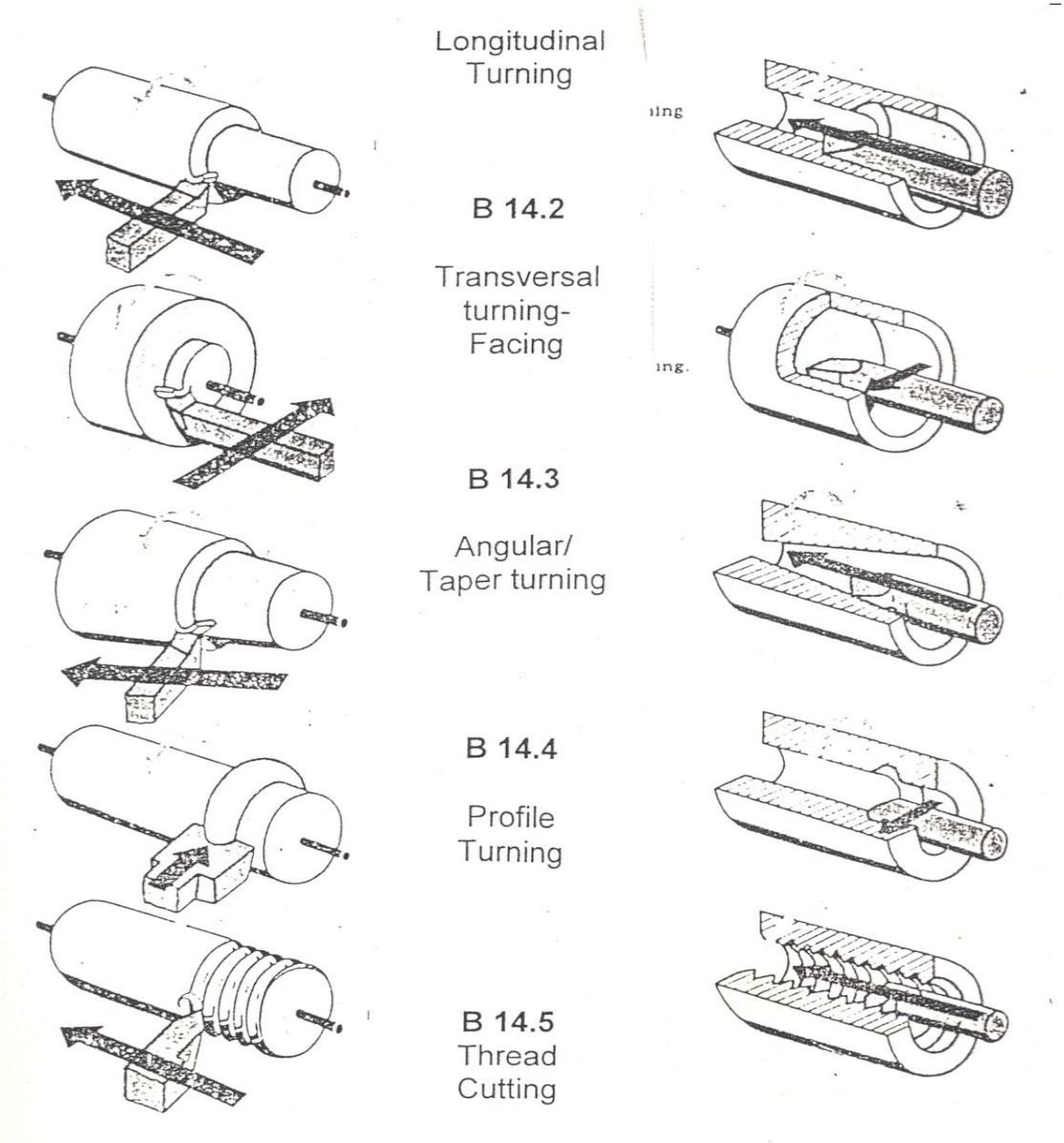
1. Longitudinal Turning
2. Tapers by taper turning
3. Profiles by profile turning
4. Threads by thread cutting

In addition, counter sink, drilling, reaming, grooving, knurling, parting off (operations) are carried out. Grinding and milling operations are carried on the lathe with special attachments. The lathe is also used for manufacturing of cylindrical bolts, cylindrical shafts, shafts with square cross section, Eccentric shafts, crank shafts, bushes, sleeves, pulleys, knobs, machine handles, spindles, washers and machining of housing and casting etc.

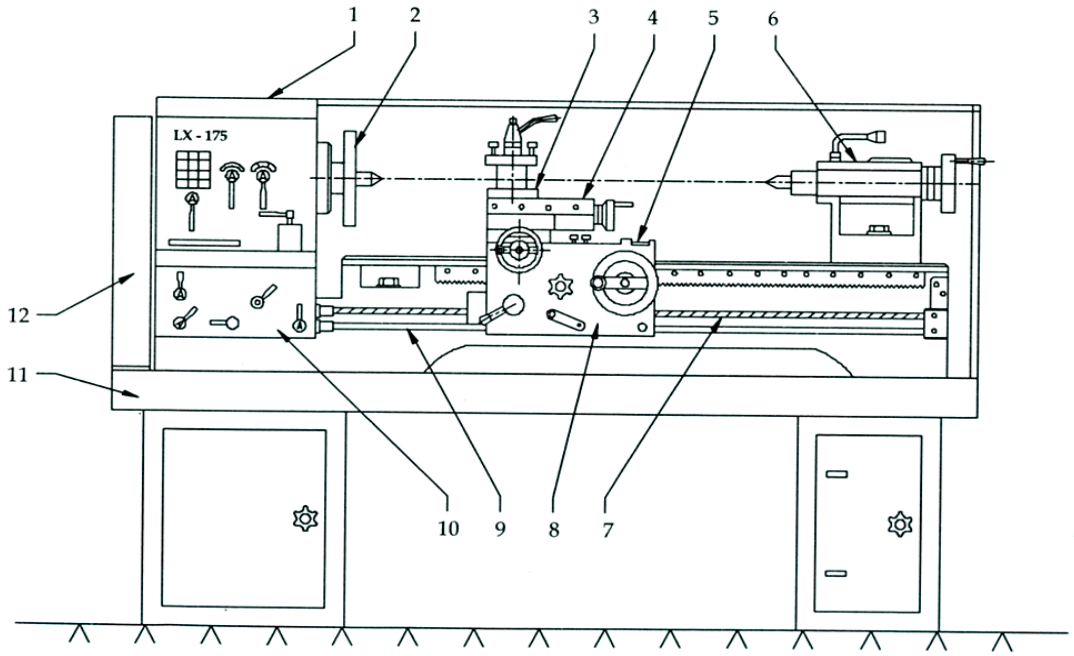
Turning process:

Turing is process of removing extra material from the work piece to the required shape and size by feeding the single point cutting tool against the rotating work piece [Basically to produce cylindrical objects]

OUTSIDE TURNING **INSIDE TURNING**



MAIN PARTS OF THE LATHE MACHINE



1	Head Stock	5	Saddle With Cross Slide	9	Feed Shaft
2	Chuck Plate	6	Tail Stock	10	Norton Gear Box
3	Tool Post	7	Lead Screw	11	Tray
4	Compound Slide	8	Apron	12	Side Cover

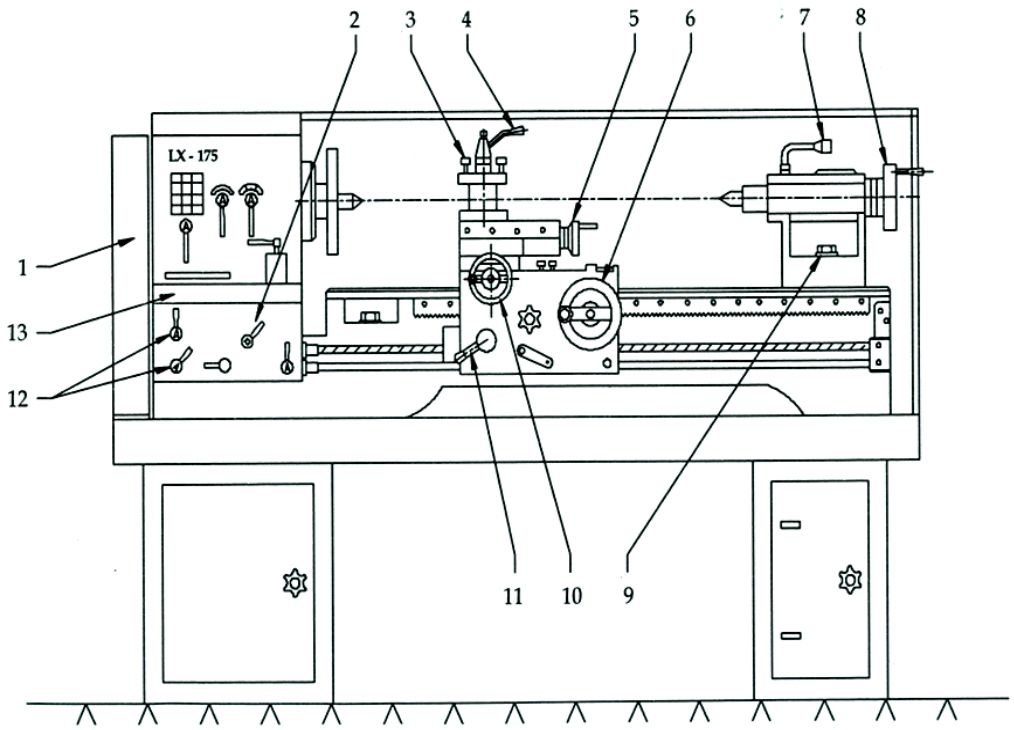
Lathe specifications:

1. The maximum diameter of a work that centre held.
2. The swing over the bed (this is the perpendicular distance from the lathe axis to top of the bed).
3. The length of the bed.
4. The length of the bed ways & type.
5. The maximum length of work that can be turned b/n centers.
6. The range of threads that can be cut.
7. The capacity of lathe (Motor).
8. Range of spindle speed.
9. Range of feed.
10. Size of the spindle nose and types of spindle nose.

INTRODUCTION TO MAIN PARTS OF THE LATHE MACHINE

Sl. No.	Parts		Description
1.	Head stock	:	Head stock is one type of gear box & it is the heart of the machine. Which gives various speed by means of gear arrangement. The gear change lever is given in the head stock body to change the speed.
2.	Chuck Plate	:	Chuck plate is provided to mount the chuck on it.
3.	Tool Post	:	Tool post is mounted on the compound slide, which is used to hold the tools.
4.	Compound Slide	:	Compound slide is used to give angular & small longitudinal motion to the tool.
5.	Saddle & Cross Slide	:	Cross slide is mounted on the saddle. Cross slide give transverse motion whereas saddle gives longitudinal motion.
6.	Tail Stock	:	Tail stock is used to hold the job for between centre turning.
7.	Lead Screw	:	Lead screw is used for threading operation. Which is also known as thread shaft.
8.	Apron	:	Apron is a gear box which gives automatic feed to the carriage.
9.	Feed Shaft	:	Feed shaft is used for auto feeding.
10.	Norton gear box	:	Norton gear box is used to obtained metric as well as BSW thread in various pitch for threading operation.
11.	Tray	:	Tray is provided to collect the cutting fluid & chip when machine is in running condition.
12.	Side Cover	:	Side cover is provided in the back side of the machine for protection of gear train & for safety purpose.

BASIC CONTROLLING PARTS OF LATHE



1 R / F Speed Change Lever
2 Speed Change Lever
3 Tool Post Bolt
4 Tool Post Handle
5 Compound Hand Wheel
6 Apron Hand Wheel
7 Quill Clamping Lever
8 Tail Stock Hand Wheel
9 Clamping Bolt
10 Surface Hand Wheel
11 Half Nut Operating Lever
12 Norton Gear Box Opeating Levers
13 Operating Pannel

BASIC CONTROLLING PARTS

(1) R/F SPEED CHANGE LEVER

The function of this lever is to change the direction of motion of lead screw. It is advisable to operate this lever only after the machine stops.

(2) SPEED CHANGE LEVER

We can obtain 8 various speed as per our requirement by operating this lever. Don't operate this lever when the machine is in running condition.

(3) TOOL POST BOLT

The cutting tool is holding by these bolts. Always use spanner to tighten & loosen these bolts.

(4) TOOL POST HANDLE

During the turning process sometimes it is necessary to give an angle to the cutting tool. By means of this lever we can clamp the tool post at required position.

(5) COMPOUND HAND WHEEL

This hand wheel in longitudinal direction operates the compound upper side. A graduated dial ring is provided with this hand wheel. On this dial ring 1 division = 0.021mm.

(6) APRON HAND WHEEL

This hand wheel is used to give longitudinal travel to the carriage with surface and compound slide on the bed guide ways. On apron hand wheel 1 division = 0.200 mm.

(7) QUILL CLAMPING LEVER

By means of this lever, tailstock quill can be clamped in required position.

(8) TAIL STOCK HAND WHEEL

This hand wheel operates the tailstock quill. The graduated dial ring is provided on this hand wheel. On this dial ring 1 division = 0.050 mm.

(9) CLAMPING BOLT

The function of this bolt is to locate the tail stock body at required position on the bed guide ways.

(10) SURFACE HAND WHEEL

This handle operates the surface in transverse direction. A graduated dial ring is provided on this hand wheel. On this dial ring 1 division = 0.10 mm.

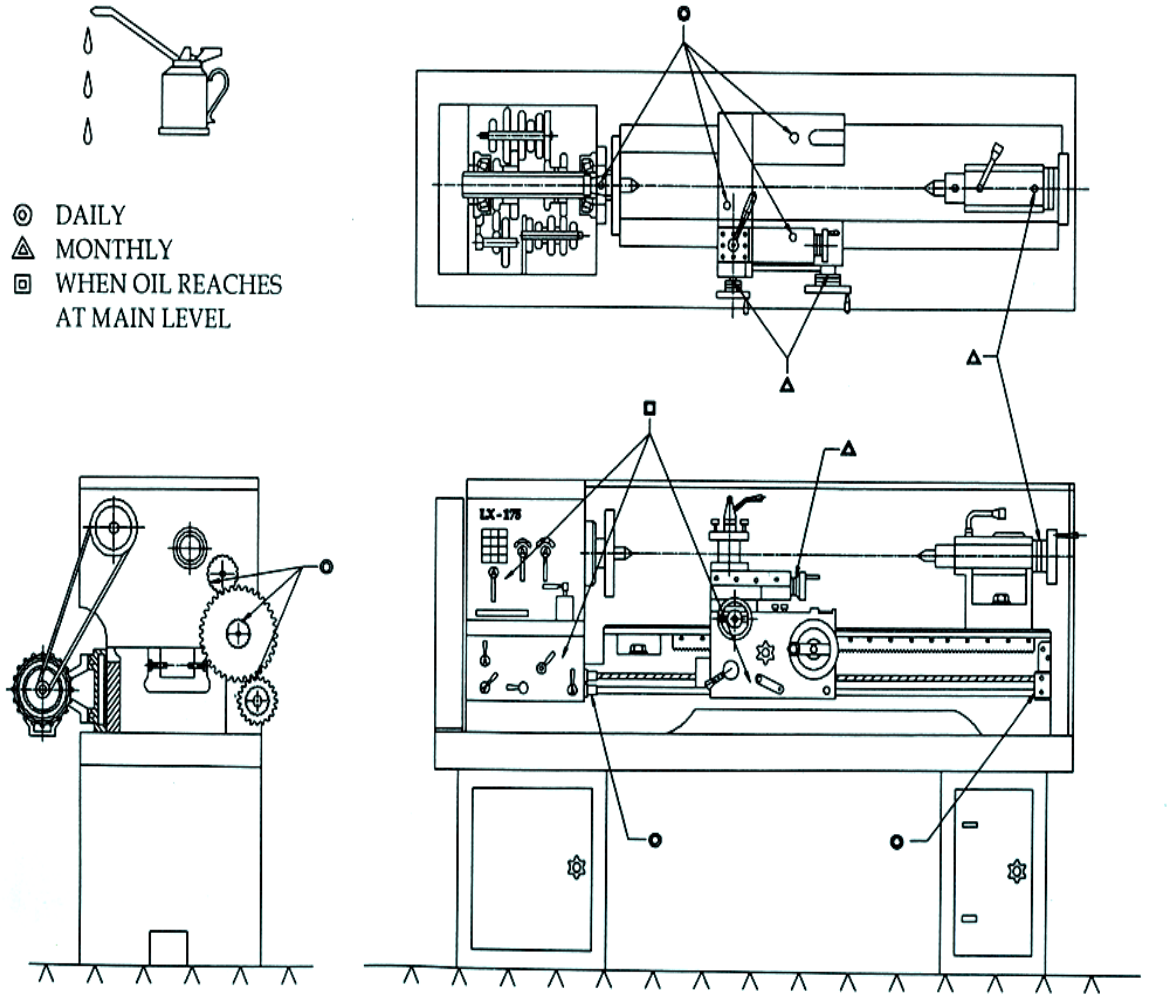
(11) HALF NUT OPERATING LEVER

This lever is used to engage or disengage the lead screw while threading operation is performed.

(12) NORTON OPERATING LEVERS

Norton gear box is operated by means of this lever so that various pitch of thread can be select.

LUBRICATION CHART



LUBRICATION

Proper lubrication is the matter of vital importance. The accuracy of the lathe depends on the proper and regular lubrication. We are therefore, enclosing herewith the lubrication chart and lubrication instructions.

If the lubrication is neglected then the bearing surfaces may damage, impairing the accuracy and shortening the life of the machine.

Before putting the machine in operation, all the Oil cups, Apron, Norton Gear Box & Head stock should be checked and filled with oil until the oil reaches the "Red Line" in the oil sight glass.

ASSEMBLY WISE LUBRICATION INSTRUCTION

(1) HEAD STOCK

- Threads on the spindle nose should be always cleaned and oiled before mounting the chuck plate or faceplate.
- Head stock body should be filled up with oil. The level of the oil should be always maintained. The oil is used for head stock is EP – 90 Gear Oil.
- Oil nipple on the various parts like brackets. Punja etc. must be properly filled with oil.

(2) TAILSTOCK

- There are two oil holes plunged by oil cup and by oil nipple. Oil cup carry oil to the housing and tailstock quill.

(3) APRON

- A hole is provided in the front face of apron to pour oil in apron. Pour the oil till level comes up to the "Red Mark" on the oil sight glass of the apron. The oil used for apron is EP–140 Gear Oil.
- All the rotating parts and bearing s of the apron are splash lubricated. An oil-drain plug provided at the bottom to change the oil

(4) SADDLE

- Two oil cups are provided on the top face of the saddle. Fill these cups with oil daily. Oil flows and reaches to the Flat and V guide ways of the bed.
- Surfaces Screw should be lubricated by the nipple. Which is give on the screw boss.
- Two oil nipples are provided on the top face of the surface slide, which carry oil in the both the guide ways of the saddle.

(5) COMPOUND SLIDE

- Two oil nipples are provided on the front face of the compound slide, which carry the oil for both the guide ways of the slide.
- To oil the housing of the compound slide oil nipple is provided on the compound boss.

(6) LEAD SHAFT & FEED SHAFT

- Clean the lead shaft, feed shaft & rack with the cotton waste daily & oil the same properly.
- Both lead screw brackets (Front and Rear) having an oil nipple on the tine top face, which supply oil to the bearing and housing.

(7) NORTON GEAR BOX

- Norton gear box should be filled up by Gear EP–90 to get proper efficiency of the gear box. An oil sight glass is provided on the Norton to check the oil level. Change the oil when it required.

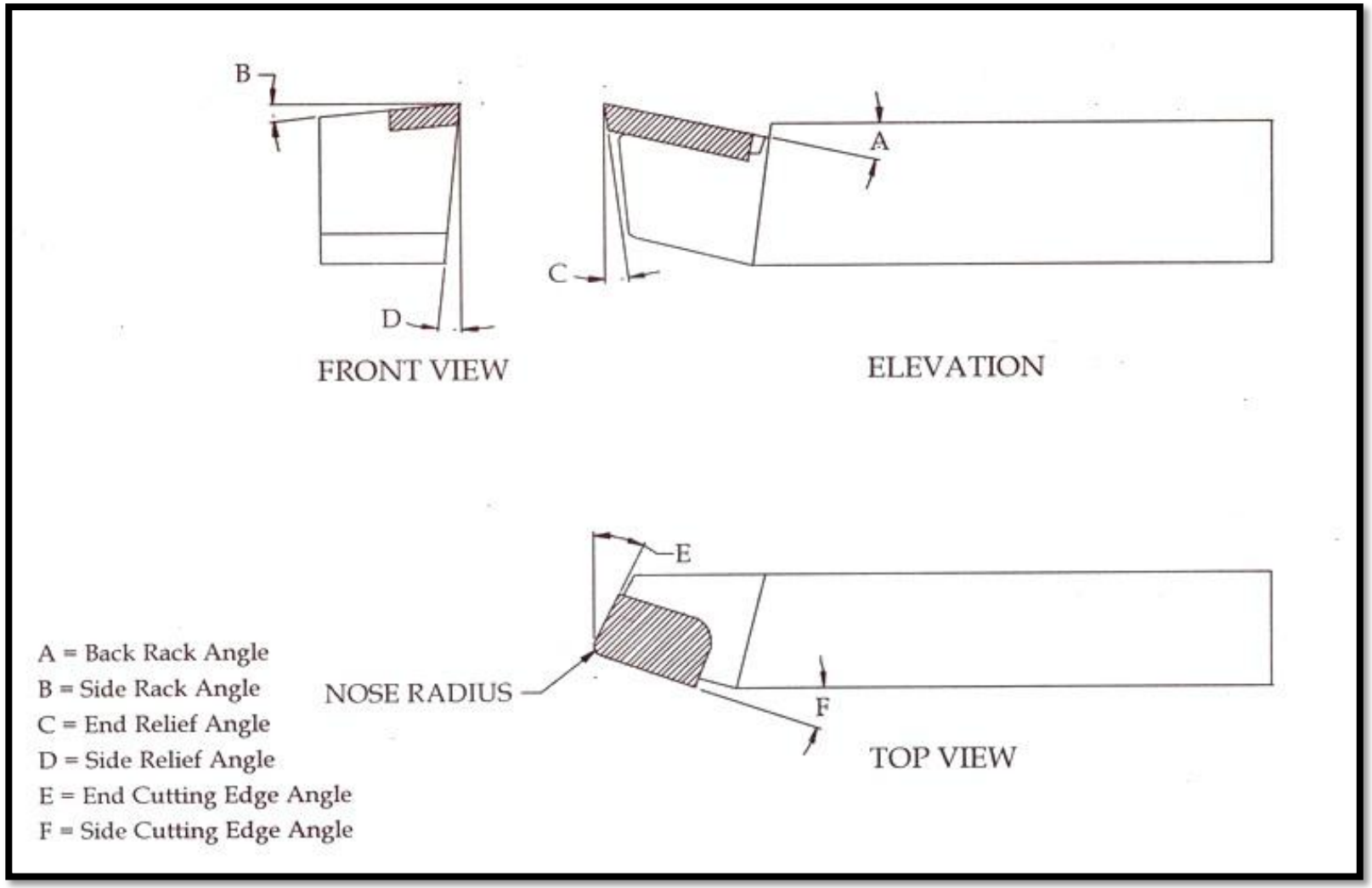
(8) GUIDE WAYS

- Before starting the lathe, operator should always clean both the guide ways of the bed thoroughly and should oil properly.

PROBLEMS IN WORKS & ITS REMEDIES

Sl. No.	Problem	Remedies
1.	Inaccurate turning	❖ Check proper grouting of the machine ❖ Check proper leveling of machine. ❖ Put proper support by steady rest; follow rest of centre support by tailstock. ❖ Clamp cutting tool firmly with lesser over hanging. ❖ Set proper speed & feed and use proper grade of tool
2.	Vibration produced during turning	❖ Tight the spindle check nut & check the hotness of bearing
3.	Noise in gear train end feed mechanism	❖ Check that gears are matching properly with correct backlash. ❖ Check any damages marks on the gear teeth. ❖ Lubricate gear train at all points thoroughly.
4.	The depth of cut changes at the time of longitudinal feed	❖ Check the depth of cut, if excess reduce it. ❖ Adjust the wedges of the surface and compound slide.
5.	Difficulty in tracking heavy cuts	❖ Checks the belt tensions if loose adjust the same for required tension. ❖ Check whether the automatic feed engaging star nut give in the apron is tightened properly.
6.	Apron and carriage assy. Slide move tightly on the bed ways	❖ Clean the sliding surfaces and lubricate it thoroughly ❖ Loose the carriage clamping screw if it is tight ❖ Check the machine level.
7.	Threading Overlaps	❖ Check the lead screw play and half nut play. If the play is more adjust the same. ❖ Check the change gear train as per thread chart.

TOOL GEOMETRY



$A = 12^0 – 14^0$, $B = 12^0 – 14^0$, $C = 6^0$, $D = 6^0$, $E = 30^0$, $F = 12^0$

TOOL GEOMETRY & SELECTION CHART

Material	Hardness HRB	High speed steel (Angle in Degree)					Carbide tools(Angle in Degree)						
		A	B	C	D	E & F	Brazed		Trow way		C	D	E & F
							A	B	A	B			
Alloy Steels, Carbon steels, High strength steel Tools steels, Nitriding & Structural Steel etc.	85-225	10	12	5	5	15	0	6	-5	-5	5	5	15
	225-325	8	10	5	5	15	0	6	-5	-5	5	5	15
	325-425	0	10	5	5	15	0	6	-5	-5	5	5	15
	45-58 HRC	0	10	5	5	15	-5	-5	-5	-5	5	5	15
Wrought free machining stainless steel	135-275	50	8	5	5	15	0	6	-5	-5	5	5	15
	275-425	0	10	5	5	15	0	6	-5	-5	5	5	15
Gray cast iron, Ductile cast iron, Malleable cast iron	100-200	5	10	5	5	15	0	6	-5	-5	5	5	15
	200-300	5	8	5	5	15	0	-5	-5	-5	5	5	15
	300-400	5	5	5	5	15	-5	-5	-5	-5	5	5	15
Wrought & Cast Aluminum Alloy	30-150 500 Kg	20	15	12	10	5	3	15	s0	5	5	5	15
Wrought & Cast Copper Alloy	40-200 500 Kg	5	10	8	8	5	0	0	0	5	5	5	15
Wrought & Cast Nickel Alloy Thermo plastics Thermosetting	80-360	8	10	12	12	5	0	6	-5	-5	5	5	15
	All	0	0	20-30	15-20	10	0	0	0	0	20-30	15-20	10
	All	0	0	20-30	15-20	10	0	15	0	15	5	5	15

NOTE:-Nose radius and cutting edge angle will generally be dedicated by type of operation being performed when not specified, use 1.2 mm nose radius.

APPLICATION OF CUTTING TOOLS

Sl. No.	Application	Range of Application	Feed
1	**TURNING**		
	(a) Straight Turning L.H.	External Turning	Longitudinal
	(b) Straight Turning	-do-	-do-
	R.H.		
	(c) Off-Set Turning L.H.	External turning & facing	Cross & Longitudinal
	(d) Off-Set Turning R.H.	-do-	-do-
	(e) Turning	External turning & facing	Longitudinal
	(f) Turning	External turning & facing shoulders at an angle of 90^o to work axis	Longitudinal
2	**FACING**		
	(a) Off-Set Facing	Turning shoulders at an angle of 90^o to face	Cross
3	**CUTTING OFF**		
	(a) Cut-Off	Cutting of blanks	Cross
	(b) Finish Shovel nosed	External Finish Turning	---
4.	**BORING**		
	(a) Boring	For Through hole	---
		Boring	
	(b) Boring	For blind hole boring	Longitudinal
5.	**FORMING**		
	(a) Form Tool	For Form Turning	Cross
6.	**THREADING**		
	(a) Threading	External Threading	Longitudinal
	(b) Threading	Internal Threading	Longitudinal

NORTON THREAD CHART

T pi	A	C	KNOB	LEVER
4	33	88	8	BC
4.5	33	88	7	BC
5	33	88	6	BC
5.5	33	88	5	BC
6	33	88	4	BC
6.5	33	88	3	BC
7	33	88	2	BC
7.5	33	88	1	BC
8	33	88	8	AC
9	33	88	7	AC
10	33	88	6	AC
11	33	88	5	AC
12	33	88	4	AC
13	33	88	3	AC
14	33	88	2	AC
15	33	88	1	AC

TPI	A	C	KNOB	LEVER
16	33	88	8	BC
18	33	88	7	BC
20	33	88	6	BC
22	33	88	5	BC
24	33	88	4	BC
26	33	88	3	BC
28	33	88	2	BC
30	33	88	1	BC
32	33	88	8	AC
36	33	88	7	AC
40	33	88	6	AC
44	33	88	5	AC
48	33	88	4	AC
52	33	88	3	AC
56	33	88	2	AC
60	33	88	1	AC

4:3 RATIO, 4 TPI LEAD SCREW CHANGE GEARS			
33	41	88	39

PITCH	A	C	KNOB	LEVER
0.5	39	88	1	AD
0.625	39	88	4	AD
0.75	39	88	6	AD
0.875	41	88	7	AD
0.937	39	88	8	AD
1	39	88	1	BD
1.25	39	88	4	BD
1.5	39	88	6	BD
1.75	41	88	7	BD
1.875	39	88	8	BD
2	39	88	1	AC
2.5	39	88	4	AC
3	39	88	6	AC
3.5	41	88	7	AC
3.75	39	88	8	AC
4	39	88	1	BC
5	39	88	4	BC
6	39	88	6	BC
7	41	88	7	BC
7.5	39	88	8	BC

FEED CHART (mm/rev.)

POSITION BC		
Lever	**Longitudinal**	**Traverse**
1	0.42	0.11
2	0.46	0.12
3	0.51	0.13
4	0.55	0.14
5	0.61	0.15
6	0.66	0.17
7	0.76	0.19
8	0.85	0.21

POSITION AC		
Lever	**Longitudinal**	**Traverse**
1	0.21	0.05
2	0.22	0.06
3	0.24	0.062
4	0.27	0.07
5	0.30	0.08
6	0.34	0.09
7	0.38	0.10
8	0.51	0.14

Example:

To Cut 3 mm Pitch With The Help Of Our "Norton Gear Box" Know Position Must Be As Below.

1) Top Knob In "A" Position
2) Bottom Knob In "C" Position.
3) 1 to 8 no. Star Knob (R. H. Side) In "6" Position.
4) Disengage – Engage Lever In "Engage" Position
5) N.B.: only use the gear $\frac{A}{C} = \frac{39}{88}$ Of Last Line for Threading the Same Line.

Cutting speed:

The speed at which the cutting edge passes over the material, which is expressed in meters per minute.

$$V = \frac{\pi DN}{1000} \text{ Meter/minute}$$

Where: V = Cutting speed in Meter/minute.

Π = 3.14

D = Diameter of work piece in mm

N = Rpm

Example: Find out the cutting speed to turn 50Ø bar at an rpm of 160.

$$V = \frac{\pi DN}{1000}$$

V = 3.14 x 50 x 160 / 1000

V = 25 Meter/minute.

Feed:

The feed of the tool is the distance it moves along the work for each revolution work and it is expressed in mm/rev.

Factors governing the cutting speed:

- Finish required
- Depth of cut
- Tool geometry
- Properties and rigidity of the cutting tool & its mounting
- Properties and rigidity of workpiece material
- Type of cutting fluid used
- Rigidity of the machine tool

Factors governing the feed:

- Tool geometry
- Surface finish required in the work
- Rigidity of the tool
- Coolant used

Turning time calculation:

The time required for a cut is found by,

$$\text{Time to turn} = \frac{Length\ of\ cut\ X\ Number\ of\ cuts}{Feed\ X\ rpm}$$

Example:

A mild steel Ø40mm and 100mm length has to be turned to Ø30mm in a one cut for full length using a HSS tool with a feed rate of 0.2 mm/rev, determine the turning time.

$$\text{Turning time} = \frac{Length\ of\ cut\ X\ Number\ of\ cuts}{Feed\ X\ rpm}$$

= 100 x 1/ 0.2 x 238.6

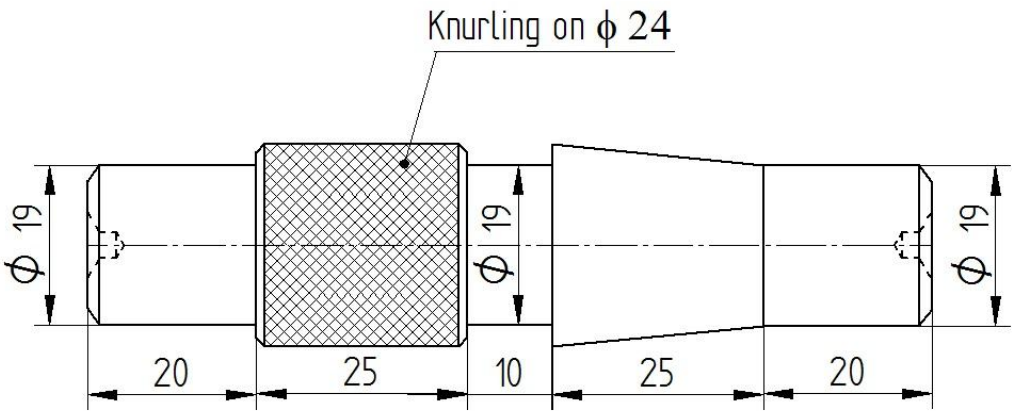
= 2.09 minutes

(Or)

= 2 minutes 5.4 seconds

TURNING MODELS

MODEL No. 01



Note: All dimensions are in mm only

Material: M S bright rod

Size: Ø25 x 105 Length

Tolerance: ±0.50

Taper Turning Calculation:

A)

$$Tan\theta = (D - d)/2l$$
$$= (24 - 19)/2l$$
$$= (24 - 19)/2(25)$$
$$\theta = _____$$

MODEL No. 01

Tools required	Operations
1. Facing / turning tool	1. Facing
2. Undercutting tool	2. Counter sinking
3. Combination centre bit	3. Plain turning
4. Knurling tool	4. Step turning
5. Vernier caliper	5. Chamfering
	6. Grooving
	7. Taper turning
	8. Knurling

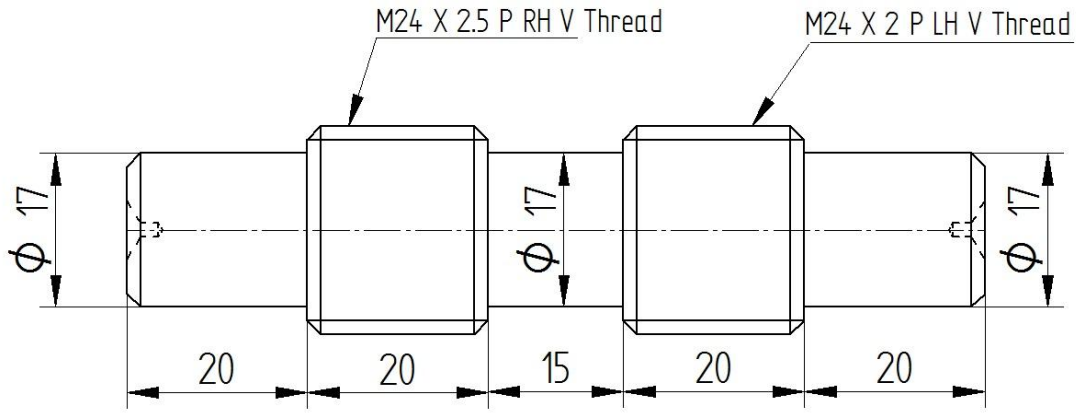
Procedure: (1st step)

1. Study the drawing
2. Hold the workpiece on 3 jaw chuck by keeping 60 to 70 mm outside and face the workpiece to clear the roughness
3. Center drilling on the face of the work
4. Plain turn Ø24 to maximum length
5. Step turn Ø19 to 20 mm length
6. Undercut Ø19 to 10 width
7. Taper turning
8. Chamfering 0.5 all sharp corners

(2nd step)

1. Reverse hold the job on Ø19 and face to maintain total length 100 mm
2. Centre drilling
3. Step turn diameter 19 for a length of 20 mm
4. Turn diameter 23.7 mm for knurling to a length of 25 mm
5. Chamfer 0.5 mm all sharp corners
6. Take the revolving centre support
7. Form the knurling on diameter 23.7 by using diamond knurling tool
8. Chamfer knurled corners

MODEL No. 02



Note: All dimensions are in mm only

Material: M S bright rod

Size: Ø25 x 105 Length

Tolerance: ±0.50

Blank size for thread cutting:

Blank size = Major diameter $- \frac{Pitch}{10}$

$= 24 - \frac{2}{10}$

$=24 - 0.2$

$= 23.8$ mm

Blank size = Major diameter $- \frac{Pitch}{10}$

$= 24 - \frac{2.5}{10}$

$=24 - 0.25$

$= 23.75$ mm

MODEL No. 02

Tools required	Operations
1. Facing/ plain turning tool	1. Facing
2. Undercutting tool	3. Counter sinking
3. Combination centre bit	4. Plain turning
4. V threading tool	5. Step turning
5. Vernier caliper	6. Under cutting
6. Screw pitch gauge	7. chamfering
7. Center gauge	8. Threading

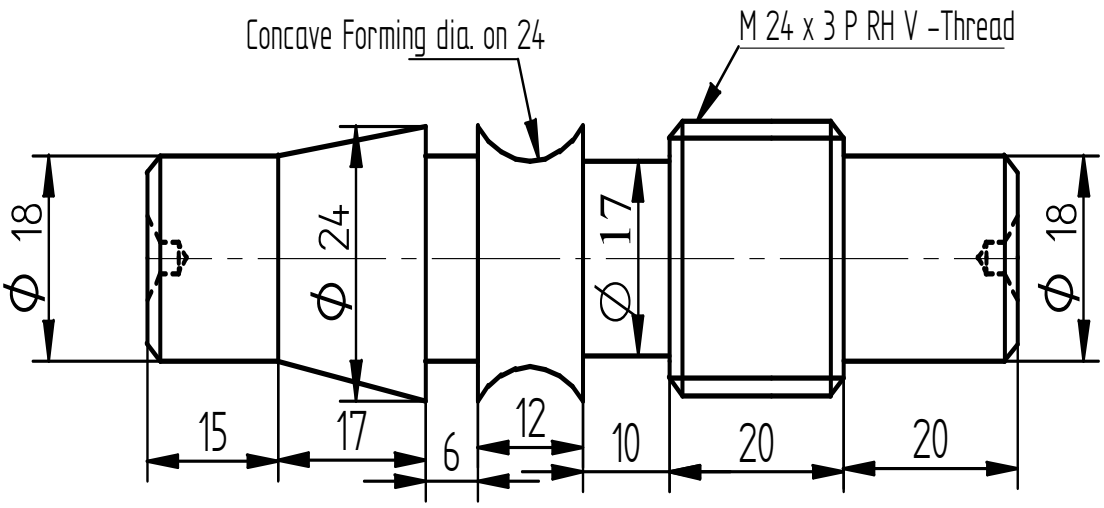
Procedure: (1st step)

1. Study the drawing.
2. Hold the workpiece on 3 jaw chuck by keeping 60 to 70 mm outside and face the workpiece to clear the roughness.
3. Face the job and counter sinking at one end.
4. Plain turning the job to Ø23.8 to maximum length.
5. Step turning to Ø17 for a length of 20 mm.
6. Under cut the dia 17 for a length of 15 mm as per the sketch.
7. Threads to be cut on diameter 23.8 mm for a length of 25 mm.

(2nd step)

1. Reverse hold the job on Ø19 and face to maintain total length 100 mm
2. Centre drilling
3. Step turn diameter 17 for a length of 20 mm
4. Turn diameter 23.75 mm for threading to a length of 20 mm
5. Chamfer 0.5 mm all sharp corners
6. Take the revolving centre support
7. Threads to be cut on diameter 23.8 mm for a length of 25 mm.

MODEL No. 03



Note: All dimensions are in mm only

Material: M S bright rod

Size: Ø25 x 105 Length

Tolerance: ±0.50

MODEL No. 03

Tools required	Operations
1. Facing/ turning tool	1. Facing
2. Under cutting tool	2. Counter sinking
3. Form turning tool	3. Step turning
4. V threading tool	4. Threading
5. Vernier caliper	5. Form turning
6. Screw pitch gauge	
7. Center gauge	

Procedure: (1st step)

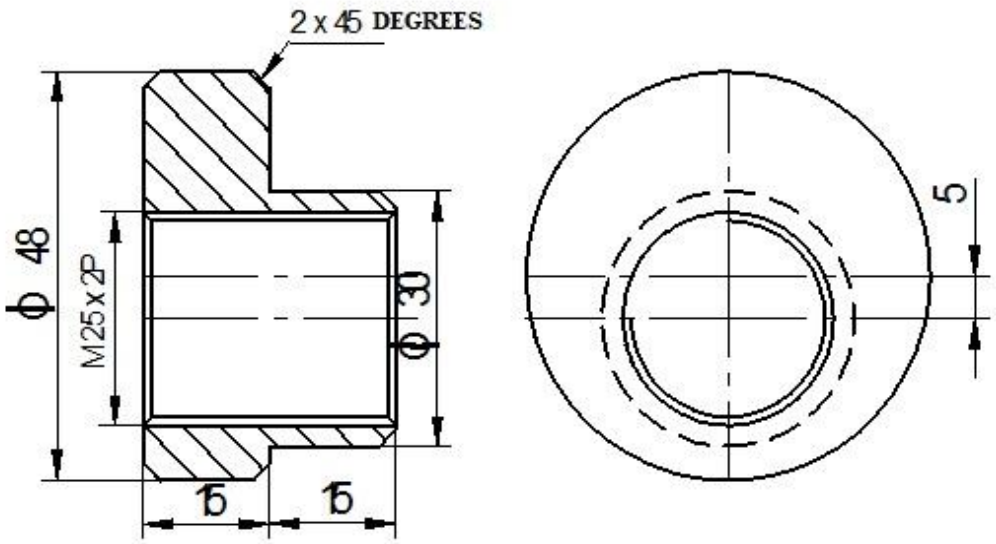
01. Study the drawing.
02. Hold the workpiece on 3 jaw chuck by keeping 60 to 70 mm outside and face the workpiece to clear the roughness.
03. Face the job and counter sinking at one end.
04. Plain turning the job to Ø23.7 to maximum length.
05. Step turning to Ø17 for a length of 20 mm.
06. Under cut the dia. 17 for a length of 10 mm as per the sketch.
07. Threads to be cut on diameter 23.7 mm for a length of 20 mm.

(2nd step)

01. Reverse hold the job on Ø17 and face to maintain total length 100 mm
02. Centre drilling.
03. Step turn diameter 18 for a length of 20 mm.
04. Under cutting diameter 18mm for a length of 6 mm as per the sketch.
05. Concave and convex are to be formed by using forming tool as per the sketch.

MODEL No. 04

[Eccentric turning with internal threading]



Note: All dimensions are in mm only

Material: M S bright rod

Size: Ø50 x 35 Length

Tolerance: ±0.50

MODEL No. 04

Tools required	Operations
1.Facing tool	1.Facing
2.Turning tool	2.Turning
3. Vernier height gauge	3. Drilling
4. Try square	4. Boring
5. Centre punch	5.Ecentric turning

Procedure:

1. Study the drawing.
2. Set the cutting tool for centre height.
3. Prepare the work piece for the Ø 48mm and to a length of 30 mm.
4. Mark the work piece center with the help of Vernier height gauge and V block with 'C' clamp and try square.
5. Mark the 5 mm offset from centre of Ø48 mm by using Vernier height gauge and V block.
6. Punch the eccentric centre point with the help of centre punch.
7. Hold the job in four jaw chuck and true the job to eccentric centre point with the help of dead centre.
8. Do eccentric turning to a Ø30 mm to a length of 15 mm (use slow speed)
9. With the help of centre bit and drill bit drill the hole to the eccentric point Ø18 mm hole and bore it up to Ø23.8 mm.
10. Do internal threading by using internal threading tool.
    Hole size (Minor Ø) = Major Ø – 2 x depth of thread
    = 25 – 2 x 0.61
    = 25 – 1.22
    = 23.78 = 23.8
11. Finally check the dimensions as per given drawing.

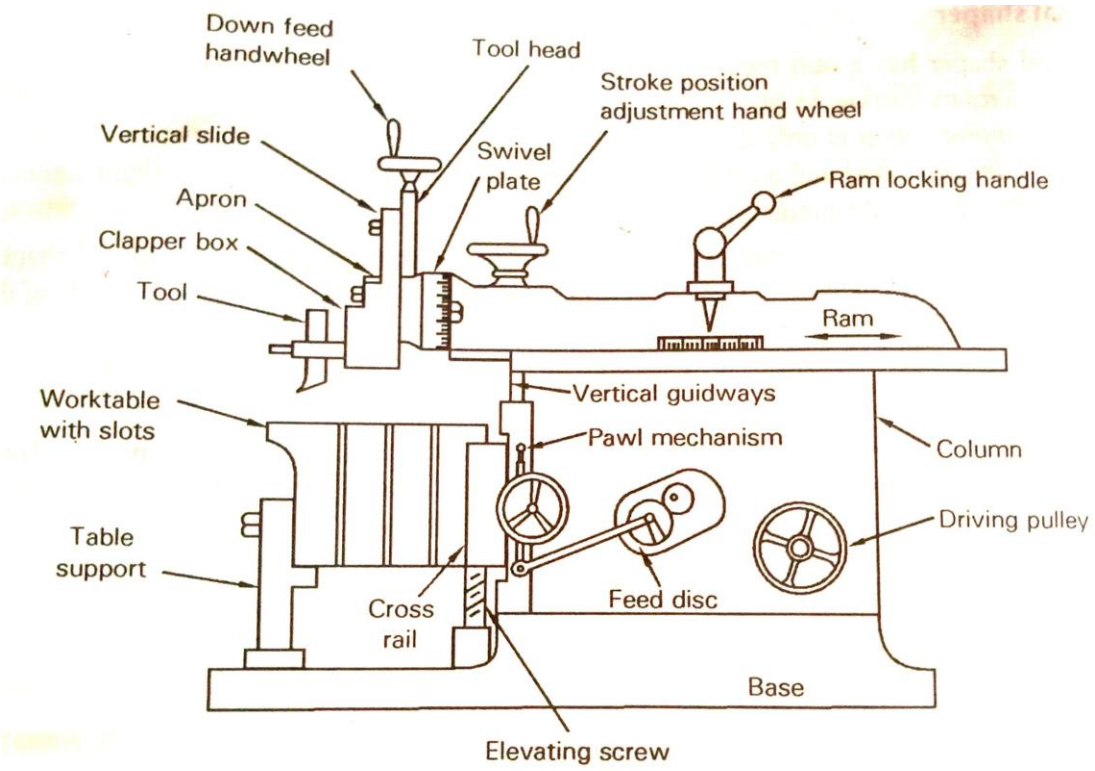
SHAPING

Shaping is a process of removing metal from surfaces in horizontal by the use of single point tool held in a ram that reciprocates the tool in a linear direction across the work pieces.

Application of shaping machine;

To manufacture guide gibs, dovetail and V block etc….

Shaping machine:



Parts of a Horizontal shaper

Principle parts of a shaper:

Sl. No.	Parts	Description
01	**Base**	It is a heavy cast iron body that support all other parts of machine
02	**Column or pillar**	It houses, driving motor, control devices, mechanism of driving the ram and work table top of the column the ram reciprocates cross rail vertically along these guides ways
03	**Cross rail and saddle**	It can be raised or lowered by means of elevating screw to accommodate work piece of different height. It carries the table cross feed screw together with the pawl and ratchet drive mechanism.
04	**Table**	The table is provided with T slots on its top and on its side for clamping the work piece the front face of the table is supported by an adjustable table support to with stand the weight of the work piece and cutting action during operation.
05	**Ram**	The ram is a rigidly braced casting the ram reciprocates on the guide ways.
06	**Tool head**	The tool head is mounted at the front end of the ram. The tool head holds the tool, the necessary vertical and angular feed movement

Operating controls of a shaping machine:

Sl. No.	Controls	Function
07	**Main switch**	Power supply to shaper in main electrical panel.
08	**Starter**	ON & OFF switch control to run or stop the shaper.
09	**Ram locking handle**	Stroke adjustment
10	**Ram and gear movement hand wheel.**	To adjust the stroke length and change of speed gear box
11	**Speed changing levers (2 nos.)**	For variation of stroke feed movement
12	**Spindle for elevating screw**	For vertical movement of the table
13	**Spindle for cross feed**	Cross feed movement of the table both by hand and pawl and ratchet drive mechanism (Auto feed movement).
14	**Spindle for ram stroke adjustment**	To set stroke length
15	**Hand wheel for tool head movement.**	To give depth of cut to work piece
16	**Clapper box**	----------
17	**Oil flashing unit**	----------
18	**Tool locking bolt**	----------

Specification of a shaper:

- Maximum length of stroke of ram
- Maximum horizontal travel of work table
- Maximum vertical travel
- Dimension of table working surface
- Power of the motor

Accident prevention during shaping machine:

- Before starting the machine, it should be continuously operated by hand in order to assure that ram or table does not strike anywhere.
- Carefully operate the vertical adjustment of the table by seeing the front supporting plate.
- Chips should be removed only by means of hook and brush.
- Measurement of the work piece should be taken only after the machine is stopped.

Sequence of operation plan to perform job in shaper:

Sl. No.	Operations	Tools
01.	Mounting and aligning of work piece	Machine vice with steel parallels
02	Clamping of shaping tools	Grove tool
03	Setting the no. of cycles, stroke length, stroke position and feed.	----------
04	Mark the block recesses and groves	Granite surface plate, vernier height gauge, V block, centre punch, ball pen hammer, anvil
05	Successive shaping of longitudinal sides (cutting depth is set 0.5 mm in each cut)	Grooving tool
06	Rough shaping of V block	Grooving tool
07	Setting tool slide at angle clamping of single pointed tool shaping oblique surface.	Single pointed tool
08	Setting tool slide into normal position	----------

SHAPING MODELS

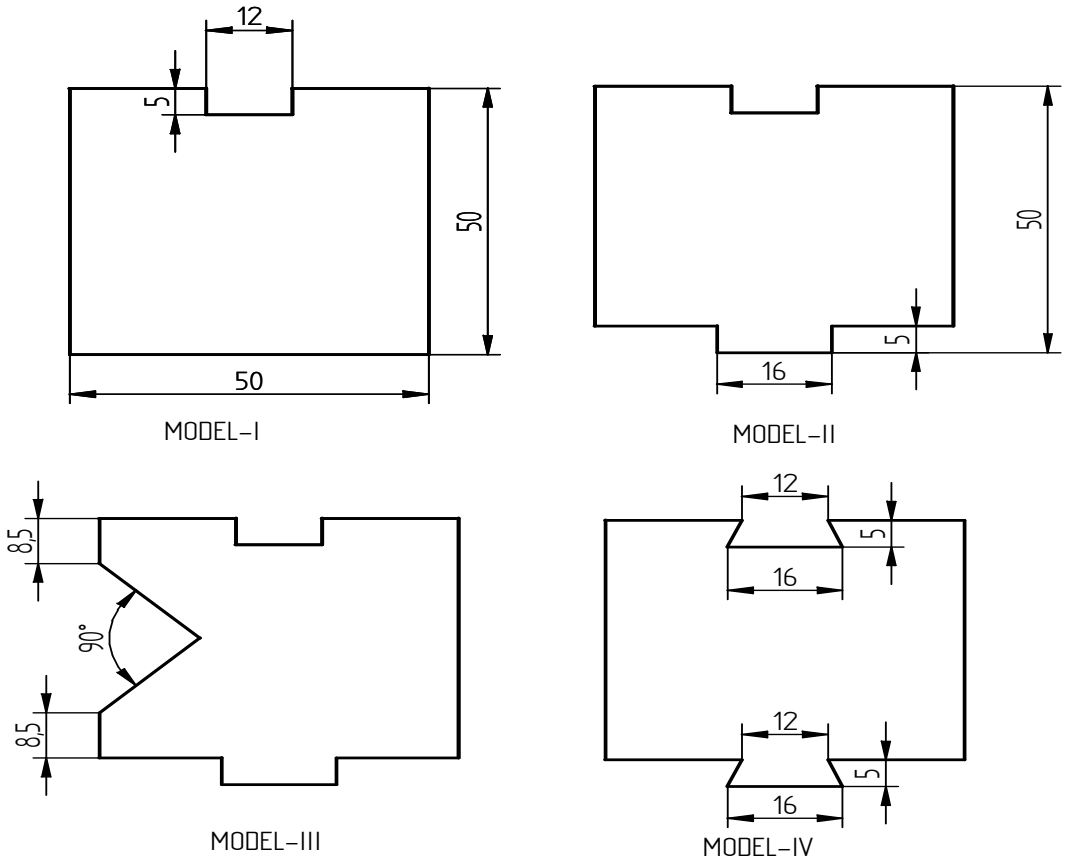
Aim – Prepare a 'V' block on a rectangular block on shaping machine

Apparatus – Vernier height gauge, steel rule, shaping tool center punch, hammer, spanner set, and Vernier caliper.

Operation – Marking, shaping

Procedure –

1. Take the rectangular block of standard size and mark the dimension on the work.
2. Hold the job on the work holding device on a work table of a shaping machine.
3. Produce a slot on the work piece on 3 sides of the rectangular block as per drawing.
4. Rotate the tool head to an angle 45◦ and produce to V slot as per sketch.
5. Finish the job as per the sketch.



All dimensions are in mm

MILLING

It is a machining process in which metal is removed by rotating multiple-tooth cutters, as the cutter rotates each tooth removes a small amount of material from the advancing work for each spindle revolution. (The relative motion between work piece and cutter can be in any direction. Surface having any orientation can be machined in milling).

Practical applications:

Machining of plane, curved surface, slots, groves, gears, teethes, guide gibs, bolt, splined shaft and ring nut are few example parts of milling operations.

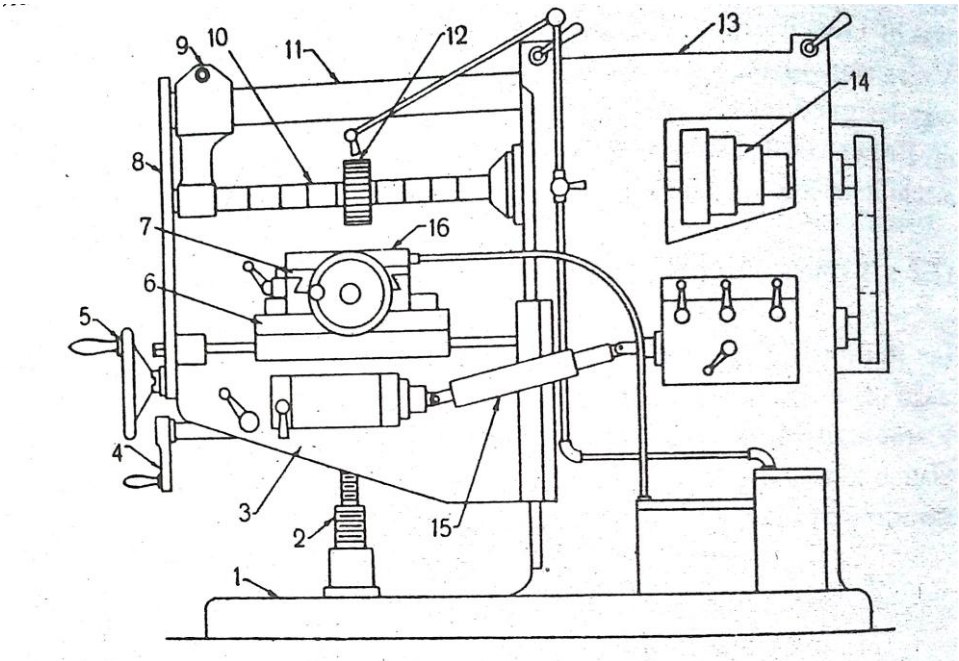
Principle parts of milling machine:

1. Base
2. Column
3. Spindle with supporting arm
4. Over arm, supporting bracket
5. Knee
6. Saddle
7. Work table
8. Main drive
9. Feed drive
10. Vertical head spindle

Operating controls of milling machine:

Sl. No.	Controls	Functions
11	Main switch	Power supply to milling machine
12	Push button starter	Starting and stopping of main motor
13	Levers for selecting spindle speed	Selection of suitable speeds
14	Levers for selecting feed drive	Selection of suitable speeds
15	Hand wheel for longitudinal feed or movement	Hand movement of table (longitudinal)
16	Hand crank for cross feed	Hand movement of table (cross)
17	Hand crank for vertical feed	Hand movement of the table(vertical)
18	Lever for auto feed movement	Auto movement both to and fro

MILLING MACHINE



Column and knee type milling machine

1. Base, 2. Elevating screw, 3. Knee, 4. Knee elevating handle, 5. Crossfeed handle, 6. Saddle, Table, 8. Front brace, 9. Arbor support, 10. Conepulley, 15. Telescopic feed shaft.

Technical specification of milling machine

1. Over all surface of the table
2. Longitudinal traverse of the table hand/power
3. Cross travel of the table hand/power
4. Vertical travel of the table hand
5. Spindle nose to outer Arbor
6. No. of spindle speeds
7. Motor for spindle drive

ATTACHMENTS FOR MILLING

1. Universal Dividing Head

Universal dividing head is an important work holding and indexing device used on milling machine. With the help of the dividing head the work pieces can be accurately divided to any fraction of a revolution enabling the correct spacing of the grooves that can be machined on the periphery of the work piece.

Universal dividing heads find wide use in the production of spur gears, splines, helical gears, and other indexing requirements on a milling machine. In this method marking is not necessary.

Method of Indexing

1. Direct Indexing: Small no. of divisions

The Indexing takes place by rotating the dividing head spindle, where by the required divisions can be achieved through the relevant Index plate and indexing pin.

Operation Sequence

Worm and worm wheel must be disengaged by means of the disengaging lever.

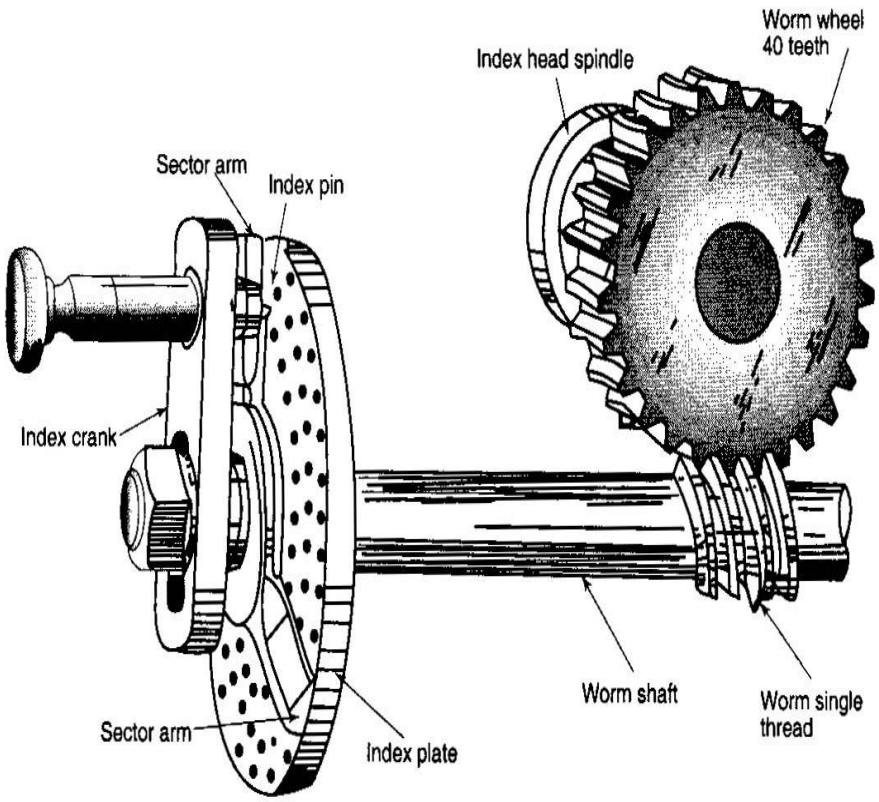
Loosen clamping lever, Release Index pin. Rotate the main spindle with the direct Index plate through the desired indexing holes.

Engage Index pin. Clamp lever tightened firmly commences the milling process.

Divisions of direct indexing

1. Face with 24 Notches	2	3	4	6	8	12	24
2. Face with 5 and 7 Notches	5	7					

The reversing of notch plate can be done by losing the knurled nut.



Indexing method of a dividing head

2. Indirect Indexing: (Any No. Of Divisions)

The indexing process takes place through worm and worm wheel with the constant drive ratio of 1:40 with this drive ratio the following relation is given.

One rotation of the main spindle requires 40 rotations of the Indexing lever.

Calculation of the required number of Index lever rotations

1. Full number of Index lever rotations are achieved when divisions of 40 by the required number of divisions, gives the full number

Example: Divisions required: 10

D: Number of Index lever rotations

IS: Dividing head constant

T = Divisions required

D = IS/t = 40/10 = 4

i.e., 4 rotation of the Index lever represents 1/10 rotation of DH Spindle

2. No full number is achieved, if the divisions are 40 from the required divisions. Then the index lever rotation must be further divided by using corresponding hole circle.

The hole circles of the double-sided index plate are as follows:

15-17-19-21-27-37-41-47

16-18-20-23-29-33-39-49

Example 1: Required number of division t = 29

Constant ratio = 1:40 Dividing head is Constant is = 40

No. of Index lever rotations = D = IS/t = 40/29 = $1\frac{11}{29}$ i.e.

To achieve the desired no. of 29 division on the dividing head spindle, the Index lever must be rotated by 1 full rotation and 11 holes extra on the 29 hole circle.

Example 2: Required Number of Divisions t = 132

$$D = \frac{IS}{t} = \frac{40}{132} = \frac{\frac{40}{4}}{\frac{132}{4}} = \frac{10}{33} \text{ i.e.}$$

To achieve the desired number of 132 divisions on the dividing head spindle, the Index lever must be rotated by 10 holes on the 33-hole circle.

Example 3: Required number of divisions t = 9

$$D = \frac{IS}{t} = \frac{40}{9} = \frac{40(3)}{9(3)} = \frac{120}{27} = 4.44 \text{ i.e.}$$

To achieve the desired number of divisions 9 on the dividing head spindle, the Index lever must be rotated by 4 rotation + 12 holes extra on the 27 holes circle.

Sequence of Operation:

Engage Worm and Worm wheel by means of the swing provided. Set Index lever on the corresponding hole circle.

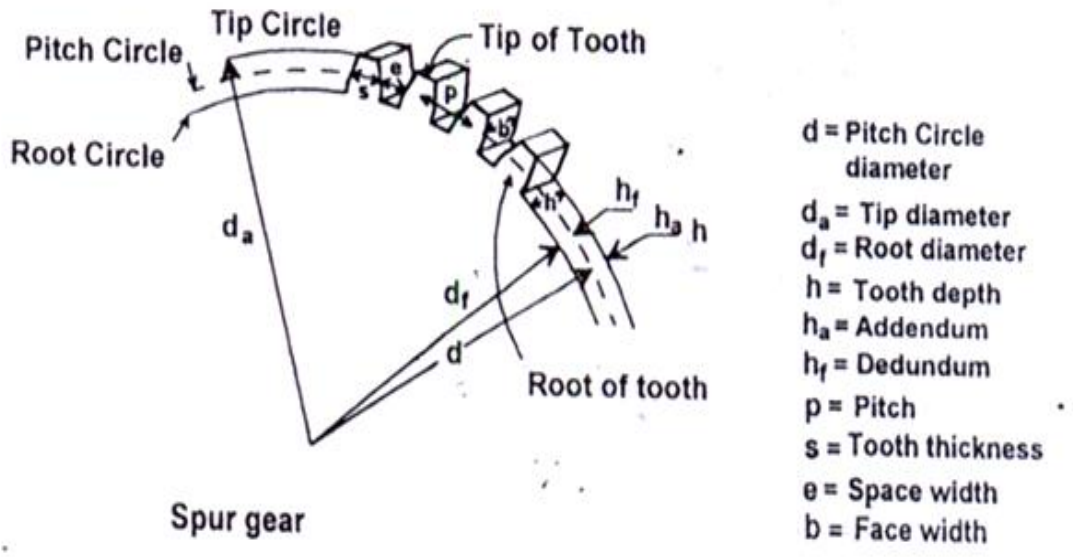
Release Index into the market hole on the selected hole circle.

Set the first indicator to touch the index pin.

Set the second indicator by rotating it over the number of holes and clamp the indicator by means of the clamping screws.

Loosen clamping lever; rotate the index lever by the number of rotations and also by the no. holes and release the Index pin in last hole before the second indicator rotate the indicator set further until the first indicator rests on the Index pin tighten clamping lever and start the milling practice

DIMENSIONS OF SPUR GEAR



The tooth form is limited by the tip and root circle

On the pitch circle tooth are spaced. The distance between the two teeth measured on the pitch circle is called the PITCH

The pitch is the product of constant and fig π.

The number with which π is multiplied is the MODULE (m)

Modules are standardized to a selected series. The Module is an absolute fig and the product in pitch is specified in mm.

Pitch = Module × π

P = m × π in mm

Module = $\frac{Circular\ Pitch}{\pi}$

Circular Pitch = $\frac{Pitch\ circle\ Circumference}{No.of\ teeth}$

Module is a standardized quantity, whose purpose is to enable calculations with numbers, it is measured in mm.

Example: Calculate the pitch in mm for a module 2 = 2 × 3.14 = 6.28 mm

Since the pitch is a multiple of π simple figures are obtained for the pitch circle diameter.

Pitch circle diameter = module × no. of teeth

d = m × z

Note: m = module

Z = no. of teeth

Teeth depth h = 13/6 m = 2.166 m = 0.7 p

Addendum h_a = 6/6 mm = 1 m = 0.3 p

Addendum h_f = 7/6 m = 1.166 m = 0.4 p

Tip diameter = $d_a = d + 2h_a$

(OR)

$d_a = d + 2m$

(OR)

$d_a = m \times z + 2m$

(OR)

$d_a = m (z + 2)$ (mm)

(OR)

Outside diameter: OD = m (z + 2) (mm) of the blank

Example: Calculate the following dimensions for a gear with module 2 and 30 teeth

Results: Pitch circle diameter = d = m × z = 2 × 30 = 60 mm

Addendum h_a = 1 m = 1 × 2 = 2mm

Dedundum h_f = 1.66 × m =1.166 × 2 = 2.332 mm

Tooth depth h = 2.166 × m = 2.166 == 2 = 4.332 mm

Tip diameter = d_a = m(z + 2) = 2(30 + 2) = 64 mm

Classification of the set of cutters,

Cutter no.	No. of teeth to be cut						
1	2	3	4	5	6	7	8
135 To rack	55 To 135	35 To 54	26 To 34	21 To 25	17 To 20	14 To 16	12 To 13

A cutter for milling a particular type of gear is specified by diametrical pitch, pressure, angle, cutter no., and bore size of cutter.

MILLING MODEL

Aim – Spur gear cutting on a gear blank using milling machine.

Apparatus – Universal milling machine, gear blank mandrel, indexing head and Vernier caliper.

Operation – Facing, plain turning, drilling, boring, chamfering, gear cutting.

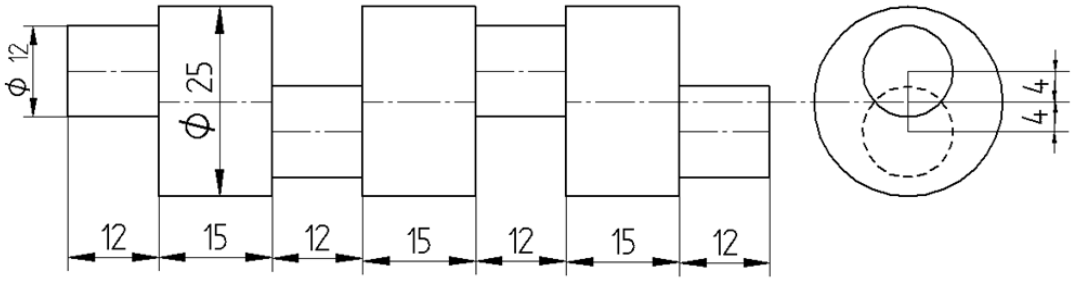
Procedure –

1. Mounting and aligning of the dividing head and tail stock on the horizontal milling machine.
2. Mounting of gear milling cutter on the cutter arbor and checking for concentric running.
3. Clamping of work piece between centre and setting to the centre of the cutter.
4. Adjusting the sector arms for the indexing head [dividing head]
5. Setting of revolution and feed for milling.
6. Cutter should have slightly on the work piece.
7. with drawing work piece out of range of the cutter and lifting.
8. Milling of first tooth space.
9. With drawing work from the cut and turning the indexing handle by the tooth pitch milling of the next tooth space.
10. Milling of remaining tooth.

Additional Models

Model No. 01

[Crankshaft Turning]



Note: All dimensions are in mm only

Material: M S bright rod

Size: Ø25 x 105 Length

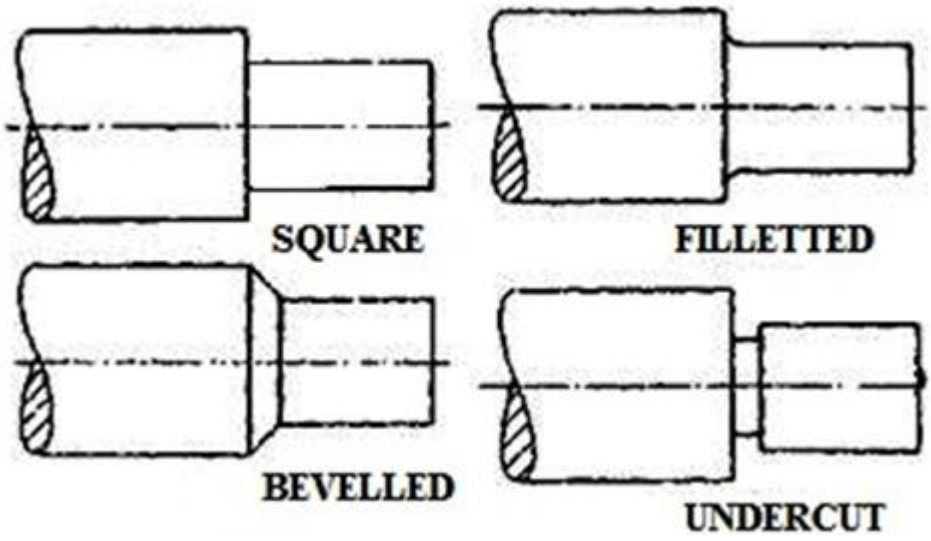
Tolerance: ±0.50

Procedure:

01. Facing both the sides of work piece and maintain the total length.
02. Marking the offsets on both the faces of the work piece by using vernier height gauge, C-clamp and V block on surface plate.
03. Center punch the offset points.
04. Hold the work piece firmly in four jaw independent chuck by truing the marking center by using centre at tailstock.
05. Turn the diameter 12 mm as per the sketch.
06. Reverse hold the job and repeat all the operations.

Model No. 02

[Shoulder Forming]



Shoulder:

Whenever more than one diameter is machined on a shaft, the section joining each diameter is called shoulder or step.

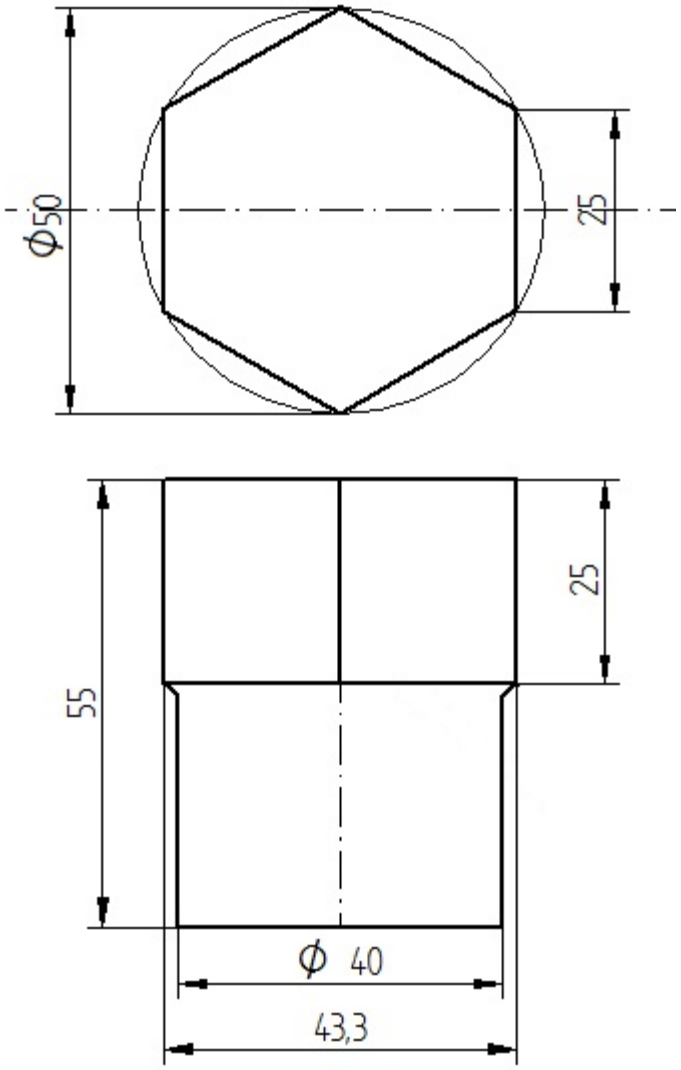
Purpose of shoulder forming:

- For mating parts to fit at right angles against the face of the step.
- To eliminate sharp corners.
- To give additional strength at the junction of steps.
- To give a good appearance.

Filleted shoulders are generally used on parts which require additional strength at the shoulder. The rounded corner is pleasing in appearance and also strengthens the shaft at this point without any increase in the diameter of the part.

Model No.03

[Converting Circular Job In to Hexagonal Shape]



Note: All dimensions are in mm only

Material: M S bright rod

Size: Ø50x 55 Length

Tolerance: ±0.50

Details:

Side of the hexagon = 25 mm

Across corners of the hexagon = 50 mm

Across flats = side × √3 =25×√3=43.30

Thickness = 25 mm

Procedure:

01. Facing both the sides of work piece and maintain the total length.
02. Marking to be done on the face of the work piece as per the sketch.
03. Aligning the across flats lines in the four jaw chuck; facing to be done to achieve the flat surface.
04. Repeat the procedure for all the sides.

VIVA -VOCE

1. What is machine?

A device consisting of fixed and moving parts that modifies mechanical energy and transmits it in a more useful form.

2. What is machine tool?

Machine is a mechanical device which having a provisions for holding the work and tool with on a facilities rotation of work and different feed of the tool.

3. Define the term turning?

Turning is a machining process to bring the raw material to the required shape and size by metal removal. This is done by feeding a single point cutting tool against the direction of rotation of the work.

The machine tool on which turning is carried out is known as lathe.

4. What are the different types of lathes?

Centre lathe, bench lathe, capstan lathe, combination lathe, turret lathe, CNC lathes.

5. What are the differences between the center lathe and Capstan Lathe?

Centre lathe - It is a manually operated lathe, It has only one tool post tool changing time is more, It has tail stock, Only one tool can be fitted in the tail stock, Number of speeds is less, Tool changing time is more, The machine should be stopped for changing tool, It is not suitable for mass production, The tool is centered manually after changing the tool,

Capstan/turret lathe - It is a semi automatic lathe, Front and rear tool posts are available. Tool changing time is less, It has turret head instead of tail stock, Six different tools can be fitted in the turret head. Number of speeds is more, Tool changing time is less, Tool can be changed without stopping the machine, It is suitable for mass production , The tool is centered automatically,

6. How the center lathe can be specified?

- The maximum diameter of a work that can be held
- The length of the bed
- Distance of the between centers
- The range of threads can be cut

- ❖ Capacity of the lathe
- ❖ Range of spindle speed

7. What are the functions of lead screw and feed rod?

lead screw – for thread cutting purpose.

feed rod – to provide automatic feeding either for facing or turning.

8. What are the different methods of taper turning?

1) Compound slide method
2) Tailstock offset method
3) Form tool method
4) Taper turning attachment method

9. What is meant by eccentric turning?

When different diameters are turned on different axis, it is said to be eccentric turning.

10. What is the difference between L.H. thread cutting R.H. thread cutting?

a) A right hand bolt thread screws into the nut when it is rotated clockwise.
b) A right hand bolt thread screws into the nut when it is rotated anticlockwise.

11. Why the knurling operations are necessary for the given models in m/c shop?

a) A good grip and make for positive handling
b) Good appearance
c) For raising the diameter to a small range for assembly to get a desired fit.

12. How the change gears calculations can be done during thread cutting operation for British and Metric pitches?

Standard general formula is,

The gear ratio = driver/driven = pitch of the work/pitch of the lead screw

Gear ratio for cutting metric thread on British lathe

Gear ratio = driver/driven = pitch to be cut on the job/pitch of lead screw

= pitch to be cut in mm x TPI on lead screw x 5/127

Gear ratio for cutting British thread on metric lathe

Gear ratio = driver/driven = pitch to be cut on the job/pitch of lead screw in mm

= 127/5 x pitch of work (TPI)/pitch of lead screw in mm

Note: a translating gear of 127 teeth is provided for cutting metric and British threads on different lead of lead screw i.e. TPI or mm.

13. What are the differences between 3-jaw chuck and 4-jaw chuck?

3 – Jaw chuck

Only cylindrical or hexagonal work center, internal and external jaws are available, setiing of work is easy, less gripping power, work pieces can't be set for eccentric turning, concentric circles are not provided on the face.

4 – Jaw chuck.

A wide range of regular and irregular shaped jobs can be held, jaws are reversible for external and internal holdings, setting of work is difficult, more gripping power, work pieces can be set for eccentric turning, concentric circles are provided.

14. What are the differences between lathe accessories and lathe attachments? Give examples.

a) The *lathe accessories* are machined, independent units supplied with the lathe, which are essential for the full utilization of the lathe,

   Example,

   1) *Work holding accessories* – 4 – jaw chuck, 3 – jaw chuck, face plates, lathe mandrels.
   2) *Work supporting accessories* – catch plate, driving plate, lathe centers, lathe carriers, fixed and travelling steady rests.

b) Attachment is an optional extra attachments to produce tapers, contours, thread forming, grinding, etc…

   Example,

1) Taper turning attachment
2) Forming attachment
3) Cylindrical, grinding, thread, grinding attachment

15. What is meant by single point cutting tool?

Single point cutting tools have one cutting edge which performs the cutting action.

Most of the lathe cutting tools are single point cutting tools.

16. What is meant by multi point cutting tool? Give examples.

These tools have more than one cutting edge and they remove metal from the work piece simultaneously by the action of all the cutting edges,

Ex. Files, hacksaw blade, twist drills, reamers, milling cutters, hand taps, and spilt dies, grinding wheels.

17. What are the properties of cutting tool material?

The most important basic properties of only cutting tool is,

- Cold hardness
- Red hardness
- Toughness

18. What is meant by H.S.S. tool? What are the elements present in that?

HSS (High Speed Steel) is an alloy of high carbon steel with an alloying elements like Tungsten 18%, Chromium 4% and Vanadium of 1%.

19. What is meant by carbide tipped tool?

These tools are made of two different metals, the cutting portions of these tools are tungsten carbide which are brazed to ordinary metal blank which are tough (low cost).

20. Define cutting speed. Feed and depth of cut?

a) *Cutting speed* – "The speed at which the cutting edge passes over material" which is expressed in meters per minute is called the cutting speed.

$V = \Pi DN/1000$ meter/min. (OR) $V = \Pi DN/12$ feed/min.

Where – V = cutting speed in meters/min

$\Pi = 3.14$

D = diameter of work piece in mm

N = R.P.M

b) *Feed* – The feed of the tool is the distance it moves along the work for each revolution of the work. and it is expressed in mm/revolution.

c) *Depth of cut* – It is the advancement of the tool at the beginning of the feed which is perpendicular to the type of feed.

21. What is the spindle speed during thread cutting operation?

Set the spindle speed to about $1/4^{th}$ of the normal turning speed.

22. What is difference between orthogonal cutting and oblique cutting?

Orthogonal cutting – Is a process of cutting operation where only two forces

i.e. tangential and axial forces are acting on the tool while turning

Oblique cutting - Is a process of cutting operation where three forces

i.e. Tangential, axial and radial forces are acting on the cutting tool while turning.

23. Why steady rest and follower rest are used?

A steady rest and follower rest are the lathe accessories used to give extra support for a long slender work piece in addition to the centre support during turning.

24. Why the mandrels are used?

Lathe mandrels are devices used to hold the job for machining on lathes. They are mainly used for machining outside diameters with reference to bores which have been duly finished by either reaming or boring on a lathe.

25. What are the measuring (limit) gauges used while doing/machining components on lathe?

Internal features check	*External features check*
Cylindrical plug gauge	Plain ring gauge
Taper plug gauge	Taper ring gauge
Screw threaded plug gauge	Screw pitch gauge
Fillet gauge	Radius gauge

26. What is the formula for calculating the machining time on lathe?

Time to turn = length of cut x no. of cuts / feed x r p m minutes

(OR)

$T = L \times n / f \times N$ min.

27. Which are the factors governing the cutting speed?

- Finish required
- Depth of cut
- Tool geometry
- Properties of cutting tool material
- Properties of work material
- Type of cutting fluid used
- Rigidity of the machine tool

REFERENCES

01. **Manufacturing Technology,** Serope Kalpakjian, Steuen. R. Sechmid, Pearson Education Asia, 5th Ed. 2006
02. **Production Technology,** R K Jain Khanna Publications, 2003
03. **Production Technology,** HMT, Tata Mc Graw Hill, 2001
04. **Fundaments in Metal Machining and Machine Tools,** G Boothroyed, Mc Graw Hill, 2001
05. **Manufacturing Science,** Amitabha Ghosh and Mallik, affiliated East West Press, 2003