Subject Name & Code:

MANUFACTURING PROCESSES-BE04000191

ASSIGNMENT-6: Planers, Shapers and Slotters (CO-2,3,4)

Q1. Explain the working principle of a slotting machine with a neat sketch.

Slotting Machine (Slotter):

- **Definition:** Reciprocating machine tool where **ram moves vertically** to produce slots, keyways, and internal profiles.
- **Classification:** Vertical shaper.

Working Principle:

1. **Cutting Motion:** Ram with tool moves **vertically down** (cutting stroke) and returns up (idle stroke).
2. **Feed Motion:** Workpiece on table is fed after each cutting stroke in longitudinal, cross, or rotary direction.
3. **Quick Return Mechanism:** Ram moves slower during cutting stroke and faster during return stroke to reduce idle time.

Main Parts:

- **Base:** Heavy cast iron base; supports entire machine.
- **Column:** Vertical housing containing drive mechanism.
- **Ram:** Reciprocating member carrying tool head.
- **Tool Head:** Holds cutting tool; can be swivelled for angular cuts.
- **Table:** Mounted on saddle; holds workpiece; can be moved in X, Y, and rotary axes.
- **Saddle:** Supports table; moves on bedways.

Mechanism:

- Motor drives bull gear through pinion.
- Bull gear has crank pin engaging slotted link.
- Slotted link oscillates, moving ram up and down.
- **Quick return:** Crank pin travels shorter arc during return stroke → faster return.

Applications:

- Cutting internal keyways in gears/pulleys.

- Machining internal splines, grooves, irregular profiles.
- Die sinking and mould making.

Diagram:

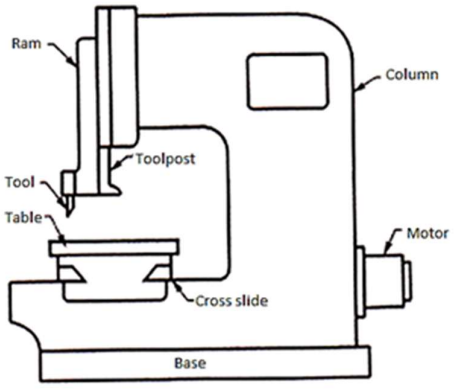

Fig.6.20 – Block diagram of a slotter

Q2. Compare shaper and planer.

Parameter	Shaper	Planer
Cutting Motion	**Tool reciprocates**; workpiece stationary	**Workpiece reciprocates**; tool stationary
Size	Small to medium (up to 900 mm stroke)	Large to very large (up to 12 m bed)
Workpiece Weight	Light to medium	Heavy and bulky
Feed Motion	Tool fed after each stroke	Tool fed intermittently
Cutting Speed	Lower; limited by ram inertia	Higher; workpiece can be moved faster
Productivity	Lower (single tool)	Higher (multiple tool heads)
Accuracy	Moderate	High

Parameter	Shaper	Planer
Floor Space	Less	More
Cost	Lower	Higher
Applications	Small dies, keyways, prototype work	Large machine beds, tables, structural parts

Summary: Shaper: Tool moves, workpiece fixed; for small jobs. Planer: Workpiece moves, tool fixed; for large jobs.

Q3. Draw a neat sketch of a planer and label its various parts.

Diagram:

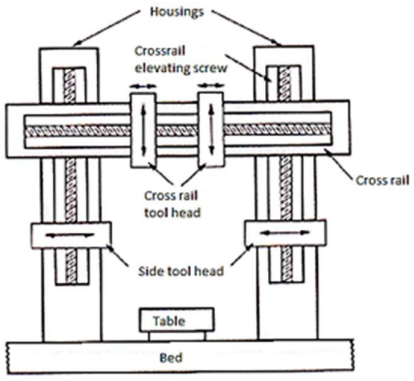

Fig.6.16 – Main parts of a Planer

Q4. Explain crank and slotted link quick return mechanism in shaper.

Crank and Slotted Link Mechanism (Quick Return Mechanism):

Components:

- **Bull Gear:** Large gear rotating at constant speed.
- **Crank Pin:** Mounted on bull gear; offset from centre.
- **Sliding Block:** Fits in slot of slotted link; moves with crank pin.
- **Slotted Link (Rocker Arm):** Pivoted at bottom; slot accommodates sliding block.
- **Ram:** Connected to top of slotted link via link pin.

Working:

- **Rotation of Bull Gear:** Motor drives bull gear through pinion at constant RPM.

- **Crank Pin Motion:** Crank pin rotates in circular path.
- **Sliding Block Movement:** Block slides within slot while rotating.
- **Oscillation of Slotted Link:** As crank pin rotates, slotted link oscillates about pivot.
- **Ram Reciprocation:** Top of slotted link moves ram forward (cutting) and backward (return).

Quick Return Principle:

- Crank pin travels through **angle α** during cutting stroke (larger arc).
- Crank pin travels through **angle β** during return stroke (smaller arc).
- Since bull gear rotates at constant speed:
    - **Time for cutting stroke ∝ α** (longer time → slower speed)
    - **Time for return stroke ∝ β** (shorter time → faster speed)
- **Quick Return Ratio = α / β** (typically 1.5 to 2)

Formula:
Quick Return Ratio = Time for Cutting / Time for Return = α / β = (360° + θ) / (360° - θ)
Where θ = angular offset of crank pin.

Advantages:

- Reduces idle time, increases productivity.
- Simple and robust mechanism.

Q5. Explain the specifications of a shaper.

Shaper Specifications:

1. **Maximum Stroke Length:** Maximum distance ram can travel (e.g., 600 mm).
2. **Table Size:** Length × Width of work table (e.g., 450 × 350 mm).
3. **Maximum Vertical Travel of Tool Head:** (e.g., 150 mm).
4. **Maximum Horizontal Travel of Table:** (e.g., 400 mm).
5. **Maximum Vertical Travel of Table:** (e.g., 300 mm).
6. **Number of Speeds:** Range of strokes per minute (e.g., 6 speeds: 15-90 SPM).
7. **Number of Feeds:** Available feed rates per stroke (e.g., 0.1-2.0 mm/stroke).
8. **Motor Power:** Main drive motor rating (e.g., 3 HP).
9. **Type of Drive:** Geared or hydraulic.
10. **Floor Space Required:** Overall dimensions.

11. **Maximum Tool Overhang:** (e.g., 200 mm).

12. **Swivel Angle of Tool Head:** (e.g., ±60°).

Example Specification: "600 mm Stroke Shaper, Table 450×350 mm, 6 speeds (15-90 SPM), 3 HP motor, Geared drive."

Q6. Compare Planers, Shapers and Slotters.

Parameter	Shaper	Planer	Slotter
Cutting Motion	Tool reciprocates horizontally	Workpiece reciprocates horizontally	Tool reciprocates vertically
Size	Small to medium	Large to very large	Small to medium
Workpiece	Small, light	Heavy, bulky	Small to medium
Tool Heads	One	Multiple (2-4)	One
Productivity	Low	High	Low
Accuracy	Moderate	High	Moderate
Drive	Crank/slotted link or hydraulic	Rack & pinion or hydraulic	Crank/slotted link or hydraulic
Feed	Tool fed after each stroke	Tool fed intermittently	Table fed after each stroke
Applications	Keyways, small dies, prototypes	Machine beds, large plates	Internal keyways, splines, slots
Floor Space	Less	More	Less

Parameter	Shaper	Planer	Slotter
Cost	Low	High	Moderate