MACHINE TOOLS

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Objectives

Lathe

Drilling machine

Shaper

Planner

Milling machine

CNC Machine

Introduction

- Lathe is a machine, which removes the metal from a piece of work to the required shape & size

- operations such as cutting, sanding, knurling, drilling, or deformation with tools that are applied to the work-piece to create an object which has symmetry about an axis of rotation.

Lathe:

- The lathe can be defined as a machine tool which holds the work between two rigid and strong supports called centers or in a chuck or face plate while the latter revolves.
- The chuck or the face plate is mounted on the projected end of the machine spindle. The cutting tool is rigidly held and supported in a tool post and is fed against the revolving work.
- While the work revolves about its own axis and tool is made to move either parallel to or at an inclination with this axis to cut the desired material. In doing so it produces cylindrical surface, if it, is fed parallel to axis or will produce a tapered surface if it is fed at an inclination.

History

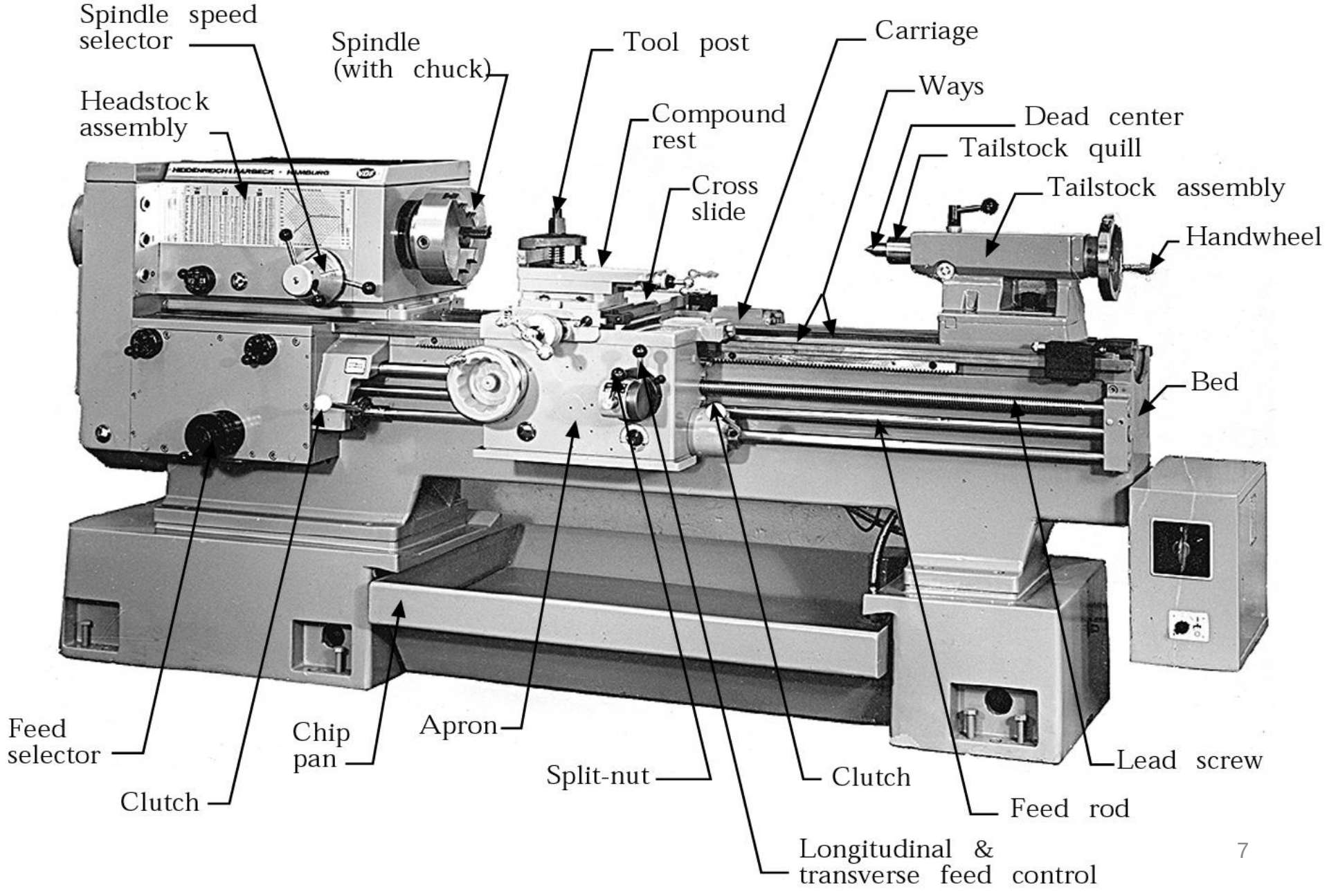
Two men lathe :

- In 1300BC two-person lathe was developed by Egyptians.
- One person would turn the wood work piece with a rope while the other used a sharp tool to cut shapes in the wood.

One man Lathe :

- The Romans improved the Egyptian design with the addition of a turning bow.

ENGINE LATHE



CNC Machines

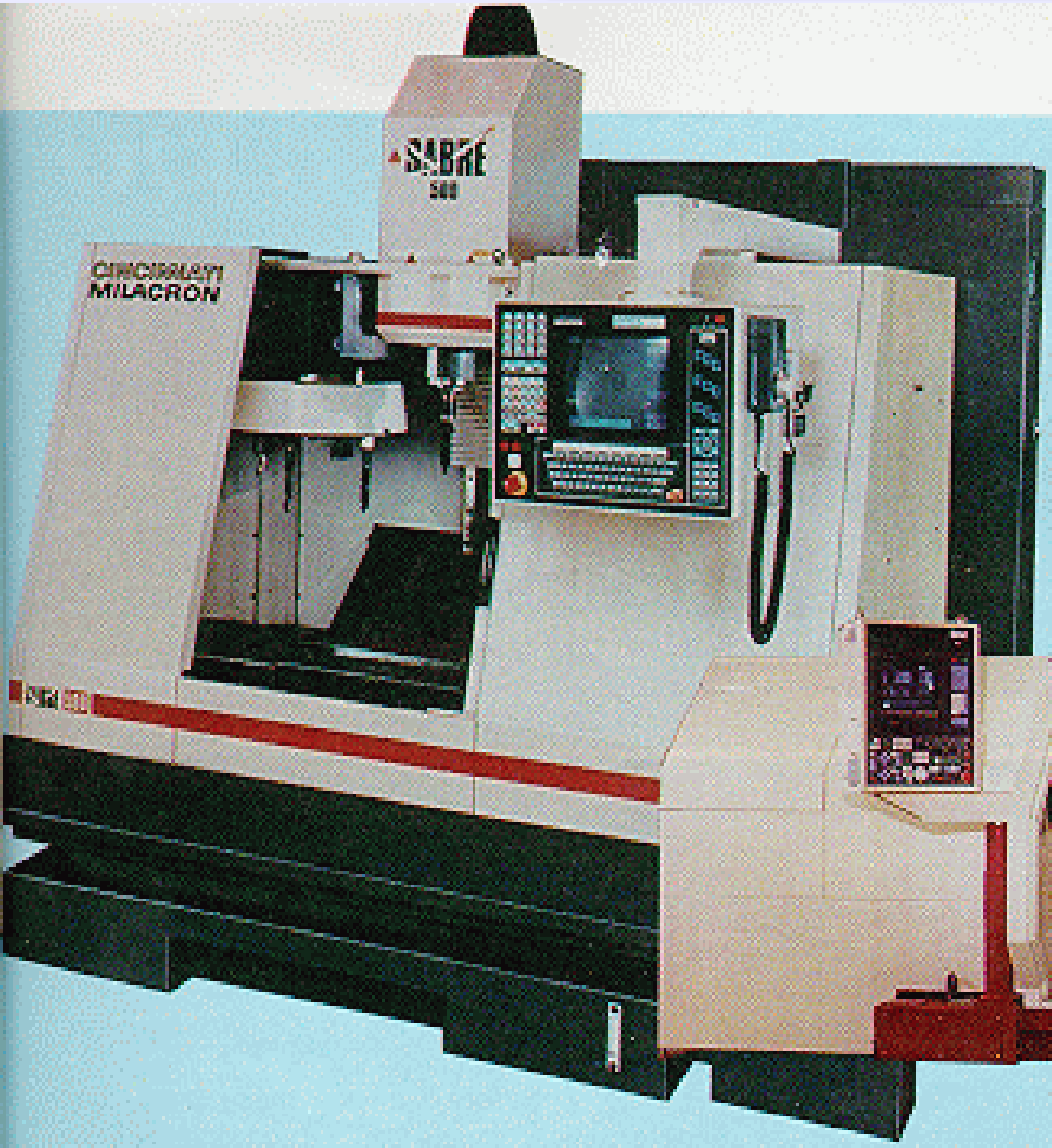


Fig. 12.
Vertical machining center.

Fig. 13.
Horizontal turning center.

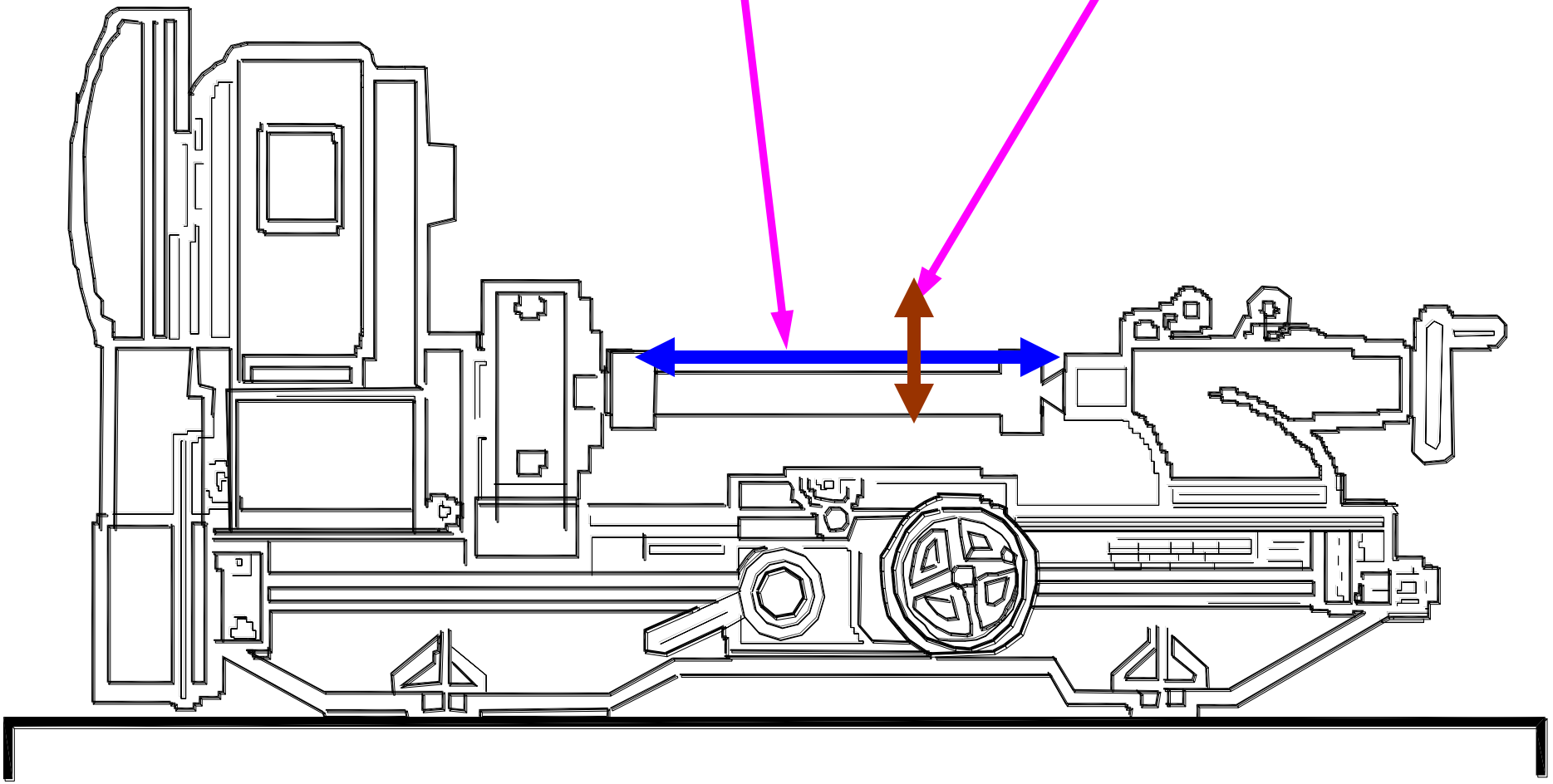
Machine Classification

- **Size designation**
  - Swing - maximum diameter that can be rotated on the lathe
    - 2x's distance from spindle center line to ways
- **Maximum distance between centers**

Size of Lathe

Workpiece Length

Swing



Size of Lathe ..

Example: 300 - 1500 Lathe

- Maximum Diameter of Workpiece that can be machined SWING (= 300 mm)
- Maximum Length of Workpiece that can be held between Centers (=1500 mm)

Types of Lathes

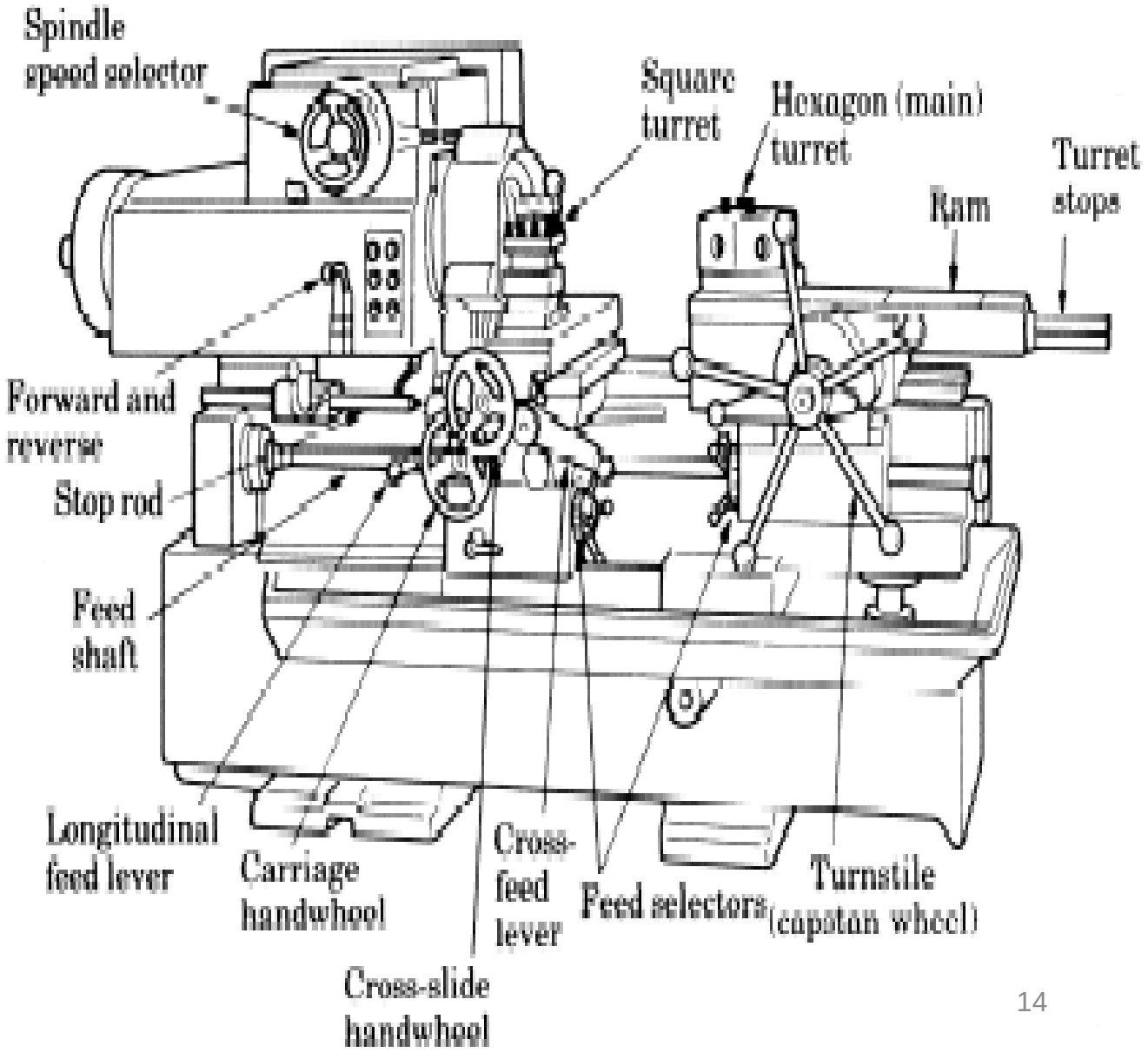
- **Speed**
  - Simple construction of a head stock and tail stock with a tool post. Used for wood turning, metal polishing, or metal spinning.1200-3600rpm
- **Engine**
  - Most frequently used lathe
  - Heavy duty
  - power drive for most tool movements
- **Bench Lathe**
  - A bench top model usually of low power used to make precision machine small work pieces

Types of Lathes

- **Tool room**
  - Greater accuracy
  - More versatility
  - Wider range of speeds and feeds
- **Turret**
  - Multiple tools set to machine part
  - High production rates
  - Still may require some operator skill

Turret Lathes

- Capable of performing multiple cutting operations on the same workpiece
  - Turning
  - Boring
  - Drilling
  - Thread cutting
  - Facing
- Turret lathes are very versatile
- Types of turret lathes
  - Ram-type: ram slides in a separate base on the saddle
  - Saddle type:
    - more heavily constructed
    - Used to machine large workpeiceces



Types of Lathes

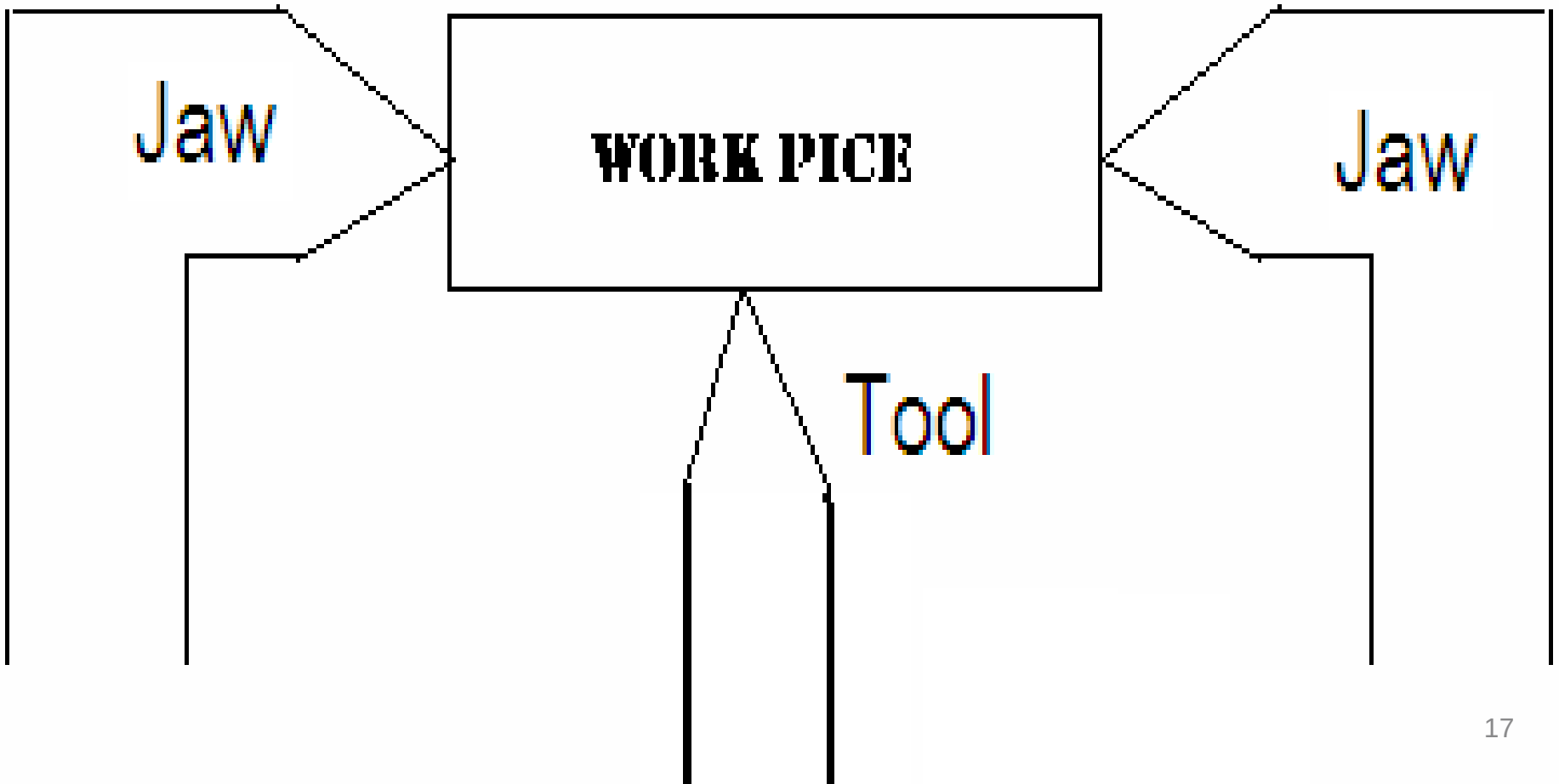
- **Automatic**
  - Similar to turret
  - A lathe in which the work piece is automatically fed and removed without use of an operator.
  - Cutting operations are automatically controlled by sequencer of some form
  - Capable of simultaneous cuts
  - Can be a cam controlled mechanism
  - Can be single spindle or multiple spindle

Types of Lathes

- **CNC**
  - Computer controlled
  - Wide variety of process capability
  - multiple axis
  - Indexing and contouring head
  - On- line and off- line programming available
  - Computer Numerical Controls (CNC)
  - Equipped with one or more turrets
  - Each turret is equipped with a variety of tools
  - Performs several operations on different surfaces of the work piece

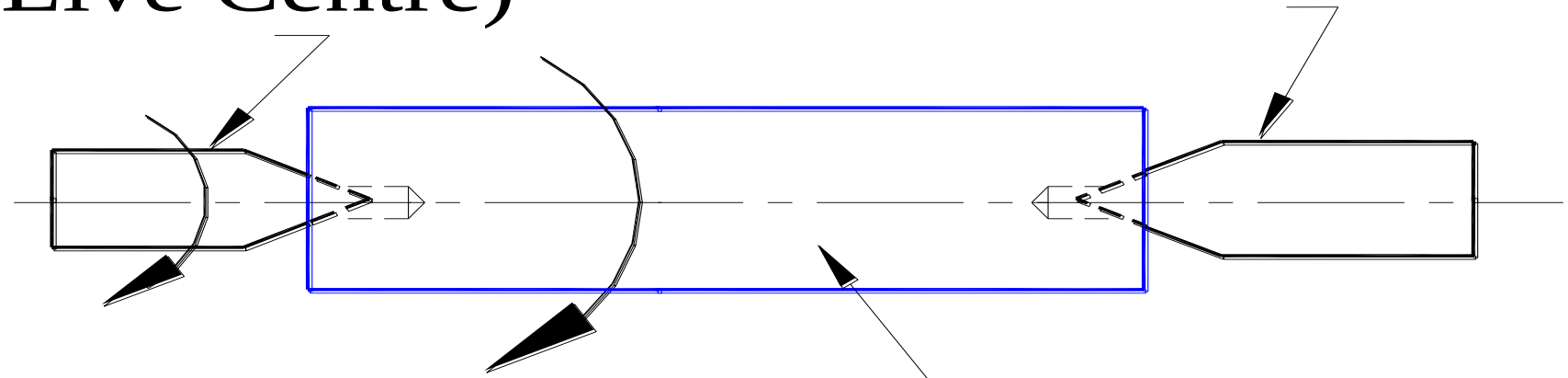
Introduction

- **A lathe is a machine tool which spins a block of material to perform various operations**

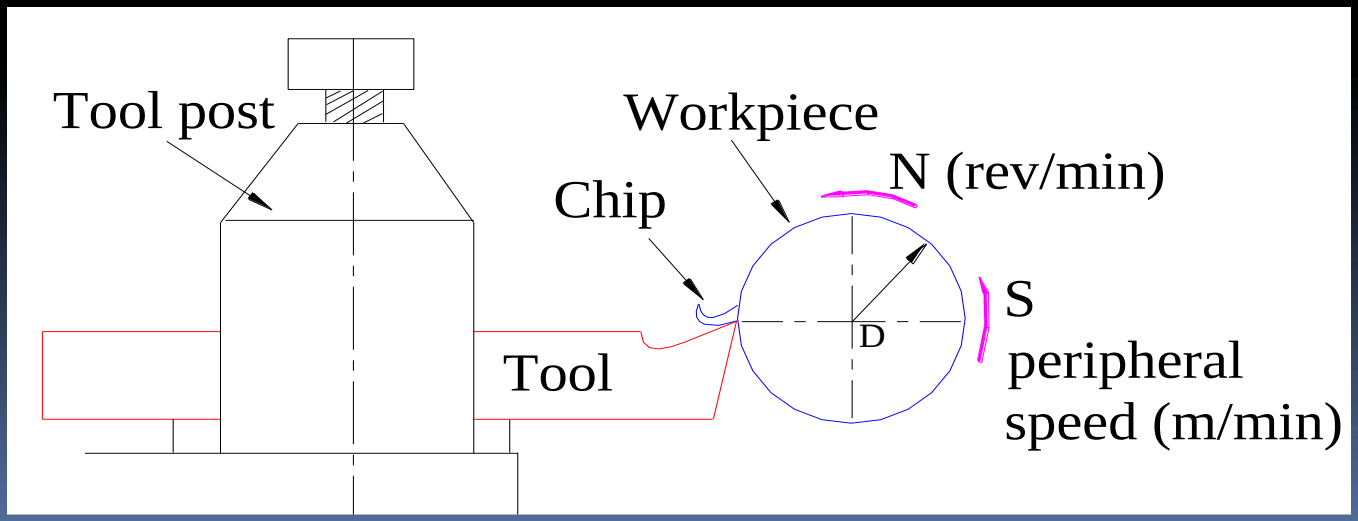


Headstock center
(Live Centre)

Tailstock center
(Dead Centre)



Workpiece



Lathe Basics

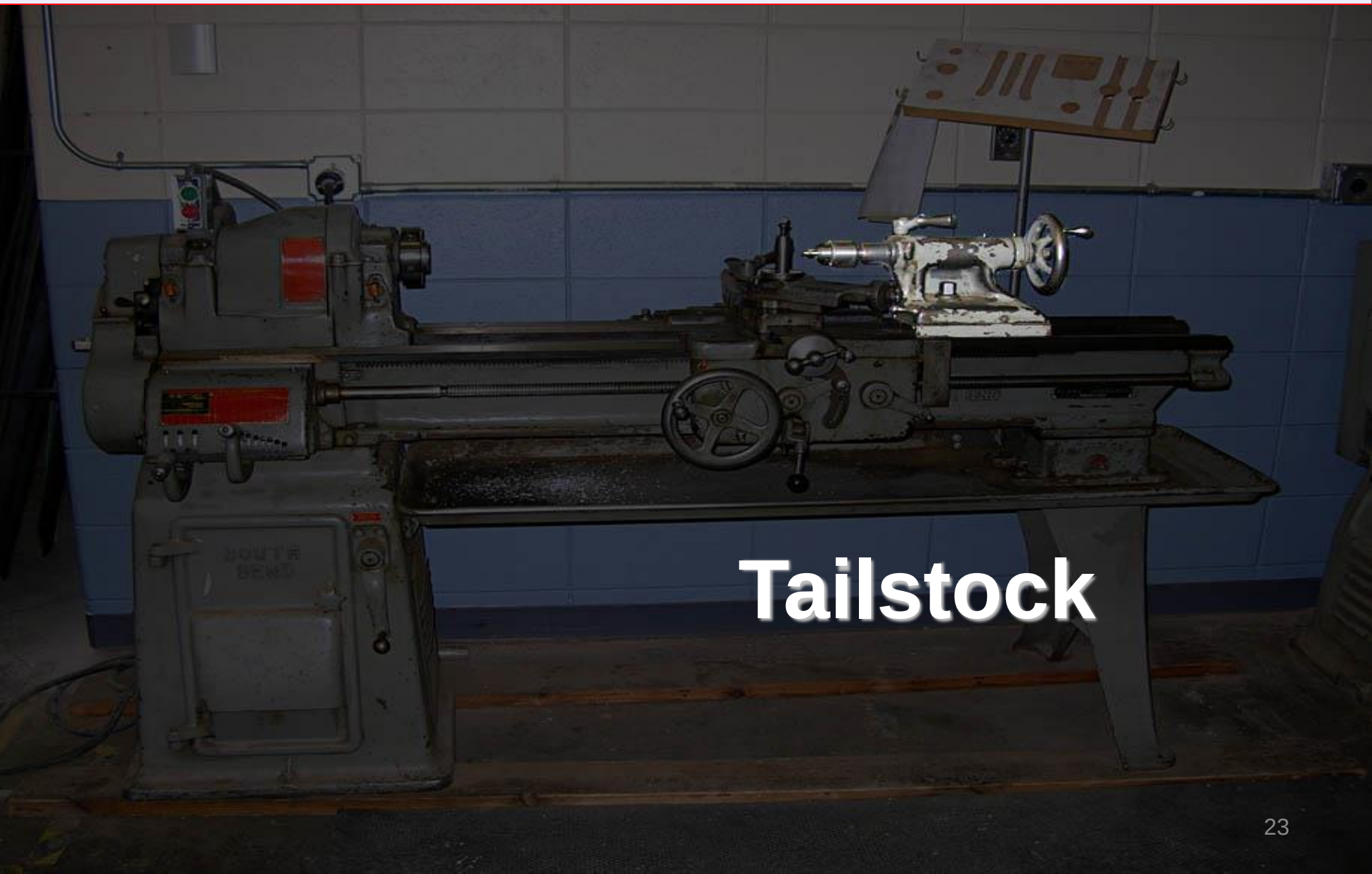
Lathe Basics

Headstock

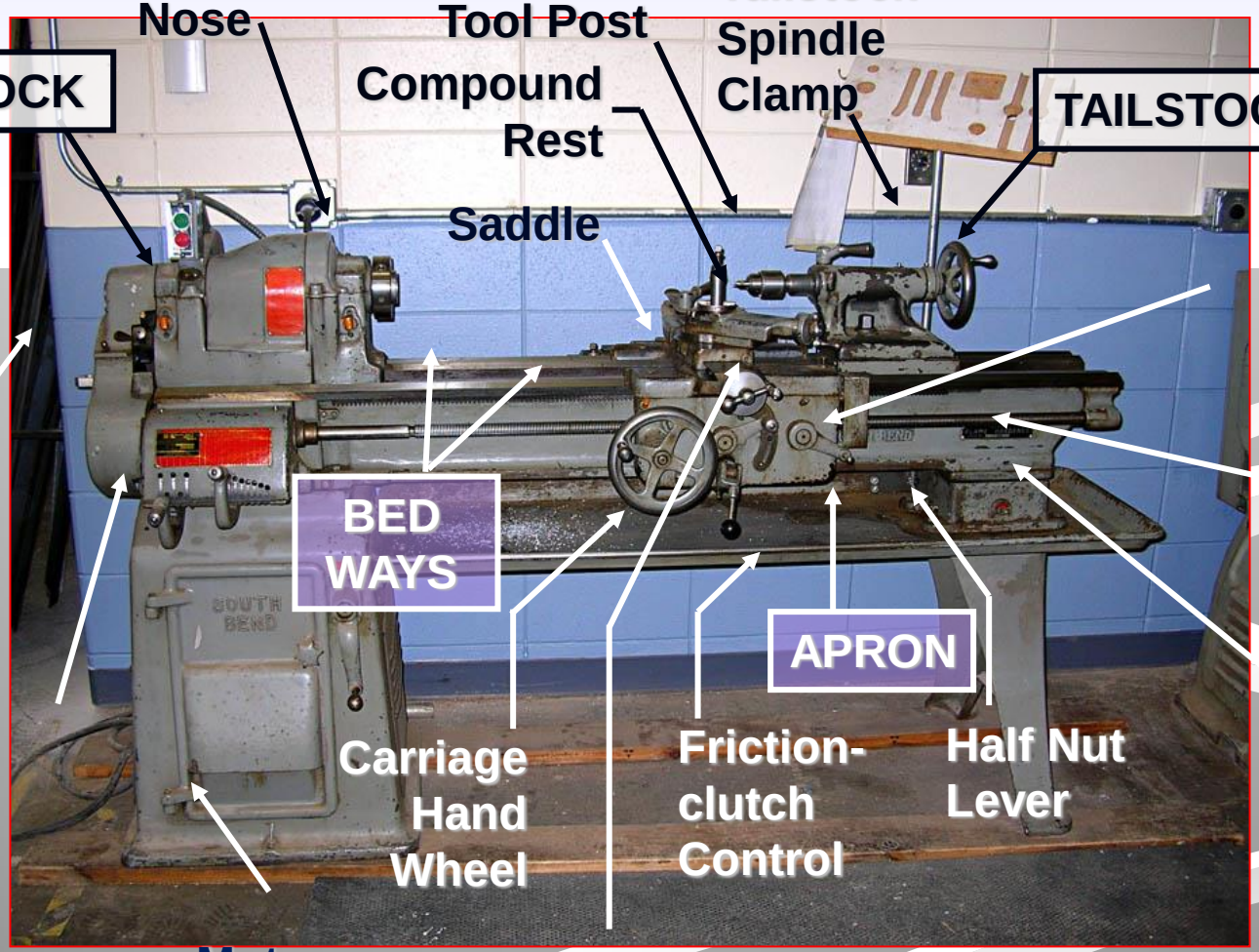
Lathe Basics

Lathe Basics

Lathe Basics

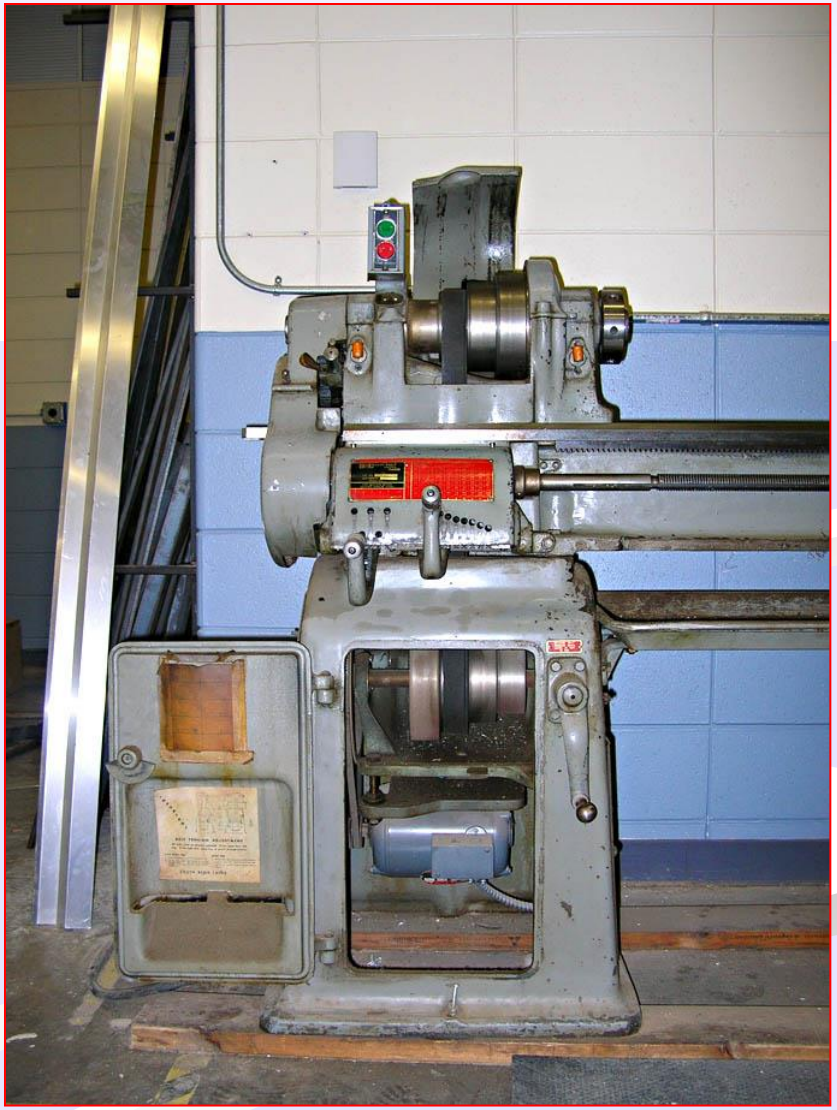


Lathe Basics



Lathe Drive Mechanism

Belts are moved from pulley to pulley to change speeds (rpm).



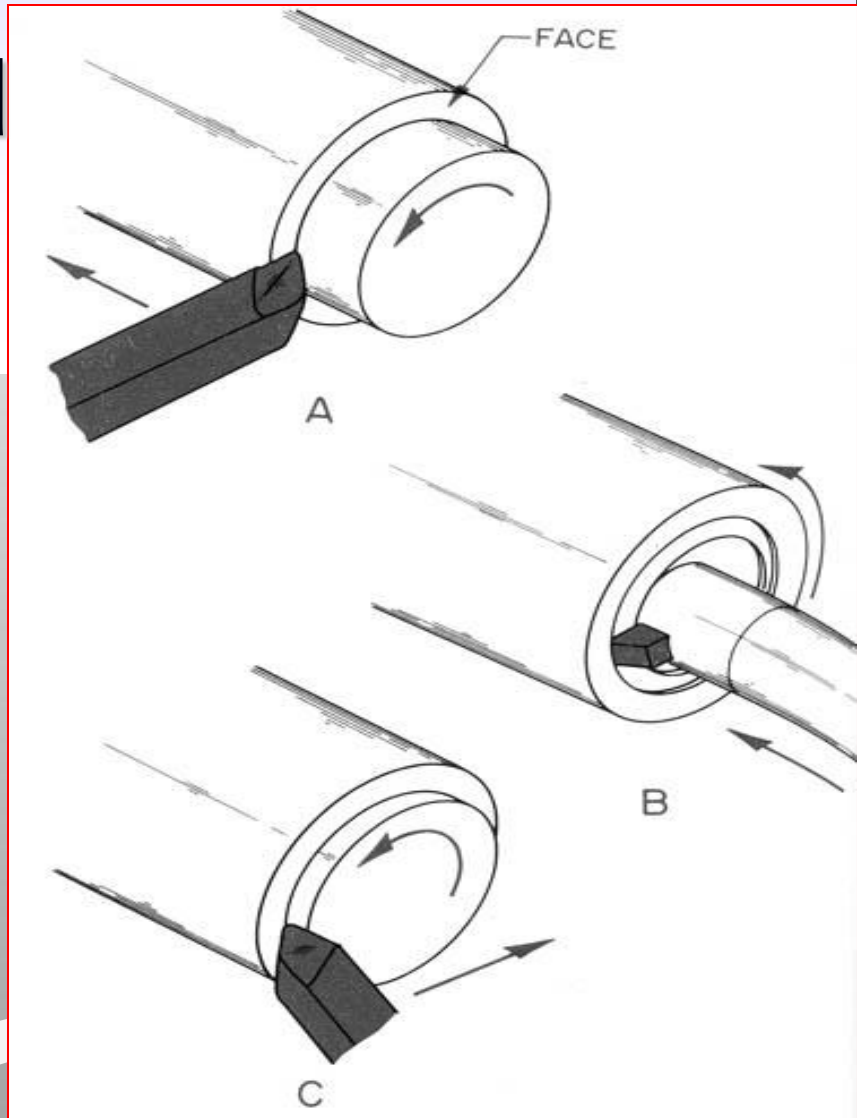
Pulley System without back gear: 4 High range speeds

Pulley System with back gear: 4 Low range speeds

Carriage Feed

A. Longitudinal Feed or "Turning" - The tool is fed *along* the work.

C. Cross Feed or "Facing" – The tool is fed *across* the work.



Carriage Feed

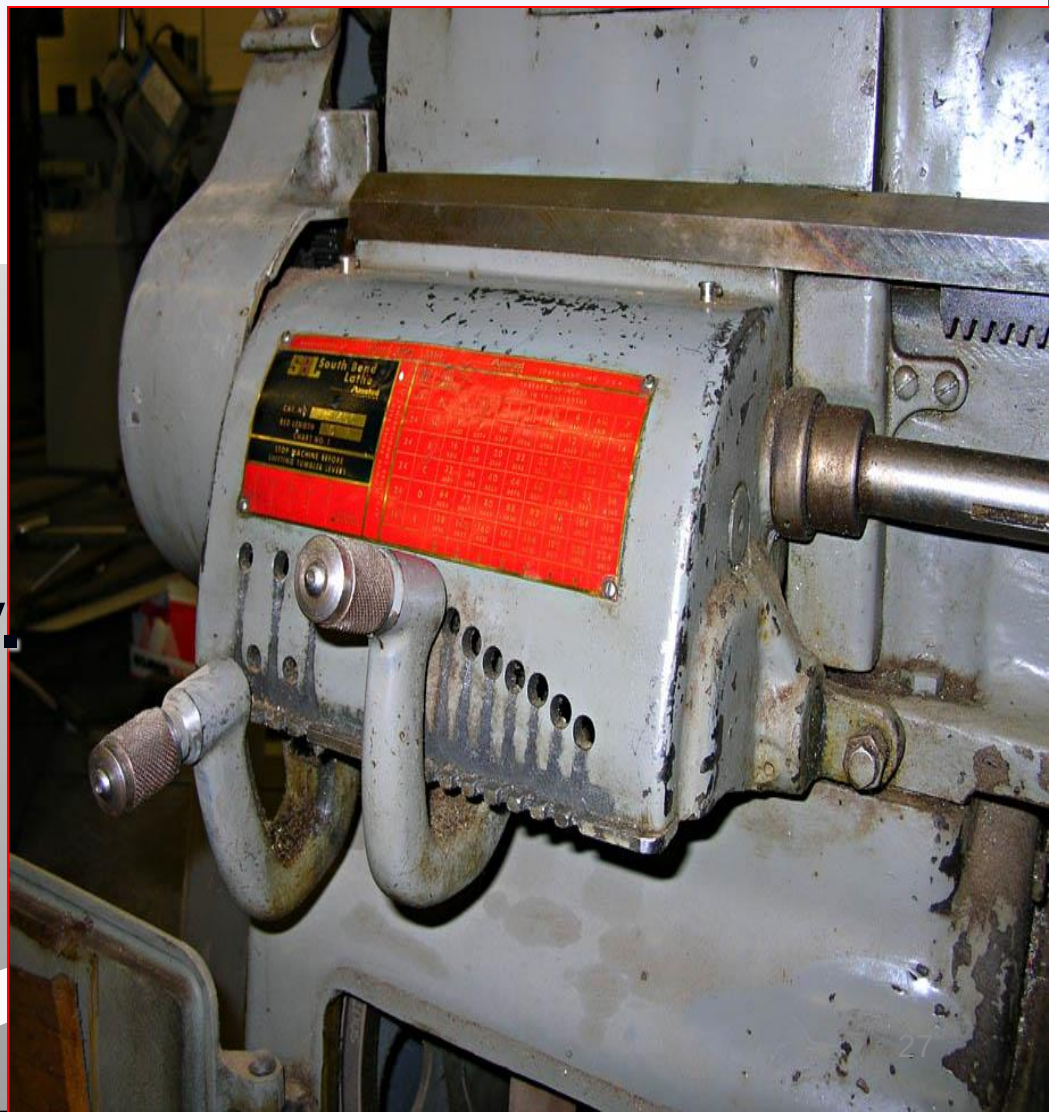
Power Feed for:

Turning

Facing

Used for greater control and accuracy.

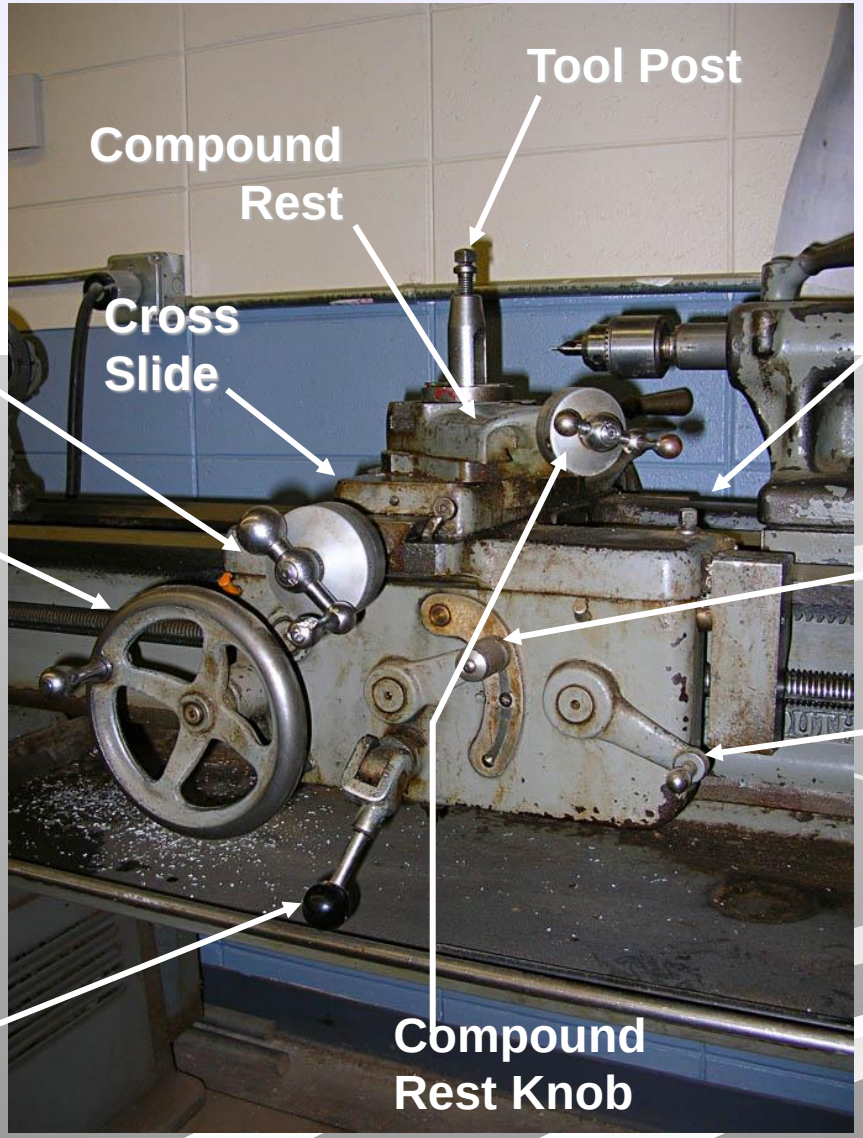
Speed controlled by the “Quick Change Gear Box”



Carriage and Apron

The controls on the carriage and apron control all the tool and carriage movement.

Lathe Carriage and Apron



Carriage and Apron

Apron Hand-wheel: Turning

Cross-feed knob: Facing

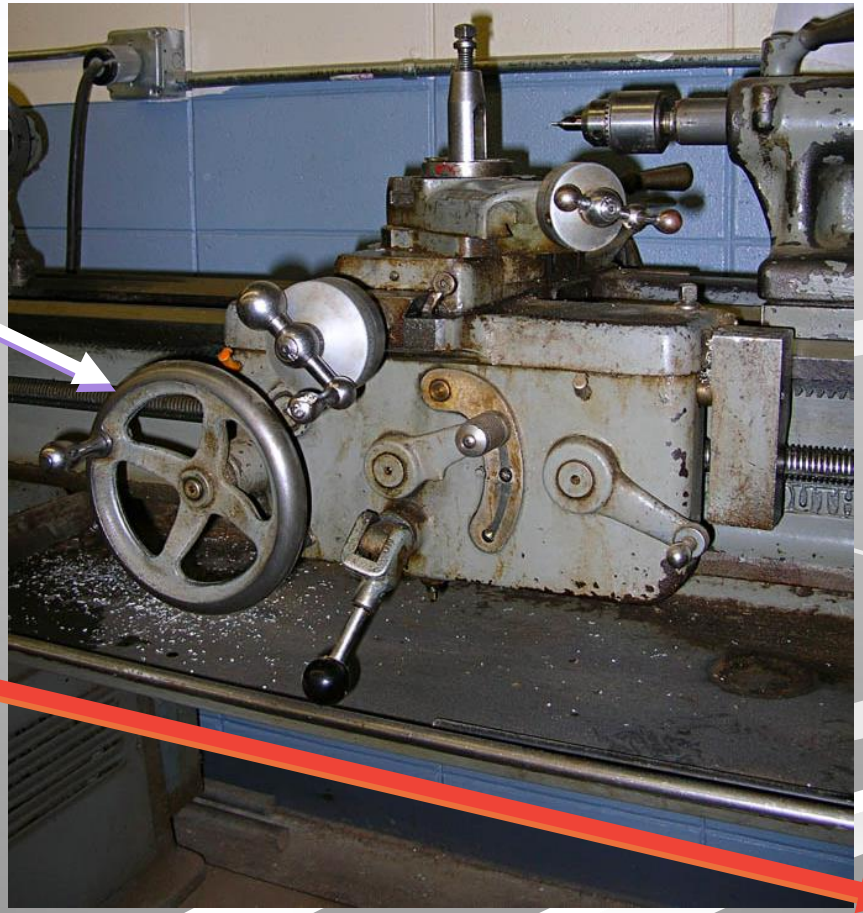
Apron Feed-change lever: Selects power feed between turning and facing

Power Feed Clutch: Engages the power feed

Apron Hand Wheel

Used to move tool along the work - for Turning (Longitudinal Feed)

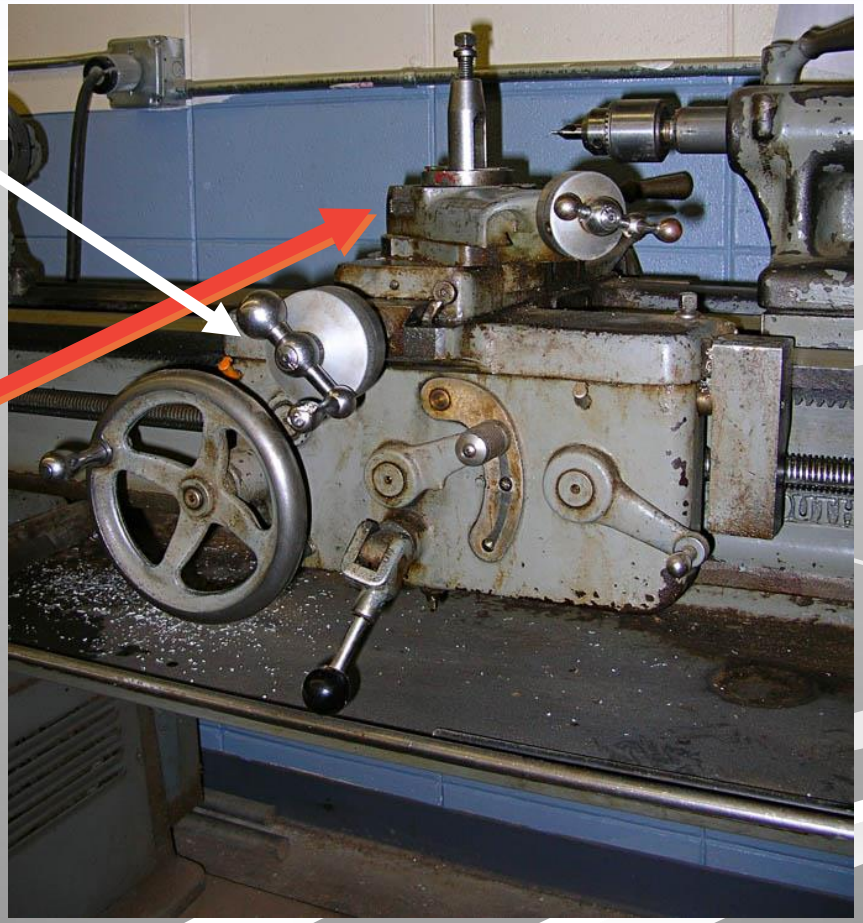
Apron Hand Wheel



Cross Feed Knob

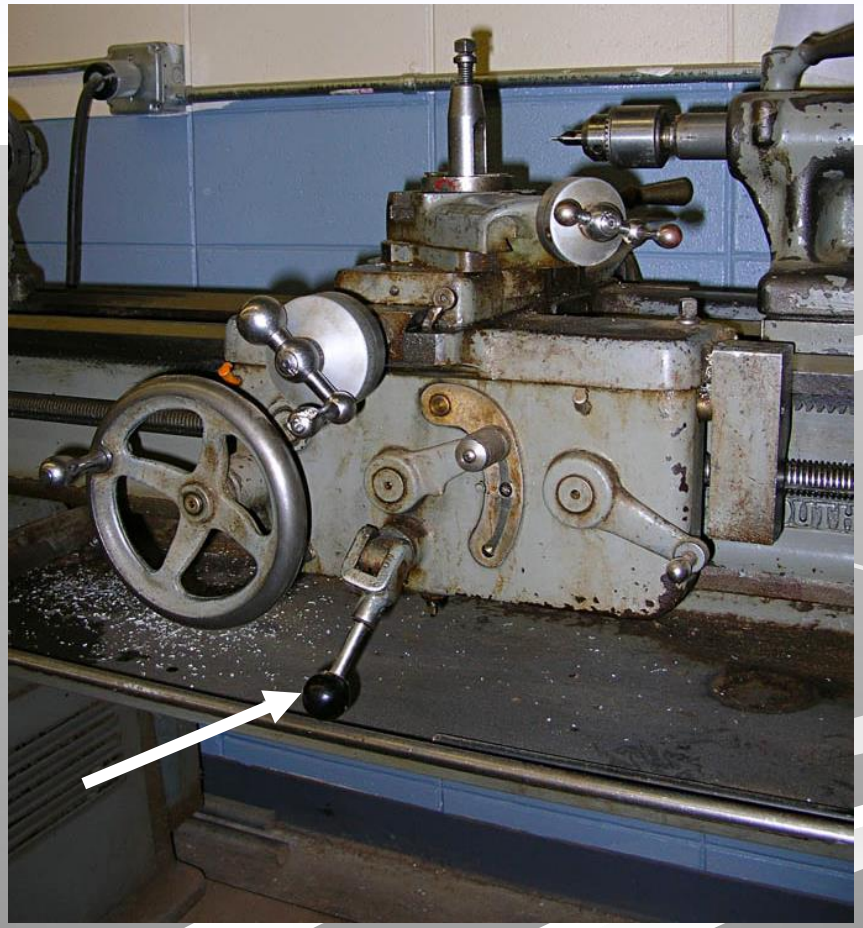
Used to move cutting tool across the end of the stock - Facing (Cross Feed)

Cross Feed Knob



Power Feed Clutch

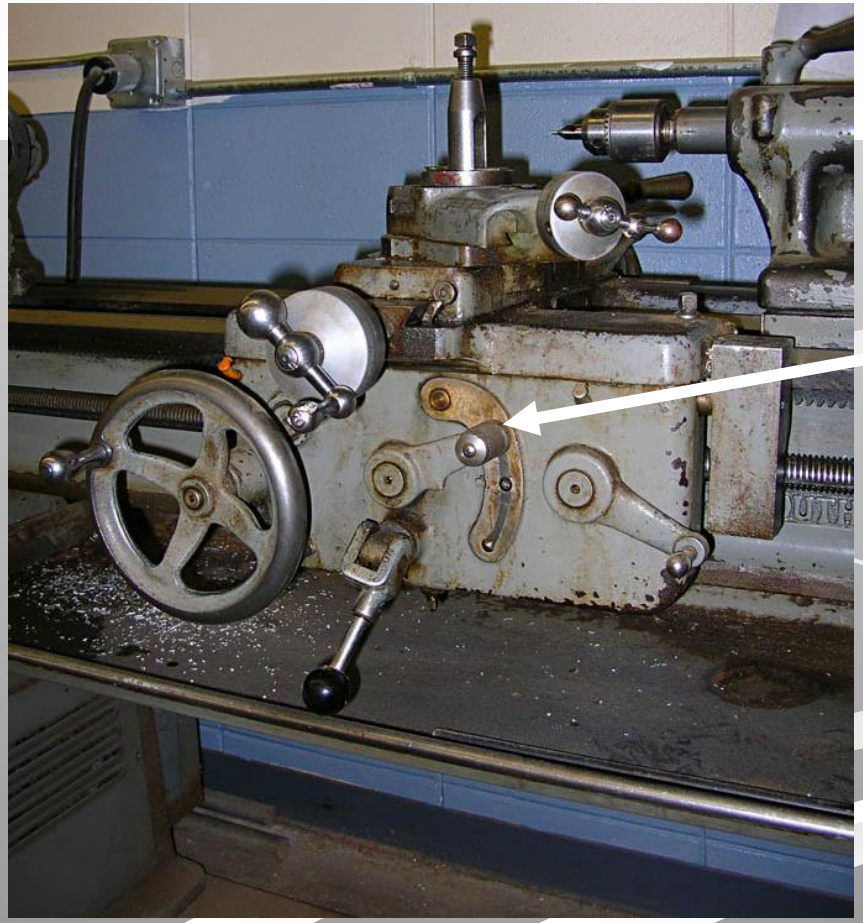
Engages the power feed for turning or facing operations



Power Feed Clutch

Apron Feed Change Lever

Switches power feed between turning and facing directions



Chuck

Three Jaw Chuck

- For holding cylindrical stock centered.

- For facing/center drilling the end of your aluminum stock

Chucks

- Used extensively for holding work for lathe machining operations
  - Work large or unusual shape
- Most commonly used lathe chucks
  - Three-jaw universal
  - Four-jaw independent
  - Collet chuck

Work Holding Devices

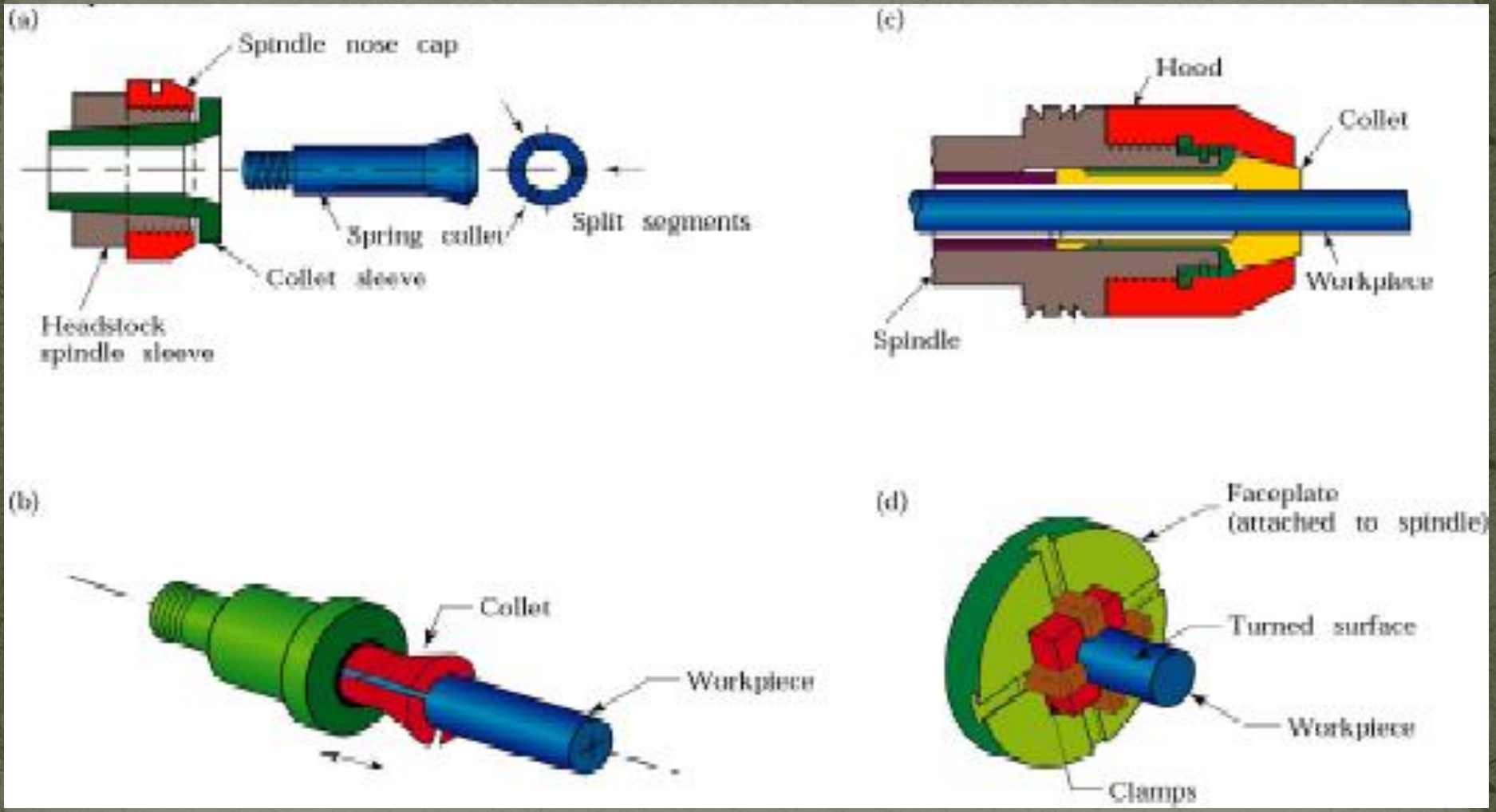


Fig : (a) and (b) Schematic illustrations of a draw-in-type collets. The workpiece is placed in the collet hole, and the conical surfaces of the collet are forced inward by pulling it with a draw bar into the sleeve. (c) A push-out type collet. (d) Workholding of a part on a face plate.

Three jaw chuck

- For holding cylindrical stock centered.
- For facing/center drilling the end of your aluminum stock

Four-Jaw Chuck

- This is independent chuck generally has four jaws , which are adjusted individually on the chuck face by means of adjusting screws

Collet Chuck

Collet chuck is used to hold small workpieces

Magnetic Chuck

Thin jobs can be held by means of magnetic chucks.

Three-jaw Universal Chuck

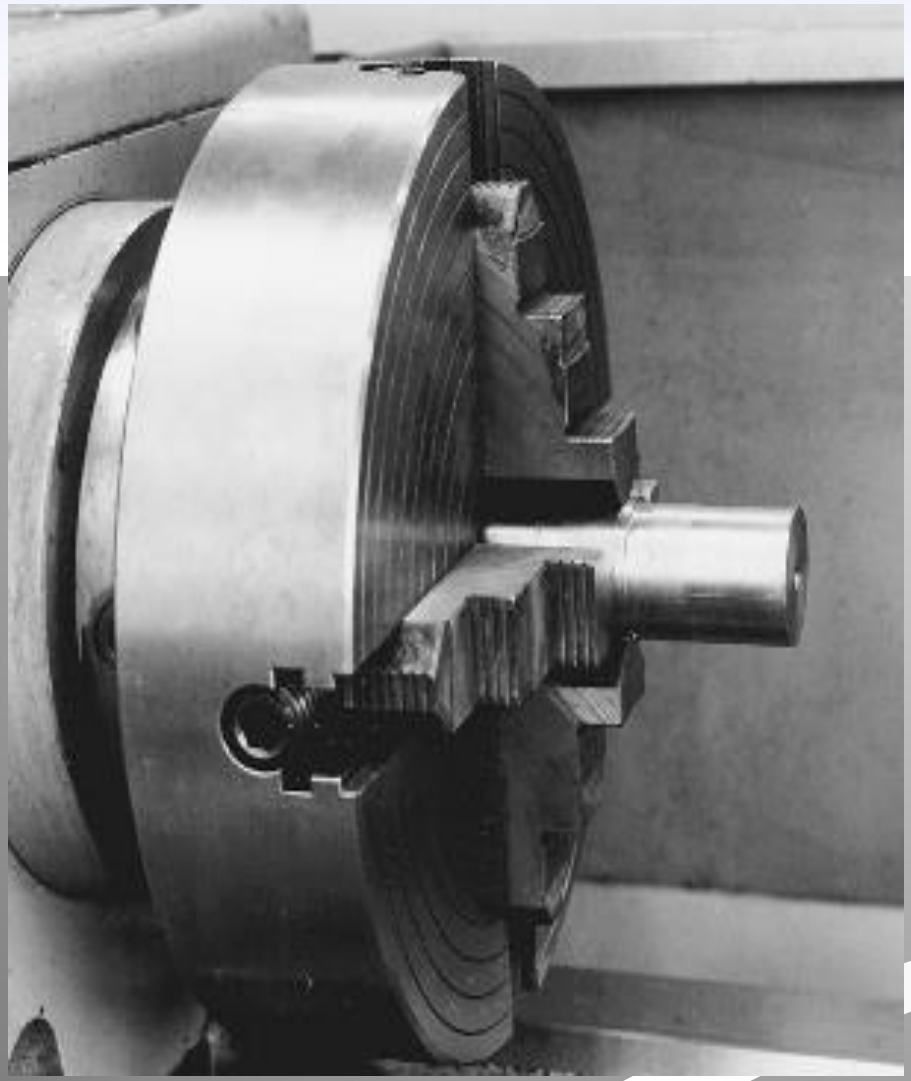
- Holds round and hexagonal work
- Grasps work quickly and accurate within few thousandths/inch
- Three jaws move simultaneously when adjusted by chuck wrench
  - Caused by scroll plate into which all three jaws fit
- Two sets of jaw: outside chucking and inside chucking

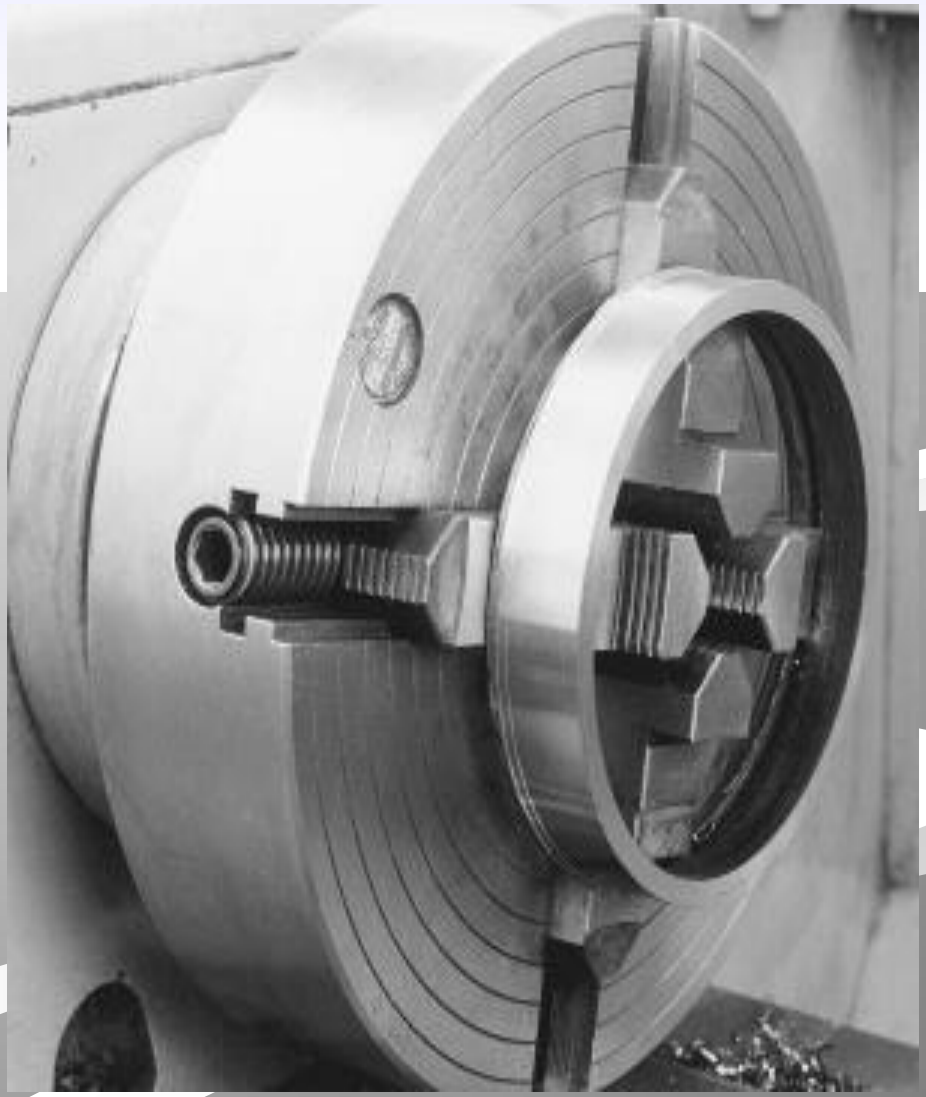
Three-jaw Universal Chuck

Four-Jaw Independent Chuck

- Used to hold round, square, hexagonal, and irregularly shaped workpieces
- Has four jaws
  - Each can be adjusted independently by chuck wrench
- Jaws can be reversed to hold work by inside diameter

Four-Jaw Independent Chucks





Headstock Spindle Types

1. Threaded spindle nose
   - Screws on in a clockwise direction
2. Tapered spindle nose
   - Held by lock nut that tightens on chuck
3. Cam-lock spindle nose
   - Held by tightening cam-locks using T-wrench
   - Chuck aligned by taper on spindle nose

Lathe Cam-Lock Spindle

Cutting Speed

D – Diameter (mm)

N – Revolutions per Minute (rpm)

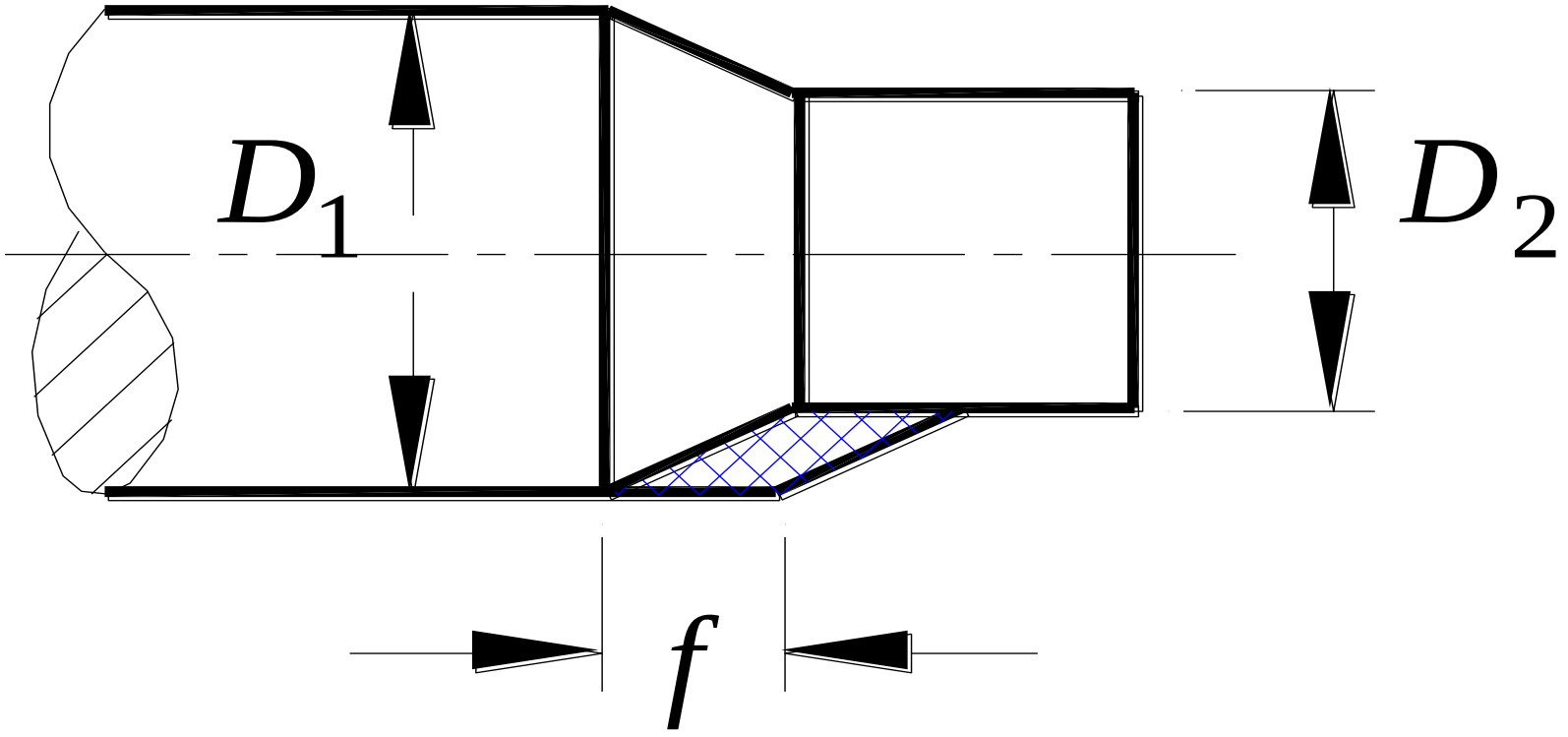
$$v = \frac{\pi D N}{1000} \quad \text{m/min}$$

The **Peripheral Speed** of Workpiece past the Cutting Tool

=Cutting Speed

Feed

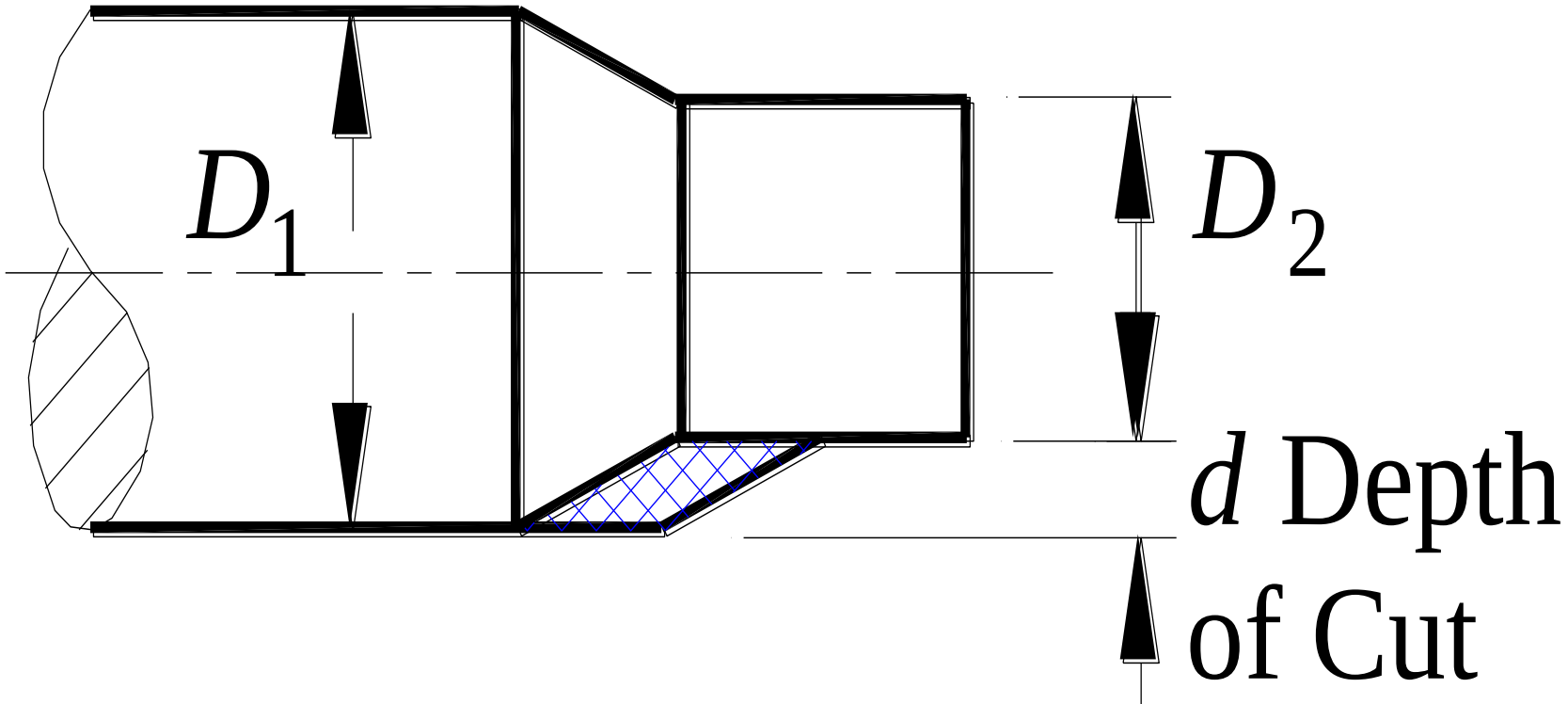
f – the distance the tool advances for every rotation of workpiece (mm/rev)



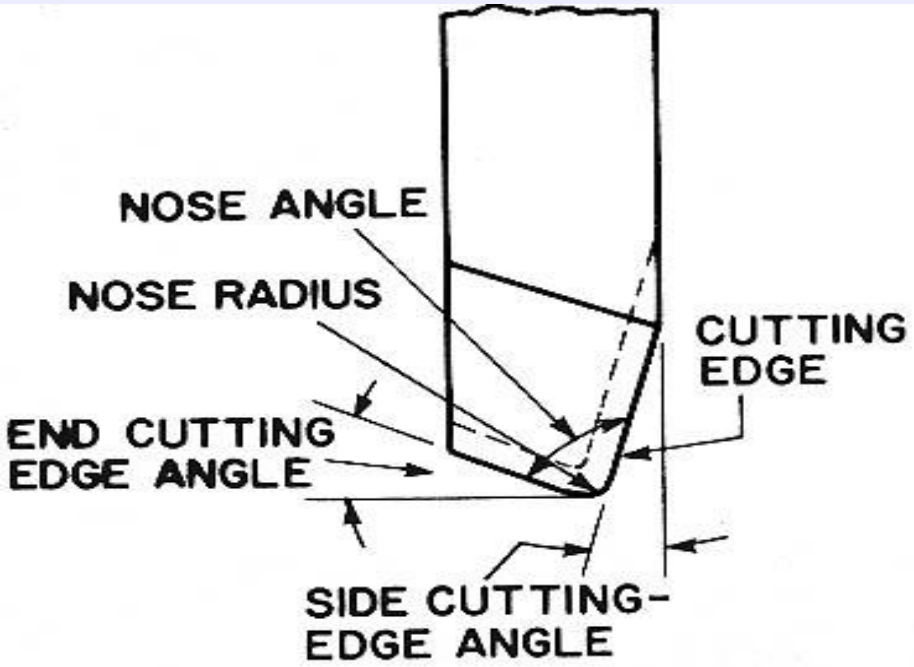
Depth of Cut

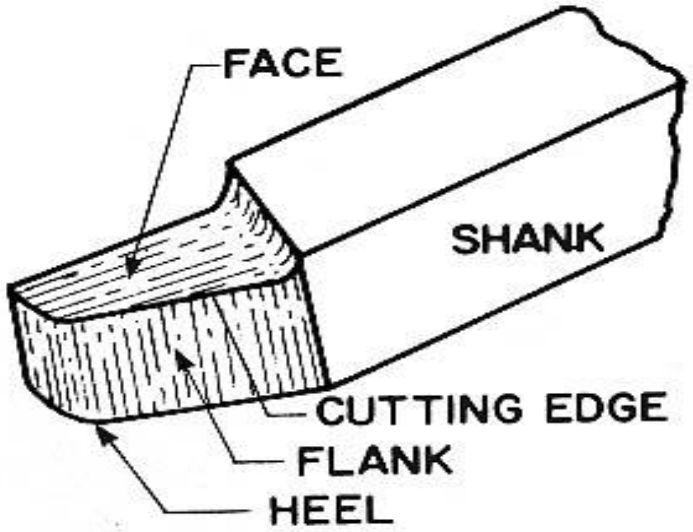
perpendicular distance between machined surface and uncut surface of the Workpiece

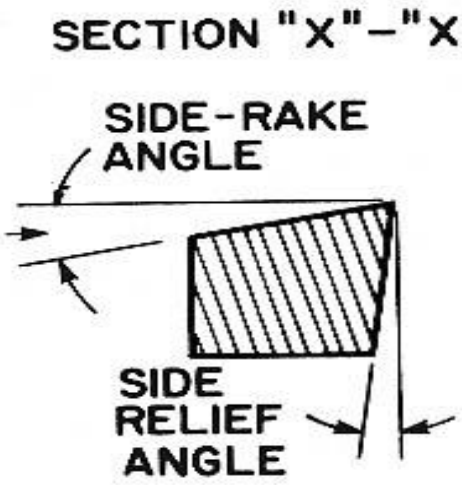
$$\boldsymbol{d} = (D_1 - D_2)/2 \quad \text{(mm)}$$

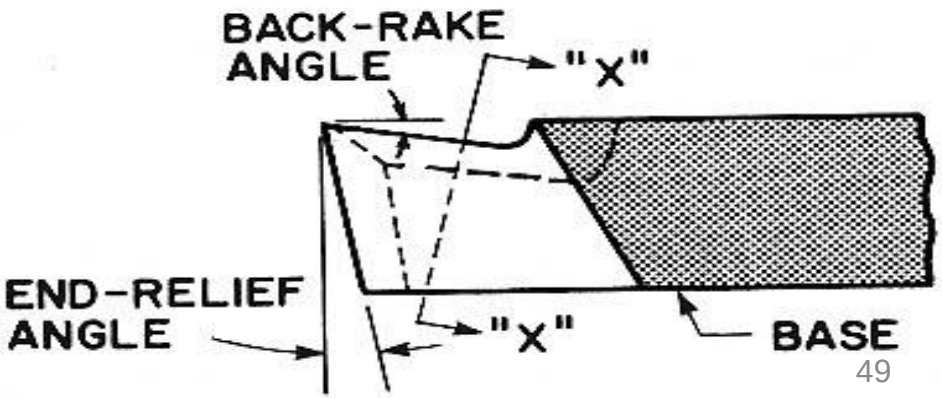


Cutting Tool

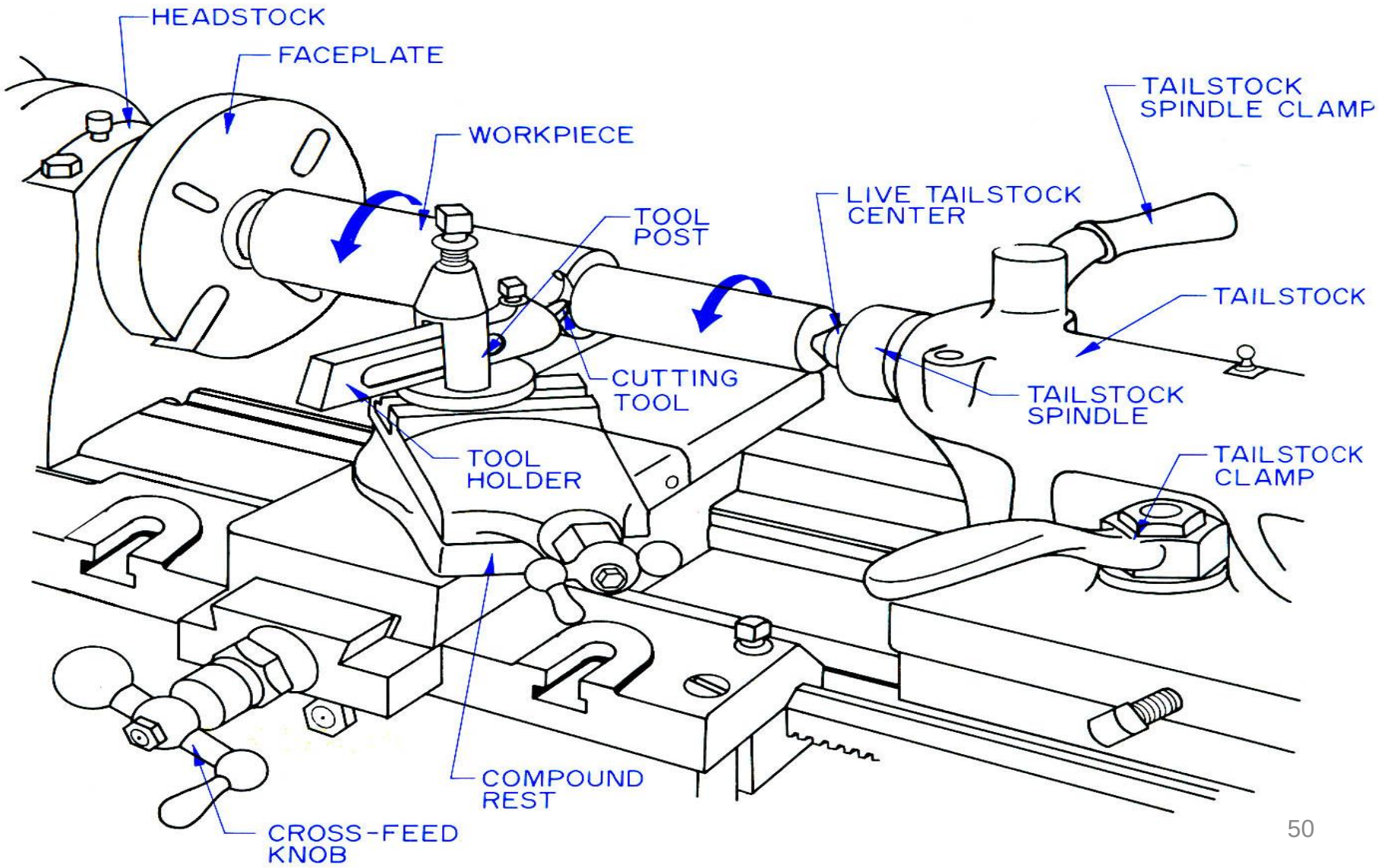






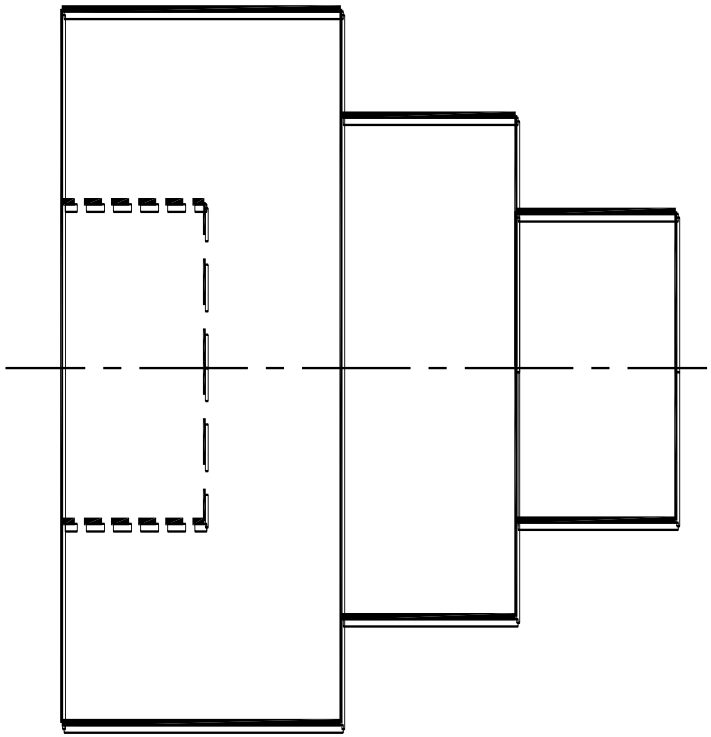


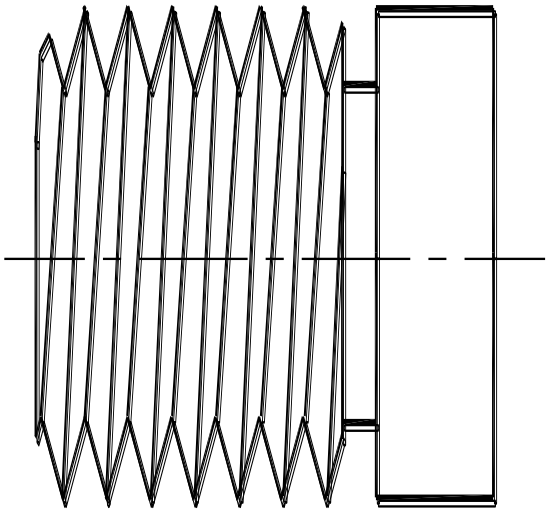
Turning Between Centers

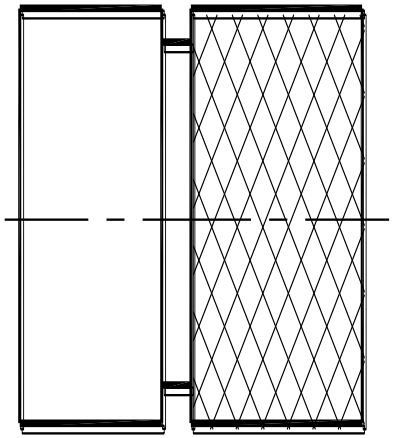


Some Typical Lathe Jobs

Turning/Drilling/Grooving/
Threading/Knurling/Facing...







Parts of Lathe: The lathe carries the following main parts as illustrated by a block diagram.

1. Bed: The bed of a lathe acts as the base on which the different fixed and operating parts of the lathe are mounted. This facilitates the correct relative location of the fixed parts and at the same time provides ways for a well guided and controlled movement of the operating part (carriage).
2. Head stock. The headstock is that part of lathe which serves as housing for the driving pulley and back gears, provides bearing for the machine spindle and keeps the latter in alignment with the bed. It consists of the following parts.
   - Cone pulley
   - Back gears and back gear lever,
   - Main spindle,
   - Live centre, and
   - Feed reverse lever – This lever is primarily used for providing power feed to the Carriage.

3. **Tail Stock**: It is mounted on the bed of the lathe such that it is capable of sliding along the latter maintaining its alignment with the head stock. The main function of the tail stock is to provide bearing and support to the job which is being worked between centers.

4. **Carriage**: The lathe carriage serves the purpose of supporting guiding and feeding the tool against the job during the operation on the lathe. It consists of following main parts:

   Saddle: It is that part of carriage which slides along the bed ways and supports the cross-slide, compound rest and tool post.

5. **Apron**: It is the hanging part in front of the carriage. It serves as housing for a number of gear trains through which power feeds can be given to the carriage and the cross-slide.

6. **Split nut**: The split nut is engaged to lead screw to give power feed to carriage when threads are cut. An important feature of the apron mechanism is the provision of a fool – proof arrangement to avoid the simultaneous operation of the split nut and automatic feed to carriage. To avoid this clash a lever is provided inside the apron which engages with both the mechanisms and acts in such a way that when the later will engaged the automatic feed will not act.

Lathe accessories: The devices employed for holding and supporting the work and the tool on the althe are called its accessories. They include the devices like chucks, driving plate, dogs, tool holders and posts, centers, collets, rests, mandrels, jigs and fixtures, etc.

Various operations on the lathe:

- Plain turning
- Taper turning
- Step turning
- Eccentric turning
- Facing
- Screw cutting on the lathe
- Drilling
- Boring
- Knurling

Lathe Operations

Turning: produce straight, conical, curved, or grooved workpieces

Facing: to produce a flat surface at the end of the part or for making face grooves.

Boring: to enlarge a hole or cylindrical cavity made by a previous process or to produce circular internal grooves.

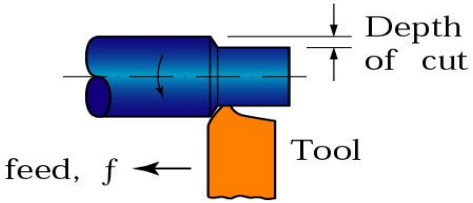
Drilling: to produce a hole by fixing a drill in the tailstock

Threading: to produce external or internal threads

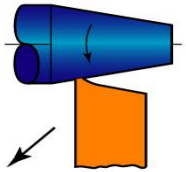
Knurling: to produce a regularly shaped roughness on cylindrical surfaces

Lathe Operations

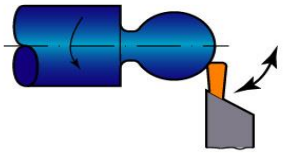
(a) Straight turning



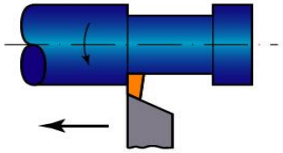
(b) Taper turning



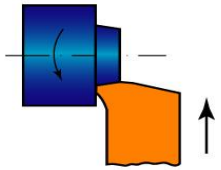
(c) Profiling



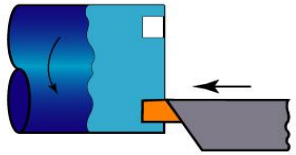
(d) Turning and external grooving



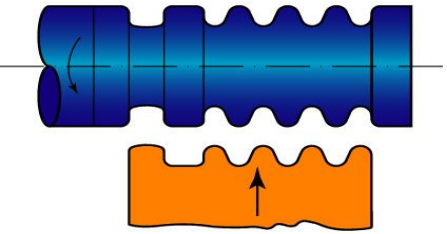
(e) Facing



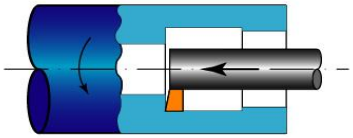
(f) Face grooving



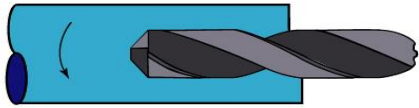
(g) Cutting with a form tool



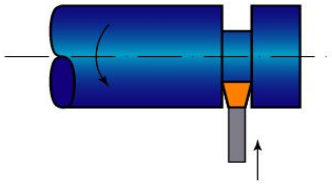
(h) Boring and internal grooving



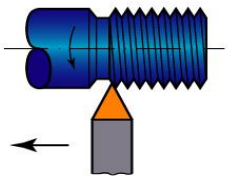
(i) Drilling



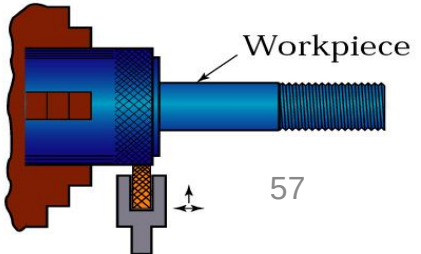
(j) Cutting off



(k) Threading

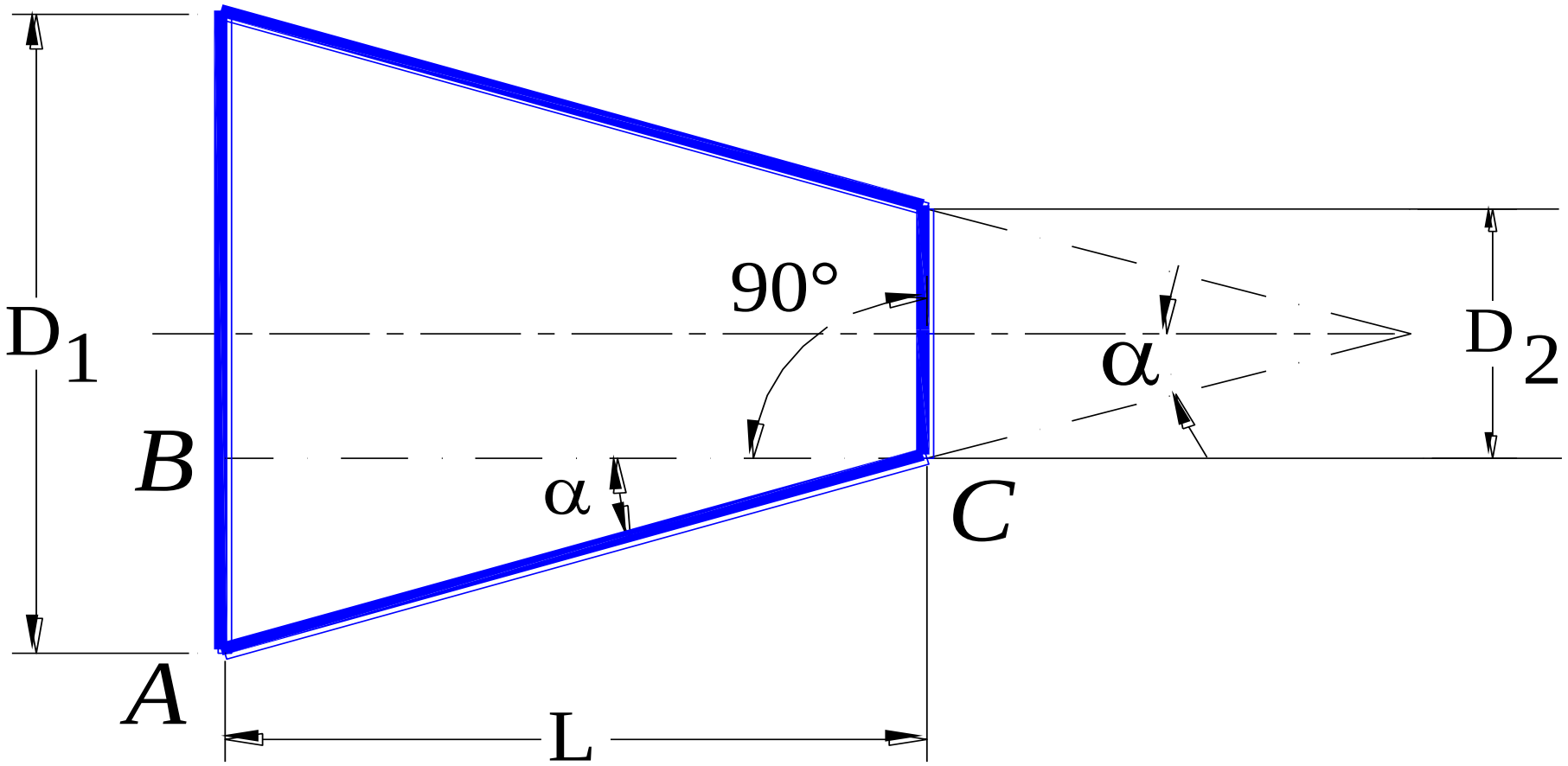


(l) Knurling



Taper Turning

- Taper: $\tan \alpha = \dfrac{D_1 - D_2}{2L}$



Taper Turning..

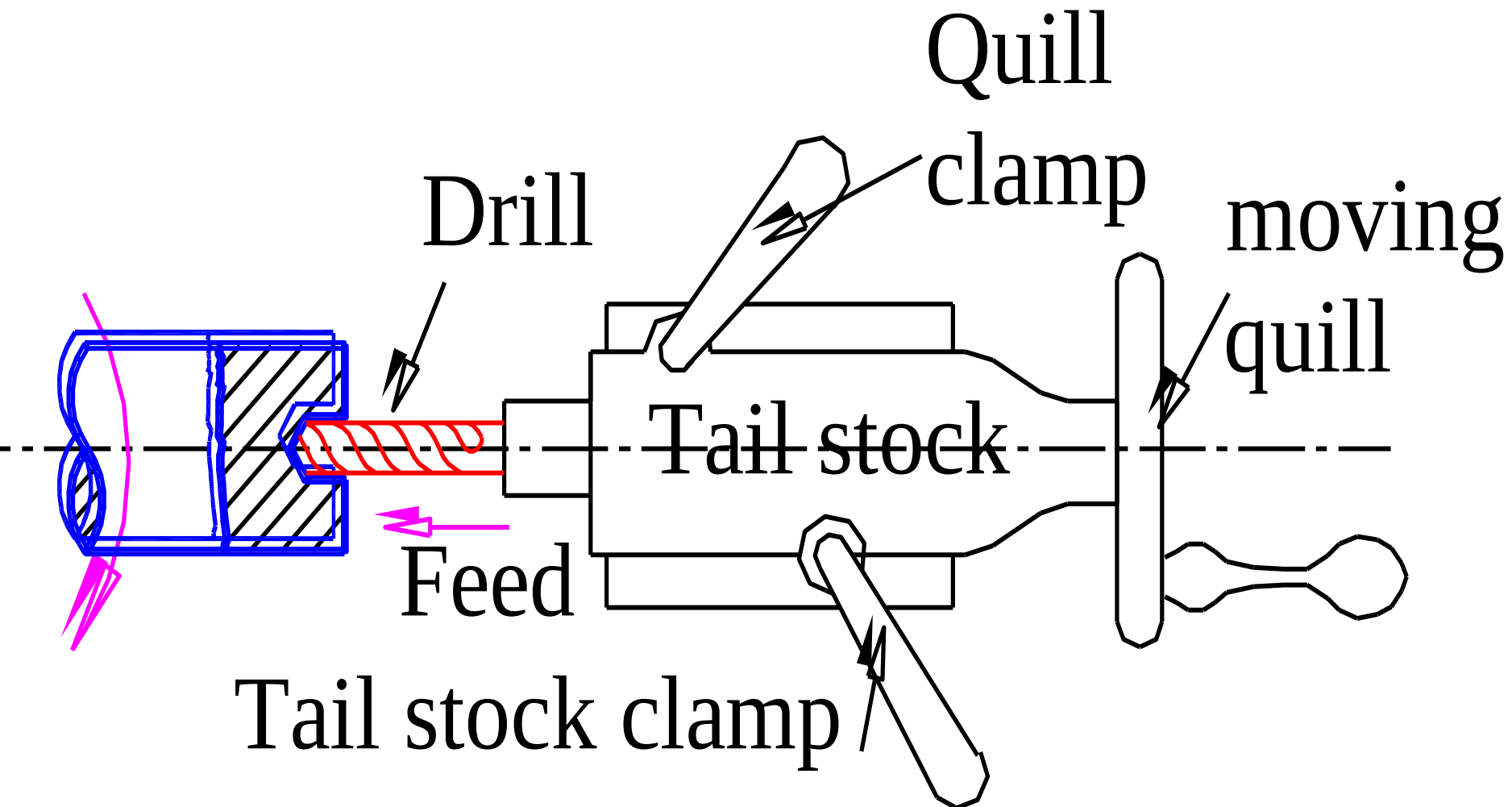
Conicity $K = \frac{D_1 - D_2}{L}$

Methods

- Form Tool
- Swiveling Compound Rest
- Taper Turning Attachment
- Simultaneous Longitudinal and Cross Feeds

Drilling

Drill – cutting tool – held in TS – feed from TS



Drill machines

Drilling Machines: The cutting action results from the rotary movement of the cutting tool or workpiece, with a feed motion of the workpiece or tool, in the direction of the rotating axis. Drilling machines are used for drilling, boring, counter-sinking, reaming and tapping operations.

Drill machines

Shaping machines

A shaping machine is used to machine surfaces. It can cut curves, angles and many other shapes. It is a popular machine in a workshop because its movement is very simple although it can produce a variety of work.

Shaping machines

Slotting machines

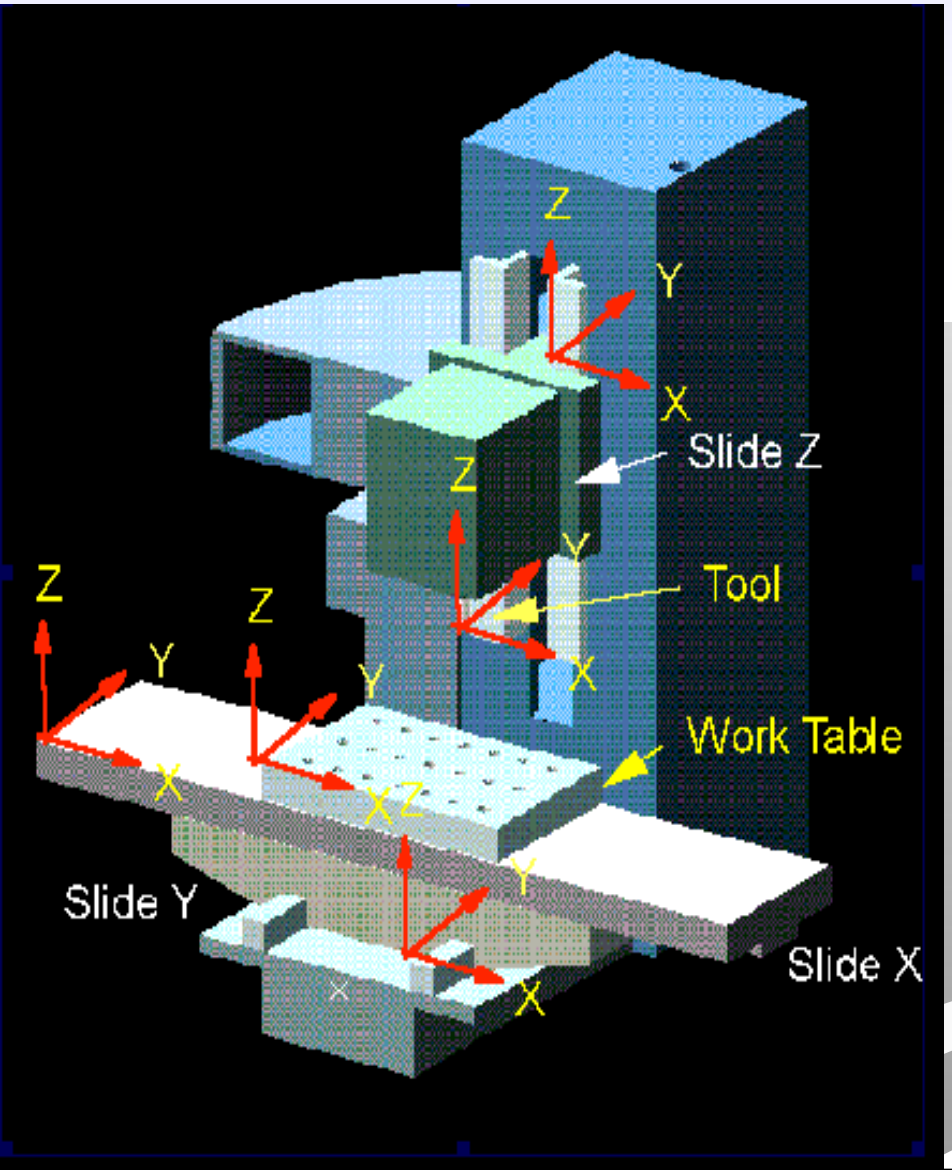
A **Slotting Machine** is utilized in cutting a slot or key ways internal or external

Planning machines

The planer is a machine tool designed to produce plane and flat surface on a workpiece which is too large or too heavy. The workpiece is securely fixed on a table called platen, and it reciprocates horizontally against a single edged cutting tool. The surface machined may be horizontal, vertical or at an angle.

Planning machines

Milling machine



In milling, both the tool and the workpiece can move horizontal or vertical direction. Milling machines are used to produce flat surfaces, sink, and slot.

Milling machine

Milling is the process of cutting away material by feeding a workpiece past a rotating multiple tooth cutter. The cutting action of the many teeth around the milling cutter provides a fast method of machining. The machined surface may be flat,angular, or curved. The surface may also be milled to any combination of shapes. The machine for holding the workpiece, rotating the cutter, and feeding it is known as the Milling machine.

Milling machine

FCM-152 Universal Horizontal Milling Machine

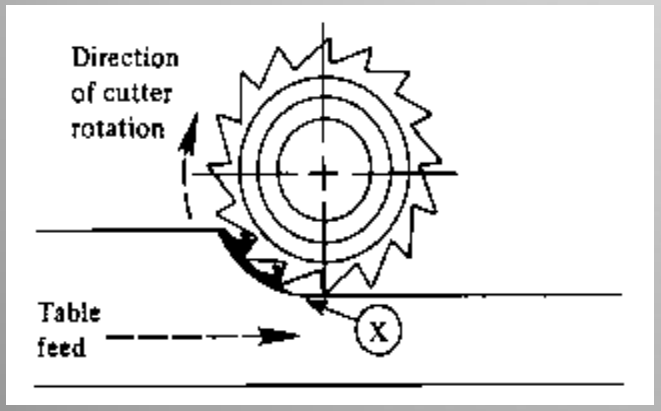
Milling machine (METHODS OF MILLING)

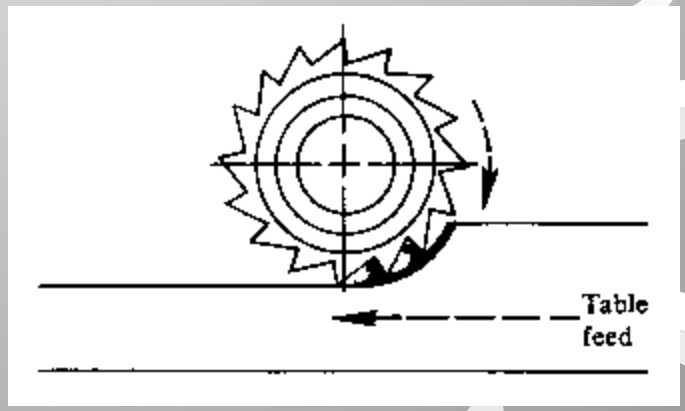
Up Milling

Up milling is also referred to as conventional milling. The direction of the cutter rotation opposes the feed motion. For example, if the cutter rotates clockwise , the workpiece is fed to the right in up milling.

Down Milling

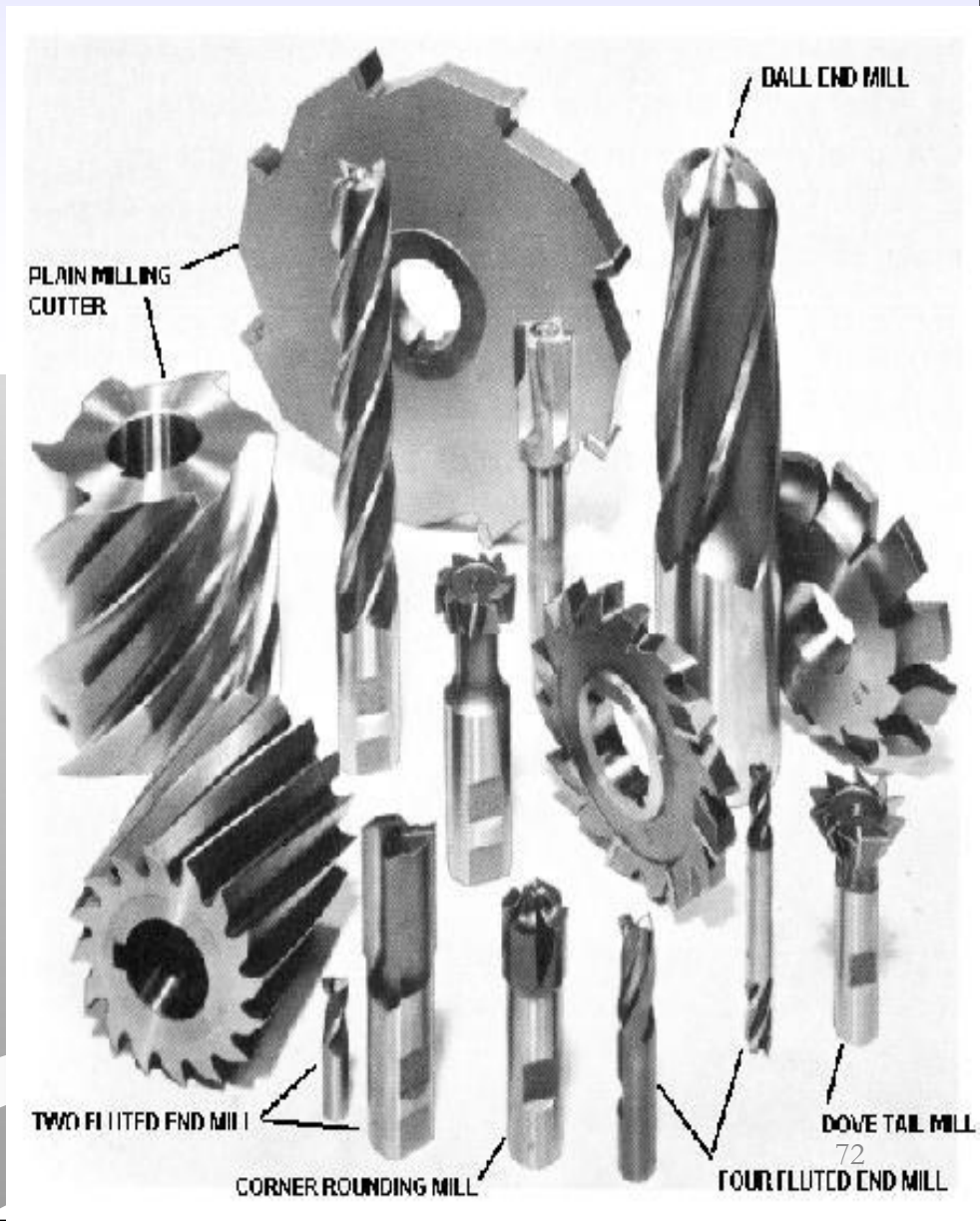
Down milling is also referred to as climb milling. The direction of cutter rotation is same as the feed motion. For example, if the cutter rotates counterclockwise , the workpiece is fed to the right in down milling.





The chip formation in down milling is opposite to the chip formation in up milling. The figure for down milling shows that the cutter tooth is almost parallel to the top surface of the workpiece. The cutter tooth begins to mill the full chip thickness. Then the chip thickness gradually decreases.

Milling machine



Grinding machines

A **grinding machine**, often shortened to **grinder**, is a machine tool used for grinding, which is a type of machining using an abrasive wheel as the cutting tool. Each grain of abrasive on the wheel's surface cuts a small chip from the workpiece via shear deformation.

Grinding is used to finish workpieces which must show high surface quality (e.g., low surface roughness) and high accuracy of shape and dimension. As the accuracy in dimensions in grinding is on the order of 0.000025mm, in most applications it tends to be a finishing operation and removes comparatively little metal, about 0.25 to 0.50mm depth.

Horizontal boring

Broaching machine

Broaching is a machining process that uses a toothed tool, called a **broach**, to remove material. There are two main types of broaching: *linear* and *rotary*. In linear broaching, which is the more common process, the broach is run linearly against a surface of the workpiece to effect the cut. Linear broaches are used in a **broaching machine**, which is also sometimes shortened to*broach*. In rotary broaching, the broach is rotated and pressed into the workpiece to cut an axis symmetric shape. A rotary broach is used in a lathe or screw machine. In both processes the cut is performed in one pass of the broach, which makes it very efficient.

Broaching machine

CNC Machines

Controls are the brain of all machine tool operation. Earily machine tool relied on operators to turn the wheels and pull the leverthat moved cutting tools and the workpiece. Today's machine tool are mostly relied on numeric control (NC), computer numerical control (CNC), programmable logic controller (PLC) and/or microprocessors.

Today, engineers create both parts design and the manufacturing programs to make them on a computer. First, an enginner designs a part using computer-aided design (CAD), then the design goes to a computer-aided manufacturing program (CAM). CAM will generate the tool-paths. Finally, the CNC on the machine tool will execute the tool-paths commands.

CNC Machines

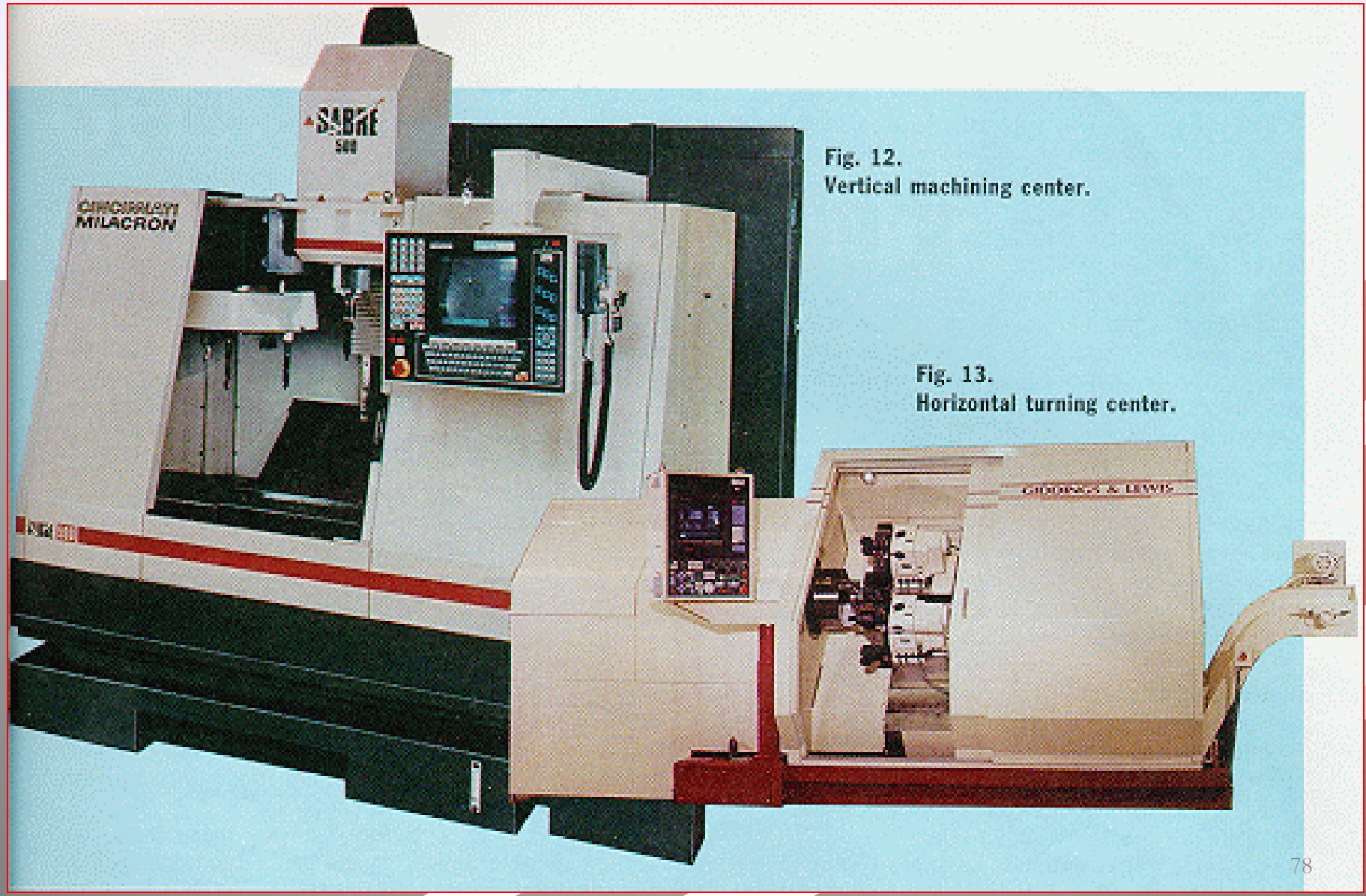
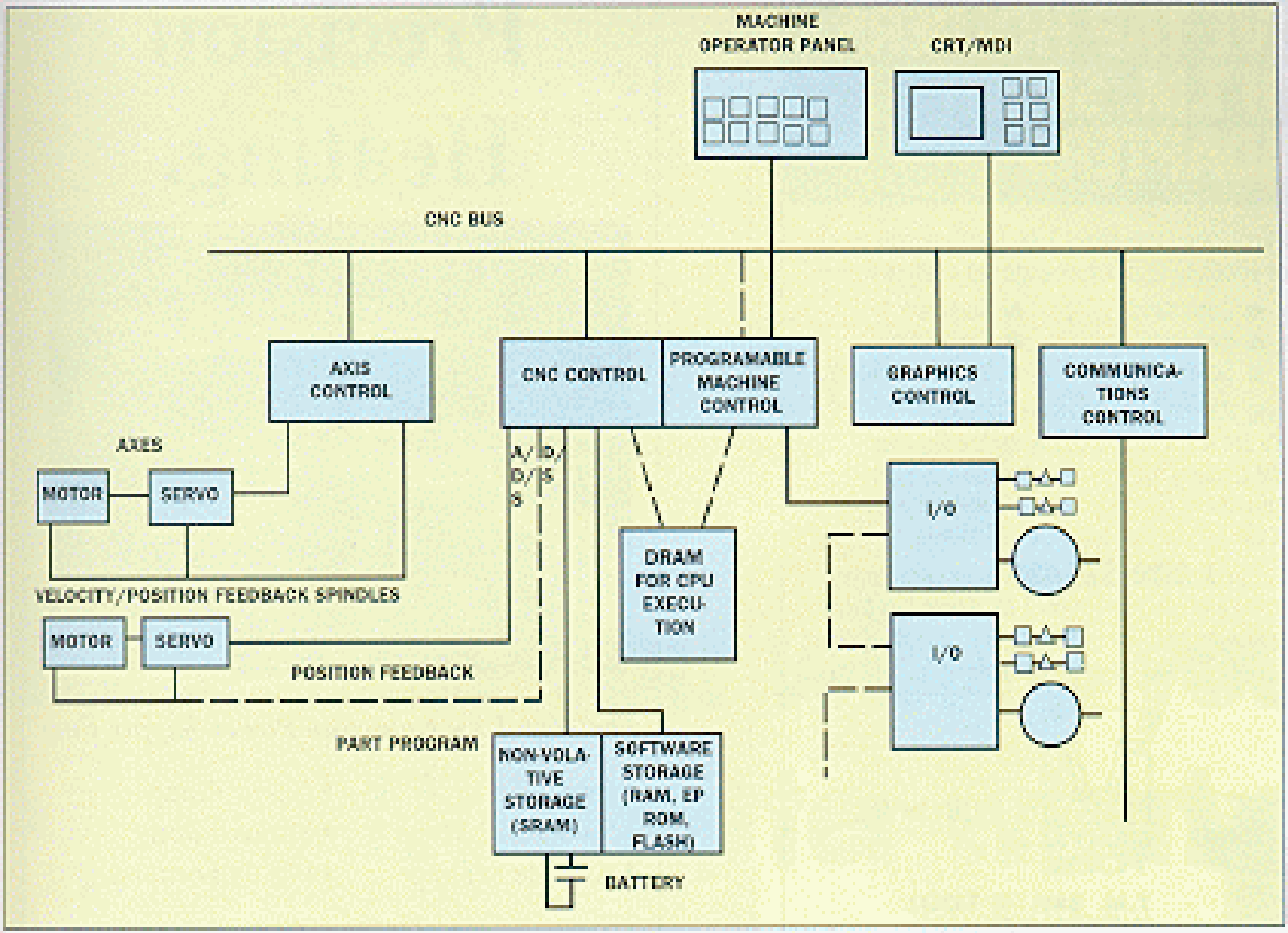


Fig. 12.
Vertical machining center.

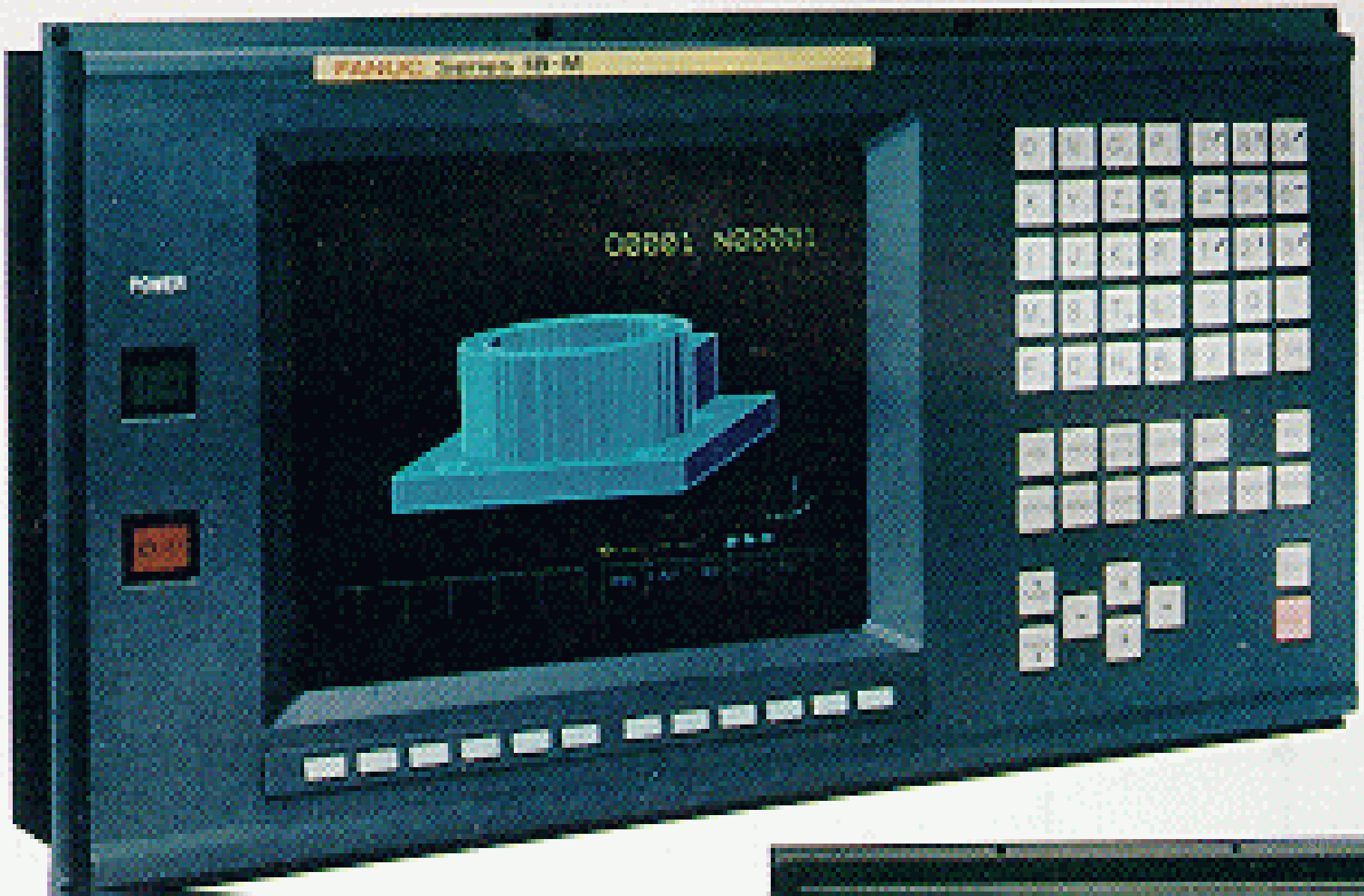
Fig. 13.
Horizontal turning center.

CNC Machines



Generic setup for a modern CNC system based on a GE Fanuc design.

CNC Machines



REPLACEMENT OF MACHINE

- OLD M/C COMPLETED ITS CODAL LIFE OR NOT. LOAD JUSTIFICATION FOR NEW M/C
- POSSIBILITY OF OUTSOURCING OF THE ACTIVITY.
- REPLACEMENT IS FOR THE SAME FUNCTION OR NOT.
- DETAILS OF THE JOBS TO BE UNDERTAKEN
- THE PROPOSAL SHOULD BE JUSTIFIED FINANCIALLY.
- LIMITATIONS FOR REPAIR THE EXISTING M/C.

NEW MACHINES

- Reason for the proposal.
- Justification for the proposal
- How managed so for
- Rate of return of the M/C
- Unit Finance vetting

STEPS TO BE FOLLOWED

Each proposal should be accompanied by
BQ/ COFMOW'/BAR lost PO rate.
Budgetary provision to be indicated.

- After receiving the sanction detailed estimate is to be prepared.
- The estimation should be sent to COS / COFMOW for specification.
- After receipt of the COS/SC's P.O. or COFMOW's A/T, the location, foundation and electrical requirements are to be finalized well before receipt of the machine.
- After receipt of the machine, joint verification of the consignment is to be made along with firm's representatives and it should be got commissioned and by the firm.
- Correspondence is to be made with the firm for any warranty repair until the expiry of warranty.

M&P Programme below 10 lakhs.

1.)CME is nodal officer for all depts. For procurement of M&P.

2.)Proposal initiated by user department with financial justification (ROR) Forwarded to HQrs. Along with unit finance vetting.

3.)Other than Mech. Dept. directly to FA&CAO certification.

4.)Mech. Dept. through CME to FA&CAO concerned.

5.)After FA&CAO concurrence proposals to CME.

6.)Consolidated proposals to AGM.

7.)AGM will sanction under GMs OOT.

8.)Procurement.

9.)Installation

10.)Warranty complaints.

THANK YOU