IPE-431

MACHINE TOOLS

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Contents

1 Lecture 01: Engine Lathe

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Booklist

Machine Tools by N. Chernov

Engine Lathe

An engine lathe, also known as a center lathe or a turning lathe, is a type of machine tool used in metalworking processes to shape and cut metal workpieces. A machine tool used for machining of mainly cylindrical workpieces. It is one of the most commonly used lathes in manufacturing and repair shops. Engine lathes are versatile machines capable of performing a wide range of operations, including **facing, centering, turning, threading, parting, drilling, boring, chamfering, knurling.** Both external and internal operations can be performed.

Components of Engine Lathe

The basic components of an engine lathe include a bed, headstock, tailstock, carriage, tool post, and various controls. Let's explore each component in more detail:

- **Bed**: The bed is the main base of the lathe and provides a rigid and stable platform for supporting other components. It is usually made of cast iron and has a flat, horizontal surface on which the workpiece rests. The bed contains guideways or V-ways that guide the movement of the carriage along the length of the lathe.
- **Headstock**: The headstock is located on one end of the bed and houses the main spindle. The spindle is driven by a motor and provides the rotational motion to the workpiece. It also contains a variety of speed and feed controls to adjust the cutting speed and direction.
- **Tailstock**: The tailstock is located on the other end of the bed and is movable along the bed's guideways. It consists of a spindle, which can be extended or retracted, and is used to support the other end of the workpiece. The tailstock often includes a center or a chuck for gripping the workpiece securely.
- **Carriage**: The carriage is mounted on the bed and can move along the length of the lathe using the guideways. It consists of several components, including the saddle, cross-slide, and apron. The carriage carries the cutting tool and controls its movement across the workpiece.
- **Tool Post**: The tool post is located on top of the carriage and holds the cutting tool securely. It allows for quick and easy tool changes, enabling the operator to use different tools for various operations.
- **Controls**: The engine lathe has a variety of controls to regulate the speed, feed, and direction of the cutting tool. These controls can be manual or automated, depending on the lathe's design and features. They enable the operator to adjust the cutting parameters according to the workpiece material and desired machining outcome.

Bed

- Main body of the machine
- All the main components are bolted on it including the headstock, tailstock, carriage etc.
- Usually made of cast iron due to its high compressive strength
- Contains guide ways that guides the carriage and tailstock

Headstock

- Provides the rotational power for the lathe's operations
- Holds the speed gear box, spindle, chuck, gear speed control levers, and feed controllers
- Made up of cast iron
- Usually positioned on the left side of the bed

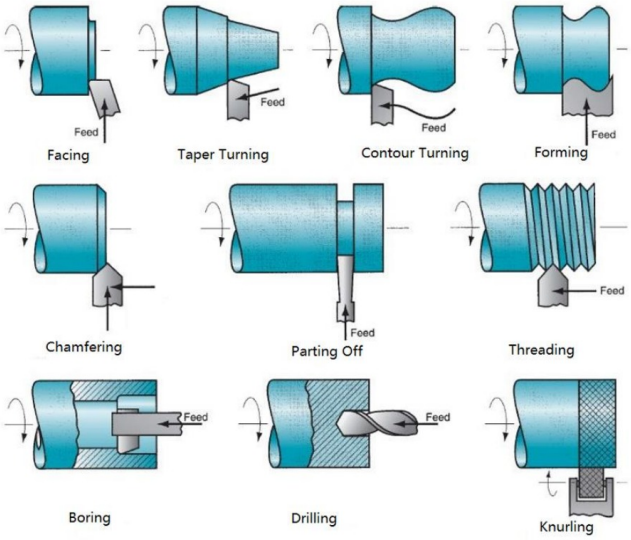


Figure 1: Operations of Engine Lathe

Figure 2: Engine Lathe Machine

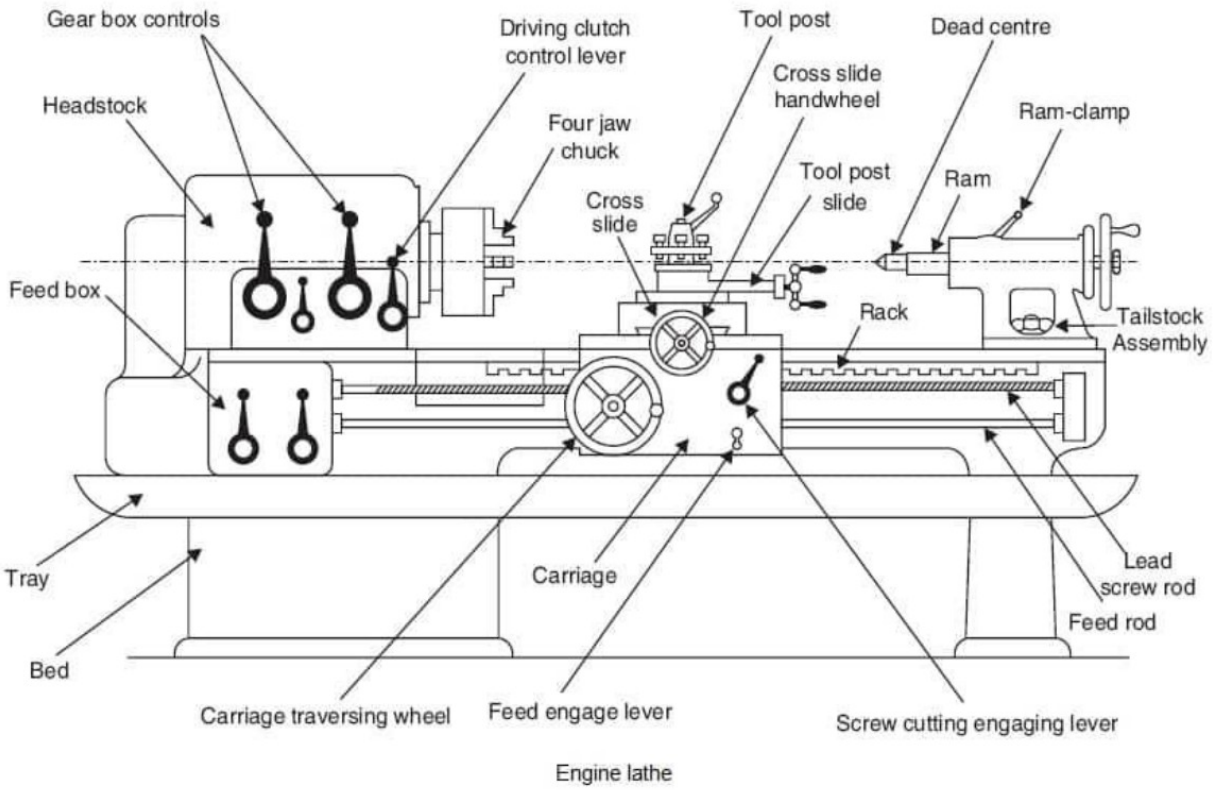


Figure 3: A Schematic Diagram Engine Lathe

Spindle

- A hollow shaft on which the chuck is mounted and rotated
- Made from good quality alloy steel and is heat treated
- Threads, tapers, etc. are made at one end of the spindle to which holding devices can be attached

Chuck

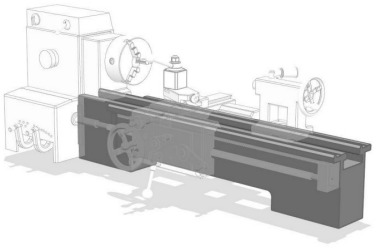
- Used to hold workpiece
- Usually of 2 types – 3 Jaw Self centering Chuck and 4 Jaw Independent Chuck
- Collet chuck is used for some special purpose cases

Tailstock

- Support the loose end of the workpiece or a job while machining
- Hold the cutting tools such as drill chucks, drills, reamers etc.
- Can slide on the bed guideways and can be clamped in any position
- Center can be live or dead; live center rotates with workpiece while dead center does not

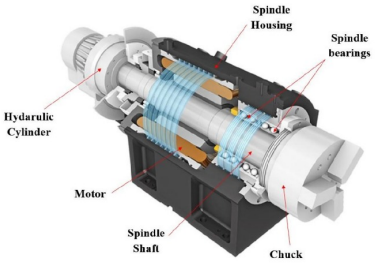
Carriage

- Located between headstock and tailstock
- Move the tool post along the bed
- Impart the feed movement along z axis of lathe machine from lead screw and feed rod
- Consists of 7 main parts – (i) Apron (ii) Saddle (iii) Cross slide (iv) Swivel plate (v) Compound Rest (vi) Top slide (vii) Tool post

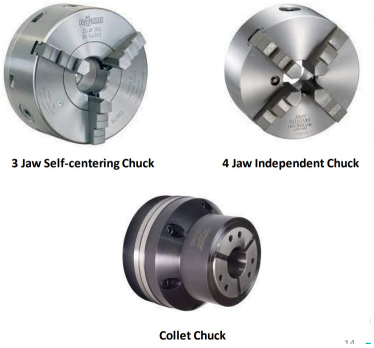


(a) Bed

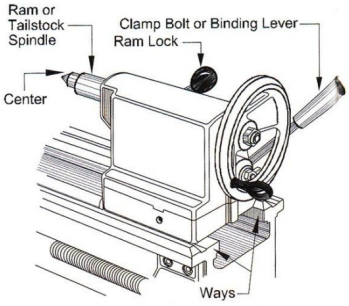
(b) Headstock



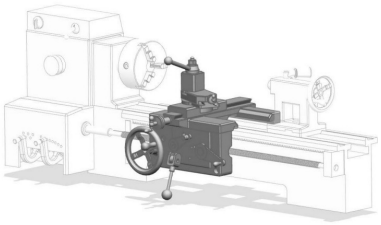
(c) Spindle



(d) Chuck



(e) Tailstock



(f) Carriage

Figure 4: Components of Engine Lathe

Apron

- Located on the front face of the carriage
- Responsible for receiving power from the lead screw or the feed rod
- Transfer the power to move either the carriage itself or the cross slide

Saddle

- A 'H' shaped part of the carriage that rides on the bed
- Responsible for supporting cross slide movements

Cross Slide

- Mounted on top surface of saddle
- Allow the movement of a tool post at a right angle to the bed guideways during machining (along x axis of lathe machine)

Swivel Plate

- Mounted on cross slide
- Allow the compound rest thus the tool post to rotate as per requirement
- Graduations of degrees are marked on the swivel plate to facilitate rotation

Compound Rest

- Mounted on swivel plate
- It is a stationary part on which the top slide moves
- Direction of the compound rest is set by the direction of swivel plate

Top Slide

- Mounted on compound rest
- Movement of this part provides the depth of cut of the corresponding lathe operation
- Tool post is mounted on top of it

Tool Post

- Mounted on top slide
- Used to hold the tools at the correct position with rigidity
- Main tool holder is known as square turret which is used for typical lathe cutting tool
- Back tool holder is used for grooving operations

Speed Gear Box

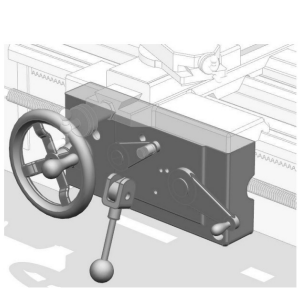
- Gear train positioned inside headstock
- Responsible for precise rotational speed of spindle
- Has a number of available standard rotational speeds
- Takes the power from main motor via belt pulley mechanism

Feed Gear Box

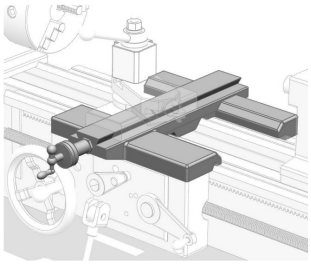
- Gear train positioned below the speed gear box
- Responsible for feed movements of carriage and cross slide
- Receives the power from spindle via change gear box
- Provides motion to lead screw and feed rod

Lead Screw & Feed Rod

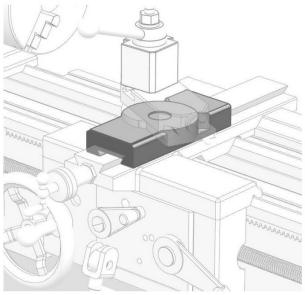
- Responsible for transferring feed motion from feed gear box to carriage
- Engage with carriage via apron
- Lead screw is used for high feed rate operations like threading while feed rod is used for low feed rate operations like turning



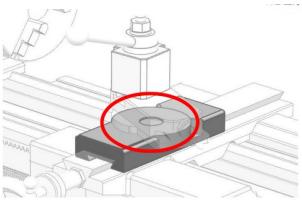
(a) Apron



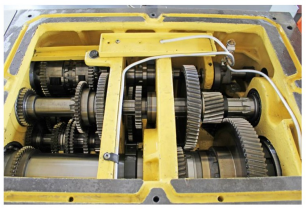
(b) Saddle



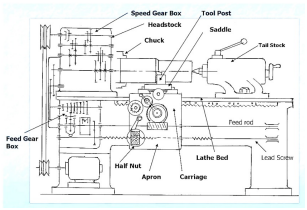
(c) Cross Slide



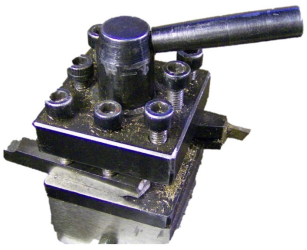
(d) Swivel Plate



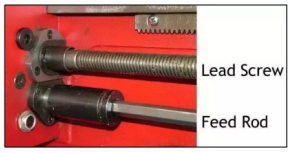
(e) Speed Gear Box



(f) Feed Gear Box



(g) Tool Post



(h) Lead Screw

Figure 5: Components of Engine Lathe

Axis of Rotation

- Along the spindle → z axis
- up to down → y axis
- front to back → x axis

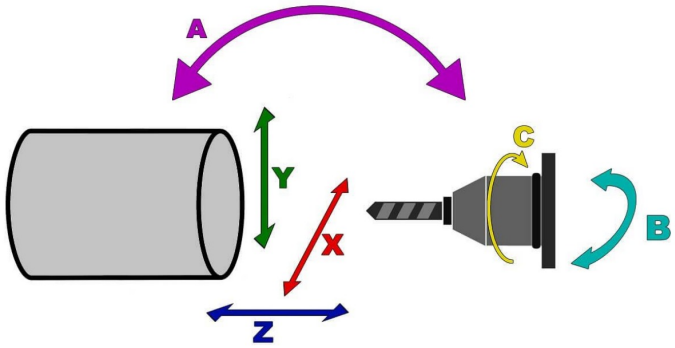


Figure 6: Axis of Rotation in engine lathe

2 Lecture 2: Apron Mechanism & Short Gear Train

Date: 12/06/2023

Apron Mechanism

- Apron mechanism is the mechanism of power transmission from feed rod to apron
- Carriage moves using rack and pinion mechanism
- Feed rod is engaged with the worm gear using key slot mechanism
- Automatic motion can be provided to longitudinal and cross direction using power clutch system

Half Nut Mechanism

- Lead screw is engaged with apron using half nut mechanism unlike key slot mechanism of feed rod
- The half nut is mounted on the back side of the apron
- Half nut can be engaged/disengaged using a lever

Main Dimension of Engine Lathe

1. Height of centers over bed
2. Maximum diameter of workpiece accommodated over the bed (most important)
3. Maximum diameter of workpiece accommodated over the carriage
4. Maximum diameter of workpiece accommodated over the gap
5. Maximum distance between centers
6. Length of the bed
7. No. of speeds and feeds

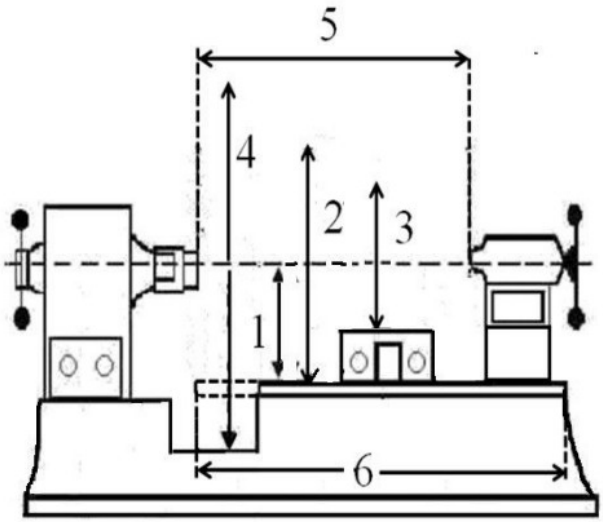
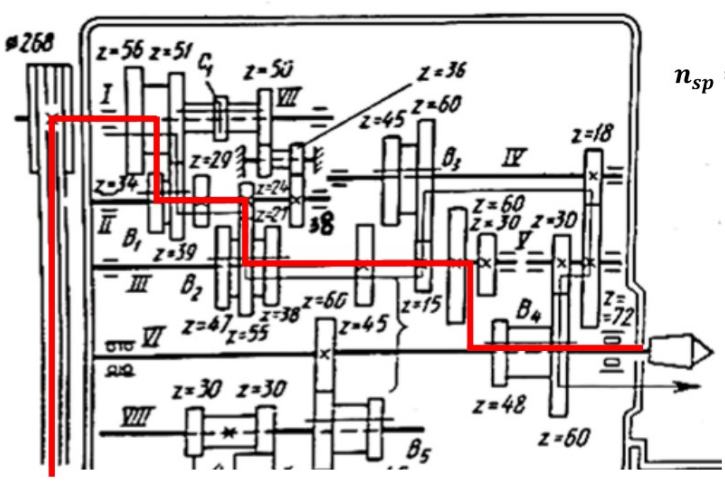


Figure 7: Main Dimension of engine lathe

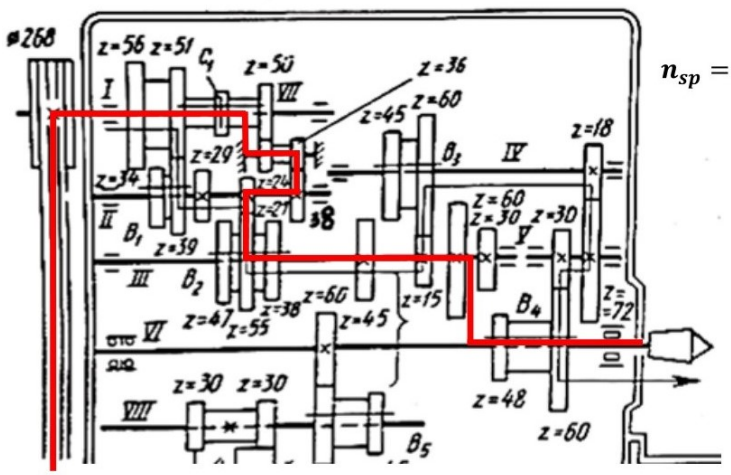
Short Gear Train



$$n_{sp} = 1460 \times \frac{148}{268} \times \underbrace{0.985}_{\text{Belt Slippage Factor}} \times \frac{51}{39}\frac{56}{34} \times \frac{21}{55}\frac{38}{38}\frac{29}{47} \times \frac{30}{60}\frac{60}{48}$$

12 High Speeds (Forward)

Figure 8: Forward Rotation (without back gear) $\rightarrow C_1$ Disengaged



$$n_{sp} = 1460 \times \frac{148}{268} \times 0.985 \times \frac{50}{24} \times \frac{36}{38} \times \frac{21}{55} \times \frac{30}{60} \times \frac{38}{38} \times \frac{60}{48} \times \frac{29}{47}$$

6 High Speeds (Reverse)

Figure 9: Forward Rotation (with back gear) $\rightarrow C_1$ Engaged