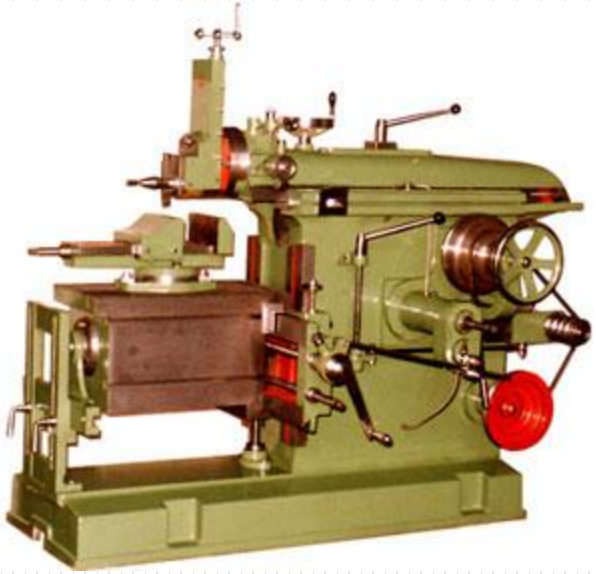
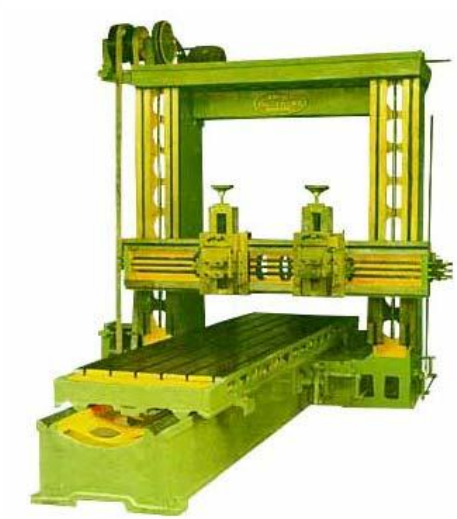
Ta 102

Workshop practice

Shaping, Planing and Slotting Operations

Lec No. 12- 13





BY

Prof .A.Chandrashekhar

Introduction

- Shaping, planning and slotting can be defined as the process of removing metal from a surface in horizontal, vertical and inclined position to produce a flat or plane surface, slots and grooves by means of a relative reciprocating motion between the tool and work piece.

- The difference between the three processes of shaping, planing and slotting is that in shaping and slotting, the tool is reciprocating and the work piece is fed in to the cutting tool while in planning, the work piece is reciprocating and the tool is fed in.

- The tool reciprocates horizontally in the shaping and vertically in slotting.

- The cutting is intermittent in all the three processes because in the relative reciprocating motion the tool cuts only in forward- working (or cutting) stroke followed by the idle-return stroke.

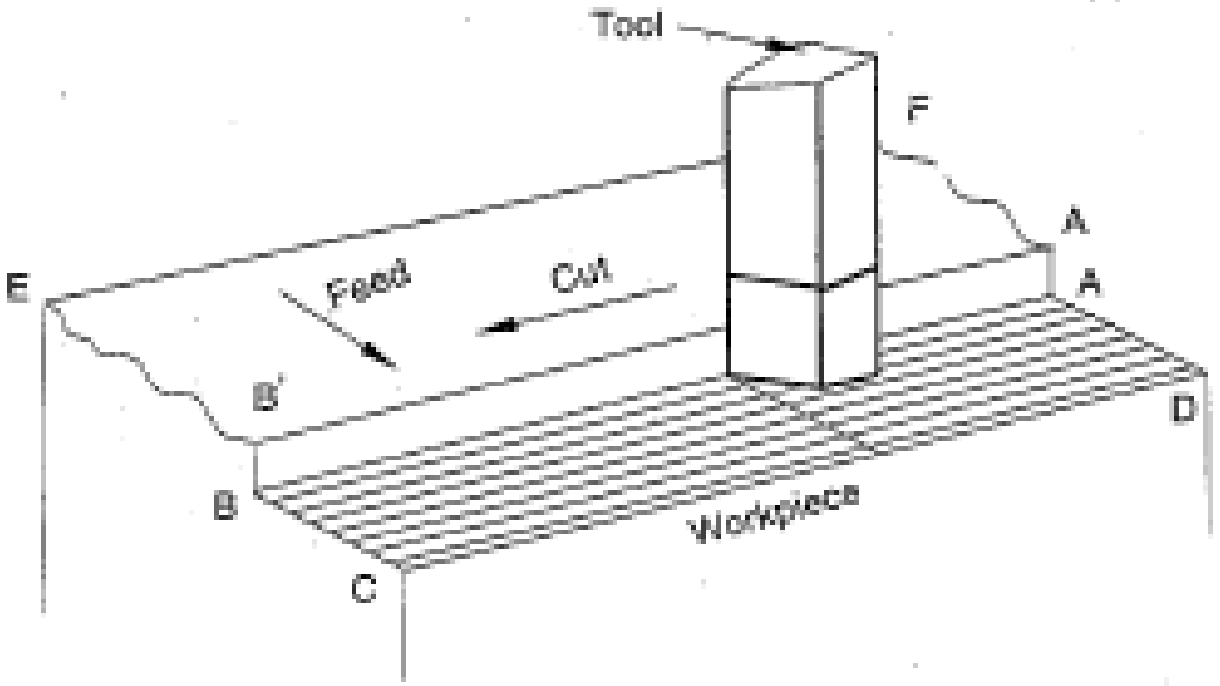


Figure 7.1 Process of producing a flat surface.

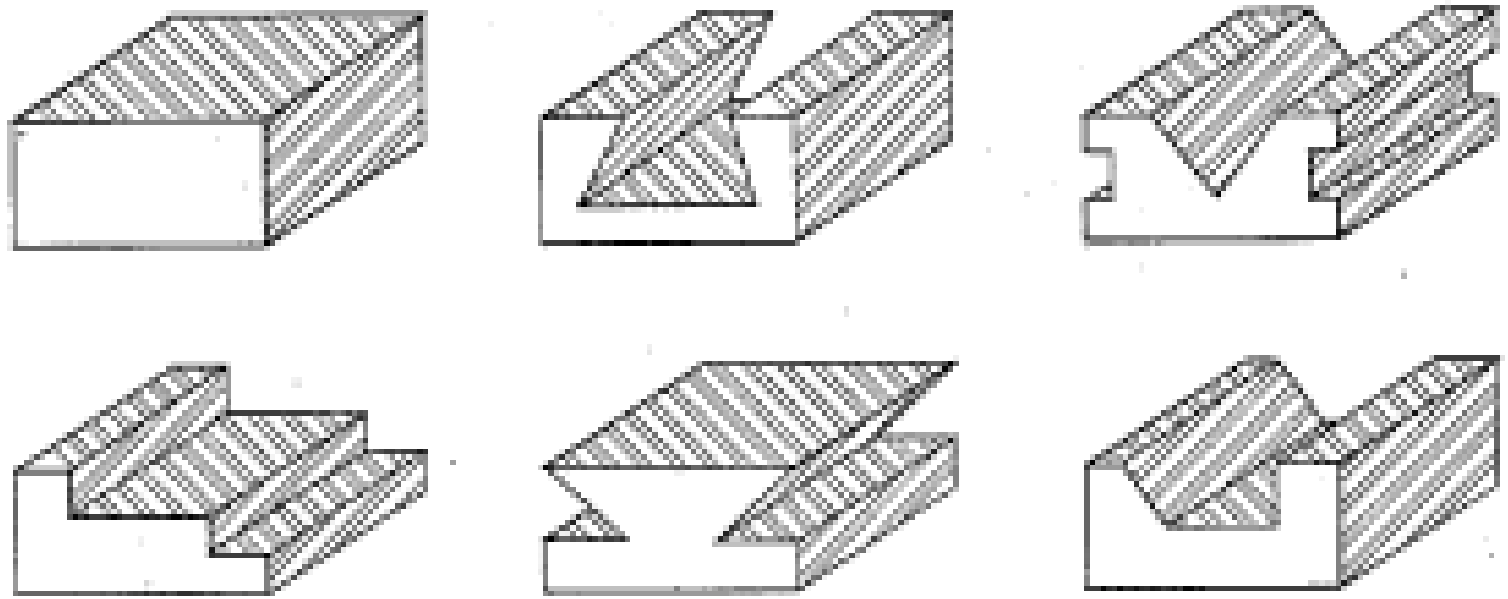


Figure 7.2 Components manufactured by the shaping process.

The Shaper

- The machine tool used for shaping operation is called shaper.
- It is designed for machining flat surfaces on small sized jobs. If the size of the job is large, then planing is used.
- In a shaper , the work piece is held stationary during cutting, while the tool reciprocates horizontally. the feed and depth of cut are normally provided by moving the work. Such shaper is called a horizontal shaper.

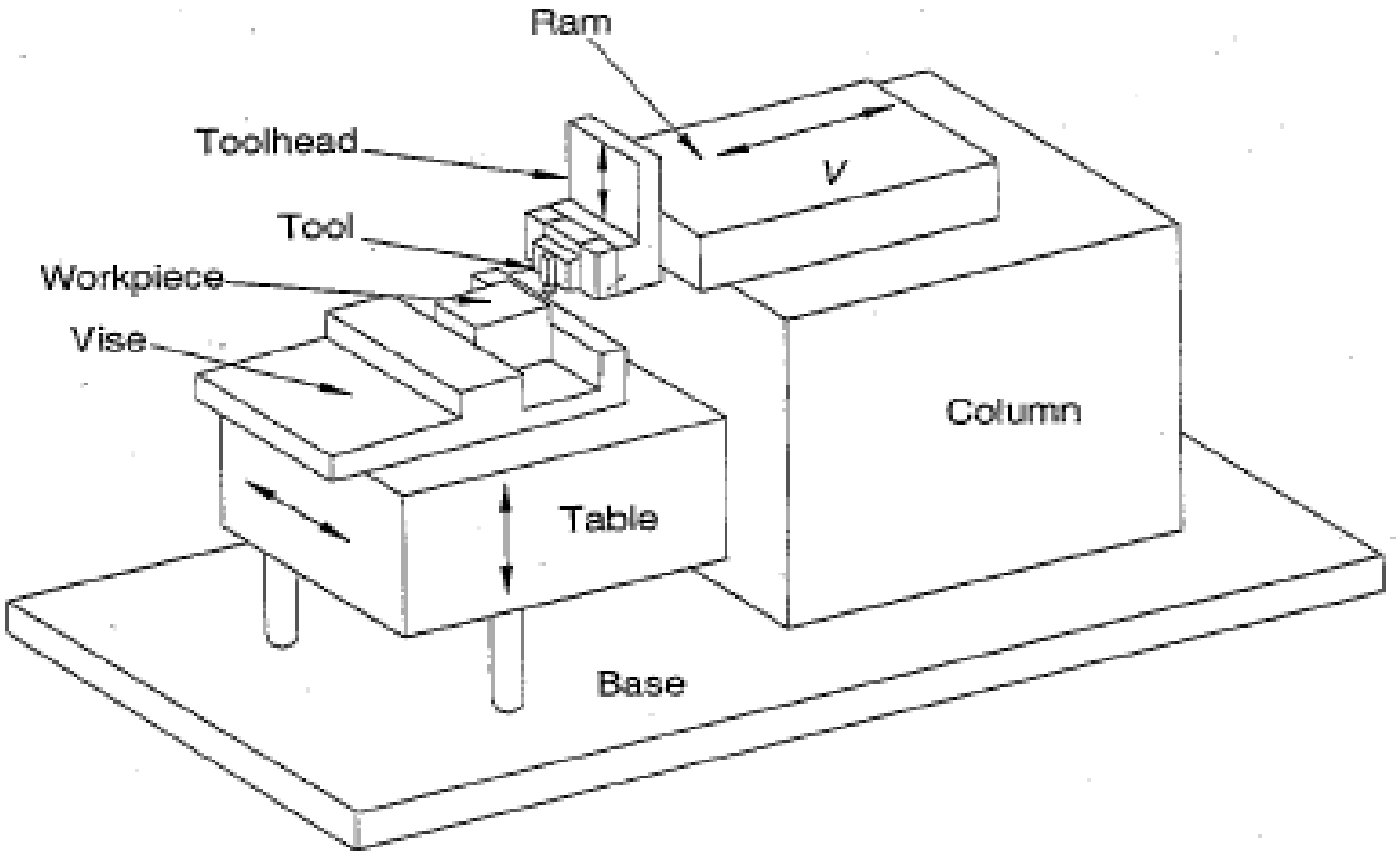
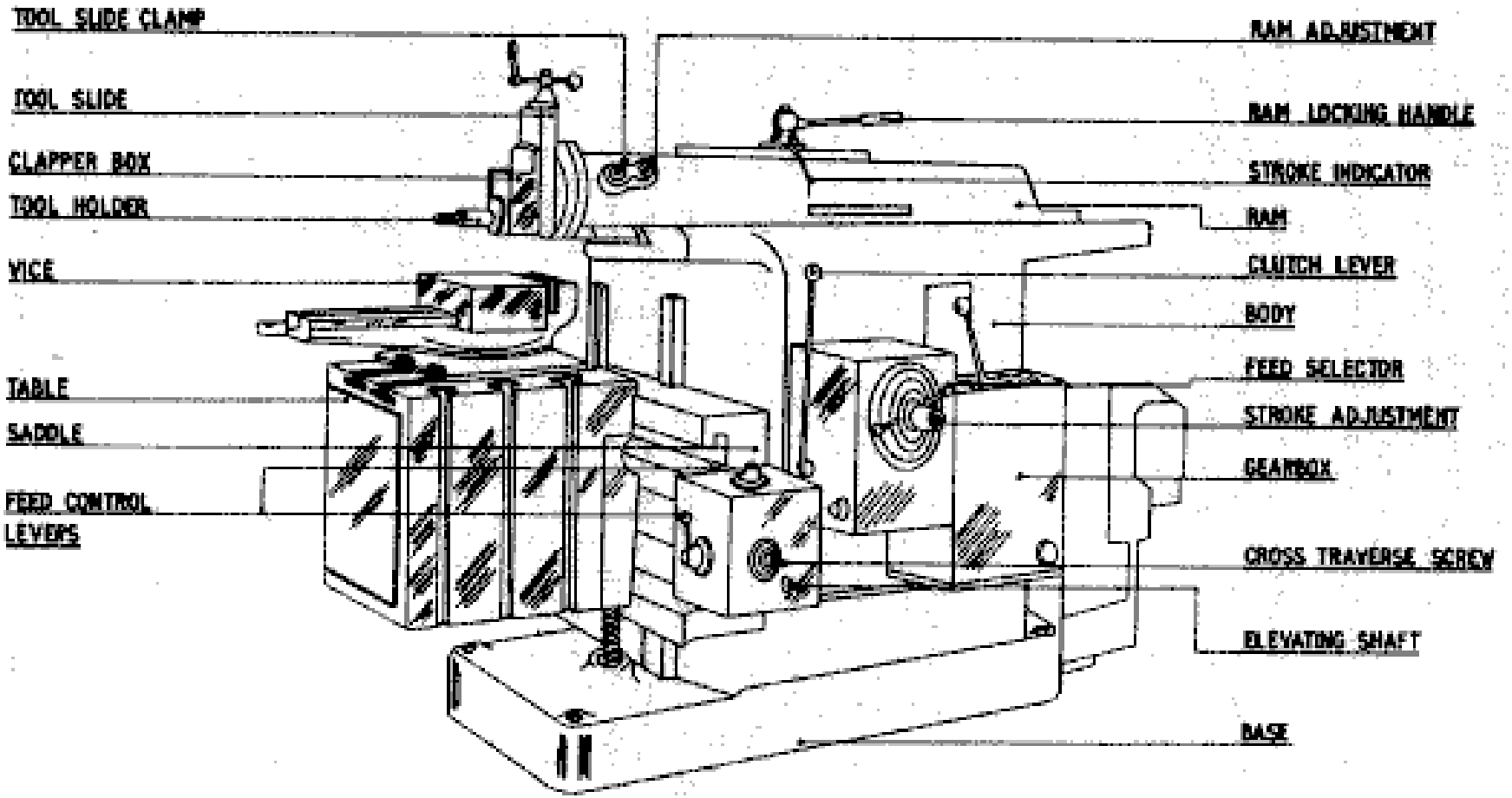


Figure 7.3 A horizontal shaper showing its main parts.


TOOL SLIDE CLAMP
TOOL SLIDE
CLAPPER BOX
TOOL HOLDER
VICE
TABLE
SADDLE
FEED CONTROL LEVERS
RAM ADJUSTMENT
RAM LOCKING HANDLE
STROKE INDICATOR
RAM
CLUTCH LEVER
BODY
FEED SELECTOR
STROKE ADJUSTMENT
GEARBOX
CROSS TRAVERSE SCREW
ELEVATING SHAFT
BASE

SHAPER

Types of Shaping Machines

- Shaping machines are the reciprocating type of machine tools in which the work piece is held stationary and the tool reciprocates.
- Most shapers have reciprocating motion in horizontal position (horizontal shapers) but shapers are also designed with reciprocating motion in vertical position(vertical shapers) or slotting machines or slotters.

The Shaping Operation

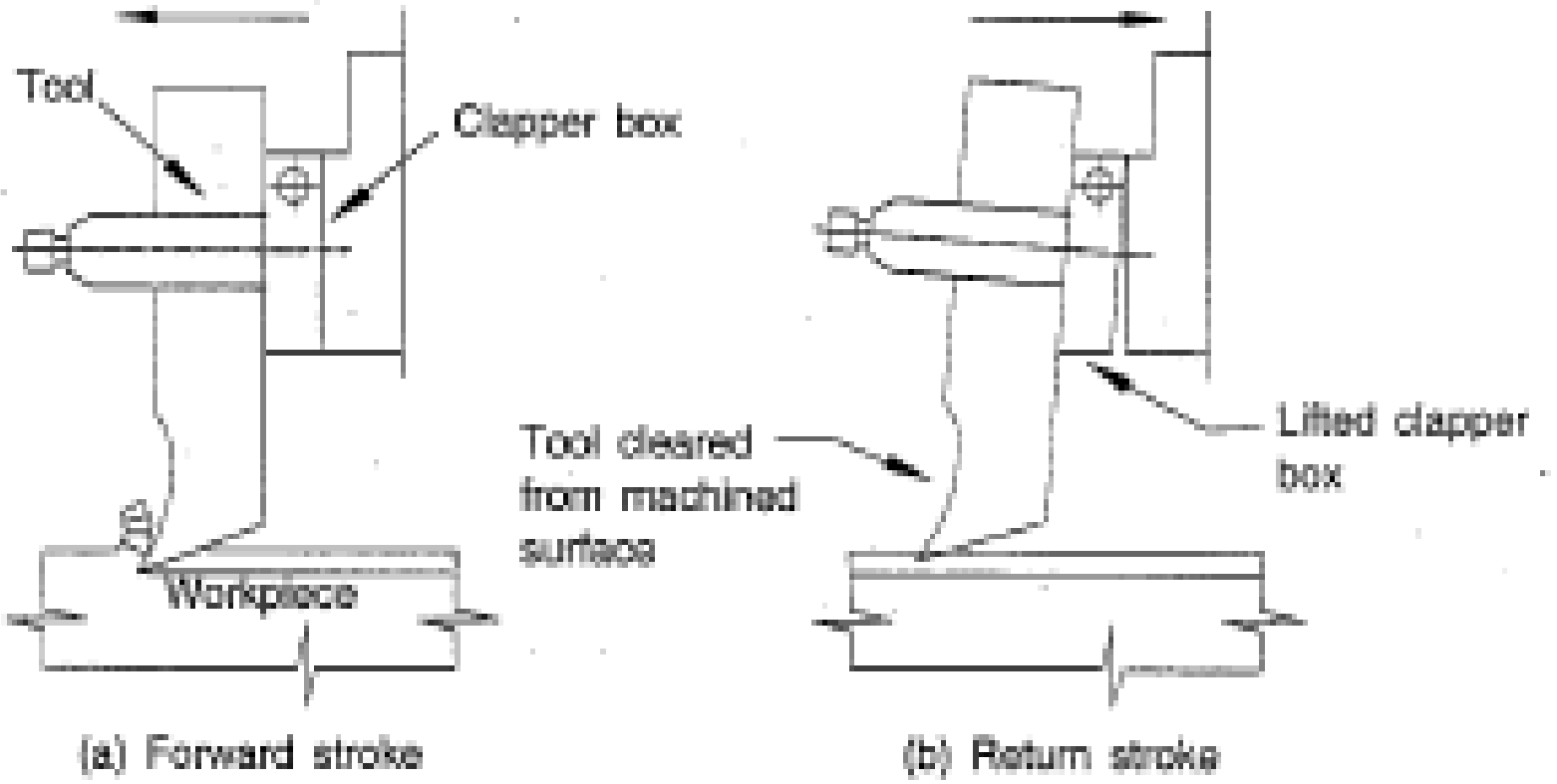
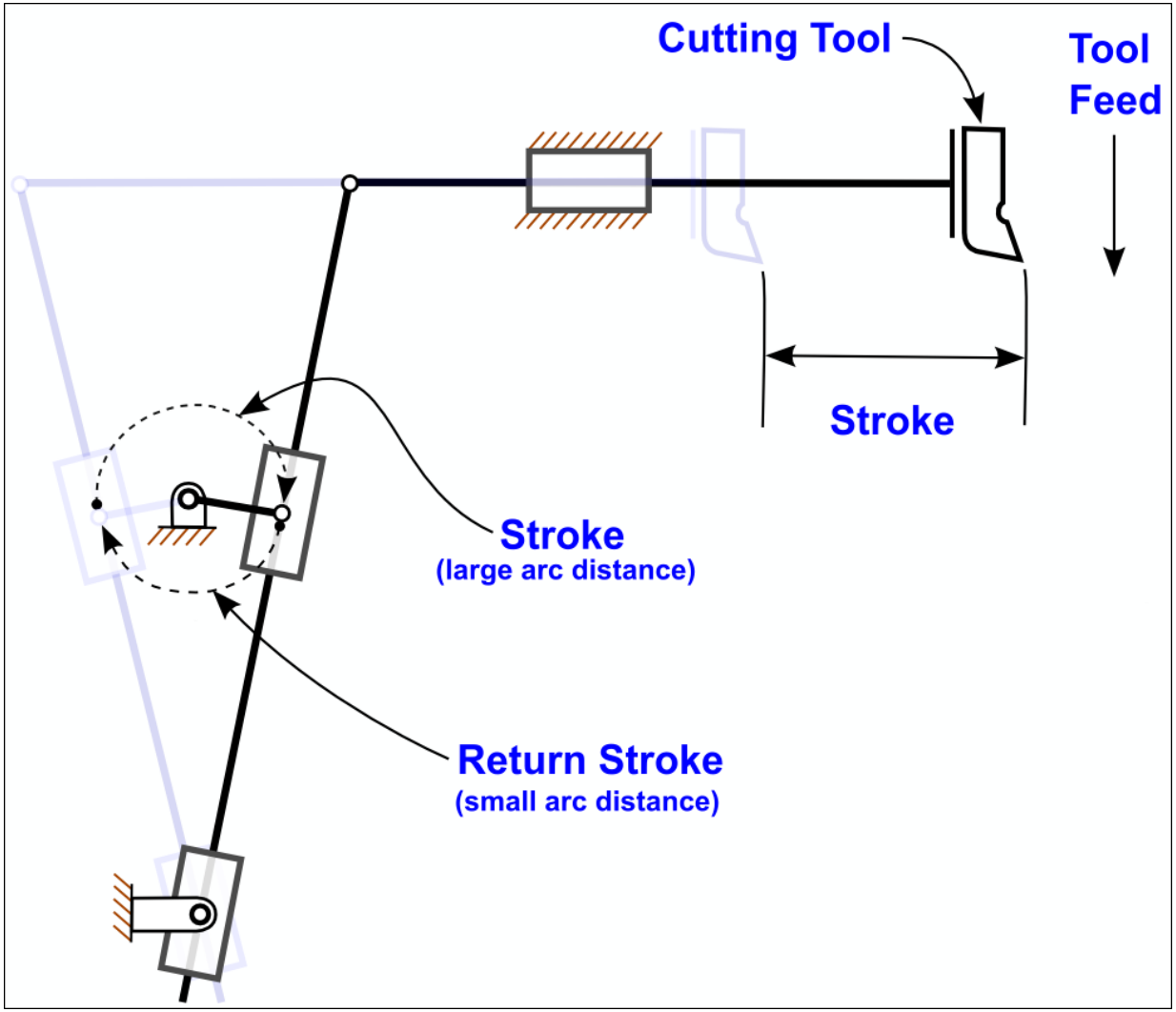
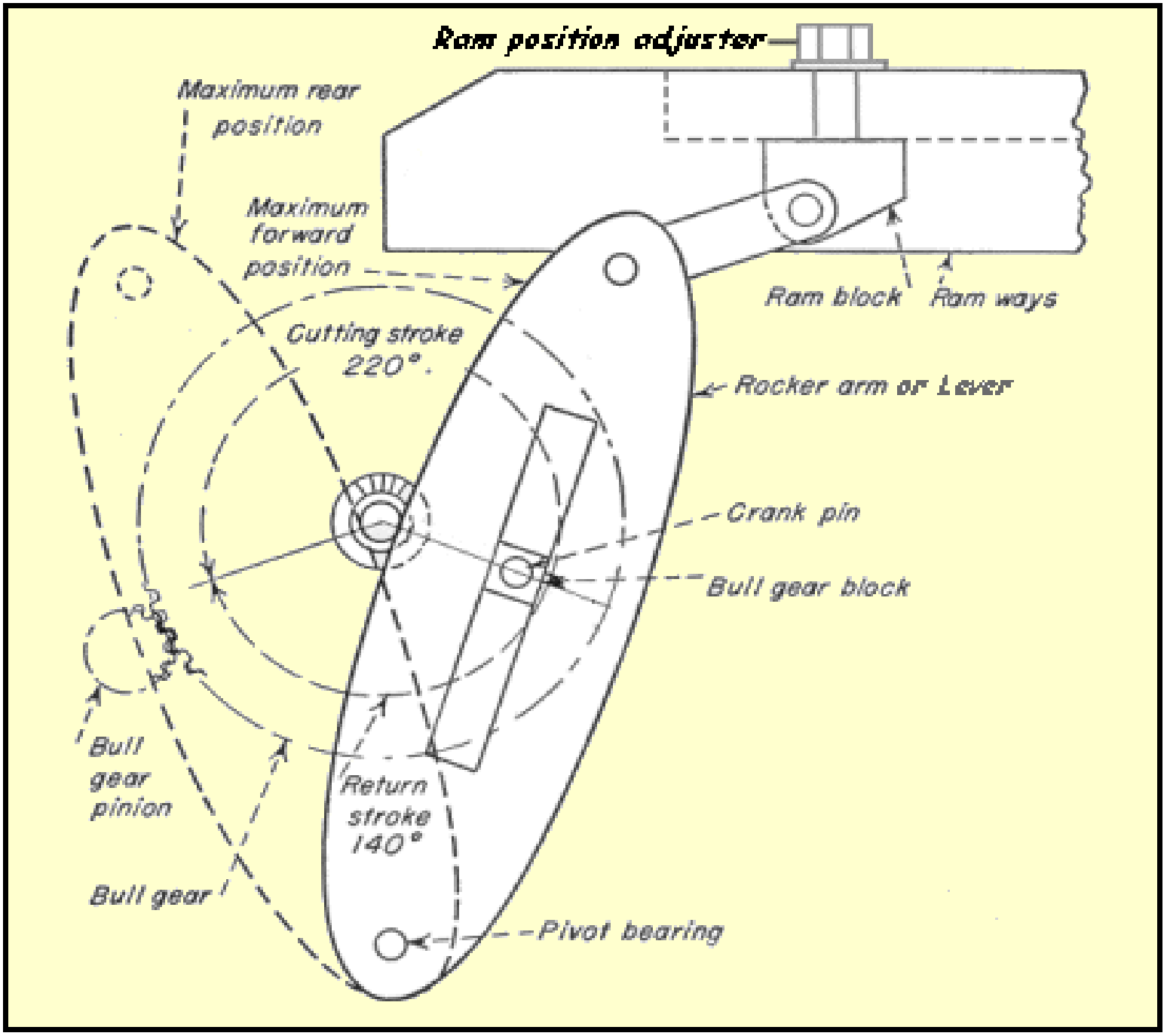


Figure 7.4 The cutting action and functioning of clapper box in a shaper.

The Shaper


Cutting Tool
Tool Feed
Stroke
Stroke
(large arc distance)
Return Stroke
(small arc distance)


Ram position adjuster
Maximum rear position
Maximum forward position
Cutting stroke 220°.
Ram block
Ram ways
Rocker arm or Lever
Crank pin
Bull gear block
Bull gear pinion
Return stroke 140°
Bull gear
Pivot bearing

Machining of Inclined Surface

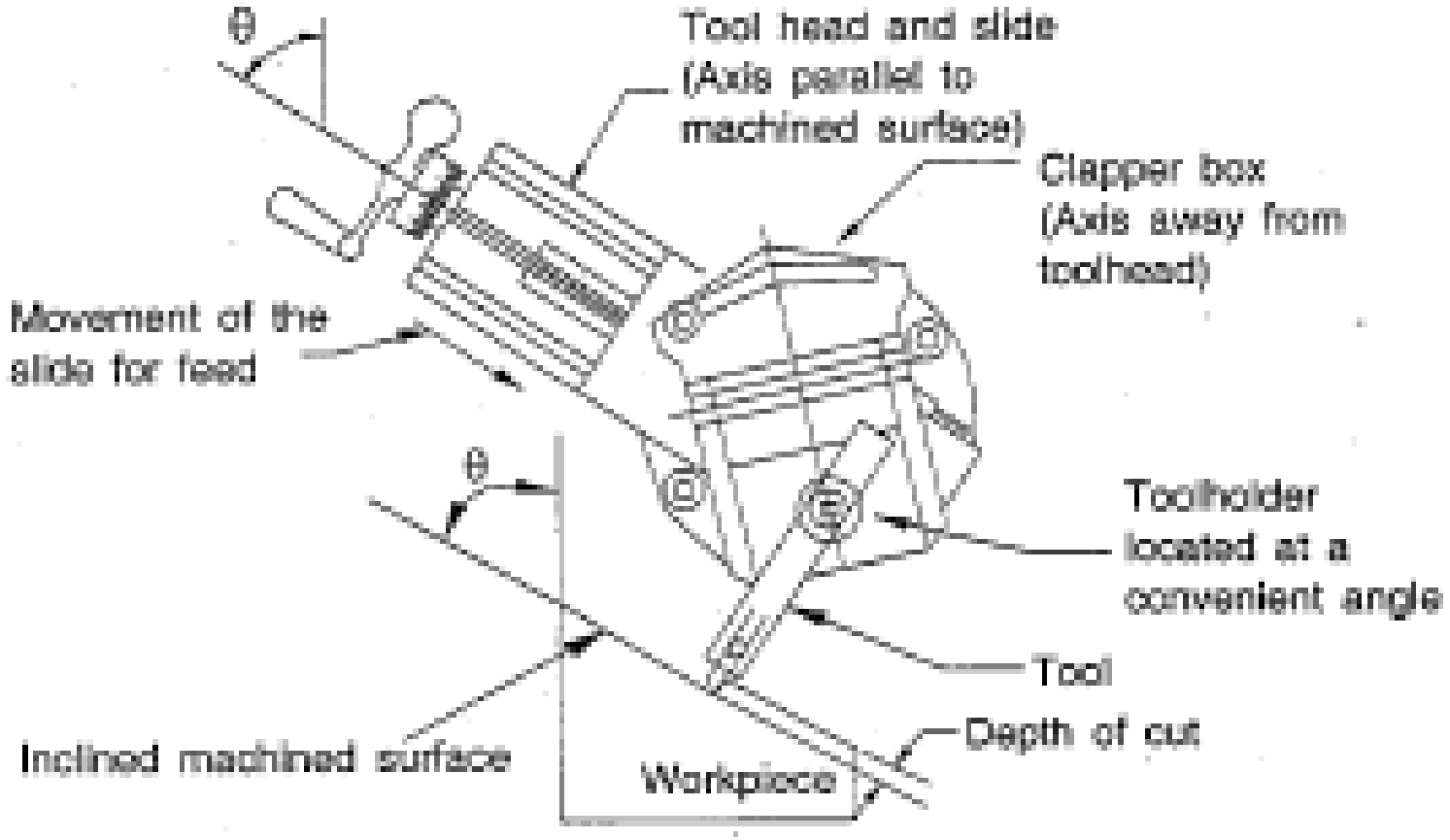


Figure 7.5 Machining of inclined surface on shaping machine.

Operating conditions in a Shaping Machine

- CUTTING SPEED

It is defined as the average linear speed of the tool during the cutting stroke in m/min, which depends on number of ram strokes(or ram cycles) per minute and length of the stroke.

$$v = \frac{NL(1+m)}{1000} \text{ m/min} \qquad (7.1)$$

where

N = the number of double strokes or cycles of the ram/min (one double or full stroke comprises one cutting and one return stroke)

L = length of the ram stroke, in mm

m = return stroke time/cutting stroke time.

- Stroke length = L
  L_j = Job of length
  C = Clearance

$$L = L_j + 2XC$$

$$L = L_j + 2 \times c \qquad (7.$$

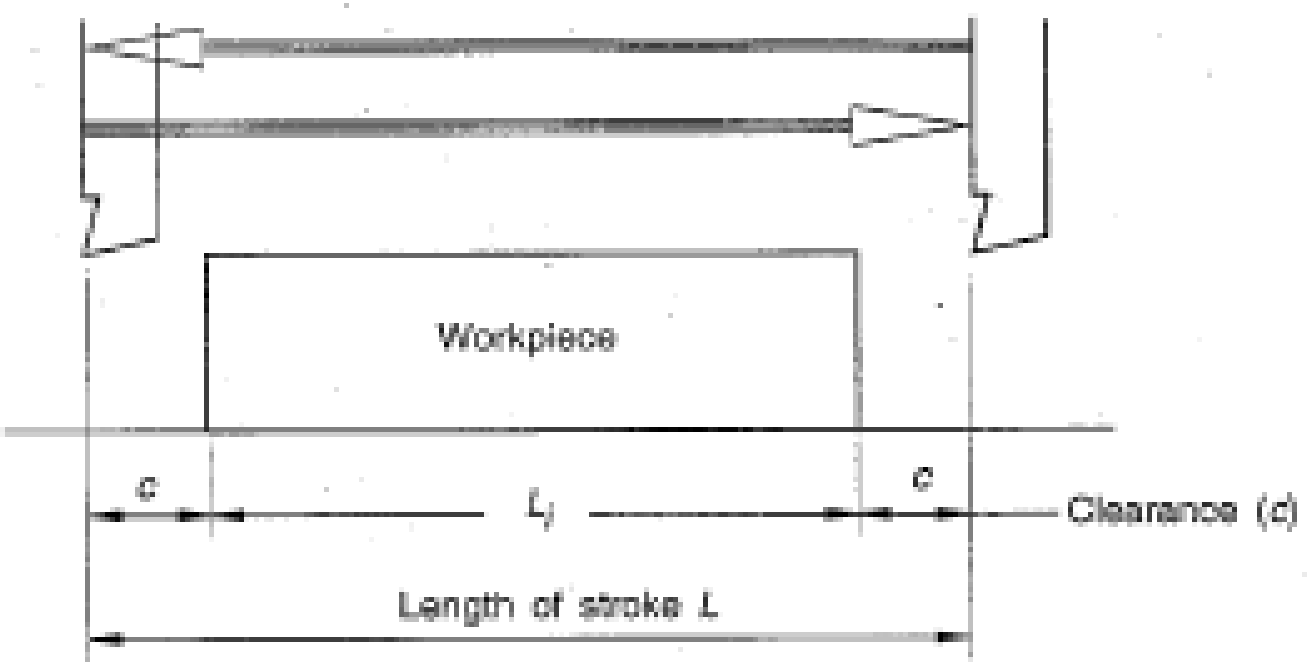


Figure 7.6 Length of stroke and length of workpiece.

Feed

- Feed f is the relative motion of the work piece in a direction perpendicular to the axis of the reciprocation of the arm.
- In shaper, feed is normally given to the work piece and can be automatic or manual.
- It is expressed in mm/double stroke or simply mm/stroke because no cutting is done in return stroke

Depth of Cut

- Depth of cut d is the thickness of the material removed in one cut, in mm.

Machining Time

From the cutting speed, we can find that the time required to complete one double stroke is given by

$$t = \frac{L(1 + m)}{1000v} \text{ min} \tag{7.3}$$

With a feed of f mm/double stroke, number of double strokes required to machine a surface of width w will be

$$N_s = \frac{w}{f} \tag{7.4}$$

Hence, total time for machining the surface will be

$$t = \frac{Lw(1 + m)}{1000vf} \text{ min} \tag{7.5}$$

or,

In terms of ram strokes N, the time for machining surface is given by

$$t_s = \frac{w}{fN} \text{min} \tag{7.6}$$

Material removal rate

$$MRR = fdNL(1 + m) \text{ mm}^3/\text{min} \tag{7.7}$$

where d is depth of cut in mm, f in mm/stroke, N in strokes/min, and L is length of stroke in mm.

The Planer

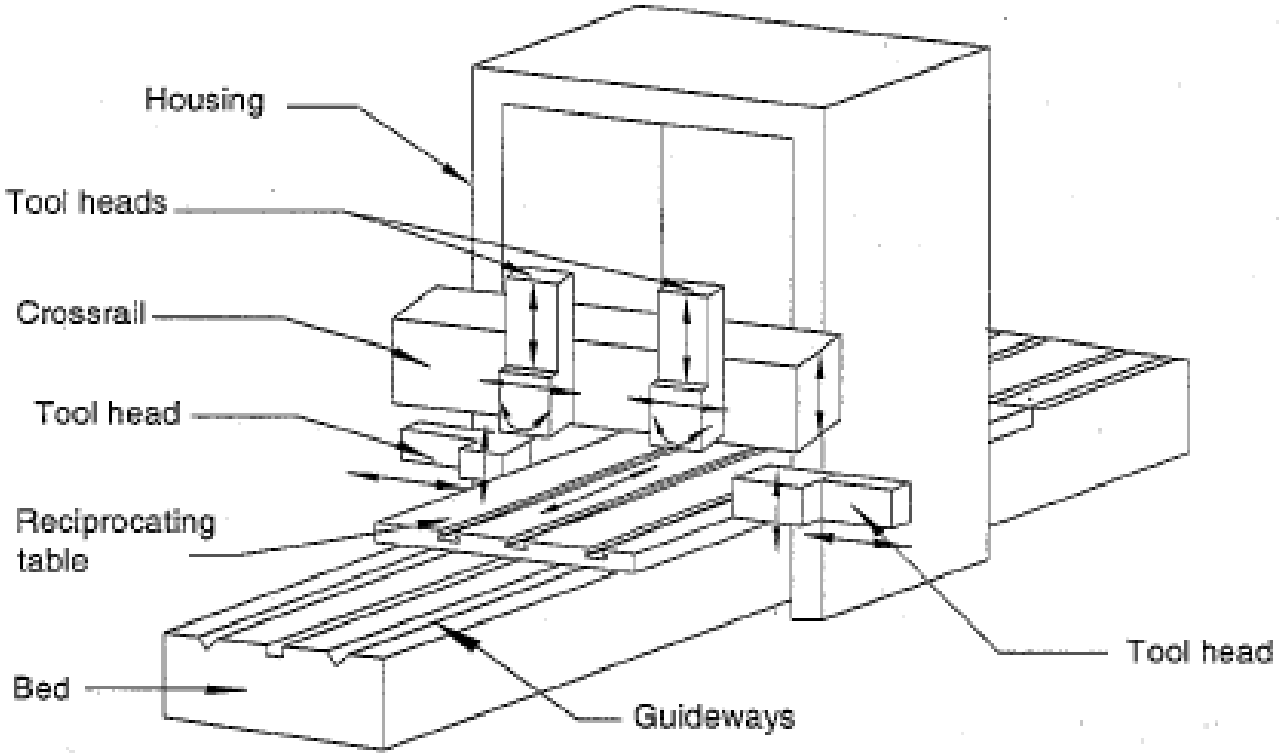
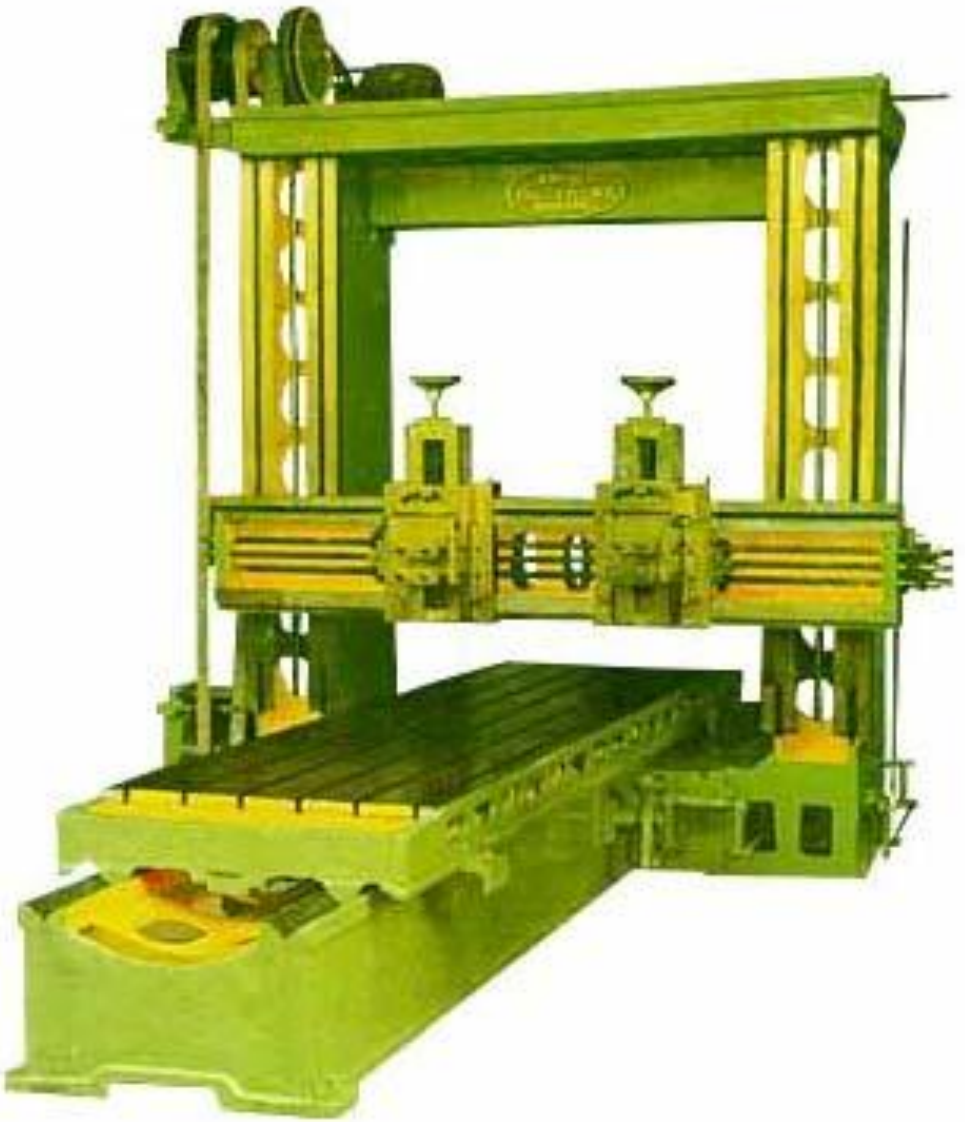


Figure 7.7 A double housing planer.

Planner



The Planer

- The planer or planing machine is a machine tool, which like the shaper produces flat surfaces in horizontal, vertical or inclined plane.
- The fundamental difference is that the planer operates with an action opposite to that of the shapers, i.e., the work piece reciprocates past one or mare stationary single point cutting tools.
- Planers are meant for machining large sized work pieces, which cannot be machined by the shaping machines.

Types of Planing Machines

- Some other types of planing machines include

  Universal planer, pit type planer and edge planer.

Operating Conditions in planers

- Cutting speed

  similar to shaper

Feed

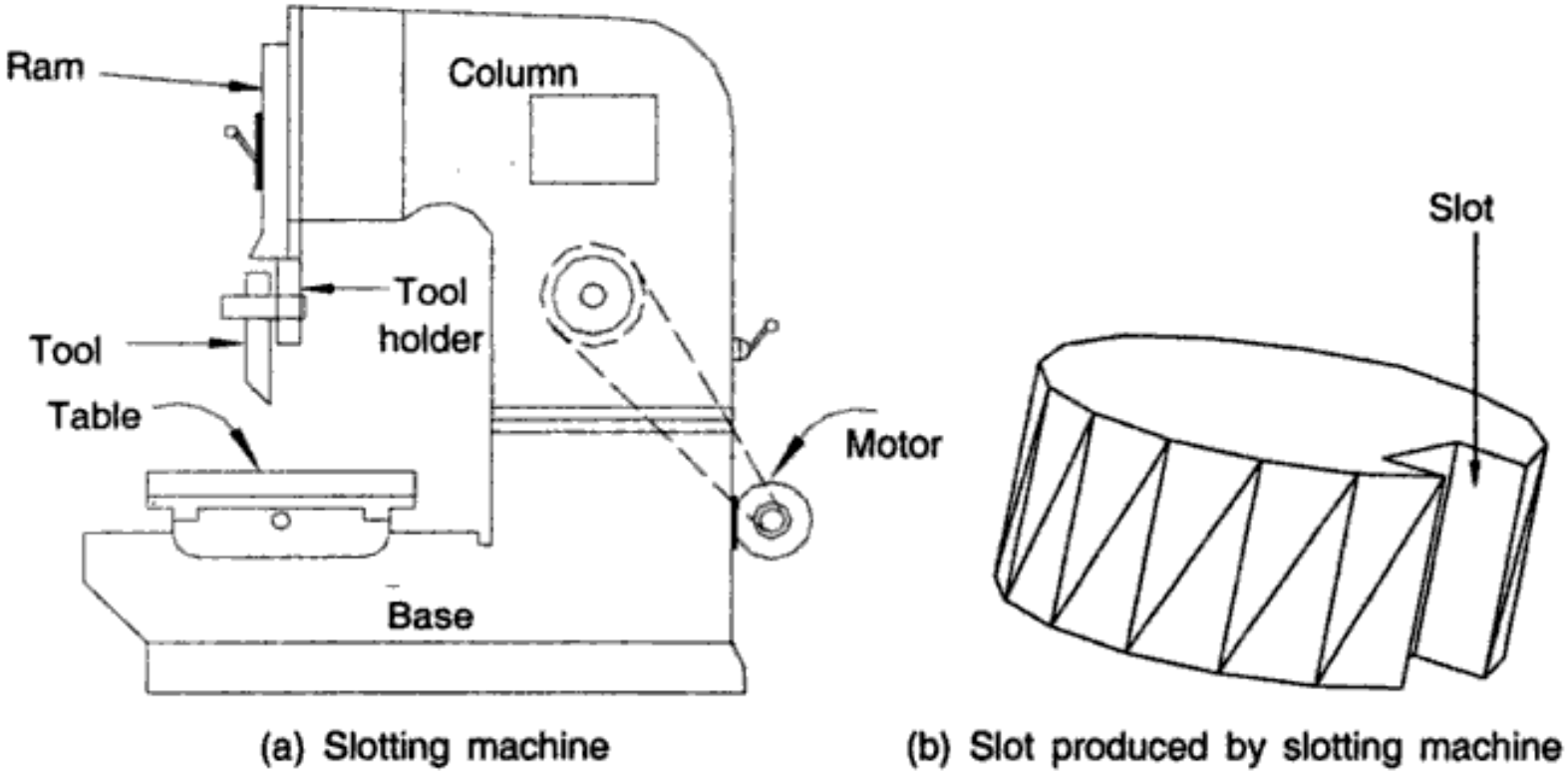
the feed in a planing machine is the distance the tool travels at the beginning of each cutting stroke and is expressed in mm/double stroke

Depth of cut, Material Removal rate.

Size of shaper and planers

- The size of planer and shaper are specified by the maximum length of stroke.
- The normal maximum stroke length of the stroke is 800mm.

Slotting Machine



(a) Slotting machine

(b) Slot produced by slotting machine

Figure 7.8 Slotting machine and a slot produced by slotting machine.

Slotting Machine

Problem 1

Example 7.1 Find the machining time required for machining a surface 600×800 mm on a shaping machine. Assume, cutting speed as 8 m/min. The return-to-cutting time ratio is 1 : 4, and the feed is 2 mm/double stroke. The clearance at each end is 70 mm.

Solution: Given

$$L_j = 600 \text{ mm}, \quad w = 800 \text{ mm}, \quad v = 8 \text{ m/min},$$

$$m = \tfrac{1}{4}, \quad f = 2 \text{ mm/stroke}, \quad c = 70 \text{ mm}.$$

From Eq. (7.2), we get

$$\text{Length of stroke } L = 600 + 2 \times 70 = 740 \text{ mm}$$

Substituting all the values in Eq. (7.5), we get

$$t = \frac{740 \times 800 \times (1 + 0.25)}{1000 \times 8 \times 2} = 46.25 \text{ min.} \quad \textbf{Ans.}$$

Example 7.2 Estimate the time required to machine a cast iron surface 250 mm long and 150 mm wide on a shaper with cutting-to-return ratio of 3 : 2. Use a cutting speed of 21 m/min, a feed of 2 mm/stroke and a clearance of 25 mm. The available ram strokes on the shaper are: 28, 40, 60 and 90 strokes/min. Also, determine *MRR* assuming depth of cut as 4 mm.

Solution: Given

$$L_j = 250 \text{ mm}, \quad f = 2 \text{ mm/double stroke}, \quad w = 150 \text{ mm},$$

$$c = 25 \text{ mm}, \quad v = 21 \text{ m/min}, \quad d = 4 \text{ mm}$$

The cutting-to-return ratio of 3 : 2 gives $m = 2/3$

From Eq. (7.2), we get

$$L = 250 + 2 \times 25 = 300 \text{ mm}$$

From Eq. (7.1), we have

$$\text{Cutting speed } v = \frac{NL(1+m)}{1000}$$

From the above equation, we find number of double strokes N per minute as

$$N = \frac{1000 \times 21}{300\left(1 + \frac{2}{3}\right)} \equiv 42 \text{ strokes/min}$$

Nearest available ram stroke is 40 strokes/min which is very near to the calculated value. Normally, we should not exceed the specified cutting speed, as it will affect the tool life adversely. Hence, select $N = 40$ strokes/min.

With a chosen value of N, we cannot use Eq. (7.5) for time calculation. Hence, substituting all the values in Eq. (7.6), we get

$$t_s = \frac{150}{40 \times 2} = 1.88 \text{ min} \qquad \textbf{Ans.}$$

From Eq. (7.7), we calculate the *MRR* as

$$MRR = 2 \times 4 \times 40 \times 300\left(1 + \frac{2}{3}\right) = 1{,}60{,}000 \text{ mm}^3/\text{min} \qquad \textbf{Ans.}$$

18. Determine the machining time required to machine three finished stocks of size 75 mm × 150 mm × 250 mm each from raw stocks of size 80 mm × 155 mm × 255 mm. Stock should be removed equally from all faces using the following data:

Cutting speed = 35 m/min.

Maximum depth of cut: for roughing = 2 mm, and for finishing = 1 mm

Feed: for roughing = 0.5 mm/stroke, and for finishing = 0.3 mm/stroke

Cutting-to-return time ratio = 3 : 1

Total clearance = 50 mm.

19. The 400mmX250mm face of cast iron block of size 400mmX250mmX 100mm is to be rough machined using HSS tool on a conventional crank shaper. Estimate the machining time assuming an average cutting speed of 20m/min and a feed of 0.2 mm/stroke. The cutting time to return time ratio is given to be 1.5 and the ram cycles available on the shapers are 28,40,60 and 90 per minute. Ans: choosing 28 strokes/min, time=44.65 min

20. The suggested cutting speed for a given tool –work piece combination on a shaper is 25m/min.Two 300X200 mm surfaces of a cast iron block 400X 300x 200 mm are to be rough machined on a shaper using HSS tool. A feed of 0.5mm/stroke may be assumed for this cutting operation. If the set up time is 10 minutes per surface and the labor and overhead charges are Rs 150 per hour, find the cost f machining 500 blocks. Assume return to cutting time ratio as 1:2.

Ans: neglecting clearance, taking L=300mm and using 56 strokes/min, Cost= Rs 51,775.

21. In a shaper work, the length of the stroke is 200mm, the number of double strokes /min is 30 and the ratio of return time to cutting time is 2:3. Find the cutting speed.

Ans: 10m/min