# Metal Cutting - 4

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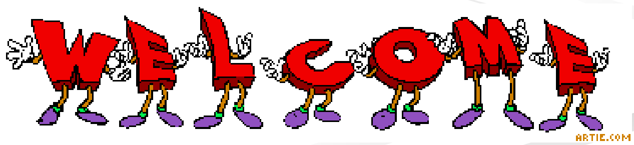



## Content

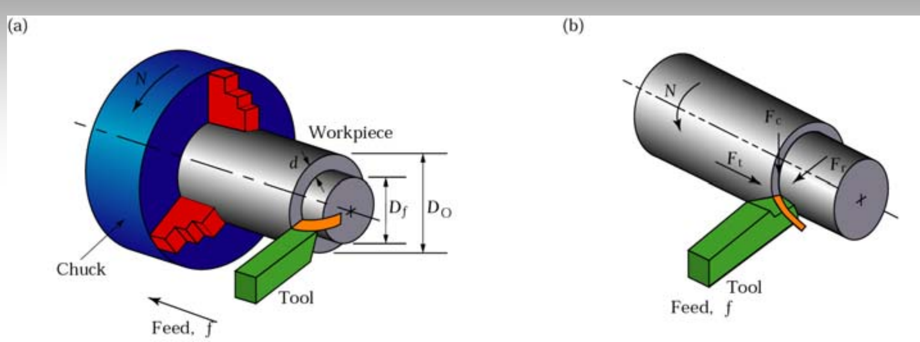
# 6.1 Pengenalan

**What is turning?**

- Turning is the machining operation that produces cylindrical parts. In its basic form, it can be defined as the machining of an external surface:
  - with the workpiece rotating,
  - with a single-point cutting tool, and
  - with the cutting tool feeding parallel to the axis of the workpiece and at a distance that will remove the outer surface of the work.
- Taper turning is practically the same, except that the cutter path is at an angle to the work axis. Similarly, in contour turning, the distance of the cutter from the work axis is varied to produce the desired shape.
- Even though a single-point tool is specified, this does not exclude multiple-tool setups, which are often employed in turning. In such setups, each tool operates independently as a single-point cutter.



# 6.1 Pengenalan




(a) Schematic illustration of a turning operation showing depth of cut, *d*, and feed, *f*. Cutting speed is the surface speed of the workpiece and the *Fc,* is the cutting force, *Ft* is the thrust or feed force (in the direction of feed, *Fr* is the radial force that tends to push the tool away from the workpiece being machined.

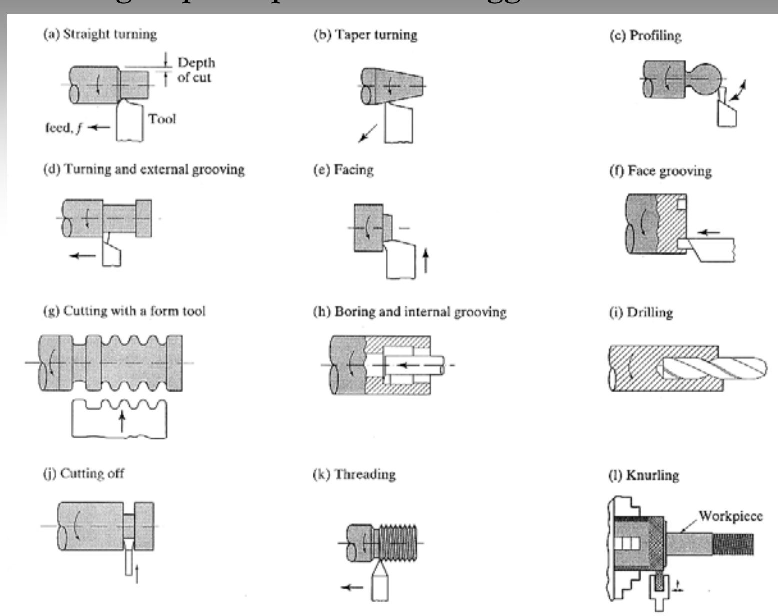
### Adjustable cutting factors in turning

***The three primary factors in any basic turning operation are speed, feed, and depth of cut. Other factors such as kind of material and type of tool have a large influence, of course, but these three are the ones the operator can change by adjusting the controls, right at the machine.***

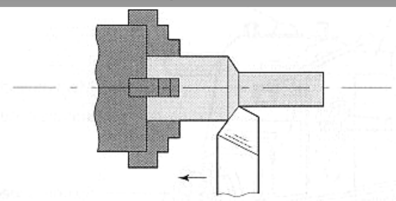
- ***Speed,*** always refers to the spindle and the workpiece. When it is stated in revolutions per minute (rpm) it tells their rotating speed. But the important figure for a particular turning operation is the surface speed, or the speed at which the workpiece material is moving past the cutting tool. It is simply the product of the rotating speed times the circumference (in meter) of the workpiece before the cut is started. It is expressed in surface meter per minute (m/min), and it refers only to the workpiece. Every different diameter on a workpiece will have a different cutting speed, even though the rotating speed (N) remains the same.
- ***Feed,*** always refers to the cutting tool, and it is the rate at which the tool advances along its cutting path. On most power-fed lathes, the feed rate is directly related to the spindle speed and is expressed in mm (of tool advance) per revolution ( of the spindle), or mm/rev.
- ***Depth of Cut,*** is practically self explanatory. It is the thickness of the layer being removed from the workpiece or the distance from the uncut surface of the work to the cut surface, expressed in mm. It is important to note, though, that the diameter of the workpiece is reduced by two times the depth of cut because this layer is being removed from both sides of the work.



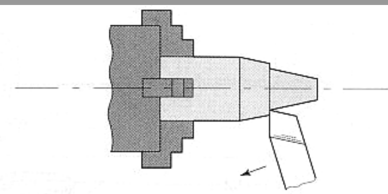
## 6.2 Pelbagai operasi pemesinan menggunakan mesin larik



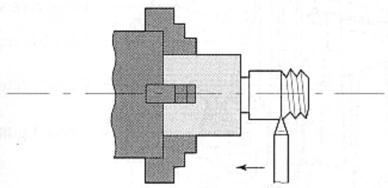
## 6.2 Pelbagai operasi pemesinan menggunakan mesin larik



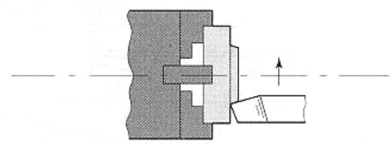
**Cylindrical turning**
The tool moves parallel to the axis of the workpiece
The feed/rev is kept small to improve the surface finish



**Conical (taper) turning**
The tool moves at an angle to the axis of the workpiece
The feed/rev is kept small to improve the surface finish



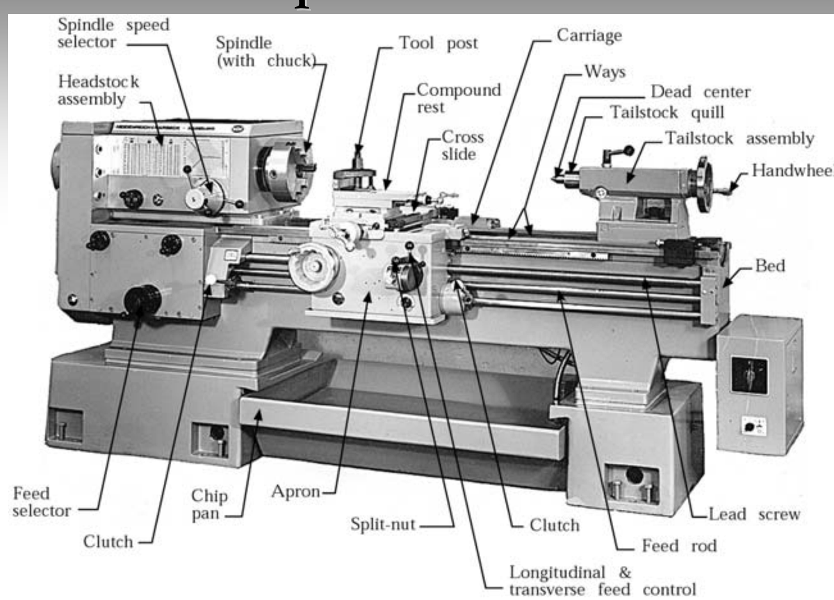
**Screw cutting**
The tool moves parallel to the axis of the workpiece
The feed/rev is coarse and equals the lead of the thread being cut: Lead = pitch × number of starts



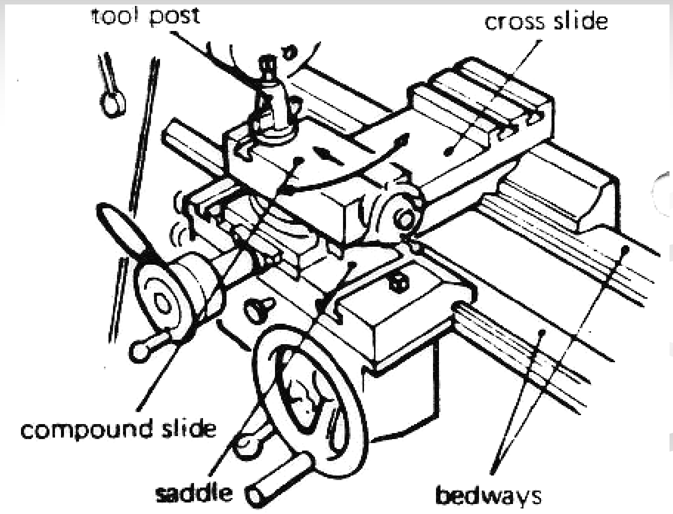
**Surfacing (facing)**
The tool moves along a path perpendicular (90°) to the axis of the workpiece
The feed/rev is kept small to improve the finish



## 6.3 Components of a Lathe

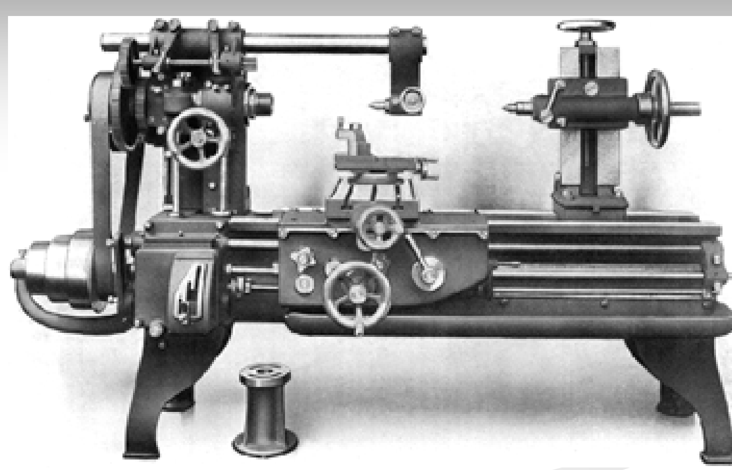


# The Saddle






# 6.4 Jenis Mesin Larik



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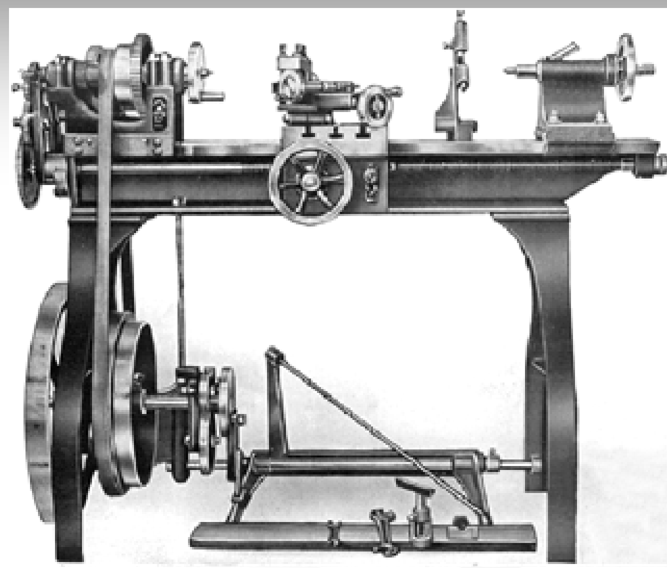

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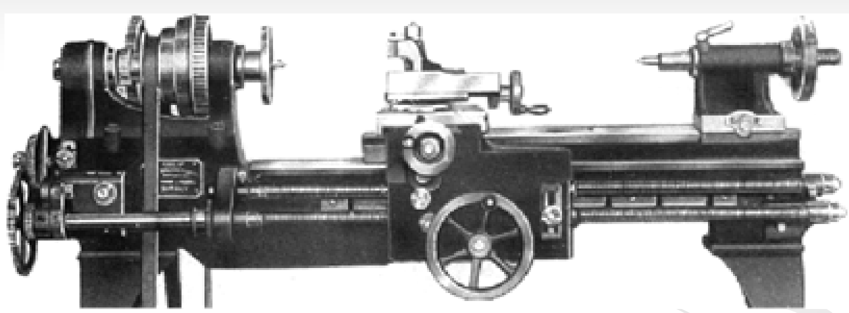

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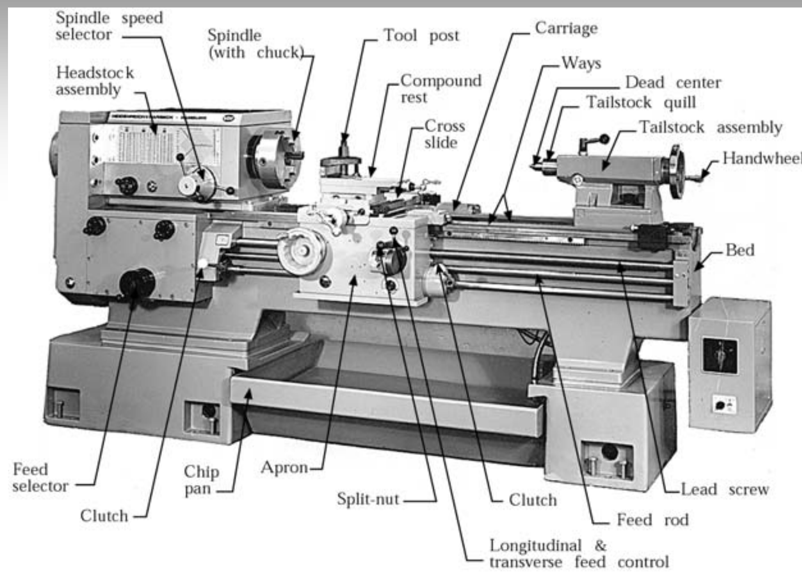
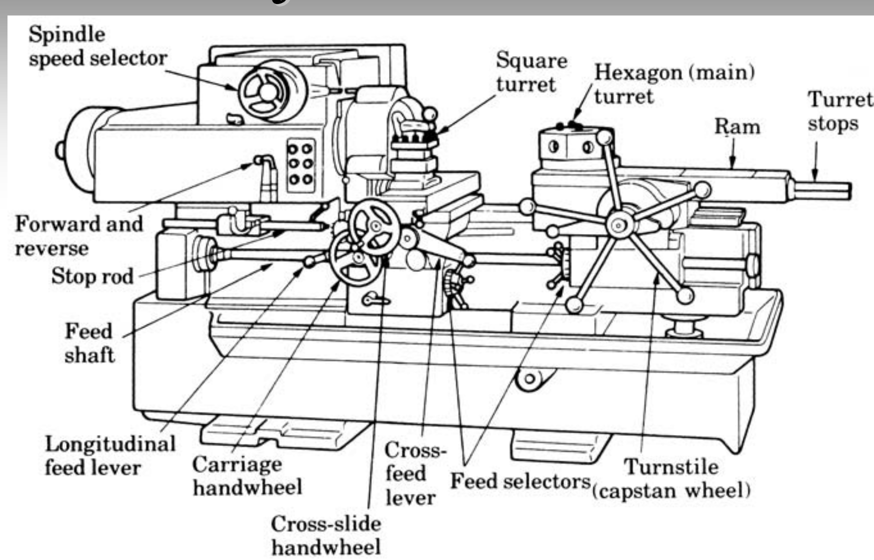





# 6.4 Jenis mesin larik



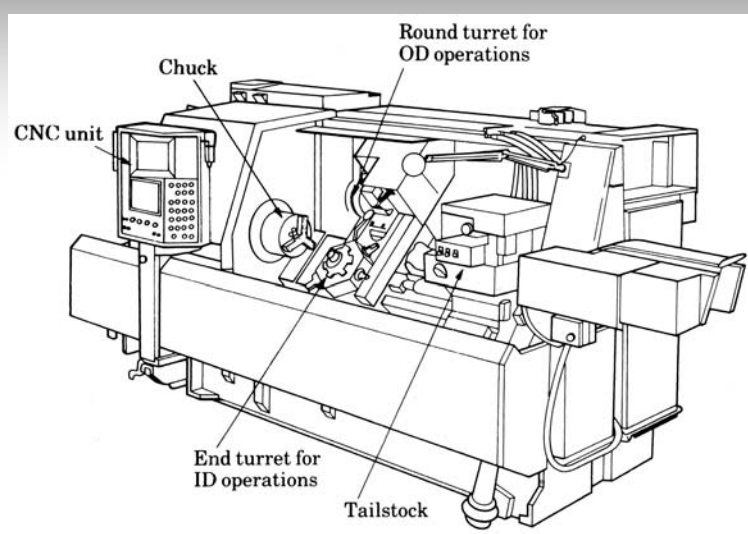
# 6.4 Jenis Mesin Larik

## Turret lathe

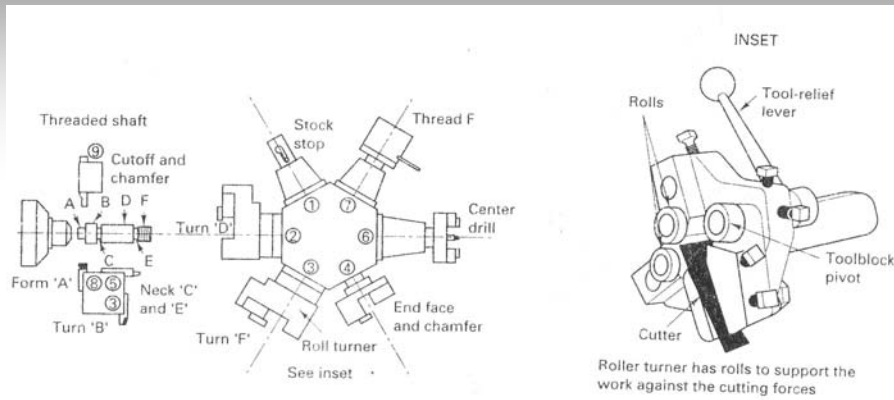
- The **turret lathe** is a form of metal cutting lathe that is used for short production runs of parts. The "turret" part of the name is a special style of tailstock that can hold up to 6 tools with straight shanks. By pushing the handlever forward, the tool is moved toward the workpiece held in the headstock, eventually making contact and cutting or forming the part. On the return stroke, the tool is retracted and indexed to the next tool held in the turret. In this way, a sequence of operations can be performed on a part without switching tools with each operation. (That is, different tools can be shifted into position without the need to unscrew one and screw in another). Each tool can be set for a different travel by a stop screw located at the far right of the turret.



# 6.4 Jenis mesin larik



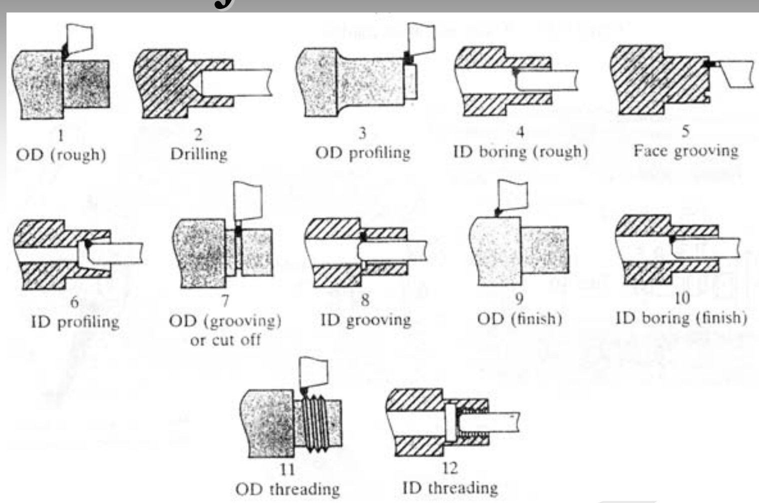
# 6.4 Jenis mesin larik




**Turret lathe tooling set-up for producing part shown. Numbers in circles indicate the sequence of operation from 1 to 9. Operation 3 is a combined operation. The roll turner is turning surface F while tool 3 on the square post is turning surface B.**

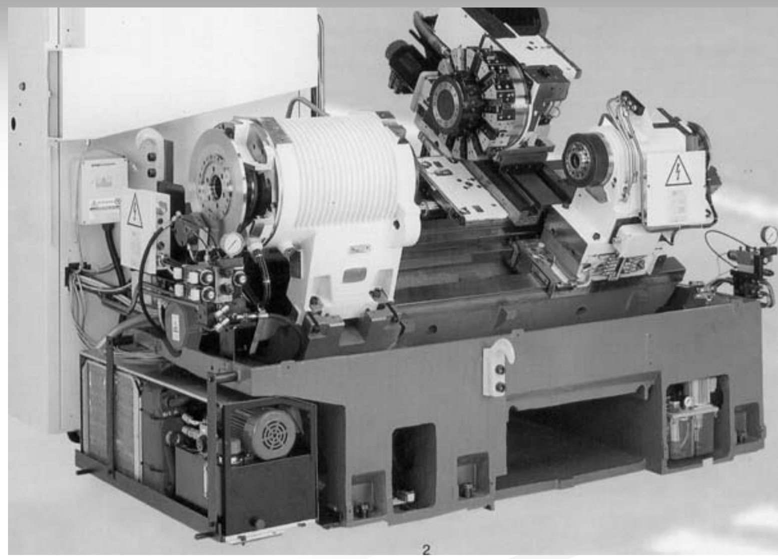


# 6.4 Jenis mesin larik



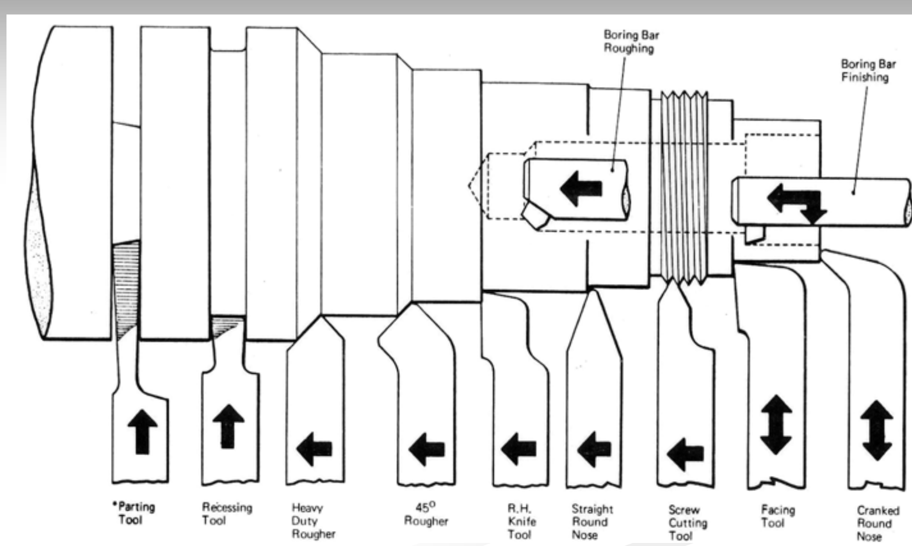

**Using a disk turret which can hold 12 to 14 tools for a variety of internal and external machining operations**

# 6.4 Jenis Mesin Larik





# 6.5 Lathe tool



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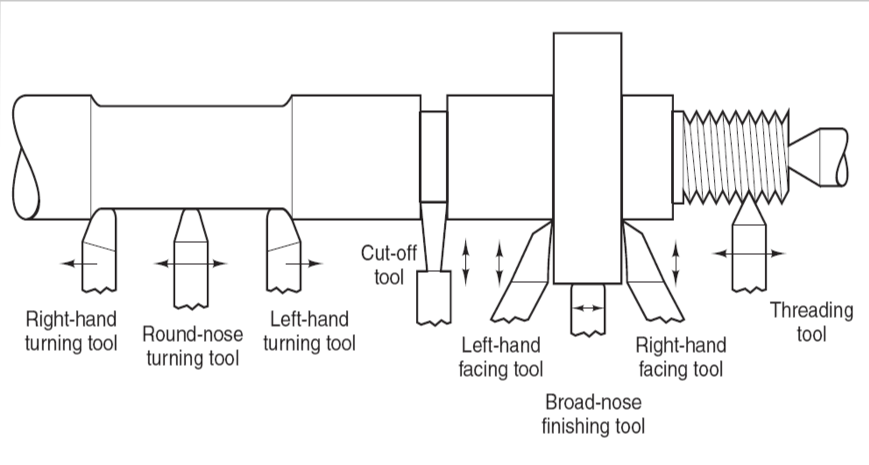




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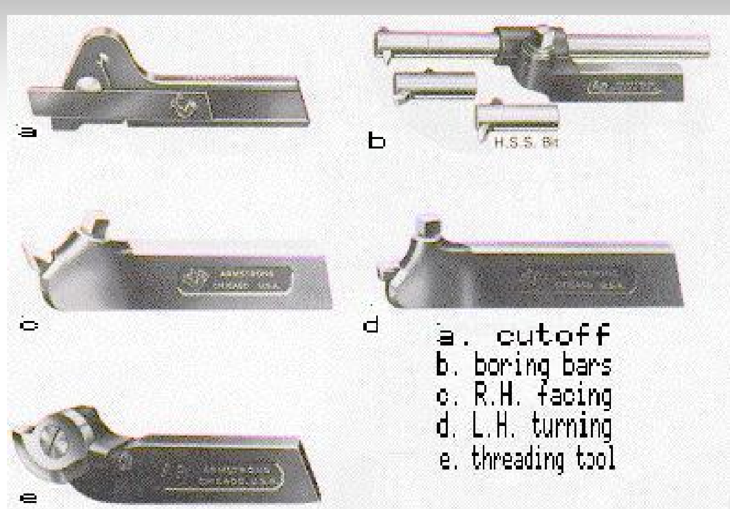


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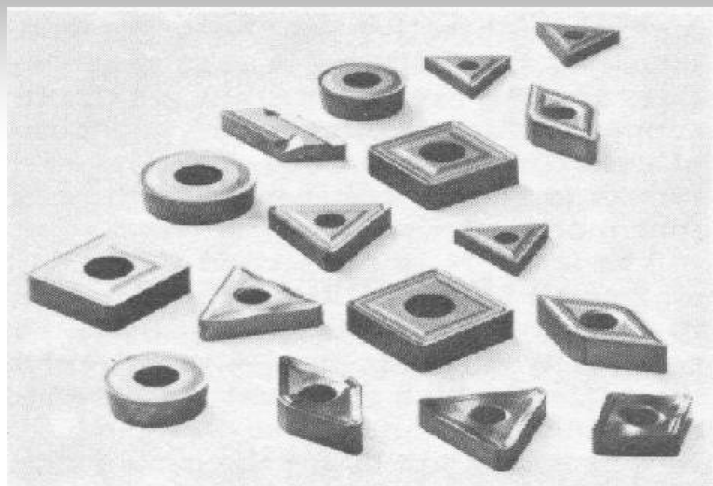

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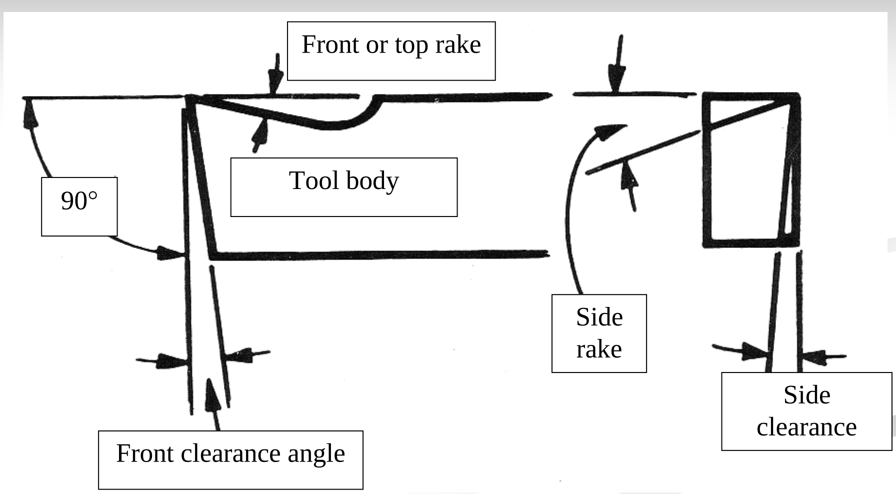


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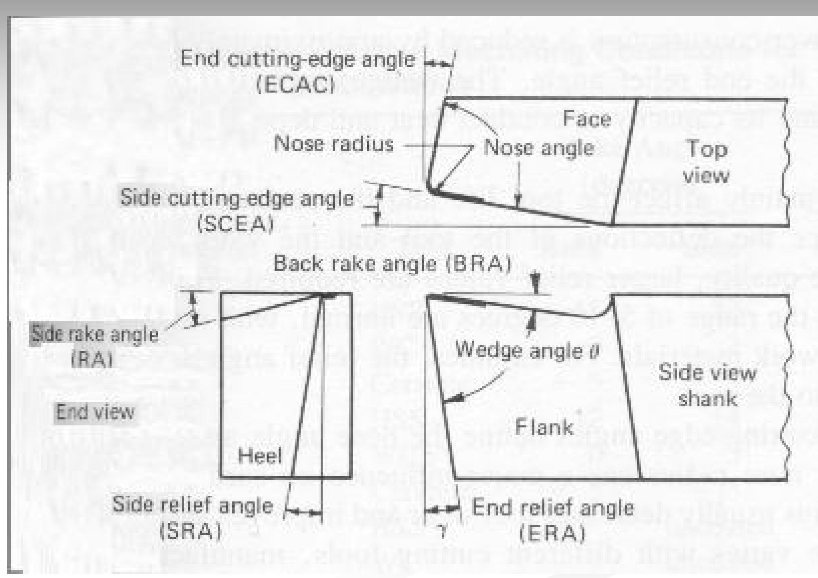
# 6.5 Lathe tools

GENERAL RECOMMENDATIONS FOR TURNING TOOL ANGLES

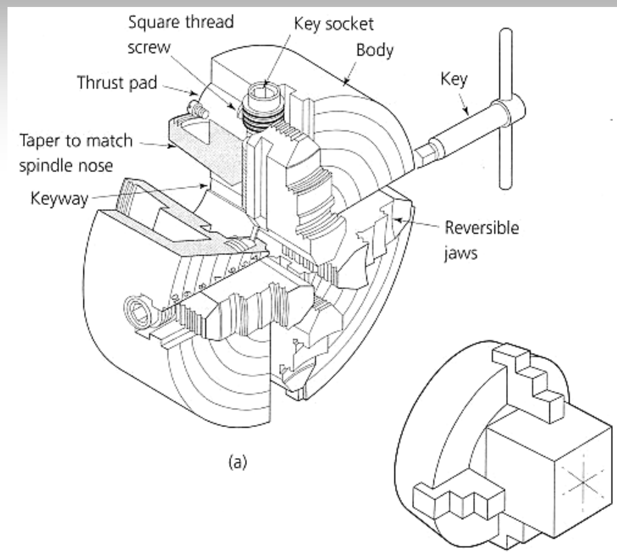
| | High-Speed Steel | | | | | Carbide (Inserts) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Material | Back Rake | Side Rake | End Relief | Side Relief | Side and End Cutting Edge | Back Rake | Side Rake | End Relief | Side Relief | Side and End Cutting Edge |
| Aluminum and magnesium alloys | 20 | 15 | 12 | 10 | 5 | 0 | 5 | 5 | 5 | 15 |
| Copper alloys | 5 | 10 | 8 | 8 | 5 | 0 | 5 | 5 | 5 | 15 |
| Steels | 10 | 12 | 5 | 5 | 15 | −5 | −5 | 5 | 5 | 15 |
| Stainless steels | 5 | 8−10 | 5 | 5 | 15 | −5−0 | −5−5 | 5 | 5 | 15 |
| High-temperature alloys | 0 | 10 | 5 | 5 | 15 | 5 | 0 | 5 | 5 | 45 |
| Refractory alloys | 0 | 20 | 5 | 5 | 5 | 0 | 0 | 5 | 5 | 15 |
| Titanium alloys | 0 | 5 | 5 | 5 | 15 | −5 | −5 | 5 | 5 | 5 |
| Cast irons | 5 | 10 | 5 | 5 | 15 | −5 | −5 | 5 | 5 | 15 |
| Thermoplastics | 0 | 0 | 20−30 | 15−20 | 10 | 0 | 0 | 20−30 | 15−20 | 10 |
| Thermosets | 0 | 0 | 20−30 | 15−20 | 10 | 0 | 15 | 5 | 5 | 15 |



# 6.5 Lathe tool



# 6.6 Peranti pemegang bendakerja

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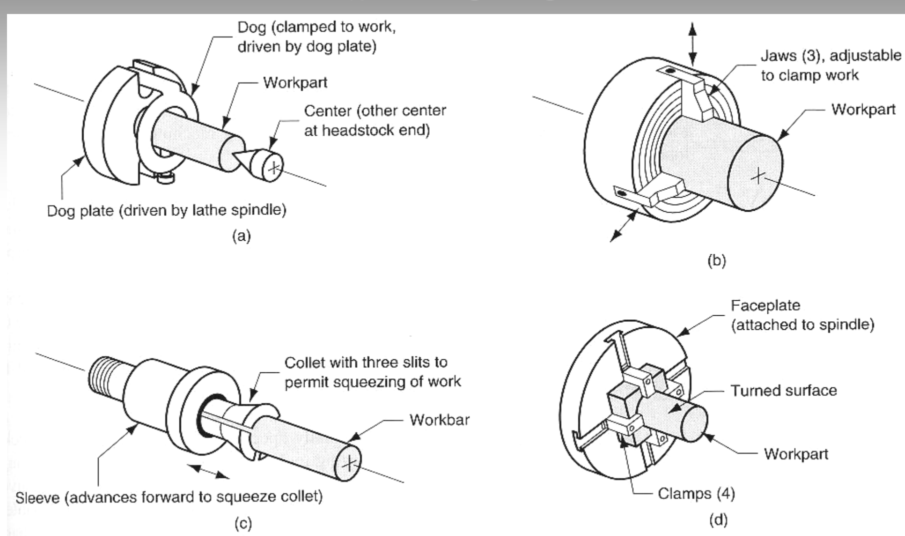


FIGURE 25.4 Four workholding methods used in lathes: (a) mounting the work between centers using a dog, (b) three-jaw chuck, (c) collet, and (d) face plate for noncylindrical workparts.

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# 6.6 Peranti pemegang bendakerja

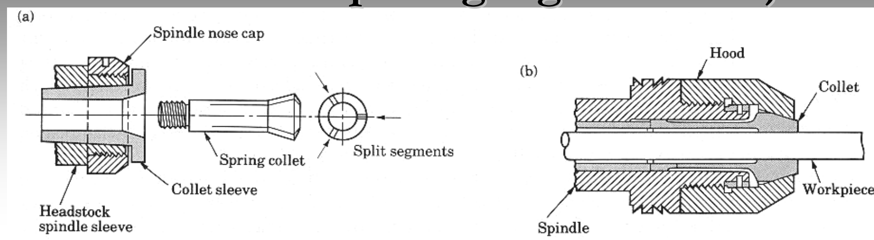



FIGURE 22.6
(a) Schematic illustrations of a draw-in type collet. The workpiece is placed in the collet hole, and the conical surfaces of the collet are forced inward by pulling it with a draw bar into the sleeve. (b) A push-out type collet.

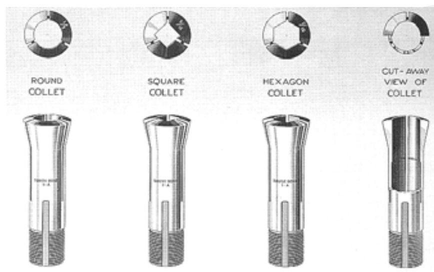
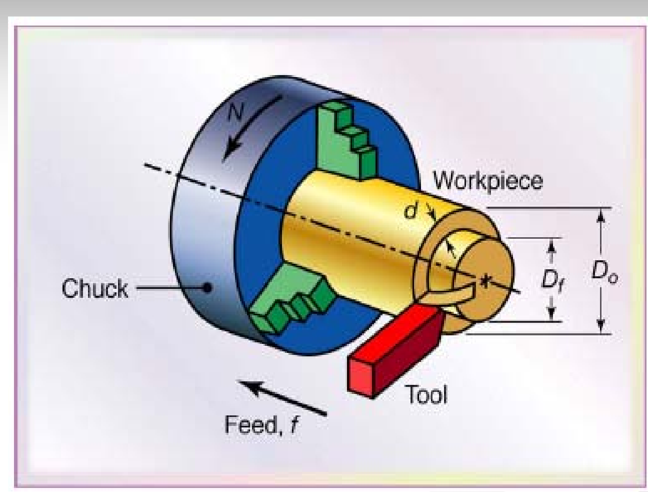



FIGURE 23-37 Several types of lathe collets. (Courtesy of South Bend Lathe.)



# 6.7 Turning parameters



# Summary of Turning Parameters & Formulas

$N$ = Rotational speed of the workpiece, rpm
$f$ = Feed, mm/rev or in/rev
$v$ = Feed rate, or linear speed of the tool along workpiece length, mm/min or in/min
= $fN$
$V$ = Surface speed of workpiece, m/min or ft/min
= p $D_o N$ (for maximum speed)
= $p\, D_{avg} N$ (for average speed)
$l$ = Length of cut, mm or in.
$D_o$ = Original diameter of workpiece, mm or in.
$D_f$ = Final diameter of workpiece, mm or in.
$D_{avg}$ = Average diameter of workpiece, mm or in.
= $(D_o + D_f)/2$
$d$ = Depth of cut, mm or in.
= $(D_o + D_f)/2$
$t$ = Cutting time, s or min
= $l/f N$
MRR = $mm^3$/min or $in^3$/min
= $p\, D_{avg}\, d\, fN$
Torque = Nm or lb ft
= $(F_c)(D_{avg}/2)$
Power = kW or hp
= (Torque) (w , where w=2p radians/min

Note: The units given are those that are commonly used; however, appropriate units must be used and checked in the formulas.



TABLE 23.4

**General Recommendations for Turning Operations**

| Workpiece material | Cutting tool | General-purpose starting conditions: Depth of cut, mm (in.) | Feed, mm/rev (in./rev) | Cutting speed, m/min (ft/min) | Range for roughing and finishing: Depth of cut, mm (in.) | Feed, mm/rev (in./rev) | Cutting speed, m/min (ft/min) |
|---|---|---|---|---|---|---|---|
| Low-C and free machining steels | Uncoated carbide | 1.5–6.3 (0.06–0.25) | 0.35 (0.014) | 90 (300) | 0.5–7.6 (0.02–0.30) | 0.15–1.1 (0.006–0.045) | 60–135 (200–450) |
| | Ceramic-coated carbide | " | " | 245–275 (800–900) | " | " | 120–425 (400–1400) |
| | Triple-coated carbide | " | " | 185–200 (600–650) | " | " | 90–245 (300–800) |
| | TiN-coated carbide | " | " | 105–150 (350–500) | " | " | 60–230 (200–750) |
| | $Al_2O_3$ ceramic | " | 0.25 (0.010) | 395–440 (1300–1450) | " | " | 365–550 (1200–1800) |
| | Cermet | " | 0.30 (0.012) | 215–290 (700–950) | " | " | 105–455 (350–1500) |
| Medium and high-C steels | Uncoated carbide | 1.2–4.0 (0.05–0.20) | 0.30 (0.012) | 75 (250) | 2.5–7.6 (0.10–0.30) | 0.15–0.75 (0.006–0.03) | 45–120 (150–400) |
| | Ceramic-coated carbide | " | " | 185–230 (600–750) | " | " | 120–410 (400–1350) |
| | Triple-coated carbide | " | " | 120–150 (400–500) | " | " | 75–215 (250–700) |
| | TiN-coated carbide | " | " | 90–200 (300–650) | " | " | 45–215 (150–700) |
| | $Al_2O_3$ ceramic | " | 0.25 (0.010) | 335 (1100) | " | " | 245–455 (800–1500) |
| | Cermet | " | 0.25 (0.010) | 170–245 (550–800) | " | " | 105–305 (350–1000) |
| Cast iron, gray | Uncoated carbide | 1.25–6.3 (0.05–0.25) | 0.32 (0.013) | 90 (300) | 0.4–12.7 (0.015–0.5) | 0.1–0.75 (0.004–0.03) | 75–185 (250–600) |
| | Ceramic-coated carbide | " | " | 200 (650) | " | " | 120–365 (400–1200) |
| | TiN-coated carbide | " | " | 90–135 (300–450) | " | " | 60–215 (200–700) |
| | $Al_2O_3$ ceramic | " | 0.25 (0.010) | 455–490 (1500–1600) | " | " | 365–855 (1200–2800) |
| | SiN ceramic | " | 0.32 (0.013) | 730 (2400) | " | " | 200–990 (650–3250 |