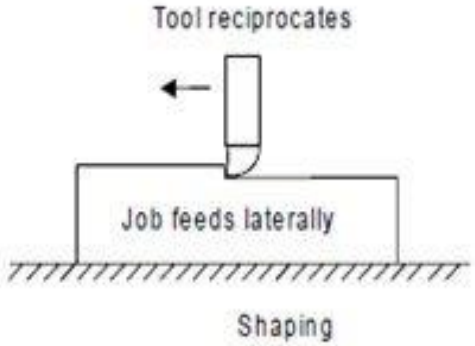
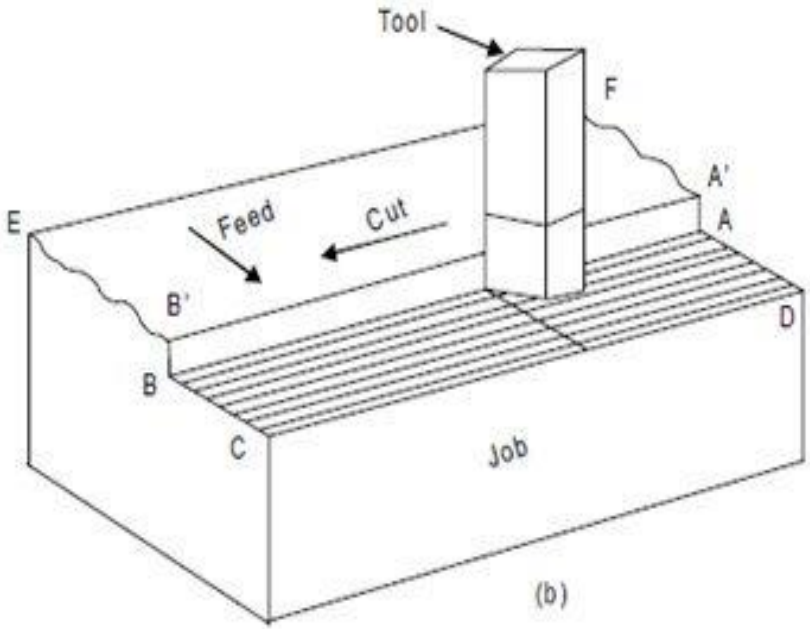
SHAPER

By Miss. Suneeti Mohanty, lect. In Mechanical
GP ANGUL

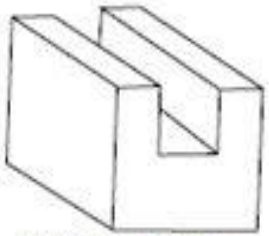
INTRODUCTION

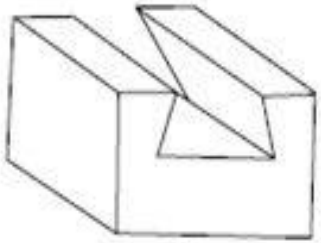
- Shaper is a reciprocating type of machine tool intended primarily to produce the flat surface in horizontal, vertical and angular direction.
- It is also used for machining of concave and convex surface



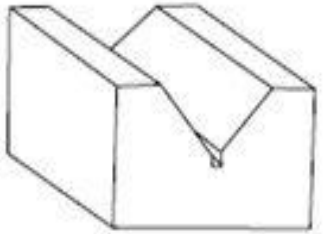


(a, b) Working principal of shaping machine


(a) Grooved block

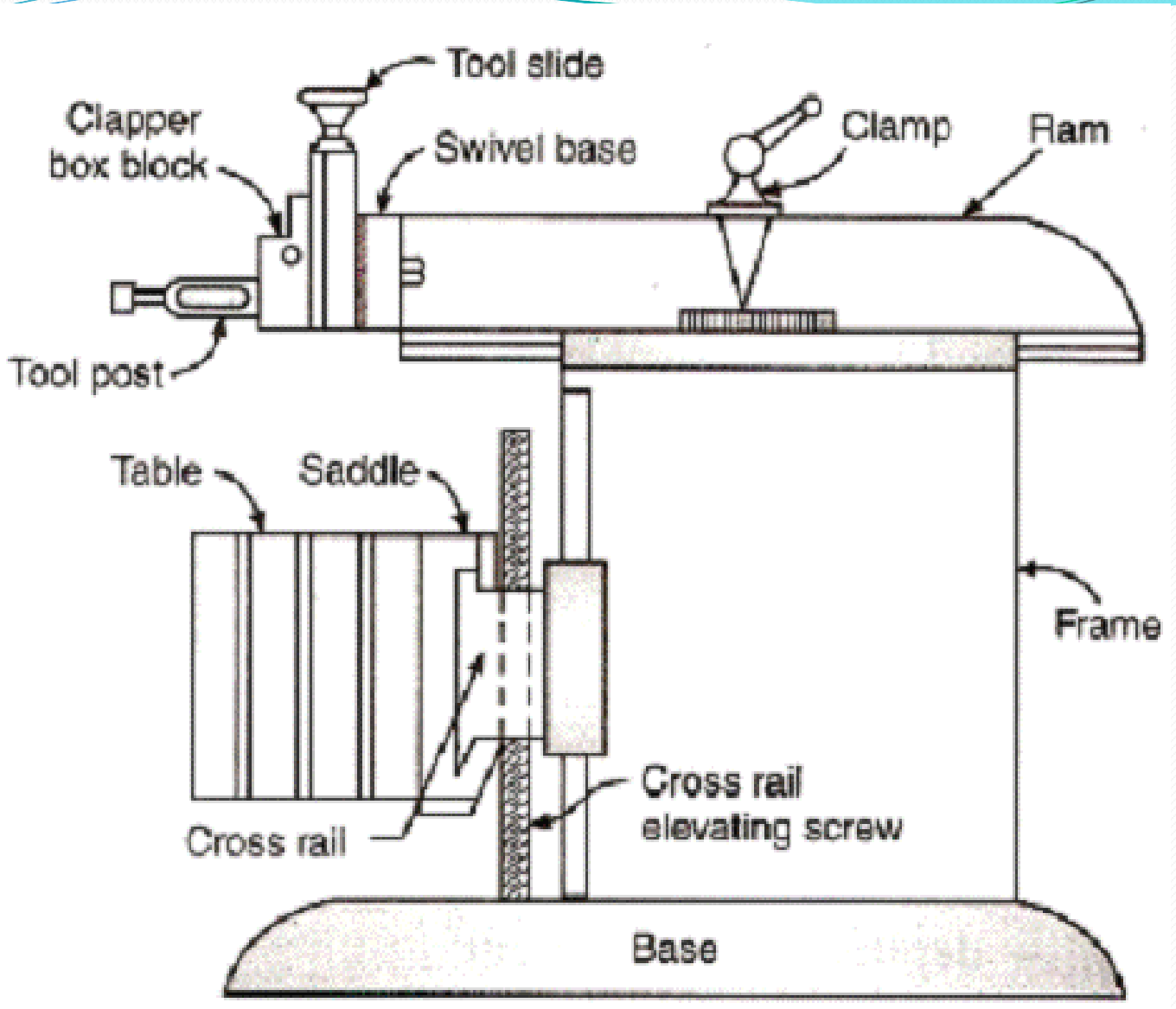

(b) Dove tail slide


(c) Guide gib


(d) V-Block

Surface produced by a shaper

Job surfaces generated by shaper


Tool slide
Clapper box block
Swivel base
Clamp
Ram
Tool post
Table
Saddle
Frame
Cross rail
Cross rail elevating screw
Base

Parts of shaper:

- **BASE:**
  - The base is the necessary bed to support all the machining tool.
  - The base is made of Grey cast iron to resist vibration in which all parts are mounted.
  - it is so designed that it can take the entire load of the machine and forces setup by cutting.
- **Column-**The column of the shaper is a hollow casting and is mounted on the base. It houses the drive mechanism (crank and slotted lever mechanism) for the ram and the table.

Parts of shaper contd:

- **Tool head(Clapper box):** It is situated at the front of the ram. It holds the cutting tool and it provides reciprocating motion for the cutting tool.
- **Table-** The worktable of a shaper is fastened over the column. The table moves across the column on crossrails to give the feed motion to the job. It can move up and down.
- **Ram-** It is the main part of the machine, which was located on the top of the column and it carries the tool head. It is made up of castiron by casting process. It provides reci[procating motion to the tool and tool. A single point tool is fastened in the tool post.

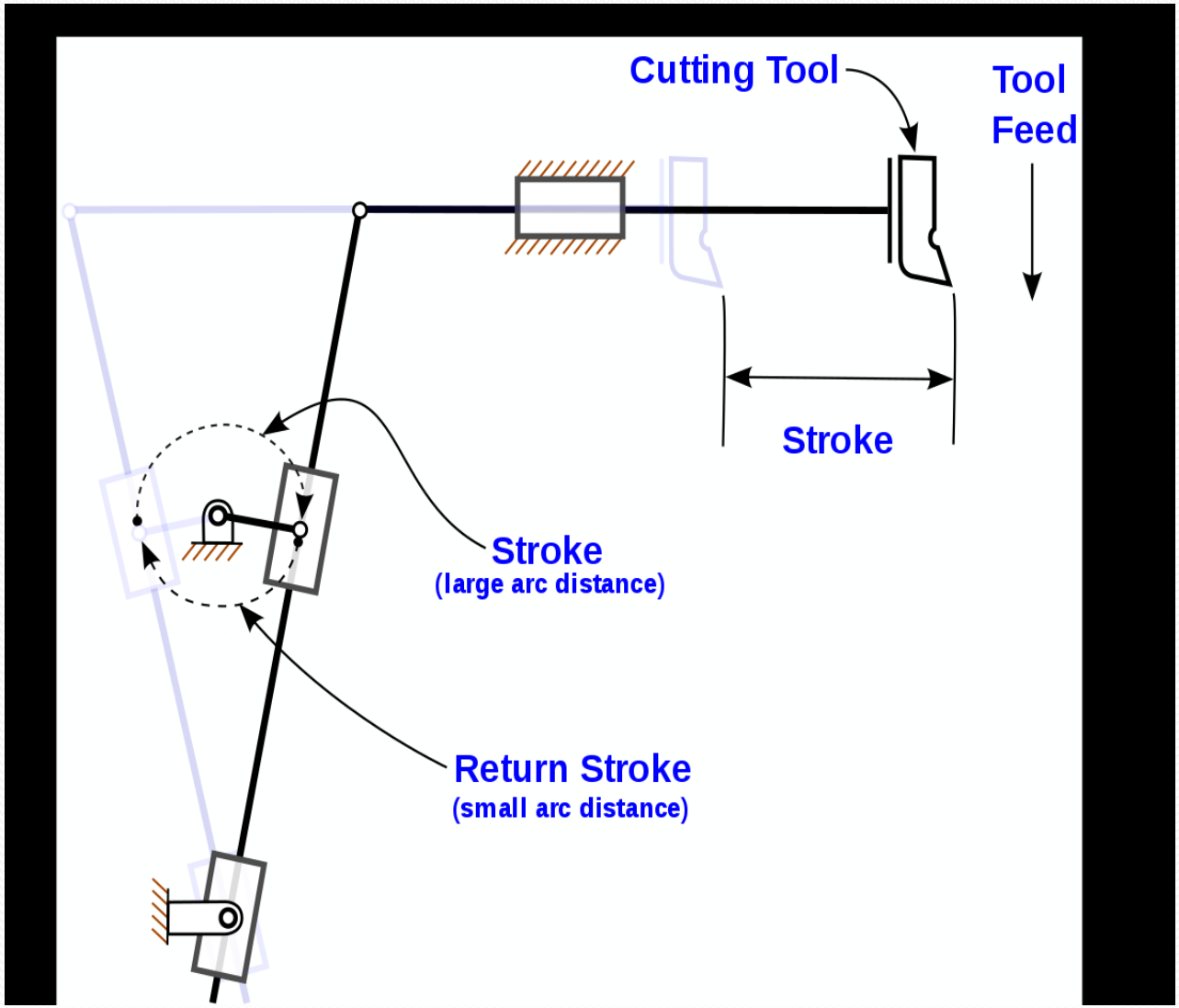
Working principle

- The job is rigidly fixed on the machine table.
- The single point cutting tool is rigidly held in the tool post which is mounted on the reciprocating ram. The reciprocating motion of the ram is obtained by a quick return motion mechanism.
- When ram reciprocate, the cutting tool held in tool holder also reciprocates forward and backward, on the surface of the work piece.
- In a standard shaper, the cutting action takes place during forward stroke. The backward stroke remains idle. This is obtained by quick return mechanism.
- The feed is given at the end of return stroke.
- The depth of the cutting is adjusted by the movement of the tool
- The feed motion is given to the workpiece by 'pawl and ratchel mechanism'

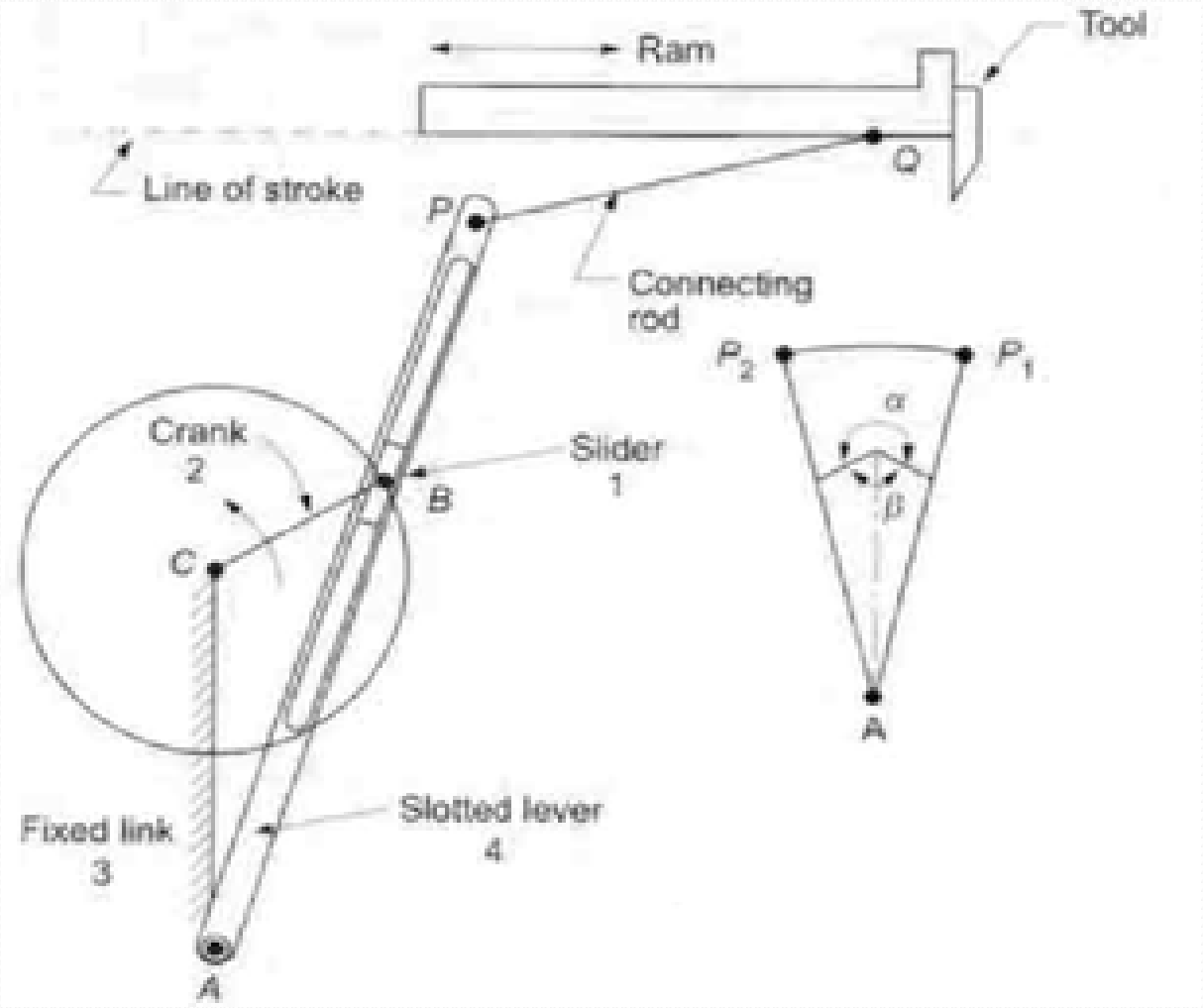
QUICK RETURN MECHANISM:

- In a shaper rotary movement of the drive can be converted into reciprocating movement by the mechanism known as quick return mechanism.
- The column of the shaper machine contains this mechanism.
- In a standard shaper, the cutting action takes place during forward stroke. The backward stroke remains idle. It means no cutting action takes place during return stroke.
- But total machining time= cutting stroke time + return stroke time. So, it is required to reduce the return stroke time to minimum possible. This is obtained by quick return mechanism.
- That's why the ram moves faster in return stroke.

QUICK RETURN MECHANISM contd:



QUICK RETURN MECHANISM contd:



HOW QRM WORKS?

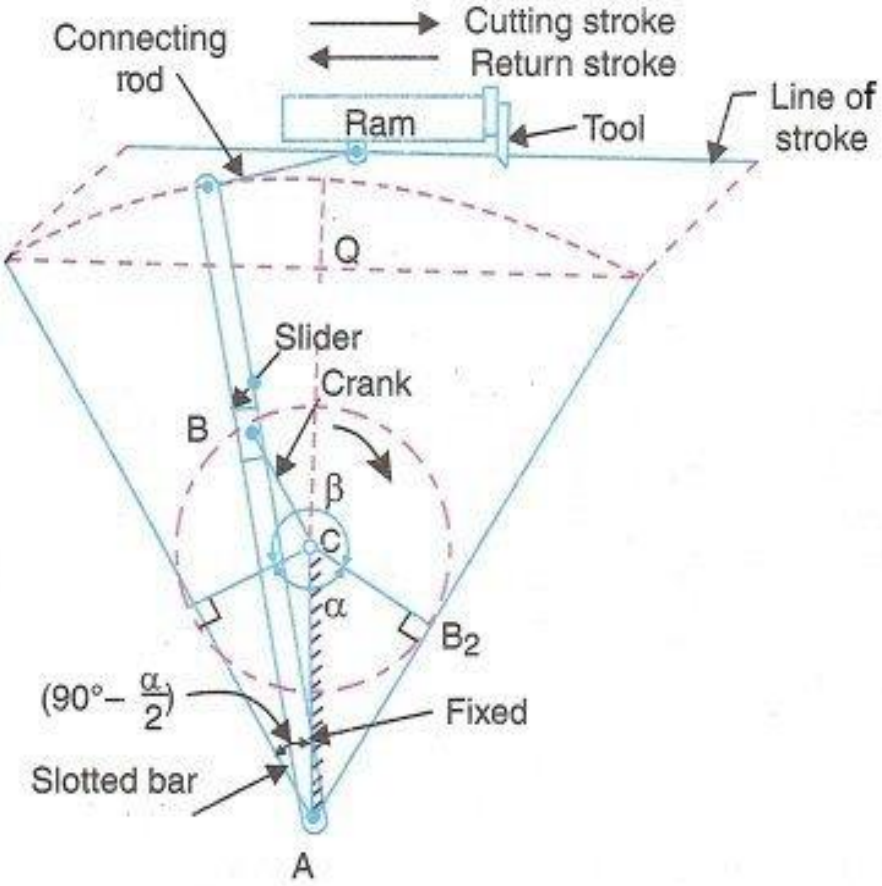
- The driving crank(link 2) revolves with uniform angular speed about the fixed centre C(shown in figure).
- The link 3 corresponds to the connecting rod.
- A sliding block attached to the crank pin at B, slides along the slotted bar AP and thus causes AP to oscillate about the pivoted point A.
- A short link PQ transmits the motion from AP to the ram which carries the tool and reciprocates along the line of stroke(shown in figure).
- The line of stroke of the ram is perpendicular to AC produced.

HOW QRM WORKS?

- The sliding block causes the slotted link to rotate but because it has a different centre of rotation, its speed is not constant.
- As we can be seen from figure from above slide, the angle through which the driving gear and slotted link rotate on the forward stroke is greater than the angle through which they rotate on the return stroke. This imparts the slow forward and quick return motion to the slider.
- We see that the angle **α** made by the forward or cutting stroke is greater than the angle **β** described by the return stroke. Hence the name quick return mechanism..

$$\frac{\text{Time of cutting stroke}}{\text{Time of return stroke}} = \frac{\alpha}{\beta}$$

HOW QRM WORKS?



Crank and slotted lever quick return motion mechanism

Specifications of shaper

- Maximum length of stroke
- Maximum tool overhang
- Max. distance b/w table surface and ram
- Min. distance b/w table surface and ram
- Dimension of table working surface
- Max. horizontal travel of table
- Max. vertical travel of table
- Max. weight of machine

OPERATIONS PERFORMED ON SHAPER

- shaping a rectangular job on shaper.
- Machining a thin job on shaper.
- Cutting an angle on a large job.
- Cutting a dovetail bearing on a shaper.
- Shaping a V or keyway in a block.
- Shaping regularly angled component.
- Shaping an irregularly curved surface.
- Cutting a keyway on a shaper when the keyway does not extend the entire length of the shaft.
- Machining angular surfaces on shapers.
- sequence of machining sides of a rectangular piece square and parallel.

THE END...

THANK YOU

Planing machine:

The photographic view in Fig. 1 typically shows the general configuration of planing machine. Planing machines are basically used for producing flat surfaces in different planes.

Though in principle the planing machines produce flat surface by the combined actions of the Generatrix and Directrix but in planing machine, instead of the tool, the workpiece reciprocates giving the fast cutting motion and instead of the job, the tool(s) is given the slow feed motion(s).

Planing machines are much larger and more rugged and generally used for large jobs with longer stroke length and heavy cuts.

In planing machine, the workpiece is mounted on the reciprocating table and the tool is mounted on the horizontal rail which can move vertically up and down along the vertical rails.

Planing machines are more productive (than shaping machines) for longer and faster stroke, heavy cuts (high feed and depth of cut) possible and simultaneous use of a number of tools.

In planing machines;

Δ The length and position of stroke can be adjusted

Δ Only single point tools are used

Δ The quick return persists

Δ Form tools are often used for machining grooves of curved section

Δ Planing machines can also produce large curved surfaces by using suitable attachments.

Fig. 1 *Photographic view of a planing machine*

WORKING PRINCIPLE OF PLANING MACHINE

The simple kinematic system of the planing machine enables transmission and transformation of rotation of the main motor into reciprocating motion of the large work table and the slow transverse feed motions (horizontal and vertical) of the tools. The reciprocation of the table, which imparts cutting motion to the job, is attained by rack-pinion mechanism. The rack is fitted with the table at its bottom surface and the pinion is fitted on the output shaft of the speed gear box which not only enables change in the number of stroke per minute but also quick return of the table. The blocks holding the cutting tools are moved horizontally along the rail by screw-nut system and the rail is again moved up and down by another screw nut pair as indicated in Fig. 1.

Construction of planning machine:

The main parts of the double Housing Planer machine is Bed and table, Housings, Cross rail, Tool heads, Driving and feed mechanism.

Bed and table: The bed is a long heavy base and table made of cast iron. Its top surface is flat and machined accurately. The flat top surface has slots in which the workpiece can be securely clamped. The workpiece needs rigid fixing so that it does not shift out of its position. The standard clamping devices used on planer machine are: Heavy duty vice, T-holders and clamps, angle plate, planer jack, step blocks and stop. The table movement may be actuated by a

variable speed drive through a rack and pinion arrangement, or a hydraulic system.

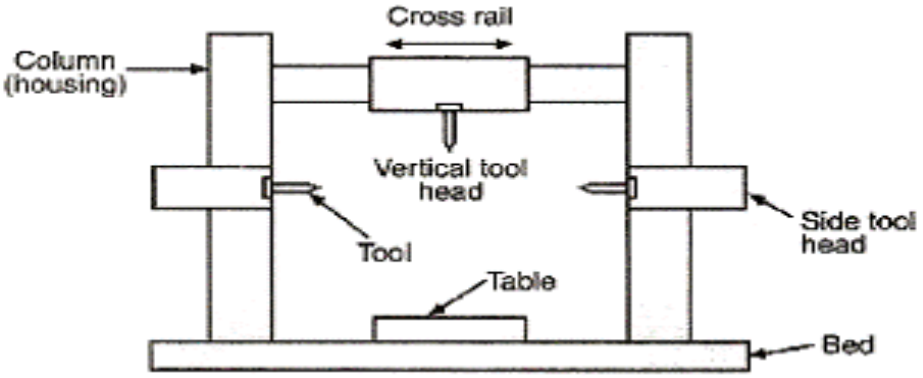


***Fig. 2** Double housing planer*

Housings: The housings are the rigid and upright column like castings. These are located near the centre on each side of the base.

Cross rail: The cross rail is a horizontal member supported on the machined ways of the upright columns. Guide ways are provided on vertical face of each column and that enables up and vertical movement of the cross rail. The vertical movement of the cross rail allows to accommodate workpiece of different heights. Since the cross rail is supported at both the ends, this type of planer machine is rigid in construction.

Tool heads: Generally two tool heads are mounted in the horizontal cross rail and one on each of the vertical housing. Tool heads may be swiveled so that angular cuts can be made.

Driving and feed mechanism: The tool heads may be fed either by hand or by power in crosswise or vertical direction. The motor drive is usually at one side of the planer near the centre and drive mechanism is located under the table.

The size of the planer is specified by the maximum length of the stroke, and also by the size of the largest rectangular solid that can be machined on it.

APPLICATION OF PLANING MACHINE:

The basic principles of machining by relative tool-work motions are quite similar in shaping machine and planing machine. The fast straight path cutting motion is provided by reciprocation of the tool

or job and the slow, intermittent transverse feed motions are imparted to the job or tool. In respect of machining applications also these two machine tools are very close. All the operations done in shaping machine can be done in planing machine. But large size and stroke length and higher rigidity enable the planing machines do more heavy duty work on large jobs and their long surfaces. Simultaneous use of number of tools further enhances the production capacity of planning machines.

The usual and possible machining applications of planing machines are

- Machining the salient features like the principal surfaces and guideways of beds and tables of various machines like lathes, milling machines, grinding machines and planing machines itself, broaching machines etc. are the common applications of planning machine as indicated in Fig. 3 where the several parallel surfaces of typical machine bed and guideway are surfaced by a number of single point HSS or carbide tools. Besides that the long parallel T slots, Vee and inverted Vee type guideways are also machined in planing machines.

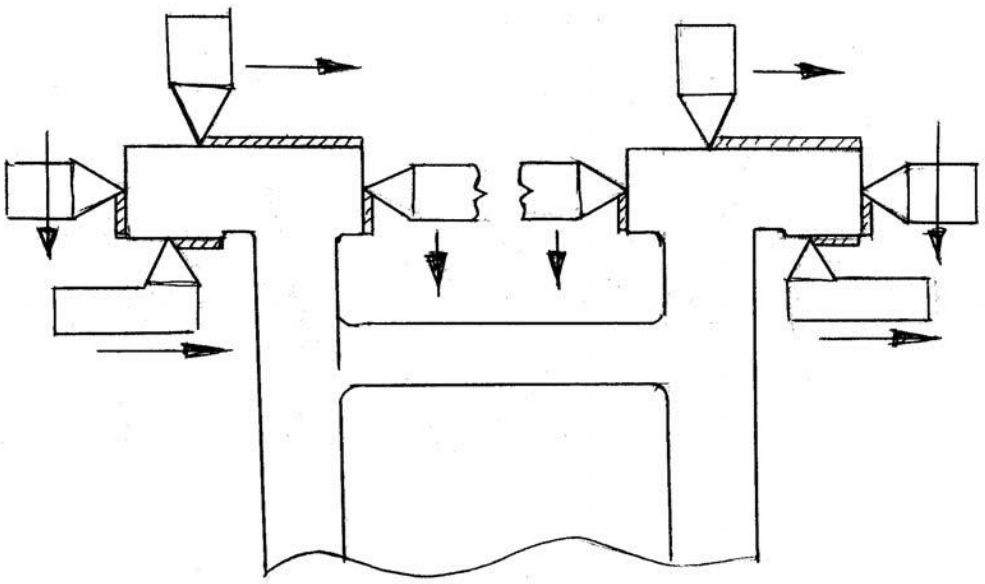


Fig. 3 *Machining of a machine bed in planing machine*

- Besides the general machining work, some other critical work like helical grooving on large rods, long and wide 2-D curved surfaces, repetitive oil grooves etc. can also be made, if needed, by using suitable special attachments.

Slotting machine

Slotting machines can simply be considered as vertical shaping machine where the single point (straight or formed) reciprocates vertically (but without quick return effect) and the workpiece, being mounted on the table, is given slow longitudinal and / or rotary feed as can be seen in Fig. 4.

In this machine also the length and position of stroke can be adjusted. Only light cuts are taken due to lack of rigidity of the tool holding ram for cantilever mode of action. Unlike shaping and planing machines, slotting machines are generally used to machine internal surfaces (flat, formed grooves and cylindrical). Shaping machines and slotting machines, for their low productivity, are generally used, instead of general production, for piece production required for repair and maintenance. Like shaping and slotting machines, planning machines, as such are also becoming obsolete and getting replaced by planomillers where instead of single point tools a large number of large size and high speed milling cutters are used.

Fig. 4 *Photographic view of a slotting machine*

WORKING PRINCIPLE OF SLOTTING MACHINE

The schematic view of slotting machine is typically shown in Fig.5 The vertical slide holding the cutting tool is reciprocated by a crank and connecting rod mechanism, so here quick return effect is absent. The job, to be machined, is mounted directly or in a vice on the work table. Like shaping machine, in slotting machine also the fast cutting motion is imparted to the tool and the feed motions to the job.

In slotting machine, in addition to the longitudinal and cross feeds, a rotary feed motion is also provided in the work table. The intermittent rotation of the feed rod is derived from the driving shaft with the help of a four bar linkage as shown in the kinematic diagram.

It is also indicated in Fig. 5 how the intermittent rotation of the feed rod is transmitted to the lead scews for the two linear feeds and to the worm – worm wheel for rotating the work table.

The working speed, i.e., number of strokes per minute, Ns may be changed, if necessary by changing the belt-pulley ratio or using an additional “speed gear box”, whereas, the feed values are changed mainly by changing the amount of angular rotation of the feed rod per stroke of the tool. This is done by adjusting the amount of angle of oscillation of the paul as shown in Fig. 5.

The directions of the feeds are reversed simply by rotating the tapered paul by 180º as done in shaping machines.

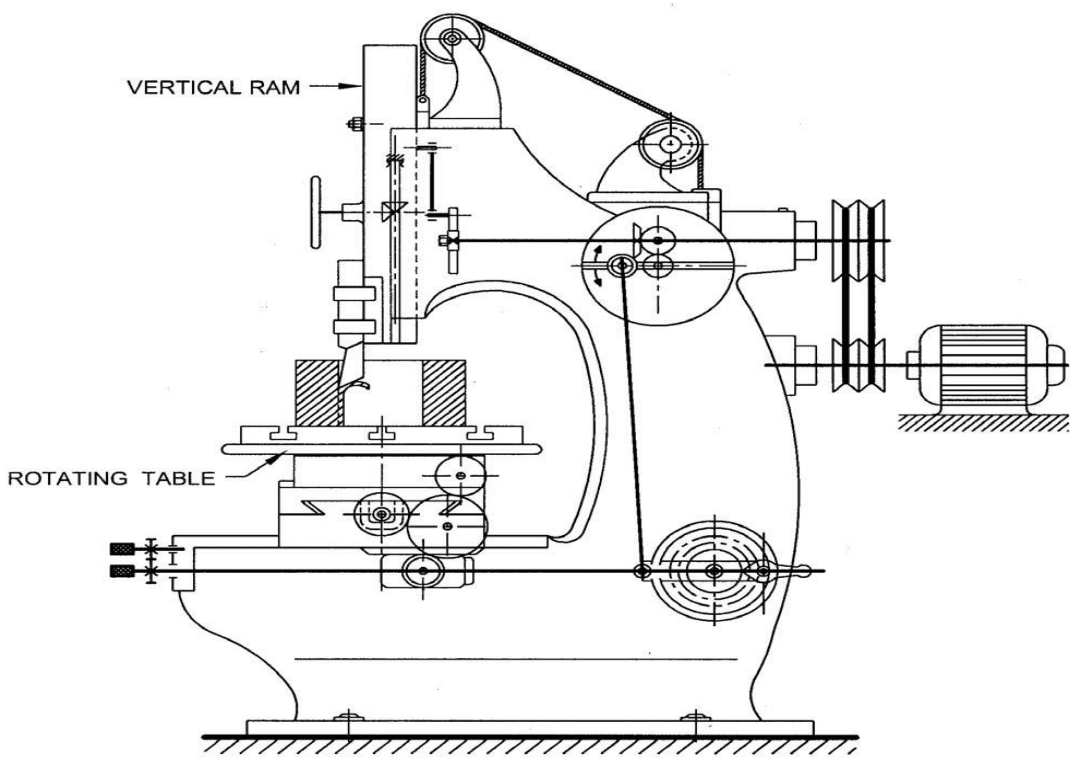


Fig. 5 *Kinematic system of a slotting machine*

Construction of slotting machine:

The slotter can be considered as a vertical shaper and its main parts are**:**

1. Base, column and table

2. Ram and tool head assembly

3. Saddle and cross slide

4. Ram drive mechanism and feed mechanism.

The base of the slotting machine is rigidly built to take up all the cutting forces. The front face of the vertical column has guide ways for Tool the reciprocating ram. The ram supports the tool head to which the tool is attached. The workpiece is mounted on the table which can be given longitudinal, cross and rotary feed motion.

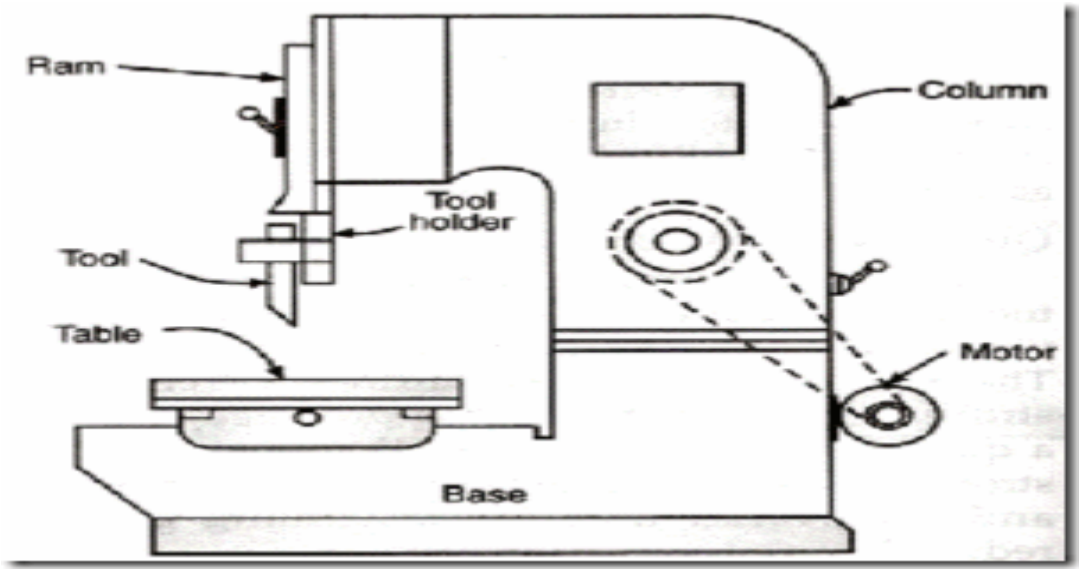
The slotting machine is used for cutting grooves, keys and slotes of various shapes making regular and irregular surfaces both internal and external cutting internal and external gears and profiles The slotter machine can be used on any type of work where vertical tool movement is considered essential and advantageous.

The different types of slotting machines are:

1. **Punch slotter**: a heavy duty rigid machine designed for removing large amount of metal from large forgings or castings

2. **Tool room slotter**: a heavy machine which is designed to operate at high speeds. This machine takes light cuts and gives accurate finishing.

3. **Production slotter**: a heavy duty slotter consisting of heavy cast base and heavy frame, and is generally made in two parts.



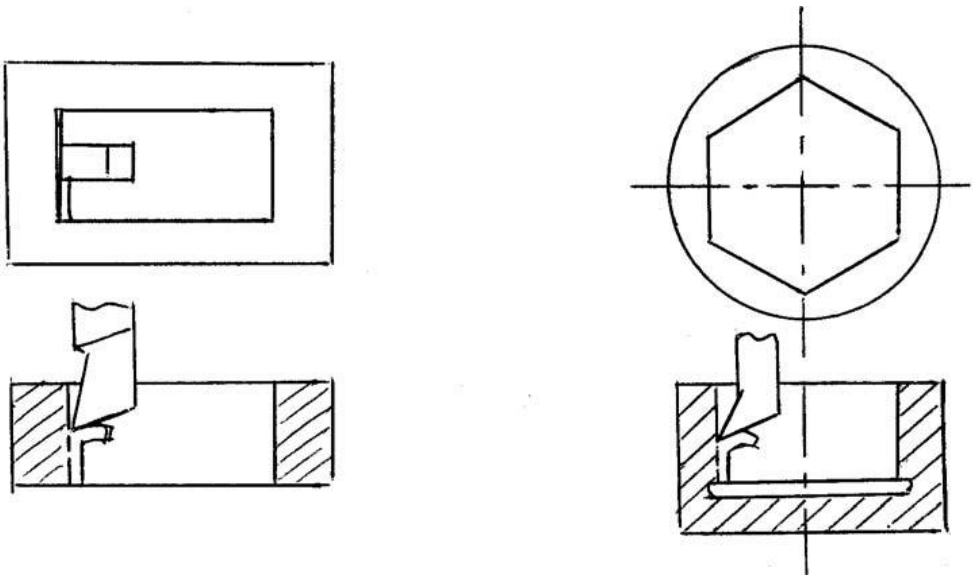
APPLICATION OF SLOTTING MACHINE:

Slotting machines are very similar to shaping machines in respect of machining principle, tool-work motions and general applications. However, relative to shaping machine, slotting machines are characterised by :

- Vertical tool reciprocation with down stroke acting
- Longer stroke length
- Less strong and rigid
- An additional rotary feed motion of the work table
- Used mostly for machining internal surfaces.

The usual and possible machining applications of slotting machines are :

- Internal flat surfaces
- Enlargement and / or finishing non-circular holes bounded by a number of flat surfaces as shown in Fig. 6 (a)
- Blind geometrical holes like hexagonal socket as shown in Fig. 6 (b)
- Internal grooves and slots of rectangular and curved sections.
- Internal keyways and splines, straight tooth of internal spur gears,internal curved surface of circular section, internal oil grooves etc. which are not possible in shaping machines.



(a) through rectangular hole (b) hexagonal socket

Fig. 6 *Typical machining application of slotting machine.*

However, it has to be borne in mind that productivity and process capability of slotting machines are very poor and hence used mostly for piece production required by maintenance and repair in small industries. Scope of use of slotting machine for production has been further reduced by more and regular use of broaching machines.