

Drilling and Boring machines

Drilling:

drilling is an operation through which holes are produced in a solid metal by means of a revolving tool called drill. since it is not possible to produce a perfectly true hole by drilling. It is considered as a roughing operation. obviously. For such holes drilling is followed by another operation called Reaming in which the required dimensional accuracy and fine surface finish are obtained by means of a multi-tooth revolving tool called Ramer. Boring is the operation employed for enlarging an existing hole. the hole may be previously drilled, cast, punched or produced through any other suitable operation.

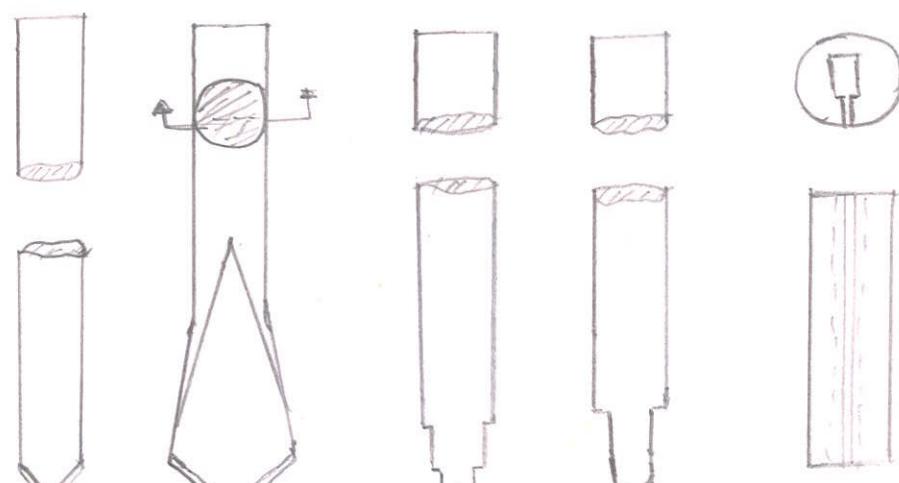
Tools for Drilling:

The tool used for drilling is called a drill. The earliest and simplest form of drill is a flat drill or spade drill, which carries a flat section at cutting edge

this form, however, is obsolete so far, as the modern drilling practice is concerned., for the following reasons

- * It is not suitable for drilling deep holes . as there is no provision . for exit of cut material during operation
- * As the metal chips remain inside, the cutting edge of this drill is spoiled very soon and frequent regrounding is required.
- * Its cutting edge can't withstand the excessive heat generated when relatively high speeds are employed

the most commonly used types



(a)

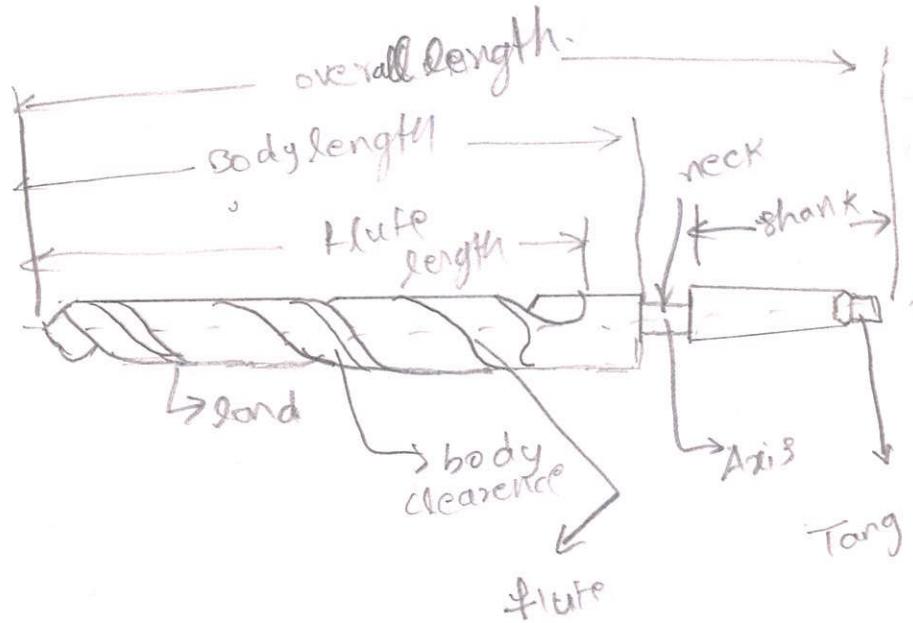
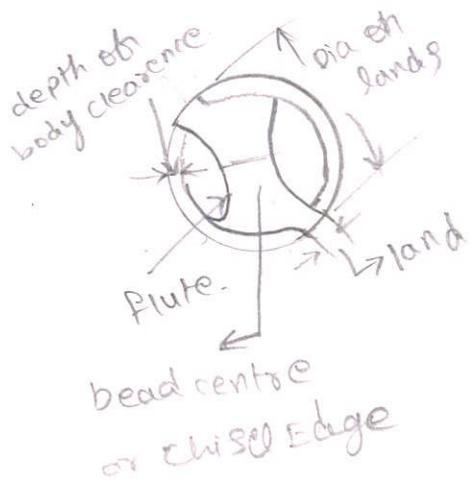
Classification of Drills:

Drills are manufactured in several different forms and sizes. The commonly used drills can be classified in many ways, as follows.

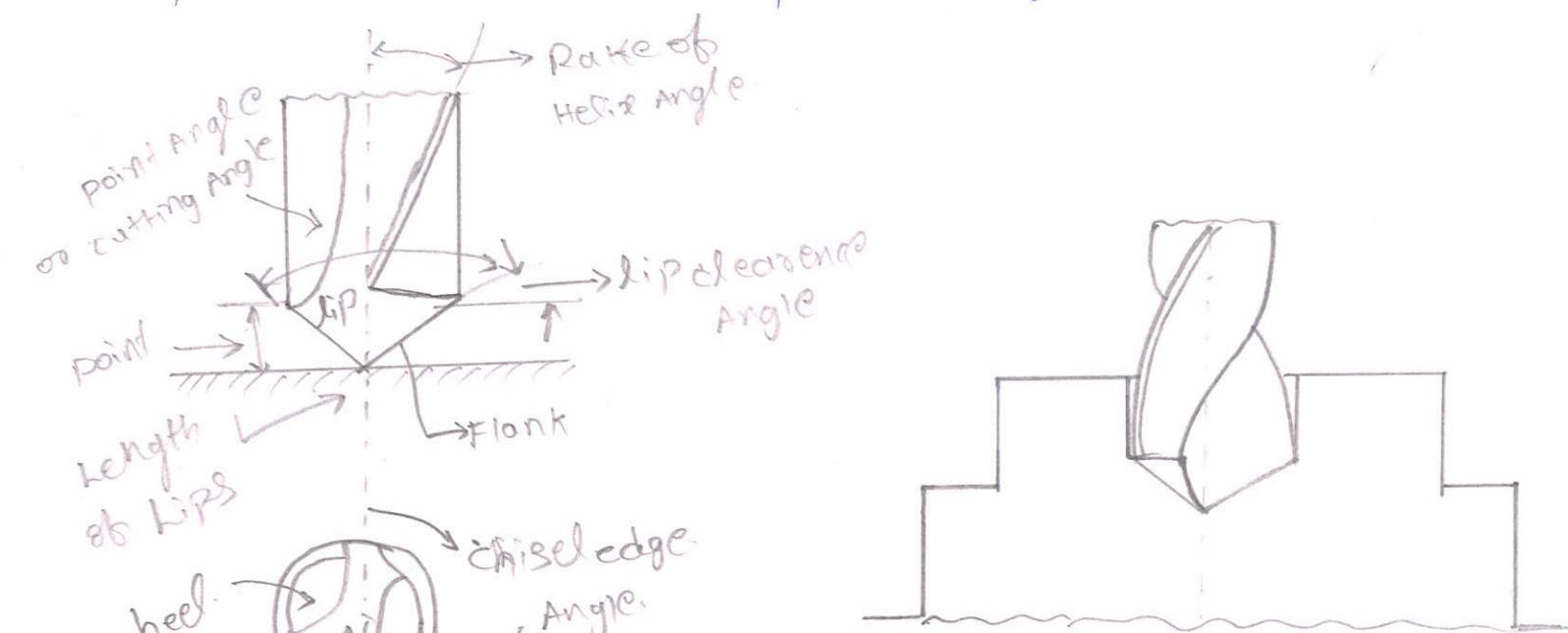
- 1) According to the type of shank they carry;
 - (a) Parallel shank
 - (b) Taper shank
- 2) According to the types of flutes.
- 3) According to length
 - (a) short series drills
 - (b) stub series drills
 - (c) long series drills
- 4) According to applications.
- 5) According to tool material
 - (a) High speed steel drills
 - (b) carbide tipped drills

Twist Drills:

It is most widely used tool in modern drilling practice. It consists of a cylindrical body carrying two spiral flutes cut on it. Twist-drills are usually made of high speed steel. Of course, a few cheaper varieties are made of high carbon steel also. They are made in various sizes to suit the work. It drills say up to 12.7MM other types of shanks used on twist drills are bit-shank and ratchet shank.



Tapered shank drills carry a tang at the end of shank to ensure a safe grip. The body consists of flutes. Their recommended values are given in this will be enable the production of a perfectly sound body. And the lips are of equal angle and length. This will production of a perfectly sound.



Advantages:

- * The chips and cutting of the metal are automatically driven out of the hole through the flutes.

- * Heavier feeds and speeds can be employed quite safely.
- * For the same size and depth of the hole they needed less power in comparison to other forms of drills.

Twist drills parts - And Terminology;
the twist drills are made to carry one of the following two types of spiral grooves on the body

1) High Helix:

They carry a helix angle of 35° to 40° and a heavy web. Their groove width is larger than that of the usual twist drills and, therefore, they enable easier and quicker disposal of chips especially in low tensile strength materials like copper, Aluminium, die casting alloys, plastics, wood etc.

2) Low Helix:

They carry a smaller helix angle and are relatively more rigid. On account of their high rigidity they are capable of taking higher torque and higher feeds. They are widely used in general drilling work.

~~Twist Drill~~ parts:

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Body, Arms, chisel edge (or) dead centre.
shank, point, Lip (or) cutting edge,
body clearance, land or margin, lip
clearance, face, flutes, flanks, web
chisel edge corner, outer corner
neck, tang, heel.

Special drills:

According to the nature of operation, material to be drilled and the resulting economy many special types of drills are used. They carry different spiral angles and the total included angles at bottom, for drilling with 130° included angle, A drill with 125° included angle.

A drill with 125° included angle.

Popular types of special drills are briefly described below.

1) Heavy duty drills

These drills carry larger helix angles and thicker webs than conventional type twist drills. They are widely used for drilling.

deep hole drills:-

these are heavy duty type drills with extra thick webs and larger helix angle. they are widely used in deep hole drilling.

oil hole drills:-

these drills are also meant for deep hole drilling. in such operations the normal problem is ob. high heat generation in the cutting zone. oil is fed upto the point during the operation in order to keep the drill point cool. and thus help the cutting as well as increase the tool life.



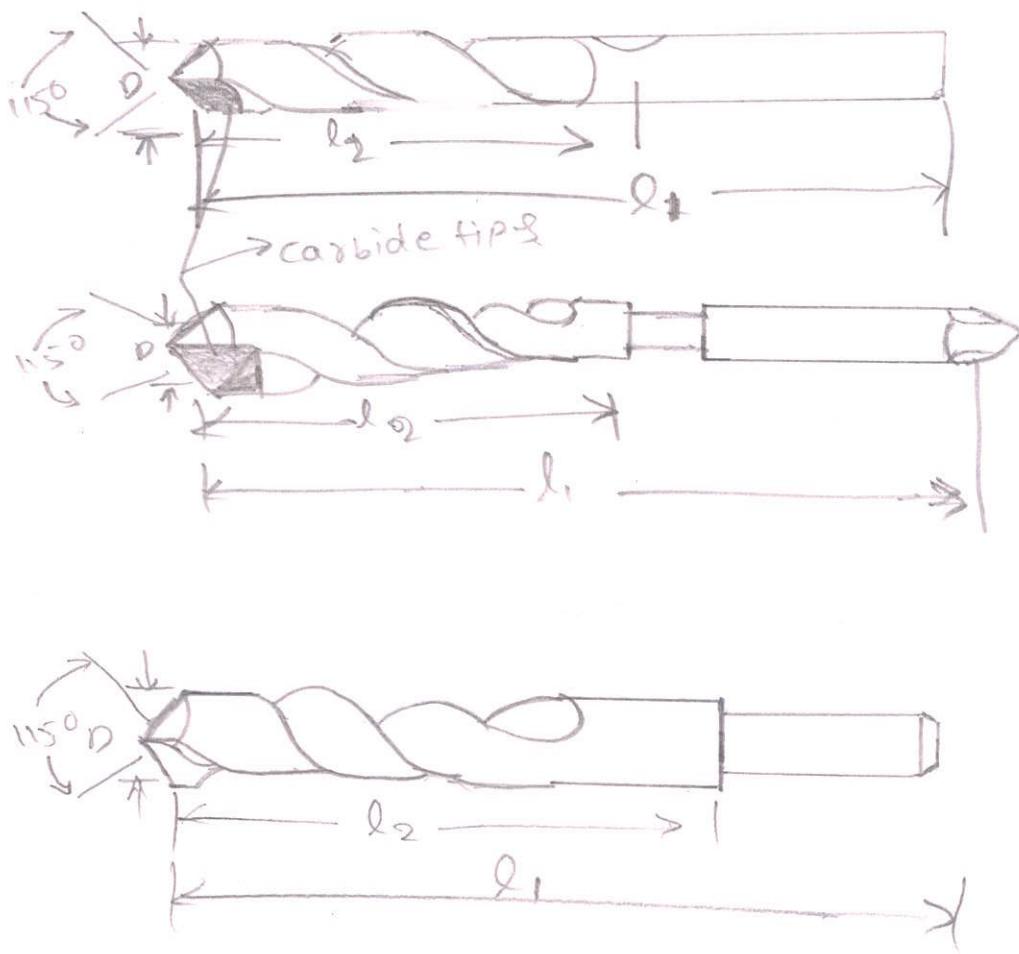
centre drills:-

these drills are double fluted parallel shank twist drills. of smaller sizes and are used for drilling centre holes at the end faces of the jobs, such as required for the work piece to be held b/w centres on a centre lathe.

masonry drills:-

these drills are generally made to contain a 115° cutting angle, usually with parallel shanks. the normal sizes widely

used range from 4mm dia to 20mm dia.
two common forms of these drills are.
shown in fig.



Drill size And specifications:-

According to Indian standards
the drills are specified by their
diameters, series they belong to, the
material they are made of and the
I.S. number.

they are made in three types.

Type N - for normal low carbon steel,

Type H - for hard materials, and

Type S - for soft and tough materials.

Ex: A twist drill specified as 9.50 IS: 5101 HS'; means a twist drill of 9.50 mm. dia. conforming to IS: 5101, made from High speed steel.

It should be noted that unless otherwise mentioned in the tool designation the type should be taken as N, and the point angle as 118° .

Normal sizes:

In metric sizes the drills are manufactured in dia ranging from 0.2 mm to 100 mm.

Fractional sizes:

In this series the drill size starts from $\frac{1}{16}''$ and go up to $5\frac{1}{2}''$ dia. upto $\frac{13}{16}''$ the size in size is uniform in steps of $\frac{1}{16}''$ and beyond this the steps are larger.

Types of drilling Machines:

Drilling machines are manufactured in various sizes and varieties to suit the different types of work. They can, however, classify

- portable drilling machine
- sensitive or bench drill
- upright drilling machine

- upright drilling machine (current type)
- radial drilling machine
- multiple spindle drilling machine
- deep hole drilling machine
- gang drilling machines
- Horizontal drilling machine
- Automatic drilling machine

portable drilling Machine:

It is very small, compact and self-contained unit carrying a small electric motor inside it. In such cases, the operation is performed on the site by means of the portable electric drill. Portable drills are fairly light in weight so that they can be easily handled by one or two men only. On account of the high speeds available, a considerable saving in time is affected by their use. Another advantage is that the holes can be drilled by means of them at any desired inclination usually they are made to hold drills upto a max diameter of 12mm., portable drills upto 18mm. dia. capacity are available. A detailed description of various types of portable drills is given in.

sensitive or Bench drill:

this type of drill machine is used for very light work. its construction is very simple and so is operation. the vertical column carries a swivelling table. the height of which can be adjusted vertically along the former. also it can be swung to any desired position. one of these pulleys is mounted on the motor shaft and the other on machine spindle. the spindle usually carries Morse taper. sensitive drills are normally manufactured having upto 20mm drilling capacity in steel.

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the drive mechanism of this machine is illustrated thus the spindle starts rotating and the cutting tool. when the drill is required to be fed into work. which is directly mounted on the pinion shaft, the keyway cut along the spindle while the motor continues to rotate on the same speed.

on these machines the drills rotate at very high speeds so that the required cutting speeds can be obtained on the peripheries of small drills used on these machines. by his hand feel he can also sense if the drill is cutting properly regrounding. for these only it is known as a sensitive drill.

upright drilling machine?

It is a production drilling machine, which is very useful when a series of drilling size holes are to be drilled respectively. performed in sequence repeatedly. the table can be raised along the column. Also, it can be moved longitudinally. side ways and across to bring the job in correct position below the tool. the tangent head, which carries six

the required tools are mounted in sequence in the turret head so that they automatically come in operating position when the head is indexed. The smaller varieties of these machines are usually manually operated, but a large variety of these machines is numerically controlled type

Radial drilling machine:

This machine is very useful because of its wider range of action. With the use of this machine, the tool is moved to the desired position instead of moving the work to bring the latter in position for drilling.

this machine consists of a base, on which is mounted a cylindrical vertical column. Clamping levels are used for locking the arm at a desired height different other controls for the spindle speed and feed. All the above adjustments contribute towards minimising to an appreciable extent. This enables drilling of holes at any desired angle. Another development in many good machines will be found that the clamping levels are interlocked. Also, in these machines it will not be possible to clamp the

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A part from the fixed column type of radial drills many other forms are also used. They include the girder and plate Radial drills. These machines are of traversing type which can be moved along the rails from one position to other.

Plant Radial Drills:

Three principle movements are possible in type of machine, vertical movements of the arm along the column, horizontal sliding movement of the drilling head or spindle head along the arm and radial swinging of the arm in horizontal plane.

Semi-universal Radial Drills:

These machines, in addition to the above three basic movements, carry provision for swinging of the spindle head about a horizontal axis which is normal to arm, enabling drilling of holes at desired inclinations with the normal vertical position.

Universal Radial Drills:

In this machine the arm itself can be rotated through a desired angle along a horizontal axis. This is

an addition to the four possible movements available on a semi-universal machine. It is normally provided with a geared drive.

The speed change gear mechanism is located on the top of the spindle head. It consists of a pair of gears above the spindle cone-pulley and another pair of gears below it. Gears G_1 and G_2 are mounted on the spindle and gears G_3 and G_4 are mounted on a shaft carried by the back plate. Gears G_3 and G_4 act as the back gears. If the back gears are not required to be used, the cone-pulley gear is again attached to the pulley by pushing the pin. For more detailed description of the principle of operation of such a mechanism the readers are advised to refer back to the fuse of back gears i.e. described

Multiple Spindle Drilling Machines

These machines are mostly used in production work and are so designed that several holes to different sizes can be drilled simultaneously. In these machines two or more spindles are driven from production with sufficient accuracy. In these machines two or more spindles are driven from a common driving shaft. The former type is commonly used. In universal type of these machines, the spindles are mounted on a common head which carries a central gear, which acts as the driving gear. All these pinions. This mechanism is quite similar to that used for driving the spindle of multi-spindle automatic lathe.

Two other types of heads are used one is known as Adjustable head and the other as gearless head. In these heads it is possible to adjust the spindles to several different positions to enable drilling of holes. A properly designed drill jig is normally used for each component to guide the drills accurately.

Deep Hole Drilling Machine:

Where very long holes of relatively smaller dia. are required to be drilled these machines are used. According to the requirement in those machines a head stock and a carriage is provided. the work is supported on a spindle, special type of drills are used on these machines. In deep hole drilling operation the work rotates at high speed instead of the drill, while the drill is fed into the work at low feed. since the drill is quite long, it is required to be adequately supported. Both vertical and horizontal designs of these machines are available, but horizontal machines are more commonly used.

The operation is quite clearly illustrated. While the drill is fed into the rotating workpiece, the coolant is simultaneously fed to the cutting edges through the passages provided in the hollow body of the drill. In case of very long workpieces the step feed method is preferred instead of continuous feed. This involves withdrawal of the drill each time it has cut through a length equal to its dia. The vertical designs of these machines are used for relatively shorter jobs.

Horizontal drilling Machines:

All the drilling machines, except one variety of deep hole drilling machines, are of vertical type. They carry their spindles in a vertical direction, and consequently the drill is held vertically in them, in which the spindle remains horizontal and so remains the tool, which are difficult to be drilled in vertical position. Also, for such subjects which, due to their excessive weight or extraordinarily large size, can't be handled easily, the operation of drilling has to be performed by keeping the job stationary and moving the machine around them. Such jobs require the use of horizontal machines. The job is marked and the machine set before the operation starts. Suitable jigs and fixtures are usually designed and used for this purpose.

Automatic drilling Machines:

These are production machines, arranged in series to perform a number of different operations in sequence at successive work stations. The workpieces, after completion of an operation at one station, are automatically transferred to the next station for another operation.

thus, if works as a transfer line. The operation sequence, related cutting speeds and feeds, start and finish of the operation on each station, it automatically switches on to the next position for the next operation till it undergoes the last operation and unloaded. According to the requirements. Each work station may carry an indexing table and suitable work-holding fixtures. Several different operations like drilling, boring, tapping, milling, honing, etc. can be performed on a job in succession on these machines.

operations done on drilling machines:-

there are a no of operations done on a drilling machine, as shown.

- | | |
|-------------------|--------------------|
| → Drilling | → Reaming |
| → Boring | → counter-boring |
| → counter-sinking | → spot facing, and |
| → Tapping. | |

Tool holding devices:-

taper shank tools, of which the shank is sufficiently large, are directly fitted in the tapered hole of spindle nose, those taper shank tools, of which the shank is too small to fit the taper hole of spindle still smaller taper shank drill or other tools are first fitted with a sleeve, which fits into the socket. this tang fits into the slot at the end of tapered hole and helps in providing a positive drive for the tool as the grip of taper alone is not sufficient. straight shank drills are always held in a drill chuck.

work holding devices

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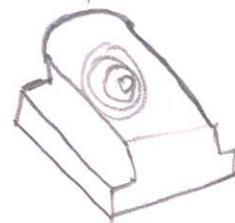
on a drilling machine the work is held by means of v block, Angle plate, clamps and bolts, Jigs and fixtures, or vices. method of holding the work by means of clamps and bolts is similar to that used on shaper or planer. described latter, when drilling is done on mass scale, suitable jigs and fixtures are used. In general work, where jobs of moderate size are to be handled vice is normally used for holding the work. An Adjustable Angle vice is a common vice used on drilling machines.



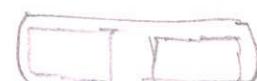
T-bolt.



U-clamp



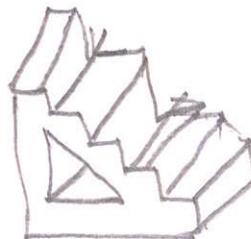
T-Nut.



stud for T-Nut



Finger clamp



step block.

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Cutting speeds, Feeds and depth of cut

The cutting speeds and feeds in drilling, as in case of other machines, depend upon many factors like material to be cut, material of tool, type of finish required, type of coolant used, capacity of machine and the tool life etc. The amount of feed per revolution usually varies b/w 0.5 mm - 0.38 mm upto 25mm dia.

$$R.P.M = \frac{\text{Cutting speed in meters per min}}{\pi \times \text{drill dia in meters}}$$

$$= \frac{\text{Cutting speed in mpm} \times 1000}{\pi \times d}$$

Also, cutting speed (s) is given by

$$s = \frac{\pi d N}{1000} \text{ mpm.}$$

where d = drill dia in mm

N = spindle speed in rpm

Feed:

It is the distance a drill moves, parallel to its axis, onto the work in each revolutions of the spindle. It is expressed in mm per revolution. If the total distance moved by the drill onto the work, parallel to its axis, in one minute is considered it can be expressed as feed in mm per minute.

Now, if N be the no. of revolutions made per minute by the drill, then;

$$\text{feed in mm/min} = \text{feed in mm/rev} \times N$$

The following factors govern the amount of feed to be provided.

→ work piece material

→ depth of drilling

→ range of available feeds

→ rigidity of machine

→ degree of surface finish required.

→ Horse power of motor

→ drill size.

depth of cut

In drilling operation the depth of cut is measured at right angles to the axis of the drill, the direction of feed, and is numerically equal to one-half of the dia. of drill. It can be expressed as

$$\text{depth of cut} = \frac{\text{depth dia}}{2} \text{ mm.}$$

INTRODUCTION-

In this chapter the slotter, planer & shaper are probably described & therefore their working principle are also represented in this chapter. Almost the three machines slotter, shaper, & planer works on the same principle.

Working principle of slotter -

In a slotter the tool is mounted on a ram which has reciprocating motion in a vertical plane. The job is mounted on a ground table which has rotary motion in addition to the cross wise movement. The tool removes the material from the job during the downward cutting stroke & upward return stroke is idle.

Type of slotters -

1) Punched slotter -

The punched slotter is a heavy, rigid machine designed for removal of large amount of metal from large forgings or casting. The length of stroke of a punched slotter is sufficiently large.

2) Precision slotted

The precision slotted is a lighter machine & is operated at high speed. The machine is designed to take light cuts at accurate finish.

Constructional Details of slotted -

- 1) Base
- 2) Column
- 3) Ram
- 4) Rotating table
- 5) Cross slide.
- 6) Saddle

1) Base or Bed -

The base is rigidly built to take up all the cutting force & entire load of the machine. The top of the bed is accurately finished to provide guideways on which the saddle is mounted.

2) Column -

The Column is a vertical member, that is cast integral with the base & houses driving mechanism of the ram & feeding mechanism. The front of the vertical Column is accurately finished for ram reciprocation.

3) Saddle -

It is mounted on the guideways & moved toward or away from the Column either by power or manual control. The top of the saddle is provided with guideways for the cross slide.

Rotary Table -

The rotary table is a circular table, that is mounted on the top of the cross slide. T-slots are cut on the top face of the table for holding the work by different clamping devices.

Bam & Tool head Assembly -

The ram is the reciprocating member of the machine mounted on the guideways of the column. It supports the tool at its bottom end on a tool head. A slot is cut on the body of the ram for changing the position of stroke.

Slotted size -

The size of a slotter, like that of a shaper, is expressed by the maximum length of stroke of the ram, expressed in mm. The size of general purpose of slotter usually ranges from 80 to 900mm.

Quick Return Mechanisms for Ram

A slotter removes metal during downward cutting stroke only whereas upward stroke no metal is removed.

- Withworth Quick return mechanism
- Reversible motor drive "
- Hydraulic drive mechanism .

- The whitworth quick return mechanism is most widely used in a medium sized slotting machine for downing the ram.
- Large machines are driven by variable speed reversible motor. This drive is similar to crank & slotted link mechanism of shapers.
- In hydraulic drive in machines used in precision or tool room work. In hydraulic drive the vibrations is minimised resulting improved surface finish

whitworth Quick Return mechanism -

The mechanism consists of a bull gear rotating at Centre "A", driving plate (disc) rotates at Centre "B". Side block & Crank pin on driving plate disc & a connecting rod

The bull gear receives its motion from driving piston which is driven by an electric motor. As the bull gear rotates about A The crank pin & the slide block rotate in a circular block or path at constant speed, rotating the driving plate about B. This causes the downing disc to rotate. Thus if the bull gear rotates in anti clockwise direction when the slide block rotates through an angle CAD The downward cutting stroke is performed, whereas when the block rotates through an angle DAC. The return stroke is completed.

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Work holding devices-

The work is held on a slotter table by a vise, T-bolts & clamps or by special fixtures. T-bolts & clamps are used for holding most of work on the table. Fixtures are used for holding repetitive work.

Slotter operations-

- 1) Machining Flat surfaces
- 2) Machining Circular surfaces
- 3) Machining Irregular surfaces or cams
- 4) Machining Grooves or Keyways.

Slotter Tools-

A slotting machine tool differs widely from a or a planner tool as the tool in a slotter removes metal during its vertical cutting stroke. This changed condition, presents a lot of difference in the tool shape. In a lathe sharper or a planner tool, the cutting pressure acts over to the tool length whereas in a slotter the pressure acts along the length of the tool. The Back & clearance angle of a slotter tool are determined with respect to a vertical plane other than the horizontal

Cutting Speed, feed & Depth Cut

Cutting speed of a slotter is defined by the rate with which the metal is removed during downward cutting stroke & expressed in m/min.

Feed is the movement of the work per double stroke in mm.

Depth of cut - The distance measured b/w the machined surface & unmachined surface in mm.

UNIT 2

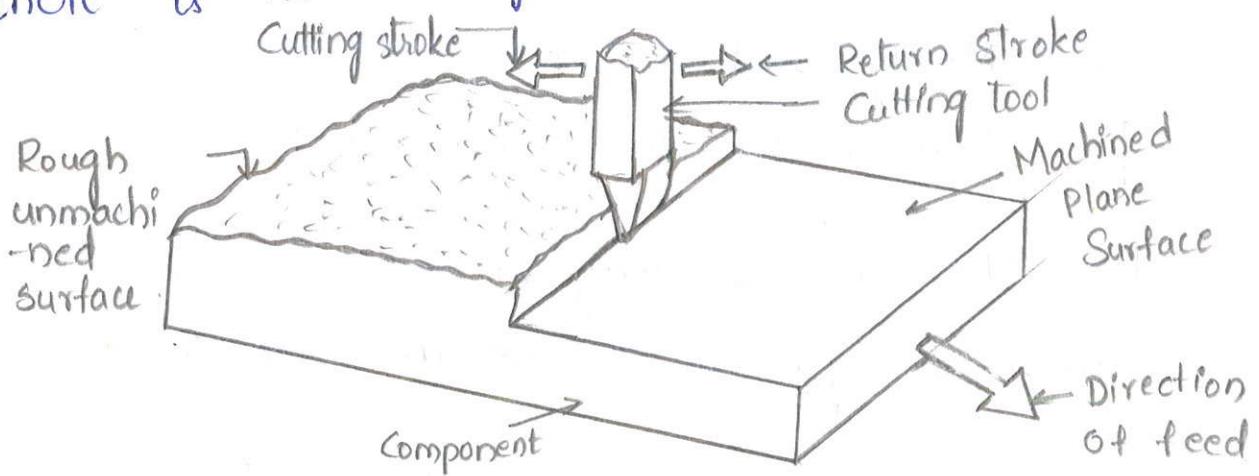
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Shaper Machine:

The shaping machine (shaper) is used for machining flat surfaces. The workpiece is held stationary on the table, the tool carried in the tool head reciprocates past the workpiece with the help of the horizontal ram.

Working principle of shaper:

The shaping machine is used for producing flat surfaces. Machining on shaper is more economical with easier work setting and cheaper tooling. On a shaper, job is fixed on table and the cutting tool reciprocates across the workpiece. The tool cuts on forward stroke and the return stroke remains idle as there is no cutting action in that stroke.



Working Principle of Shaper

Types of Shapers:

There are three basic types of shapers:

1) Horizontal Shaper:

- Ram holding the cutting tool moves in horizontal plane.
- Mostly used in producing flat surfaces.

2) Vertical Shaper:

- Ram holding the cutting tool moves in vertical plane.
- Mostly used for cutting key ways.

3) Travelling head Shaper:

- Ram holding the cutting tool reciprocates and simultaneously move cross-wise to give required feed.
- Mostly used for heavy jobs which are difficult to hold on the table and fed past the table.

Horizontal shapers may be further classified according to general designs as follows:

- 1) According to the action of the cutting stroke.
- Push type
 - Draw type
- 2) According to the type of design of the table.
- Standard shaper
 - Universal shaper
- 3) According to the type of mechanism used for driving the ram.
- Crank type
 - Gearred type
 - Hydraulic type.

Push type and Draw type shapers:

The push type horizontal shaper is common type used in practice. Metal is removed when the ram moves away from the column. Unless otherwise specified, the term shaper refers to push type horizontal shaper.

The draw type shaper, the metal is removed when the tool is drawn or pulled through the metal towards the column. It allows heavier cuts to be taken and tends to reduce vibration as the cut is made.

Standard and Universal Shaper:

In standards or plain shapers the table can only be moved vertically and horizontally to give feed.

In universal shaper in addition to these motions (vertical & horizontal motions), the work table may be swivelled and tilted. A universal shaper is mostly used in tool room because of its usefulness. Complicated work can be conveniently machined by using universal table.

Crank, Geared and Hydraulic Type Shapers:

In crank shaper, rotary motion of driving gear (bull gear) is converted into reciprocating motion of ram by crank mechanism.

The driving gear receives its rotary motion from the motor.

In geared shaper, the ram is driven by rack and pinion mechanism. This type of machine is not commonly used in practice.

In hydraulic shaper, the ram is driven by oil pressure developed by a pump which is driven by electric motor.

The action of these machines is considerably smoother than that of crank driven machines.

Construction Features:

The standard shaper has the following parts:

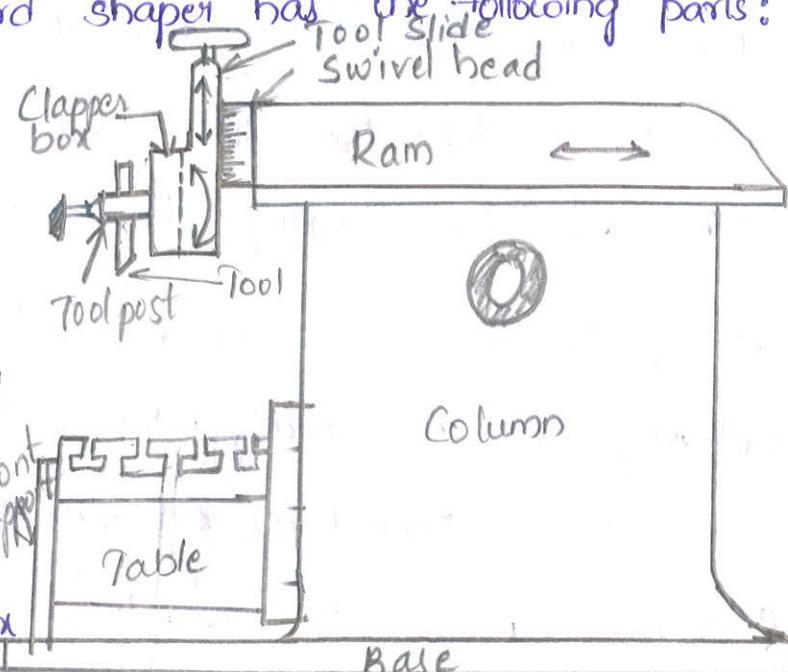
1. Base
2. Column
3. Ram
4. Table

5. Cross-rail

6. Saddle

7. Tool head

8. Clapper box



Base: The base is made of cast iron and is mounted rigidly on the floor or on the bench depending upon the size of machine. It supports other parts of machine and also acts as a reservoir for a supply of oil which is circulated to the moving parts of the machine.

2. Column: The column is vertically mounted on the base. The ram driving mechanism is enclosed in the column. The guideways, accurately ground are provided on its top on which ram slides.

3. Ram: The ram is the main moving part of a shaper, and it carries the tool head that provides cutting action. It is connected to driving mechanism

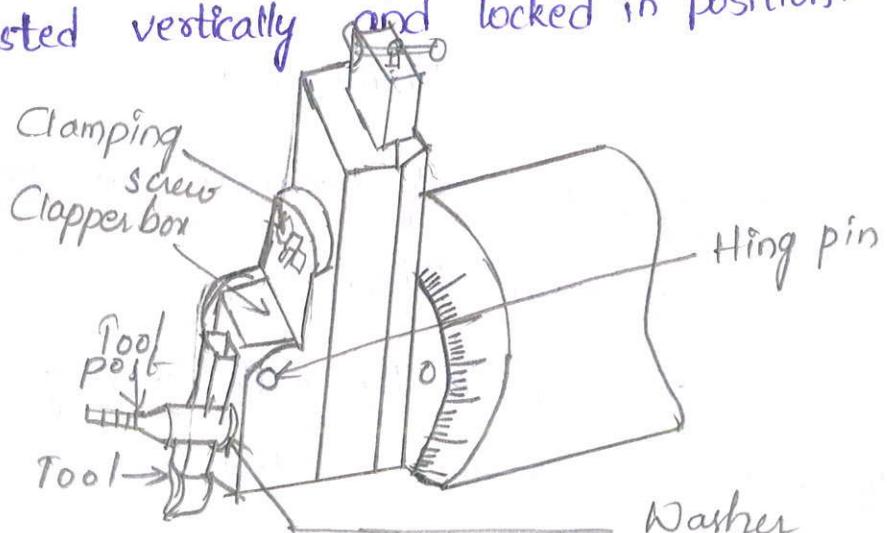
contained within the column.

Table: The table is a box like casting with T-slots cut on its top. The slots are used to hold the shaper vice for clamping the work pieces.

Cross-rail: The cross-rail is used to move the table vertically and horizontally. The vertical (up and down) movement is controlled by an elevating screw and horizontal (side wise) movements with lead screw (cross-feed screw).

Saddle: The saddle is mounted on cross-rail and supports the table. It moves across the cross rail from left to right by cross feed screw.

Tool head: The tool head is attached to the front end of the ram and can be swivelled at any angle on either side for making angular cuts. It may also be adjusted vertically and locked in position.



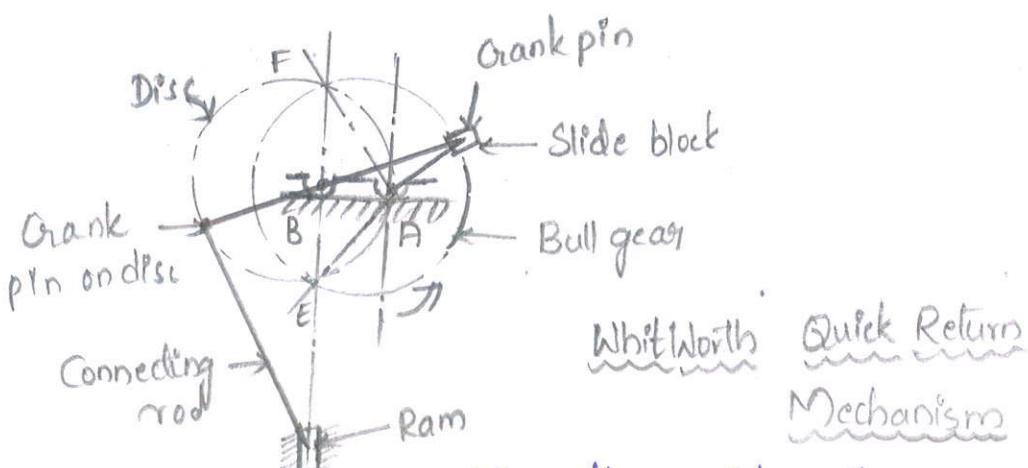
Clapper Box: The clapper box (tool block) is hinged to the tool head. It swings outward on the return stroke so that the cutting tool lift slightly and clear the work. The cutting tool is held in the tool post on the clapper box.

Size of Shaper:

The size of a shaper is specified by the maximum length of stroke of the ram. Shapers are designed in a wide range of sizes; common sizes ranges from 175mm to 900mm.

The length of stroke of ram indicates overall size of the shaper. While ordering a shaper it is necessary to mention to the type of drive, type of speed reduction, power input, cutting to return stroke ratio, the number and amount of feed and the floor space required.

Principle of Whitworth Quick Return Mechanism:



The principle of Whitworth quick return mechanism is shown in the figure. The essential features of the mechanism are bull gear driving plate and crank pin with slider. The bull gear receives its motion from pinion which is driven by an electric motor. The points A and B represent the fixed centres of bull gear and driving plate (disc) respectively. The crank pin and slider block rotates (about A) in a circular path. This causes the rotation of driving plate about the point B. The pin on the disc also rotates about the point B. When the block is at E, the ram is at the maximum speed upward position and when it is at F, the ram is at the maximum downward position. If the bull gear rotates at uniform motion of speed in anti-clockwise direction, the block rotates from E to F causing the downward stroke.

(cutting stroke) of the ram. When the block moves from E to F the return (idle) stroke is completed in lesser time. Thus the quick return motion is obtained. The length of stroke can be adjusted by altering the position of pin.

Shaper operations and Shaper tools:

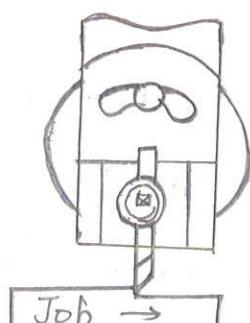
Shaper operations:

The basic operations done on the shaper can be classified as follows:

1. Horizontal cutting,
2. Vertical cutting,
3. Angular cutting,
4. Keys ways, grooves & slot cutting and
5. Irregular cutting.

Horizontal cutting: Machining of a horizontal surface on a shaper is shown in the figure.

Horizontal
Cutting



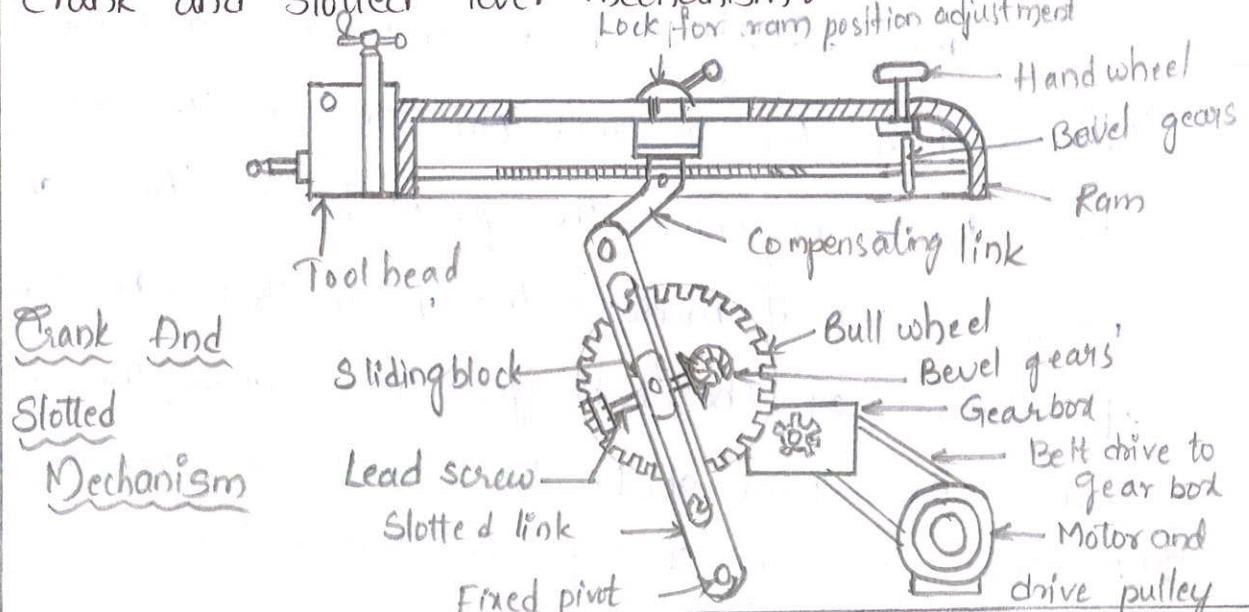
Shaper driving mechanism

A shaper cuts only in the forward stroke and return stroke (idle). To reduce the machining time, it is necessary to minimise the time required for completing the return stroke. The driving mechanism provides faster return stroke than the cutting (forward) stroke. This mechanism is called quick return mechanism.

Types of quick return mechanism: The quick return mechanism may be obtained by any one of the following methods:

1. Crank and slotted lever mechanism
2. Whitworth quick return mechanism
3. Hydraulic system.

Crank and slotted lever mechanism:



The crank and slotted lever mechanism is shown in the figure and its main features are driving gear (bull gear) and slotted link (rocker arm). An electric motor drives the bull gear by means of a pinion through a gear box. A crank pin which is fastened to the ~~the~~ bull gear moves a sliding block which is located in a slot of slotted link. One end of slotted link is pivoted at the bottom and other end is connected to the ram. The up and down movement of slider causes the slotted lever to oscillate about its pivot as the bull gear rotates. Thus the oscillating motion of slotted link lever imparts a reciprocating motion to the ram.

Crank and slotted lever mechanism enables the ram to move faster during returning (idle) stroke than during forward (cutting) stroke. The principle of quick return motion is illustrated.

The cutting stroke is made less rapidly than the return stroke because crank pin produces the cutting stroke through major arc 'ABC' and through 'DE' during its travel through minor arc 'CA' it produces the return stroke. As the speed of rotation of the bull gear is constant, this will cause the return stroke to complete in shorter time. The ratio between cutting time and return stroke may

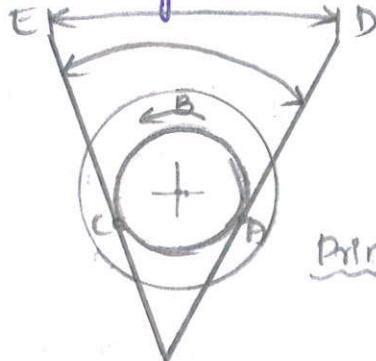
be given as,

Cutting time

Return time

Angle subtended by arc ABC

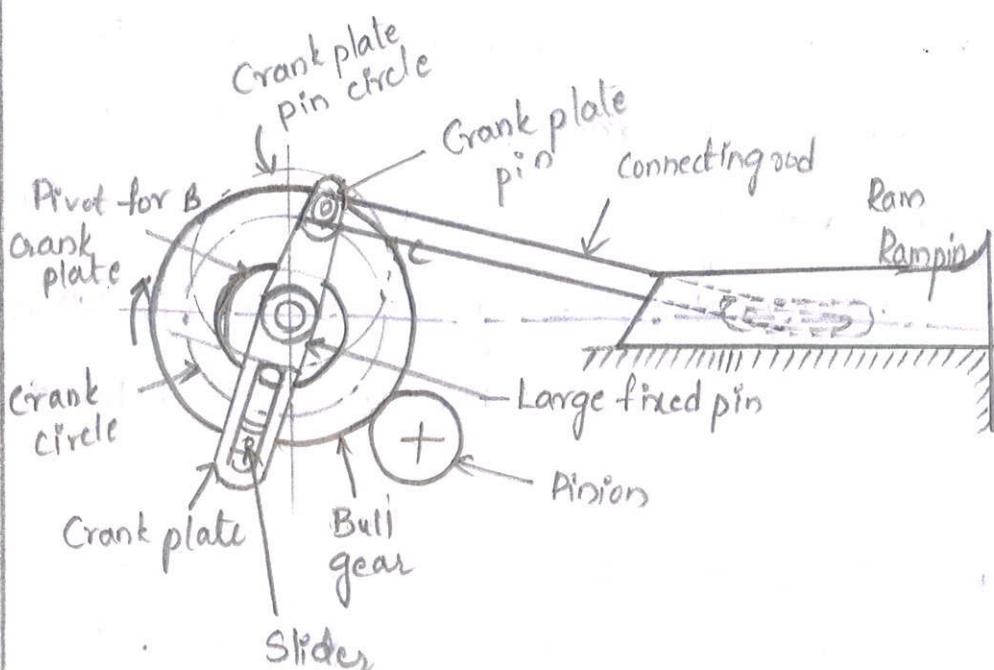
Angle subtended by arc CA



Principle of Quick Return Mechanism

This ratio is usually 3:2 and slightly changes with length of stroke. The disadvantage with this mechanism is that the quick return effect is diminished with smaller strokes.

Whitworth Quick Return Mechanism:



Whitworth Quick Return Mechanism

The line diagram of whitworth quick return mechanism is shown in the figure. Bull gear is rotated about a large fixed pin by a pinion. On a fixed pin a crank plate is pivoted eccentrically. The other end of crank plate is connected to ram by the crank plate pin.

When bull gear rotates at constant speed the crank pin (fitted on face of bull gear) with sliding block will rotate on crank circle and the sliding block causes the crank plate to rotate about its pivot. The rotation of crank plate pin along the circle causes the ram to reciprocate. Positions B and C of crank pin correspond to forward position and backward position of the ram. When the crank pin travels from C to B, the cutting stroke is performed, and the return stroke is completed when the crank pin travels from B to C. As the angular velocity of crank pin is uniform, the time taken for cutting stroke is greater than idle stroke. Thus the quick return motion is obtained by this mechanism.

The length of stroke can be adjusted by adjusting the radius of the rotation of crank plate pin. The position of the stroke may be changed by shifting the position of ram pin.

Shaper tools :

Work holding devices :

The various devices such as T-bolts, clamps, vices, V-blocks, angle plates etc.. are necessary for clamping the work to the shaper table before machining take place.

The work may be held securely on machine table by the following methods :

1. The work may be fastened to the table with the help of clamps and studs.
2. The work is held in the vice and the vice is fastened to work table with T-head bolts.
3. Cast iron angle plate is used for holding the work on work table. One surface is clamped to the table by clamps, T-bolts and other surface supports the work with clamps, T-bolts and other surface supports the work with clamps.
4. V-blocks are often used to hold the round objects with the help of T-bolts, nuts and clamps.
5. Work is supported between shaper index centres for cutting splines or gears.

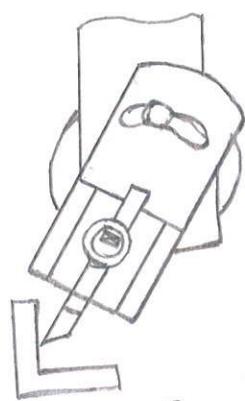
Shaper Tools and Tool Materials :

Shapers use single point cutting tools. Shaper tools are similar to lathe tools, except that rake angles of shaper tools may be slightly smaller, particularly for machining harder materials and are heavier and more rigid.

The most common materials used for shaper tool is high speed steel. Carbide tools in the form of tips, clamped on steel shank, are also used for machining harder materials.

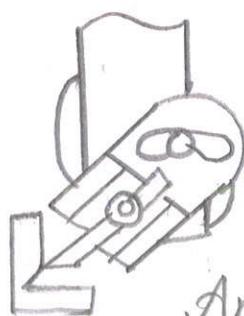
For horizontal surfaces the clapper box is centred on the tool slide. The feed is provided by movement of worktable during each return (idle) stroke of the ram and tool. The worktable is stationary during the forward (cutting) stroke. The depth of cut is set by the down feed horizontal.

Vertical cutting:



Machining of a vertical Cutting vertical surface is shown in the figure. To shape a vertical surface, the clapper is swivelled so as to prevent the cutting tool from dragging along and scoring the machined surface during the return stroke. For vertical surfaces the feed is provided manually by the down feed hand wheel, and the worktable is adjusted by hand to control the depth of cut.

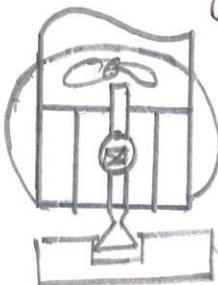
Angular Cutting:



Angular Cutting

The figure shows a setting for machining inclined surfaces. The tool head and cutting tool are adjusted to the same angle of inclined surface. The clapper box is turned away from the surface to be machined. The tool is fed by rotating the cross-feed hand wheel.

Cutting slots, grooves and keyways:



Cutting slots, grooves & Keyways

Shaper can be conveniently used to cut slots, grooves and keyways externally as well as internally. To cut a keyway that is not extended over the entire length, a hole which is slightly larger and deeper than the width and depth of keyway must be drilled at the point where the keyway ends. The clapper box must be locked to prevent raising on the return stroke.

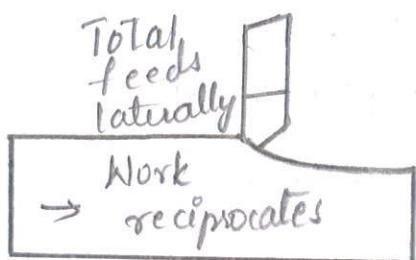
Machining irregular shapes: For machining irregular surface, the required shape is scribed on the surface of the work. The required contour or shape is obtained by manipulating vertical and horizontal feeds.

PLANNING MACHINES

Planning machine or Planer:-

The planer (planing machine), like shaper is primarily intended to produce flat surfaces. The major difference is that in planer the cutting tool is stationary and table holding the work reciprocates past the stationary tool.

Working principle of Planing Machine:



Working principle of planer

The planing machine or planer is one of the basic machine tools of the industry. It is used for producing flat surfaces. It is designed with stationary housing for holding the workpiece. Thus the work which is mounted on table reciprocates past the stationary tool; feed is given by the lateral movement of the tool; metal is cut only in the forward movement of the table and return stroke is idle and completed quickly. The principle of planer is shown in the figure.

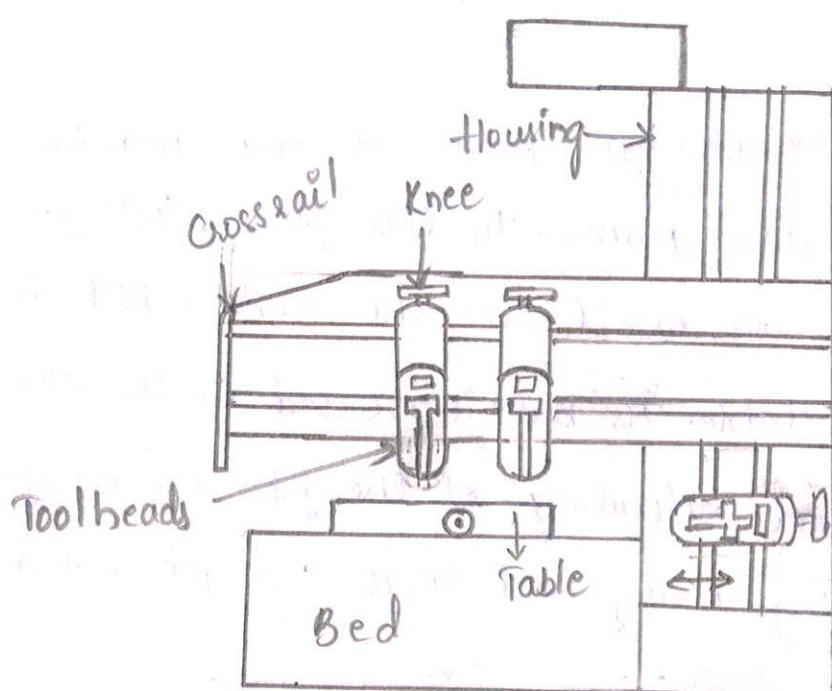
Types of Planers:

Planers are classified according to the type of housing and the type of work they can accommodate. The following list gives the various types of planers which are most commonly used.

1. Double housing planer,
 2. Open side planer,
 3. Pit type planer,
 4. Edge (plate) planer and
 5. Divided table planer.
1. Double housing planer:

Double housing planer is a standard type planer and most widely used in workshops. This planer is extremely massive and has a bed at the sides of which two vertical housings are arranged. The table moves along the ways of the bed. The housings support the cross-rail and the tool heads. The cross-rail can be moved vertically along the ways on the housings and carries two tool heads to carry the tools for planing horizontal surfaces. For planing vertical surfaces two tool heads are mounted upon the vertical faces of housing. The tools may be fed either by hand or by power. The planer table may be driven by mechanical or hydraulic drives.

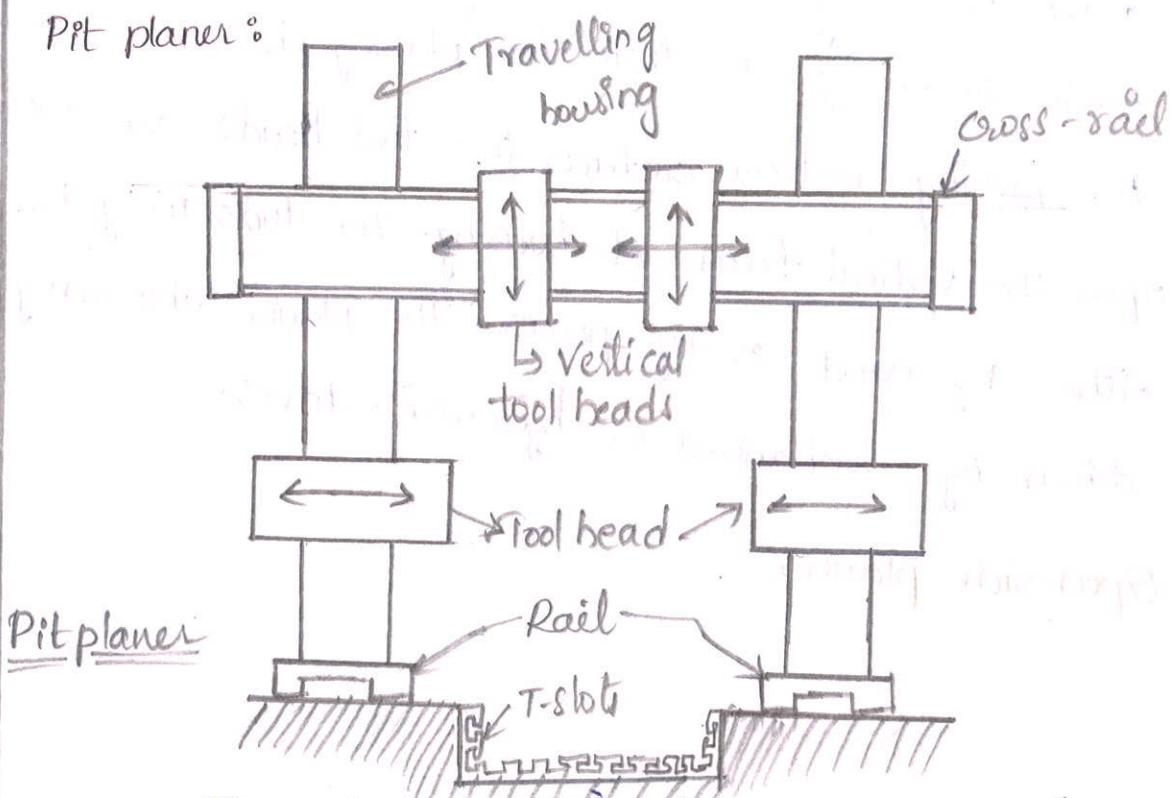
Open side planer:



Open Side Planer

The open side planer is made with only one supporting column (housing). The open side makes it possible to plane work far wider than the table. In open side planer the cross-rail is mounted in the form of cantilever, and only three tool holders are mounted. The tool feeding and driving mechanism for table are same as double housing planer.

Pit planer:



Pit planer

The pit-type planer is more massive in construction than standard planer. In this planer, tools mounted on the cross-rail are moved over the work which is held on the stationary table. Its bed is recessed in the floor. Therefore loading and unloading of the jobs are easy. It is used for planing heavy and large size jobs, and it requires less floor space.

Edge or plate planer: It is specially designed for squaring or bevelling the edges of heavy plate stock. One end of the plate is clamped to stationary machine frame while the tool reciprocates past the edge of the plates. A platform is also attached to the carriage which holds the tool. The operator standing on the platform makes the adjustment of tool during the cutting operations.

Divided table planer: This planer has two tables on the bed which are reciprocate under different tool heads. To avoid delay and to have continuous production one table is used for mounting the job while the other table for planing the job already set under the tool head. After completion, the finished jobs are removed from this table, to accomodate fresh jobs while the first table holding the jobs reciprocates past the tool for planing.

Constructional features of a Standard Planer:

Bed,

Table,

Housing or Column,

Cross-rail

Tool heads and

Driving & feed mechanism.

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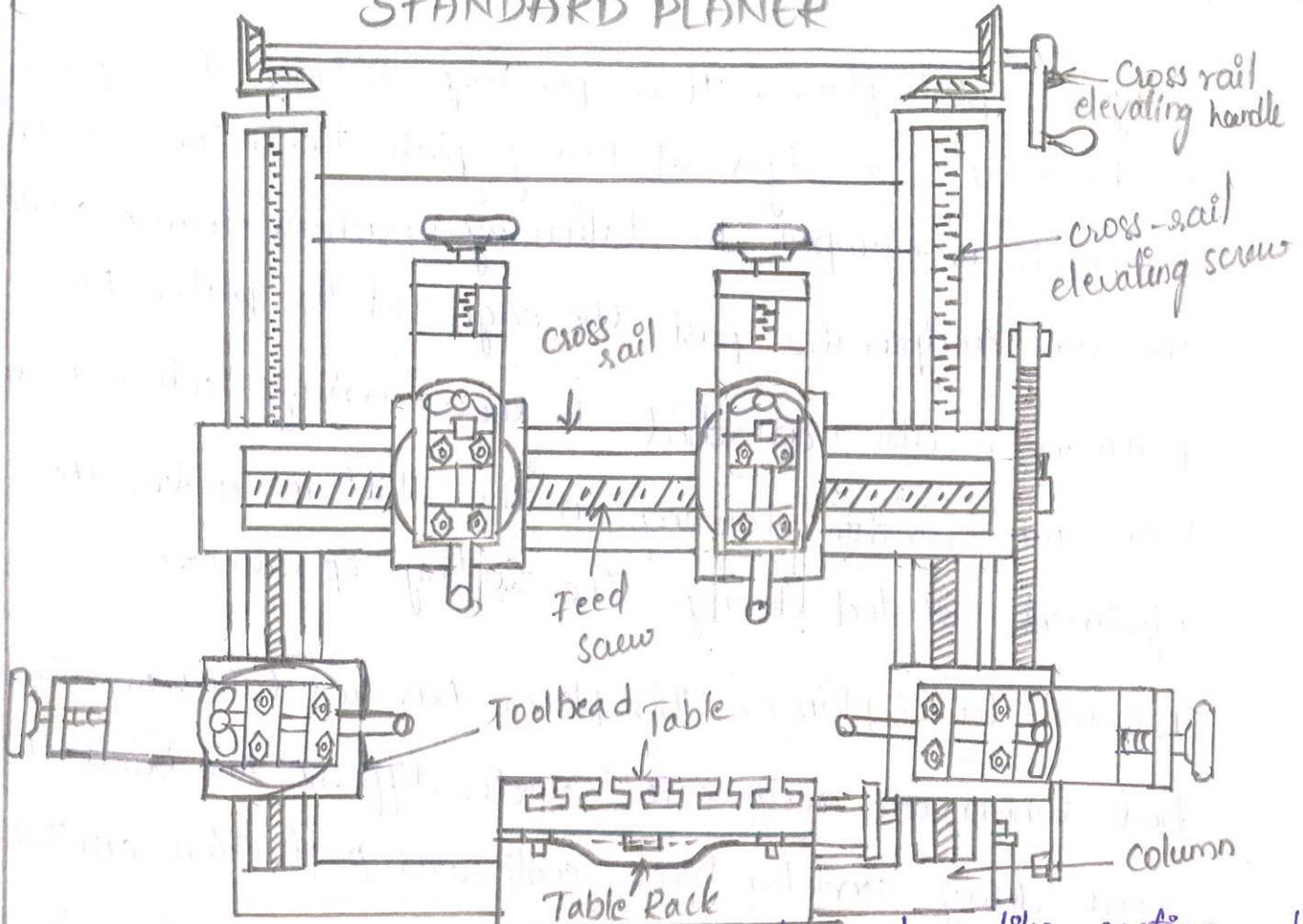
Housing or Column,

Cross-rail

Tool heads and

Driving & feed mechanism.

STANDARD PLANER



Bed: The planer bed is a large box like casting and its length is nearly twice the table length. It is made of cast iron. The guideways are provided on the top of the bed to support and guide the reciprocating planer table. It accommodates the table driving mechanism.

Table: The table (or platen) is a large rectangular casting mounted on the bed guideways. It holds the work and reciprocates along the bed guideways. The top surface has T-slots which facilitates clamping the work or work holding devices (Vice, special fixtures, etc.,) with T-bolts.

Housing or Column: Housings are long vertical structures placed on each side of the bed. It supports the cross-r

oil. It also supports the mechanism for operating the tool heads.

Cross-rail: Cross-rail is a rigid casting mounted horizontally on the vertical ways of housings. It can be moved vertically up and down by means of elevating screws located within the ways of the housing. It carries two saddles with tool heads in which tools are held. The tool heads may be moved horizontally on the guideways of cross-rail by means of feed screws.

Tool head: Tool head is attached to saddle which is mounted on cross-rail. It contains tool post for holding the tools. Its construction and operation is same as that of shaper. The tool post (clapper block) is hinged to the head so that on the return movement of the table the cutting tool will be lifted. Tool heads can be swivelled through 60° on either side of its vertical position on the cross-rail, the other two in a horizontal position on the housing below the cross-rail.

Feed Mechanism of a Planer:

In a planer the feed is provided by cutting tool at the end of return stroke. For machining horizontal surfaces cross-feed is given and while machining vertical surface down-feed is applied. These feeds may be operated by hand or by power. The following methods are used in power feed.

1. By friction disc and
2. By electric drive

In friction disc feed mechanism the part of revolution of bull gear operates gearing system, and the feed is provided at the end of return stroke. The feed mechanism is inoperative for the rest of the time.

In electric drive separate motor is used to operate feed mechanism. It is very effective and modern planers are provided with electric drive feed mechanism.

Planer Operations :

The following operations are performed in a planer:

1. Planing horizontal and vertical surfaces.
2. Planing dovetails and angular surfaces.
3. Planing curved surfaces and
4. Planing slots and grooves.

For planing horizontal surfaces straight tool is clamped in a vertical position on a cross-rail tool heads. The work reciprocates past the tool. The tool is fed by rotating the cross-feed screw.

For planing vertical surfaces apron is swivelled in a direction so that the tool will swing away from machined surface during the return stroke. The tool is fed by rotating the down feed screw.

For dovetail work the tool is held along the tool head slide which is set to a desired angle, and fed at an angle by rotating the down feed screw.

Planing a curved surface may be done by feeding the tool simultaneously in both horizontal and vertical directions.

Work holding devices used in planer:

The most common way to hold the work in planer is to clamp it directly to the table. Some special fixtures are used for holding large number of identical parts. The work may be held in a vice fastened to the table.

Planer vice is more robust than shaper vice.

The planer various work holding devices in planer are listed below:

1. Planer vice

2. T-bolts

3. Clamps

4. Packing blocks

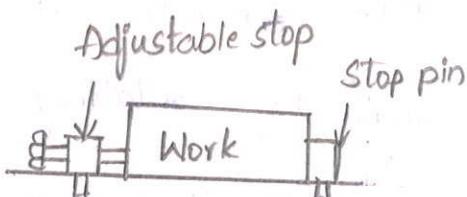
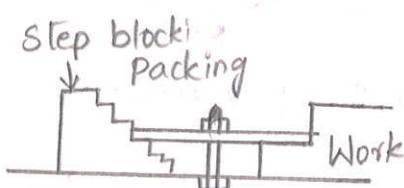
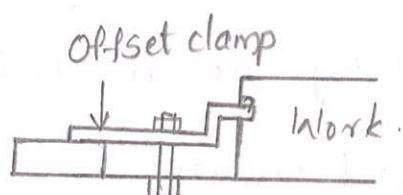
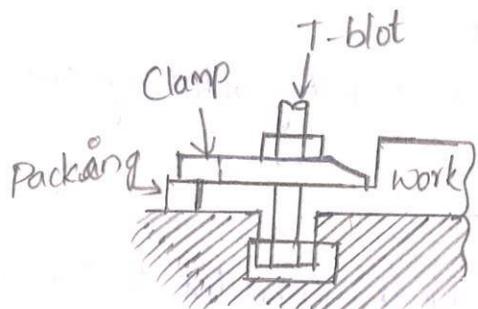
5. Parallel

6. Planer jacks

7. Angle plate

8. V-block

9. Special fixtures etc.



Planer jack

