# Part- II
# Machine Tools

# ***Basic Elements of MachineTools***

## *Work holding device:

To hold the work-piece in the correct orientation to achieve the required accuracy in manufacturing (chuck)

## *Tool holding device:

To hold the cutting tool in the correct position with respect to the work-piece and providing holding force to counteract the cutting forces acting on the tool

(Tool post)

## *Work motion mechanism

To provide the necessary speeds to the work-piece for generating the requisite surface (head stock)

## *Tool motion mechanism

To provide the various motions needed for the tool in conjunction with work-piece motion in order to generate the different surface profiles as desired

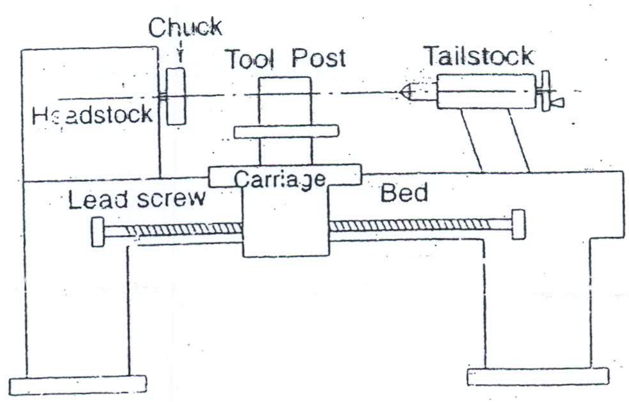
(Carriage)

## *Support Structure:

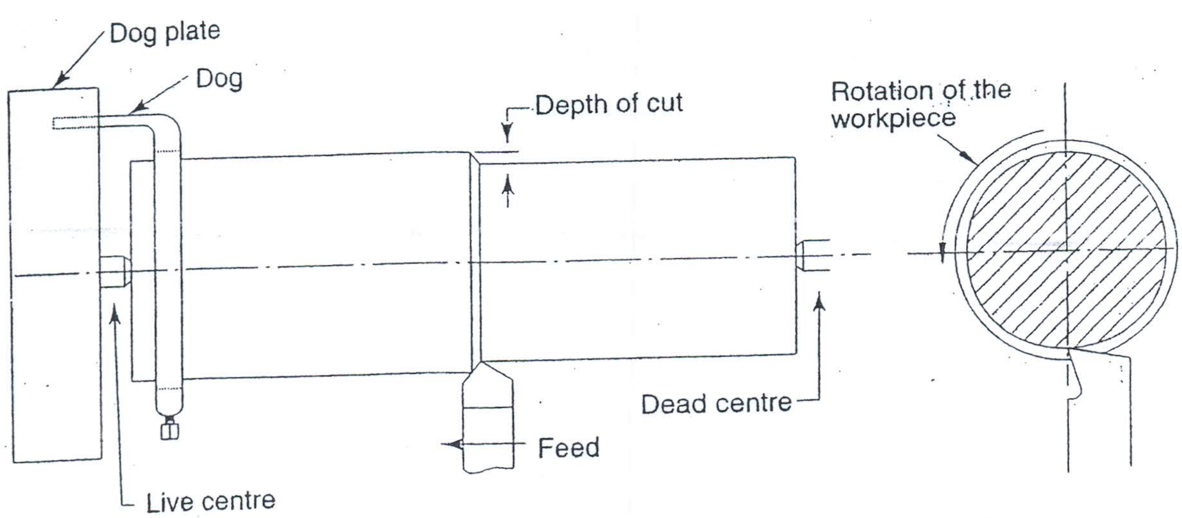
To support all mechanisms as shown above and maintain their relative position with respect to each other and also allow for relative movement between the various parts to obtain the requisite part profile and accuracy ( Bed)

# Center Lathe

- One of the most fundamental machine tools
- The principal form of surface produced in the a lathe is the cylindrical surface
- This is achieved by rotation the work-piece while the single point cutting tool removes the material by traversing in a direction ,parallel to the axis of rotation

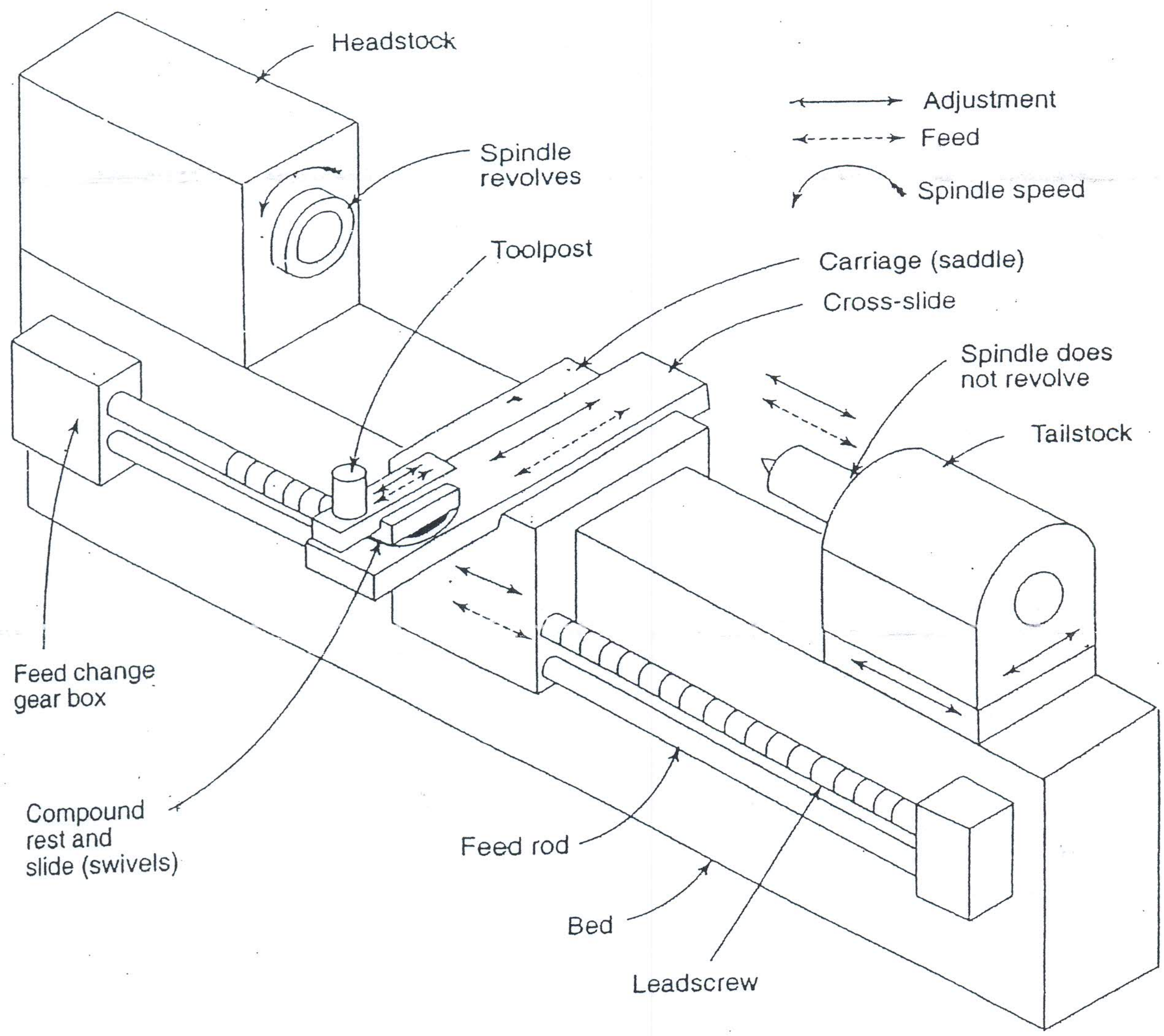



Lathe




*Cylindrical turning operation in a lathe*

# Constructional features of a center lathe




*General view of a centre lathe showing various mechanisms and features*

## ***Types of Lathes***

**1-Center lathe**

**2-Tool room lathe**

**3-Special purpose lathes**

**4-Copying lathe**

**5-Gap bed lath**

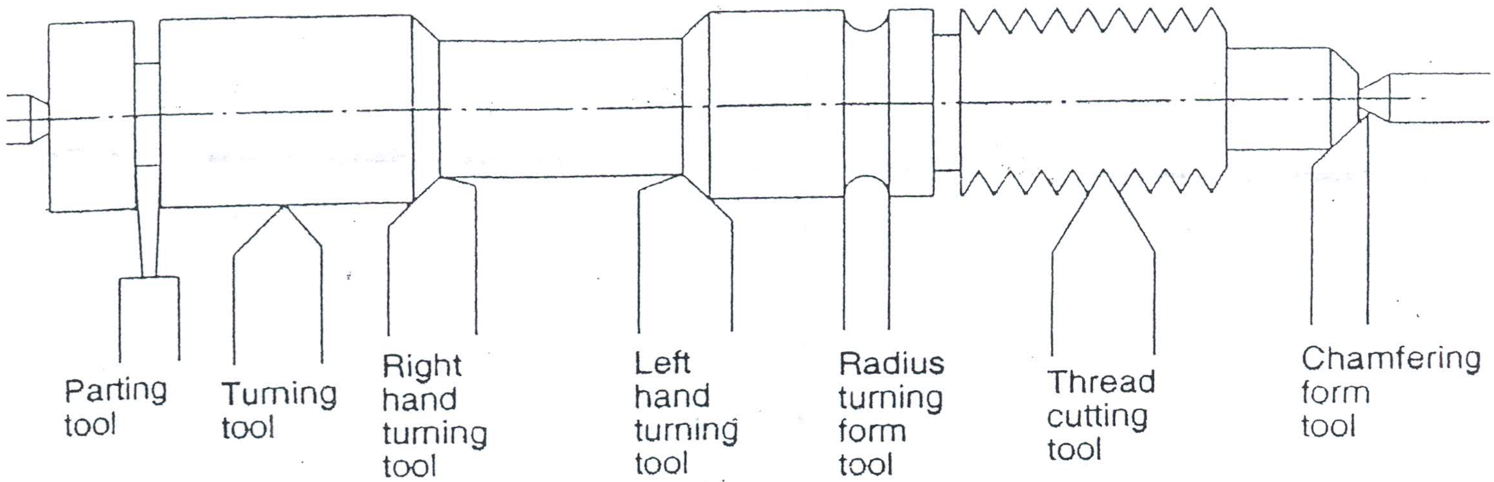
**6-Turret lathes**

**7-Automatic lathes**

**8-CNC Lathes**

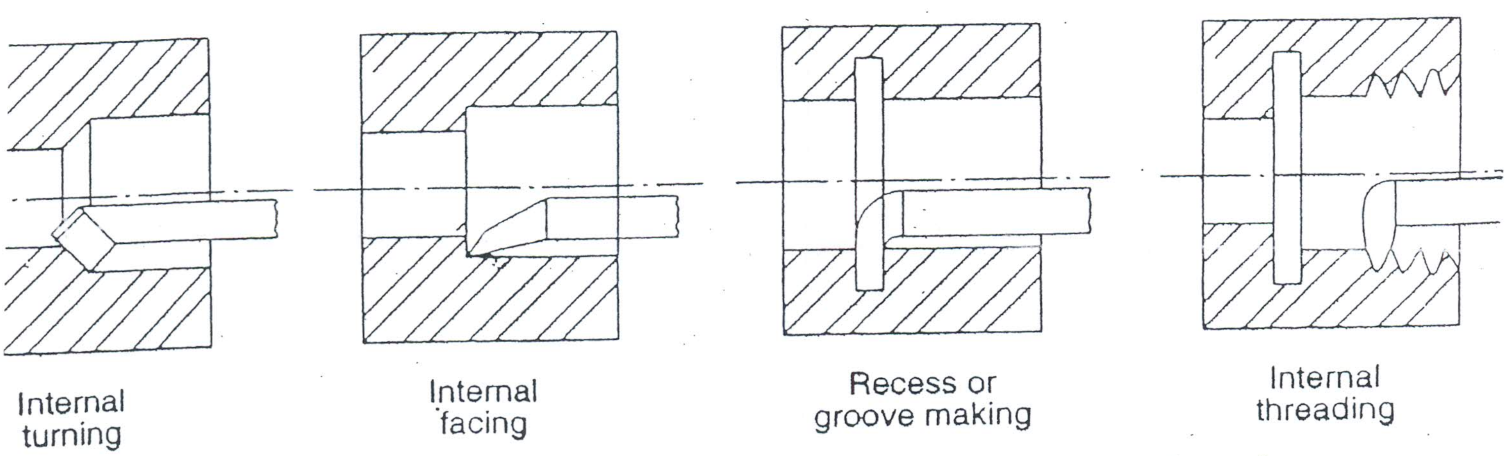
# Different Types of Tools Used

## *Tools for external surfaces




*Different kinds of tools used for external surfaces*

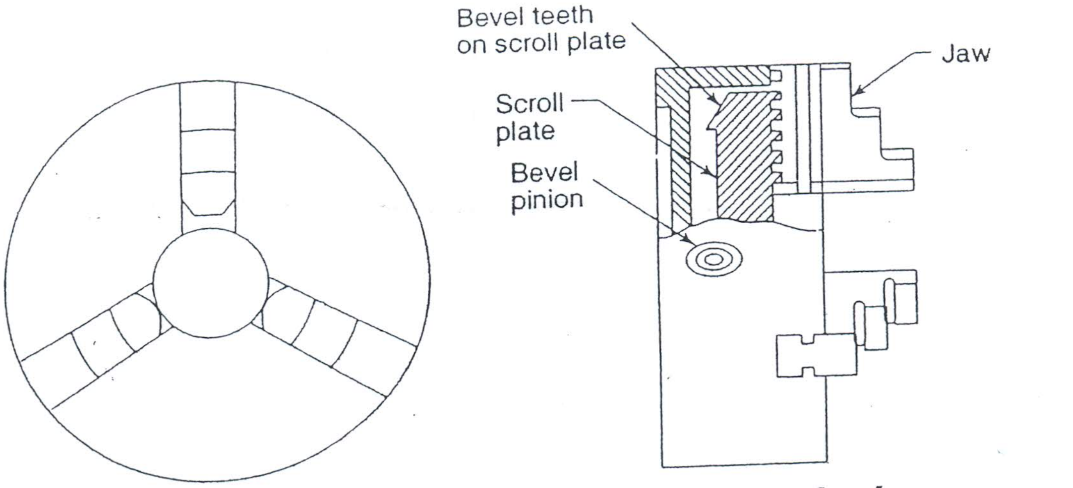
## *Tools for internal surfaces




*Different kinds of tools used for internal surfaces*

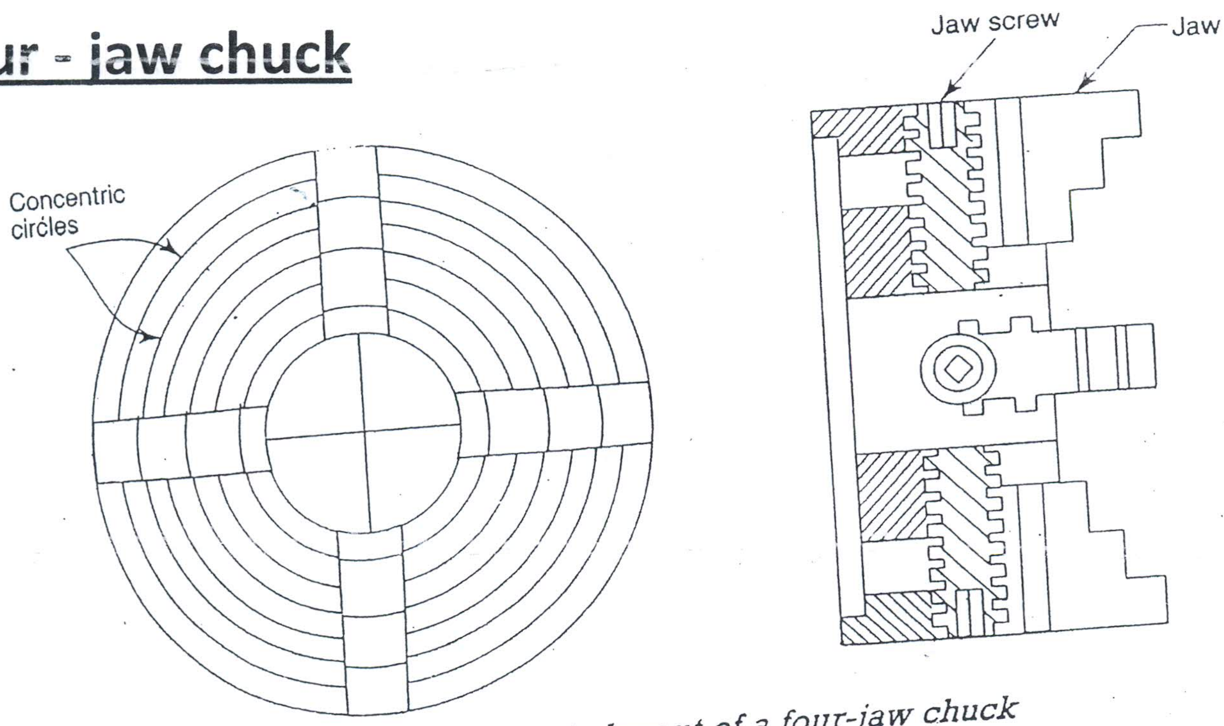
# Chucks

## Three - jaw chuck




*Schematic layout of a three-jaw chuck*

## Four - jaw chuck




*Schematic layout of a four-jaw chuck*

## Face plate

# *Lathe Specifications*

*In order to specify a lathe a number of parameters could be used based on the specific application. The major elements used for specification should be based on the components that would be manufactured in the lathe

## The Main Capacity Specifications for Lathe:

1- Distance between centers

2- Swing over bed

3-Swing over the cross slide

4-Horse power of the motor

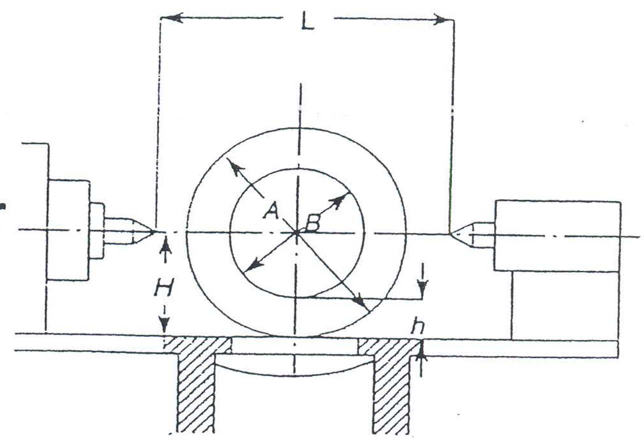
5-Cutting speed range

6-Feed range

7-Screw cutting capacity

8-Accuracy achievable

9-Spindle nose diameter and hole, size




*Capacity specifications for a lathe*

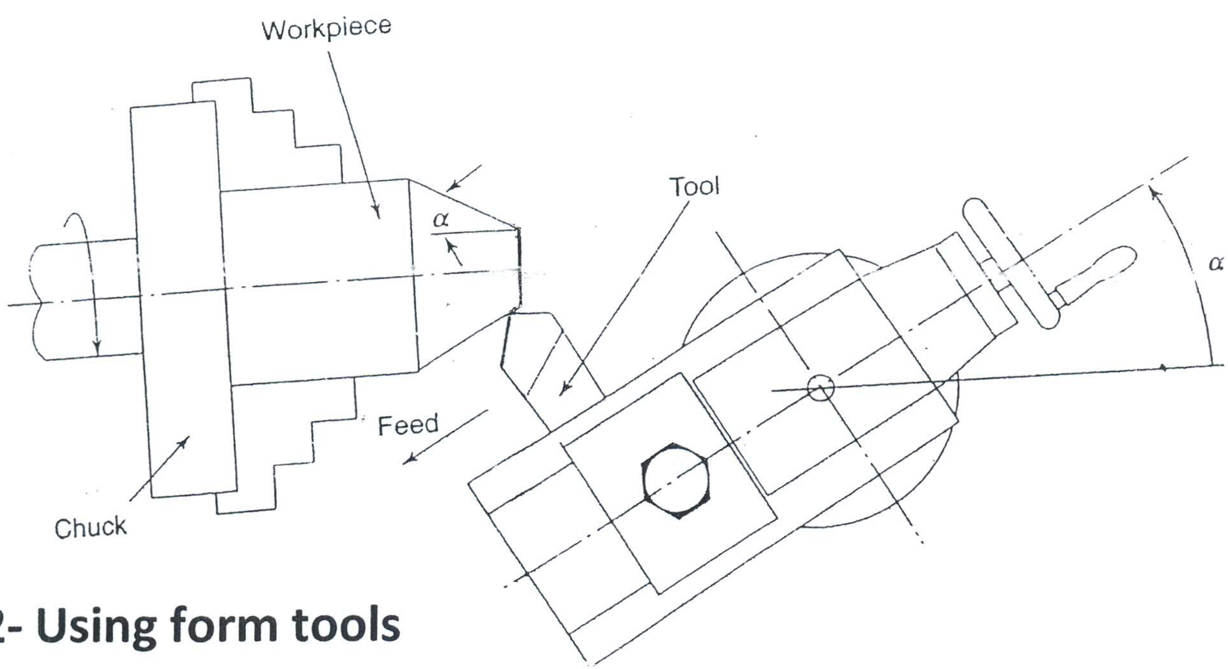
# Operations performed in a center lathe

**Turning, Facing, Knurling, Parting, Drilling, Boring**

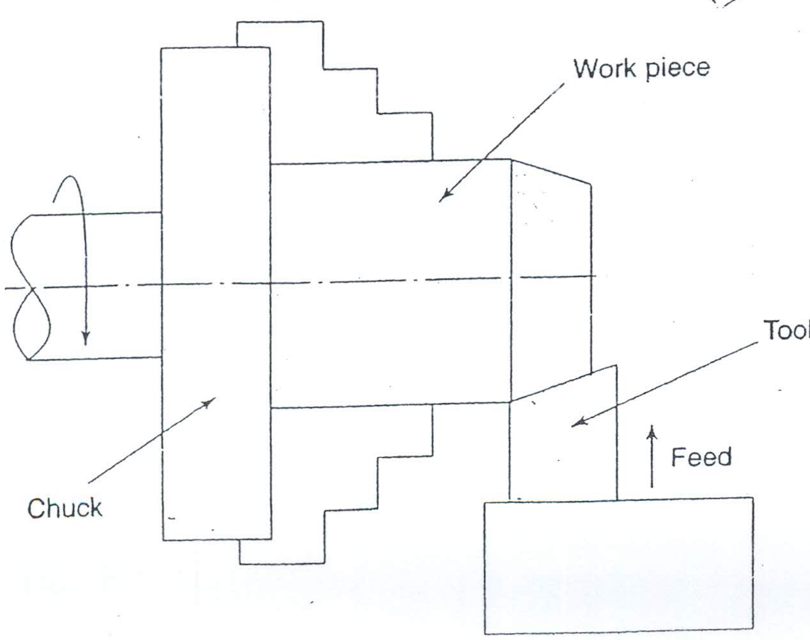
**Threading**

# Taper Turning Methods

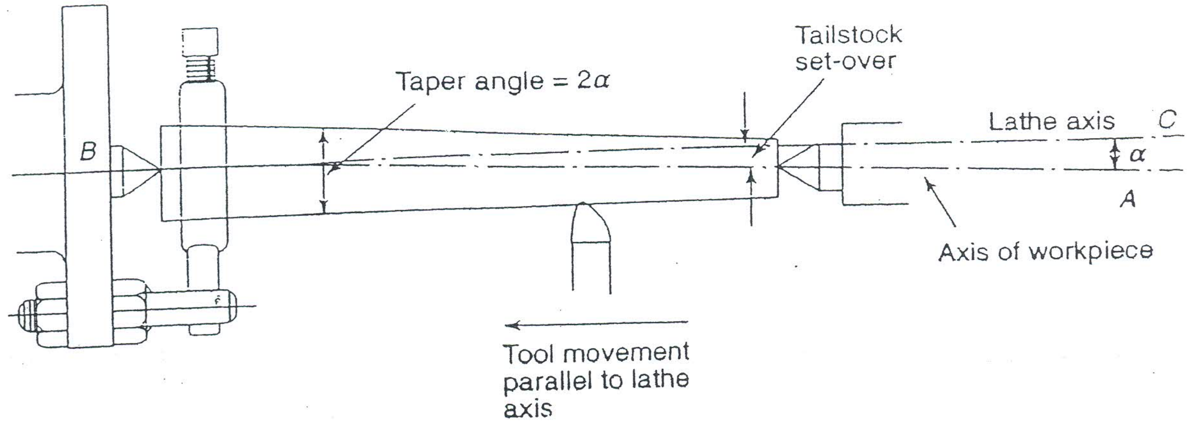
## 1- Using a compound slide



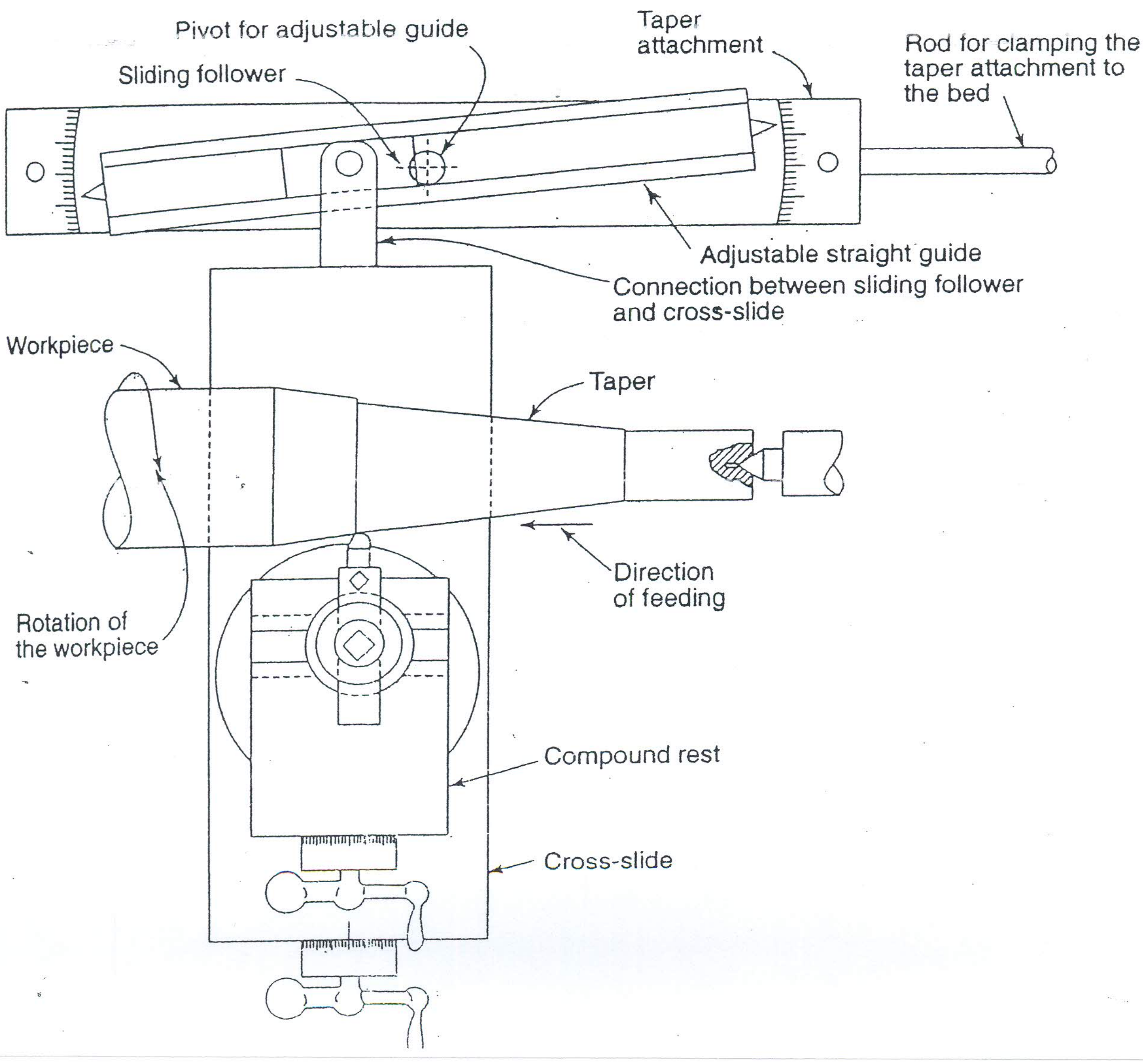

## 2- Using form tools



## 3- Offsetting the tail stock



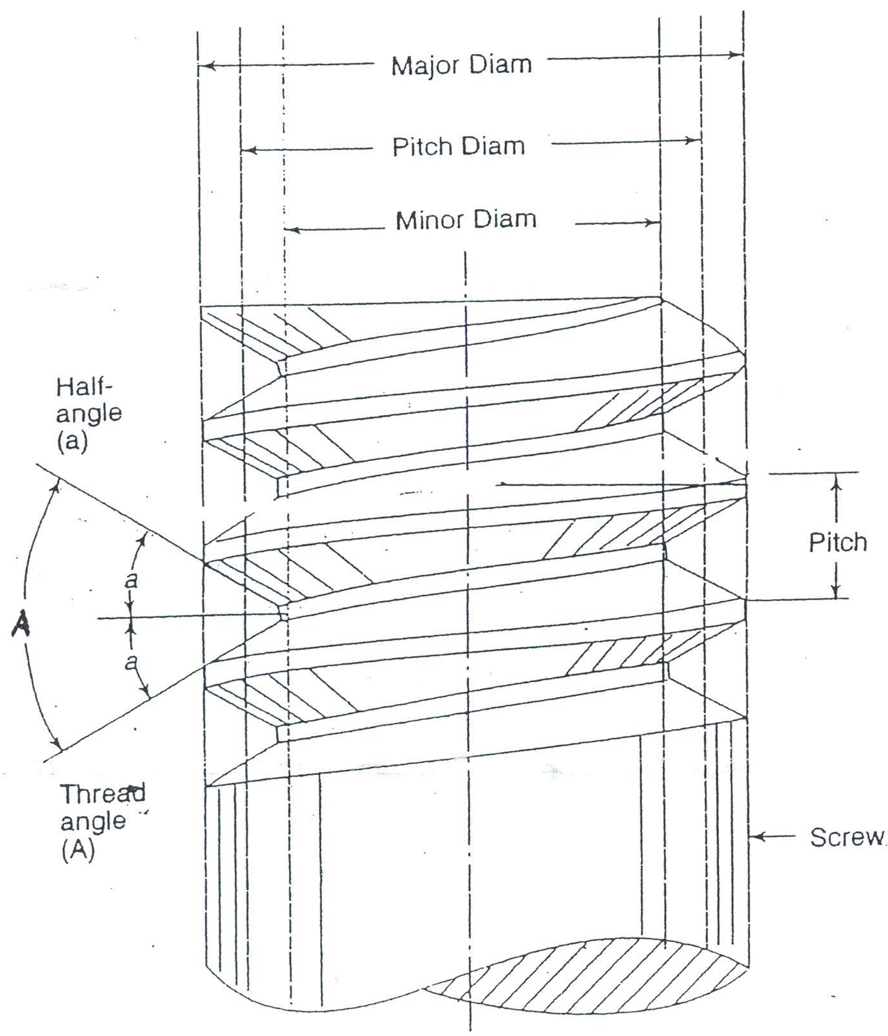

## 4-Using taper turning attachment



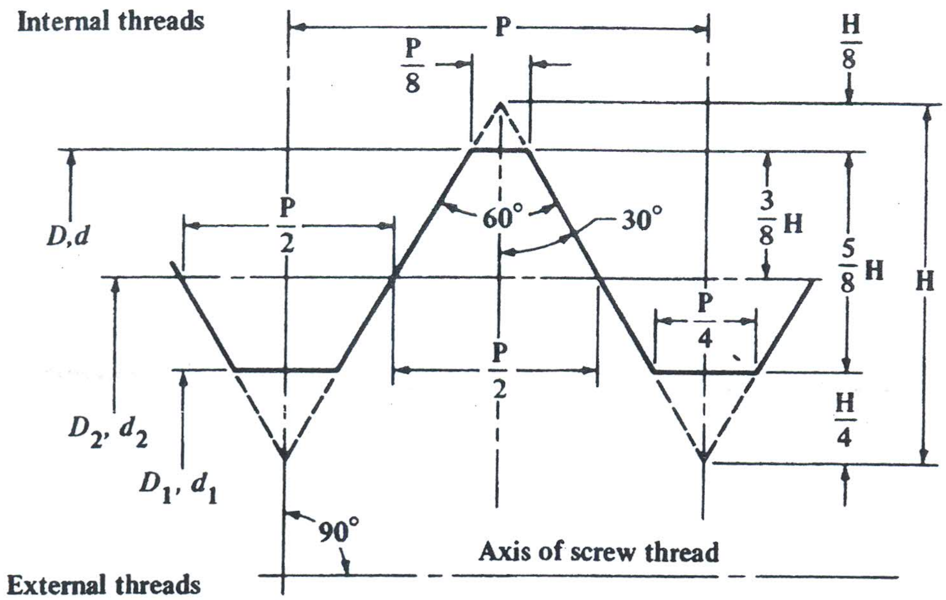
# *Threads*

**Cutting screws is another important task carried out in lathes. There are a large number of thread forms that can be machined in a lathe Such as:**

- **British standard (white worth) BSW**
- **Metric thread (ISO)**
- **American standard**




*Simple thread definition*




$$H = \frac{\sqrt{3}}{2} \times P = 0.866\,025P$$

$0.125H = 0.108\,253P$ $\quad$ $0.250H = 0.216\,506P$ $\quad$ $0.375H = 0.324\,760P$ $\quad$ $0.625H = 0.541\,266P$

# THREADS
## British and American Symbols

### A - Symbols used for British Threads

| | | |
|---|---|---|
| B S W | : | British Standard Whitworth Coarse Thread Series |
| B S F | : | British Standard Fine Thread Series |
| B S P T | : | British Standard Taper Pipe Thread |
| B S P P | : | British Standard Pipe (Parallel) Thread |
| WHIT | : | Whitworth Standard Special Thread |
| B A | : | British Association Standard Thread |

### B - Symbols used for American Threads

| | | |
|---|---|---|
| N C | : | American National Coarse Thread Series |
| N F | : | American National Fine Thread Series |
| N E F | : | American National Extra Fine Thread Series |
| N | : | American National 8, 12 and 16 Pitch Series (8N, 12N, 16N) |
| N S | : | Special Threads of American National Form |
| N H | : | American National Hose Coupling and Fire Hose Coupling Thread |
| N P T | : | American Standard Taper Pipe Thread |
| N P T F | : | American Standard Taper Pipe Thread (Dryseal) |
| N P T R | : | American Standard Taper Pipe Thread for Railing Fittings |
| A N P T | : | Army-Navy Aeronautical Pipe Thread Specification (AN-P-363) |
| N P S | : | American Standard Straight Pipe Thread |
| N P S C | : | American Standard Straight Pipe Thread for Pipe Couplings |
| N P S F | : | American Standard Internal Straight Pipe Thread (Dryseal) |
| N P S H | : | American Standard Straight Pipe Thread for Hose Couplings and Nipples |
| N P S I | : | American Standard Intermediate Internal Straight Pipe Thread (Dryseal) |
| A C M E | : | Acme Threads (Acme-C) Centralizing, (Acme-G) General Purpose |
| S T U B A C M E | : | Stub Acme Threads |
| N G O | : | American National Gas Outlet Thread |
| V | : | A 60 'V' thread with truncated crests and roots |

Classes of Tolerances NC - NF - NEF - N - NS :

| Class 1 | Class 2 | Class 3 | Class 4 |
|---|---|---|---|
| Loose Fit | Free Fit | Medium Fit | Close Fit |

# THREADS
## British and American Threads

MACHINE DESIGN
TRD-68-04

## British Standard Threads

### B. S. Whitworth threads

| Size designation | Minor diameter, mm. | Number of threads per inch |
|---|---|---|
| W 1/16" | 1.05 | 60 |
| W 3/32" | 1.70 | 48 |
| W 1/8" | 2.36 | 40 |
| W 5/32" | 2.95 | 32 |
| W 3/16" | 3.41 | 24 |
| W 7/32" | 4.20 | 24 |
| W 1/4" | 4.72 | 20 |
| W 5/16" | 6.13 | 18 |
| W 3/8" | 7.49 | 16 |
| W 7/16" | 8.79 | 14 |
| W 1/2" | 9.99 | 12 |
| W 9/16" | 11.58 | 12 |
| W 5/8" | 12.92 | 11 |
| W 3/4" | 15.80 | 10 |
| W 7/8" | 18.61 | 9 |
| W 1" | 21.33 | 8 |
| W 1 1/8" | 23.93 | 7 |
| W 1 1/4" | 27.10 | 7 |
| W 1 3/8" | 29.50 | 6 |
| W 1 1/2" | 32.68 | 6 |
| W 1 5/8" | 34.77 | 5 |
| W 1 3/4" | 37.94 | 5 |
| W 1 7/8" | 40.40 | 4 1/2 |
| W 2" | 43.57 | 4 1/2 |
| W 2 1/4" | 49.02 | 4 |
| W 2 1/2" | 55.37 | 4 |
| W 2 3/4" | 60.56 | 3 1/2 |
| W 3" | 66.91 | 3 1/2 |

B. S. Whitworth threads
DIN 11

### B. S. Fine threads

| Size designation | Minor diameter, mm. |
|---|---|
| W 3/16" – 32 | 3.75 |
| W 7/32" – 28 | 4.40 |
| W 1/4" – 26 | 5.10 |
| W 5/16" – 22 | 6.46 |
| W 3/8" – 20 | 7.90 |
| W 7/16" – 18 | 9.31 |
| W 1/2" – 16 | 10.67 |
| W 9/16" – 16 | 12.25 |
| W 5/8" – 14 | 13.55 |
| W 3/4" – 12 | 16.34 |
| W 7/8" – 11 | 19.27 |
| W 1" – 10 | 22.15 |
| W 1 1/8" – 9 | 24.96 |
| W 1 1/4" – 9 | 28.14 |
| W 1 3/8" – 8 | 30.86 |
| W 1 1/2" – 8 | 34.03 |
| W 1 5/8" – 8 | 37.21 |
| W 1 3/4" – 7 | 39.80 |
| W 1 7/8" – 7 | 42.98 |
| W 2" – 7 | 46.15 |
| W 2 1/4" – 6 | 51.73 |
| W 2 1/2" – 6 | 58.08 |
| W 2 3/4" – 6 | 64.43 |
| W 3" – 5 | 69.69 |

B. S. Fine threads

### B. S. Pipe threads

| Size designation | Minor diameter, mm. | Number of threads per inch |
|---|---|---|
| R 1/8" | 8.57 | 28 |
| R 1/4" | 11.45 | 19 |
| R 3/8" | 14.95 | 19 |
| R 1/2" | 18.63 | 14 |
| R 5/8" | 20.59 | 14 |
| R 3/4" | 24.12 | 14 |
| R 7/8" | 27.88 | 14 |
| R 1" | 30.29 | 11 |
| R 1 1/8" | 34.94 | 11 |
| R 1 1/4" | 38.95 | 11 |
| R 1 3/8" | 41.37 | 11 |
| R 1 1/2" | 44.85 | 11 |
| R 1 5/8" | 48.37 | 11 |
| R 1 3/4" | 50.79 | 11 |
| R 2" | 56.66 | 11 |
| R 2 1/4" | 62.75 | 11 |
| R 2 1/2" | 72.23 | 11 |
| R 2 3/4" | 78.58 | 11 |
| R 3" | 84.93 | 11 |
| R 3 1/4" | 91.02 | 11 |
| R 3 1/2" | 97.37 | 11 |
| R 3 3/4" | 103.72 | 11 |
| R 4" | 110.07 | 11 |

B. S. Pipe threads
DIN 259

## American Standard Threads

### American coarse threads

| Size designation | Minor diameter, mm. |
|---|---|
| NC No. 1 – 64 | 1.34 |
| NC No. 2 – 56 | 1.60 |
| NC No. 3 – 48 | 1.83 |
| NC No. 4 – 40 | 2.02 |
| NC No. 5 – 40 | 2.35 |
| NC No. 6 – 32 | 2.47 |
| NC No. 8 – 32 | 3.13 |
| NC No. 10 – 24 | 3.45 |
| NC No. 12 – 24 | 4.11 |
| NC 1/4" – 20 | 4.70 |
| NC 5/16" – 18 | 6.10 |
| NC 3/8" – 16 | 7.46 |
| NC 7/16" – 14 | 8.76 |
| NC 1/2" – 13 | 10.16 |
| NC 9/16" – 12 | 11.54 |
| NC 5/8" – 11 | 12.88 |
| NC 3/4" – 10 | 15.75 |
| NC 7/8" – 9 | 18.56 |
| NC 1" – 8 | 21.28 |
| NC 1 1/8" – 7 | 23.86 |
| NC 1 1/4" – 7 | 27.04 |
| NC 1 3/8" – 6 | 29.43 |
| NC 1 1/2" – 6 | 36.60 |

*American coarse threads*

### American fine threads

| Size designation | Minor diameter, mm. |
|---|---|
| NF No. 3 – 56 | 1.93 |
| NF No. 4 – 48 | 2.16 |
| NF No. 5 – 44 | 2.43 |
| NF No. 6 – 40 | 2.68 |
| NF No. 8 – 36 | 3.25 |
| NF No. 10 – 32 | 3.80 |
| NF No. 12 – 28 | 4.31 |
| NF 1/4" – 28 | 5.17 |
| NF 5/16" – 24 | 6.56 |
| NF 3/8" – 24 | 8.15 |
| NF 7/16" – 20 | 9.46 |
| NF 1/2" – 20 | 11.05 |
| NF 9/16" – 18 | 12.45 |
| NF 5/8" – 18 | 14.04 |
| NS 11/16" – 16 | 15.40 |
| NF 3/4" – 16 | 16.99 |
| NF 7/8" – 14 | 19.87 |
| NF 1" – 14 | 23.04 |
| NF 1 1/8" – 12 | 25.83 |
| NF 1 1/4" – 12 | 29 |
| NF 1 1/2" – 12 | 35.35 |

*American fine threads*

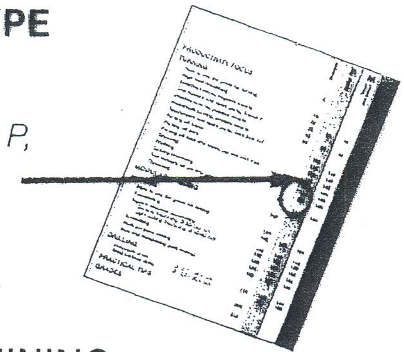
ASA B1.1-1949

Extracts from DIN 11, 259 and ASA B1.1-1949.

# HOW TO USE THE GUIDE FOR TURNING

## 1 DEFINE YOUR MATERIAL AND TYPE OF OPERATION

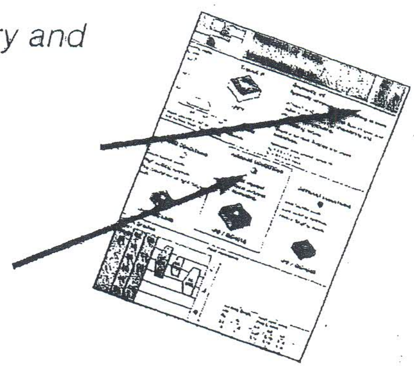
*Define your material acccrding to ISO P, M and K and identify your operation from the table of contents.*



## 2 DEFINE APPLICATION AND MACHINING CONDITIONS

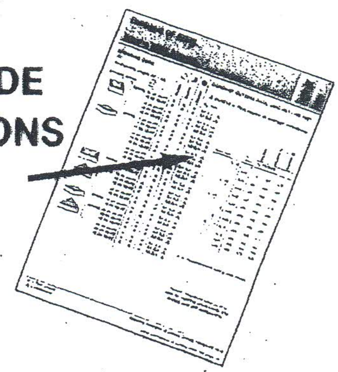
*Locate your first choice insert geometry and grade by:*

| | | |
|---|---|---|
| F / M / R | *Application:* | *Finishing* |
| | | *Medium* |
| | | *Roughing* |
| ○ / ◐ / ● | *Conditions:* | *Good* |
| | | *Normal* |
| | | *Difficult* |



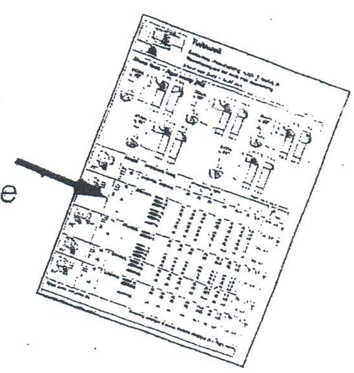
## 3 CHOOSE INSERT WITH ORDERING CODE AND CUTTING DATA RECOMMENDATIONS

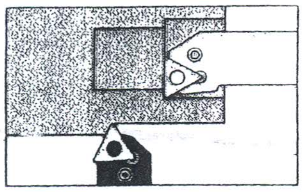
*Select the insert from the ordering page and see the speed, feed and depth of cut recommendations.*



## 4 CHOOSE YOUR TOOLHOLDER

*Select the toolholder using the insert shape and size.*

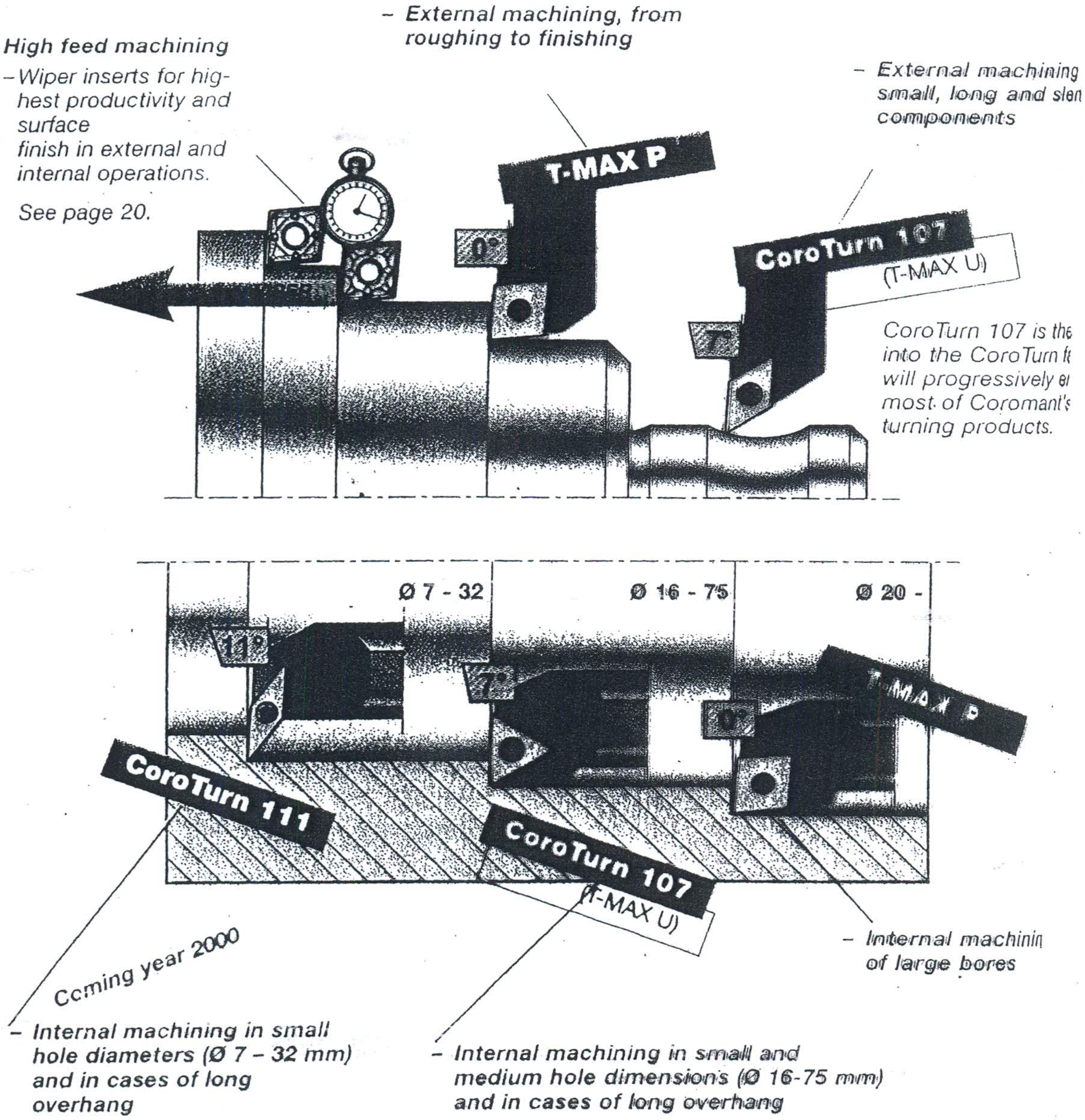




# TURNING TOOLS

## How to choose the right tool for your operation

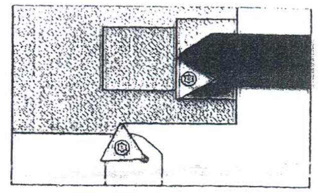
## EXTERNAL MACHINING




## INTERNAL MACHINING

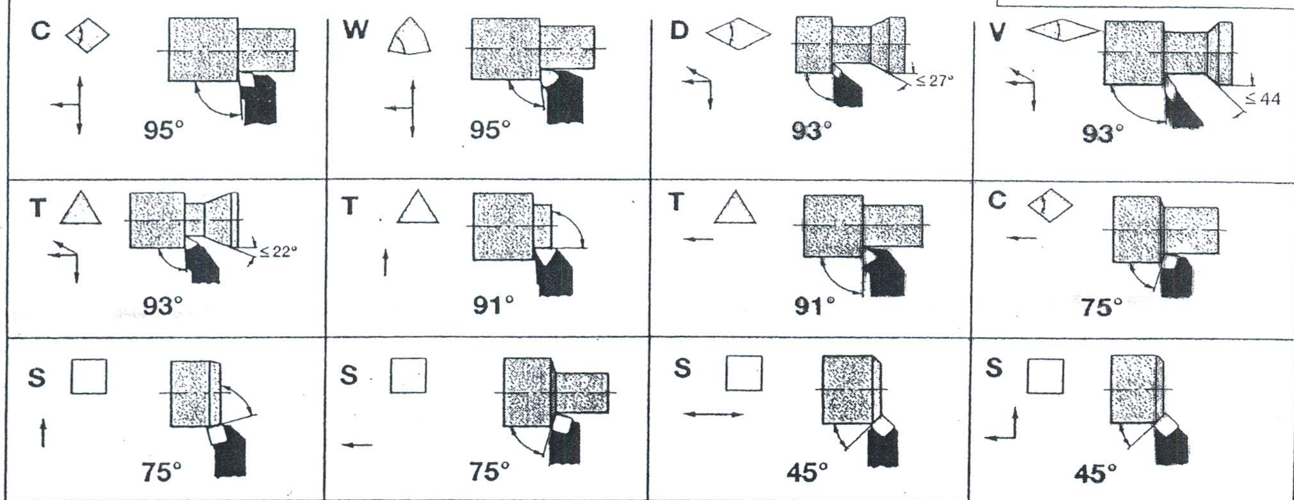
# TURNING TOOLS

**Turning with T-MAX P and CoroTurn 107 in steel, stainless steel and cast iron**

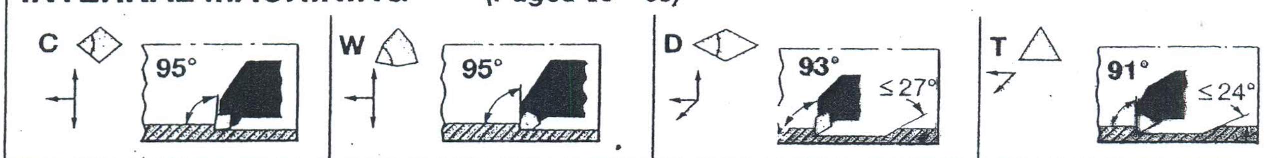


**T-MAX P**
*Top clamp*

## EXTERNAL MACHINING *(Pages 52 - 59)*



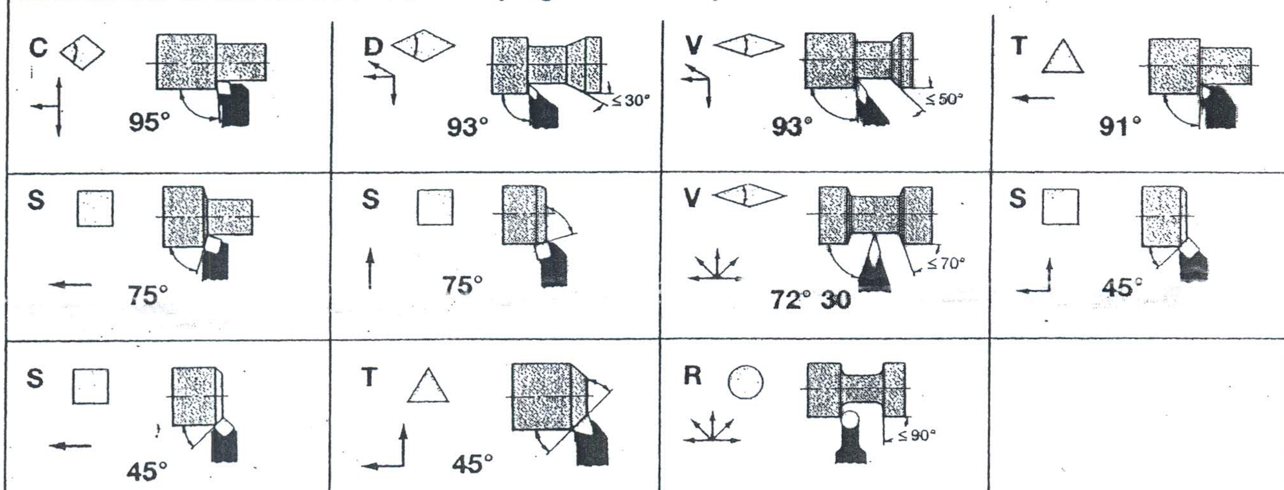

## INTERNAL MACHINING *(Pages 60 - 63)*




## INTERNAL MACHINING *(Pages 112 - 116)*

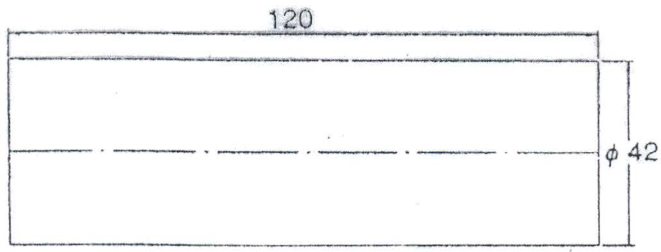
**CoroTurn 107**
*Screw clamp*


## EXTERNAL MACHINING *(Pages 106 - 111)*




**Insert shape:** **C** = *80° rhombic,* **D** = *55° rhombic,* **R** = *round,* **S** = *square,* **T** = *triangular,* **V** = *35° rhombic,* **W** = *trigon*

*Estimate the actual machining time required for the component (C40 steel) shown in Fig. 4.33. The available spindle speeds are 70, 110, 176, 280, 440, 700, 1100, 1760 and 2800. Use a roughing speed of 30 m/min and finish speed of 60 m/min. The feed for roughing is 0.24 mm/rev while that for finishing is 0.10 mm/rev. The maximum depth of cut for roughing is 2 mm. Finish allowance may be taken as 0.75 mm. Blank to be used for machining is 50 mm in diameter.*




$$\text{Stock to be removed} = \frac{50 - 42}{2} = 4 \text{ mm}$$

Finish allowance = 0.75 mm

***Roughing*** Roughing stock available = 4 – 0.75 = 3.25 mm

Since max. depth of cut to be taken is 2 mm, there are two roughing passes.

Given cutting speed $V$ = 30 m/min

$$\text{Average depth of cut} = \frac{50 + 42}{2} = 46 \text{ mm}$$

$$\text{Spindle speed } N = \frac{1000 \times 30}{\pi \times 46} = 207.59 \text{ RPM}$$

The nearest RPM available from the list is 176 RPM as 280 is very high compared to 207 as calculated.

$$\text{Machining time for one pass} = \frac{(120 + 2)}{0{:}24 \times 176} = 2.898 \text{ minutes}$$

***Finishing*** Given cutting speed $V$ = 60 m/min

$$\text{Spindle speed } N = \frac{1000 \times 30}{\pi \times 42} = 439.05 \text{ RPM}$$

The nearest RPM available from the list is 440 RPM.

$$\text{Machining time for one pass} = \frac{(120 + 2)}{0.10 \times 440} = 2.77 \text{ minutes}$$

Total machining time = 2 × 2.883 + 2.77 = 8.546 minutes