CHAPTER-3

* LATHE MACHINE *

CONSTRUCTION & WORKING OF LATHE :-

Major Components of a lathe & their function :-

INTRODUCTION :-

The lathe is one of the oldest machine tools & came to existence from the early tree lathe which was then a novel device for rotating & machining a piece of work held between two adjacent trees. A rope wound round the work with its one end attached to a flexible branch of a tree & the other end being pulled by a man caused the job to rotate intermittently. Hand tools when then used, with its further development a strip of wood called "lathe" was used to support the rope & that is hold the machine came to be known as "lathe". This device continued to develop through centuries & in the year 1797 "HENRY MAUDSLAY" an English men designed the first screw cutting lathe which is the fore runner of the present day high speed, heavy duty production lathe, a machine tool which has practically given shape to our present day civilization by building machines & industries.

FUNCTION OF THE LATHE :-

The main function of the lathe is to remove metal from a piece of work to give it the required shape & size. This accomplished by holding the work securely & rigidly on the machine & then turning it against cutting tool which will remove metal from the work in the form of chips. To cut the material properly the tool should be harder than the material of the workpiece should be rigidly held on the machine & should be fed or pressed in a definite way relative to the work

Mayor components of a lathe & their function :-

Different parts are used in a lathe machine which are important at their own field. We have discussed below mayor parts of the lathe machine.

1. Bed
2. Head stock
3. Tail stock
4. Carriage
5. Feed mechanism
6. Screw cutting mechanism.

THE BED :-

The lathe bed forms the base of the ~~base of the~~ machine. The headstock & the tailstock are located at either end of the bed & the carriage rests over the lathe bed & slides on it. The lathe bed being the main guiding member of the tool, for accurate machine work must satisfy the following conditions.

1. It should be sufficiently rigid to prevent deflection under tremendous cutting pressure transmitted through the tool post & carriage to the lathe bed.
2. It must be massive with sufficient depth and width to absorb vibration.
3. It most resist the twisting stress set up due to the resultant of two forces. The downward cutting force on the tool & the force tending to move the tool away from the work in a horizontal direction.

THE HEADSTOCK :-

The headstock is secured permanently on the inner ways at the left hand end of the lathe bed, & it provides mechanical means of rotating the work at multiple speeds. It comprises essentially a hollow spindle & mechanism for driving & altering the spindle speed. All the parts are housed within the headstock, a casting.

The spindle of the headstock, is made of carbon or nickel chrome steel. This is usually of a large diameter to resist being & it should be perfectly aligned with the lathe axis & accurately machined for producing true work surface. A hole extends through the spindle so that a long bar may be passed through the bore. The front

end of the hole is appeared for holding centres & other tools having a standard morse taper shank.

TAIL STOCK :-

The Tailstock is located on the inner ways at the right hand end of the bed. This has two main uses (1) it support the other end of the work when it is being machined between centres, and (2) it holds a tool for performing operations such as drilling, reaming tapping etc...

To accomodate different lengths of work, the body of the tailstock can be adjusted along the ways orderly by sliding it to the desired position where it can be clamped by bolts & plates.

CARRIAGE :-

The carriage of a lathe has several parts that serve to support move & control the cutting tool. It consists of the following parts -

1- saddle
2- cross-slide
3- compound slide or compound rest
4- tool post.
5- apron.

SADDLE :-

The saddle is an 'H' shaped casting that fits over the bed & slides along the ways. It carries the cross-slide & tool post. Some means are generally provided for locking the saddle to prevent any movement when surfacing operations are carried out.

CROSS-SLIDE :-

The cross-slide comprises a casting, machined on the underside for attachment to the saddle & carries location on the upper face for the tool post or compound rest. The cross-piece of the saddle is machined with a dovetail way, at right angles to the centre axis of the lather, which serves to guide the cross-slide itself.

Compound rest :-

Compound rest is set up over the cross slide & it can move in circular path.

WAYS :-

Ways are the guide ~~rest~~ rails in through which different parts of lathe machine moves. It is used for the precise movement of the carriage & other mounted parts. Ways may be inner ways & outer ways.

LEAD SCREW :-

Lead screw is known just below the feed rod. It also provides precise longitudinal movement to the carriage. It is engaged in thread cutting operation.

FEED ROD :-

Feed rod is a power transmission mechanism which provides precise longitudinal movement of the carriage. For turning operation movement of the feed rod is mandatory. In some lathe's feed may not be available & lead screw serves the purpose of the feed rod.

CHIP PAN :-

It is situated at the lower part of the lathe machine. It's function is to collect the chips while machining. Thus these chips can be collected easily & can be removed.

LEG'S :-

Leg's are used to carry all the loads of the Machine. They are bolted on the floor which prevents vibration.

APRON :-

It is situated on the carriage. It consist all controlling & moving mechanism of carriage.

SPINDLE :-

It is the main part of lathe which holds & rotates the chuck.

TYPE'S OF LATHE OPERATION :-

The working of lathe machine changes with every operation & cut desired. There are a lot of operations used for using the lathe machines. Some of the common lathe operations are →

★. FACING :-

This is usually the first step of the any lathe operations on the lathe machine. The metal is cut from the end to make it fit in the right angle of the axis & remove the marks.

★. TAPERING :-

Tapering is to cut the metal to nearly a cone shape with the help of the compound slide. This is something in between the Parallel turning & facing if one is willing to change angle then they can adjust the compound slide as they like.

★. PARTING :- /CUTOFF.

The part is removed so that it faces the ends. for this the parting tool is involved in slowly to make perform the operation. for to make the cut deeper the parting tool is pulled out & transferred to the side for the cut & to prevent the tool from breaking.

★. CHAMFERING :-

only the cutting edge is used at the corner of cylindrical shapes which is used for stress relieving of the workpiece.

★. BORING :-

A single point tool head is feed linearly to to end of the workpiece (on the inside diameter).

★. THREADING :-

A pointed tool is used to cut the outside surface of the workpiece with linear feed.

★. DRILLING :-

Drilling & Reaming is done by feeding the cutting tool along the axis of the rotating jobpiece

★. KNURLING :-

It is a metal forming method which creates a regular cross hatched pattern. It is not a machining process. It does not involve any cutting of the metal.

SAFETY MEASURES DURING MACHINING :-

- Never remove or try to defect machine safe-guards.
- don't create new hazards, such as allowing objects to fall into moving parts or by creating a new pinch point.
- Report problems with machine safeguards to your supervisor immediately.
- Never leave machines unattended with parts still moving. Remember that the parts may still be moving after the machine has been turning off.
- Remove guards only when the machine has been locked out & tagged out.
- If possible, lubricate machine parts without removing the safeguard. otherwise turn the machine off & lock it out before lubricating.
- operate equipment only when guards are in place & properly adjusted.
- Do not use unauthorized or damaged guards.
- Do not wear loose clothing, jewelry or long hair around machines - these increase the risk of being caught in the machinery.
- Ask your supervisor if you have any questions about a machine safety or how to work with machine guards safety.

* Difference between ENGINE LATHE & (CAPSTAN & TURRET) LATHE :-

ENGINE LATHE	Capstan & Turrent lathe
→ The direction of rotation is Mostly anti-clockwise.	→ It can rotate in both direction.
→ Required less power as these machines are design for doing a single operation at a time.	→ Require 4-5 times more power because of handaling 2-3 operation at a time.
→ Less number of spindle speed available in these types of lathe.	→ The vast amount of spindle speeds are available.
→ Setting & machining time is higher.	→ Setting & machining time for mass production is very less, as it's handle several operation at a time.
→ The skilled operator needed	→ Semi-skilled operator can be run the machine.
→ The lead screw present in these types of lathe is long.	→ Lead screw is not present but short threads can be easily cut by chaser.
→ Any type of taper turning can be done by this machine.	→ Only short length taper can be done with the help of the form tool.

(*) Capstan lathe components function as same as function of turrent lathe. ~~So function~~

Turret LATHE

★. Difference with respect to capstan lathe →

TURRENT LATHE	CAPSTEN LATHE
1→ In turrent lathe the main turrent is directly installed on the saddle & the saddle is move along the entire length of the lathe bed.	1. capstain lathe is ram type turrent lathe & the movement of the ram is limited.
~~2→ In turrent lathe the turrent head is directly mounted on saddle & they appear like a single unit.~~	2. turret head

CAPSTAN LATHE	TURRENT LATHE
1→ It is a light duty Machine	1→ It is a heavy duty machine.
2→ The turrent head is mounted on the ram & the ram is on the saddle.	2→ The turrent head is directly mounted on the saddle & the saddle slides over the bed ways.
3→ The saddle will not be moved during machining.	3→ The saddle is moved along with the turrent head during maching
4→ The length wise movement of turrent is less.	4→ The length wise movement of turrent is more.
5→ Short work piece only can be machined.	5→ Long workpiece can be machine
6→ It is easy to move the turrent head as it slides over the ram.	6→ It is dibbicult to move the turre head along with saddle.
7→ The turrent head can not be moved crosswise.	7→ The turrent head can be moved cross wise in some turrent lathe.

8→ As the construction of lathe is not rigid, heavy cut cannot be given.

9→ It is used for machining work pieces up to 60 m·m diameter.

10→ Collect is used to hold the work piece.

8→ As the construction of the lathe is rigid, heavy cut can be given.

9→ It is used for machining work pieces up to 200 m·m diameter.

10→ Jaw chuck is used to hold the work piece.

Major components & their function →

The turrent lathe has following parts are the main parts of which are → (i) bed
(ii) Head-Stock
(iii) cross-slide & saddle
(iv) The turrent saddle & Auxiliary slide.

(i) BED :-

The Bed is a long box like casting provided with accurate guideways upon which are mounted the carriage & turrent-saddle.

The bed designed to ensure strength & permanency of alignment under heavy duty services.

(ii) HEAD-STOCK :-

The head-stock is made up of large casting. It is located at the left-hand end of the bed. The different types of head stocks in capstain & turrent lathe are as follows →

- Step cone pulley driven headstock
- Direct electric motor driven headstock
- All geared headstock
- Preoptive or preselective headstock.

(III) CROSS-SLIDE & SADDLE :-

In small capstain lathes, hand-operated cross slide is used which are clamped on the lathe bed at the required position. The larger lathes & heavy-duty turrent lathes are equipped with usually two designs of the carriage.

- conventional type carriage
- Side hung type carriage.

(IV) The turrent saddle & auxiliary slide :-

- In a capstan lathe, the turrent saddle bridges the gap between two bed-ways, & the top face is accurately machined to provide a bearing surface for the auxiliary slide.
- The saddle is adj. on lathe bedways & clamped at the desired position. The hexagonal turrent is mounted on the auxiliary slide.
- In a turrent is directly mounted on the top of the saddle & any movement of the turrent is effected by the movement of the saddle.
- The movement of the turrent may be effected by hand or power. The turrent is a hexagonally shaped tool holder intended for holding six or more tools.

Chapter - 1

Tool Materials

Cutting Tool

In the content of machining a cutting tool or cutter is any tool that is used to remove some material from the workpiece by means of shear deformation cutting may be accomplished by single point or multi-point tools.

Cutting Tool Materials

Cutting tool materials are materials that are used to make cutting tools which are used in machining but not other cutting tools like knives or punches. Cutting tool material must be harder than the material of

the workpiece, even at high temperatures during in process.

Composition of tool material

The following material having suitable for heat treated whenever requirement in the manufacturing of machine tool.

→ Carbon tool steel
→ High speed steel
→ Cemented carbide
→ Diamonds
→ Ceramics

Carbon Tool Steel

The following composition of plane carbon steel is used in the cutting tool as follows.

→ Silicon 0.1 to 0.4%
→ Carbon 0.8 to 1.3%
→ Manganese 0.1 to 0.4%.

These tool steel have good hardness, toughness & strength when there are hardened & tempered this composition of material suitable for lower cutting speed & used in those application this material used to made up die, tap, hacksaw blade, reamer.

High Speed Steel

Tools or cut the material at effectively even at high wear resistance & hot hardness in composition is cutting speed can be 2-3 times more than carbon steel.

The different types of high speed steel used ind cutting tools -

→ Cobalt high speed steel
→ 18-H-1 high speed steel
→ molybedenum high speed steel

The composition of following material

→ Tongsten = 18% (hardness)

→ Chromium = 4% (resist corrosion)

→ Vanadium = 1% (Thermal efficiency)

→ Carbon = 0.75%

This materials gives better performance over great range of materials & cutting speed. This material hardness upto 600° C. It is used for all purpose of cutting so most of the cutting are made from this steel. Drill bits, milling cutter, single point cutting tool are made from this steel.

Molyb — High Speed Steel

The composition of material such as

→ molybdenum = 6%

→ tongsten = 6%

→ Cromium = 4%

Vanadium = 2%

This material having ability to high toughness & cutting.

Cobalt high Speed Still

It having following material composition

→ Cobalt = 12 %.
→ Tungsten = 20 %
→ Cremium = 4 %.
→ Vanadium = 2%.

Also named as super high speed still.
This type of material used for rope cutting & heavy duty tools like as mixing cutter, lathe tools, planner tools etc.

Cemented Carbide :-

It made by mixing of tungsten powder & carbon at high temperature (1500°C) the

ratio of weight like that 94 & 6. respectively the tungsten carbide combined with cobalt then compacted & sintered in furnance about 1400°C. It mainly used at higher cutting speed. The composition of material like that

→ Tungsten = 82 %

→ Titenium carbide = 10%.

→ Cobalt = 8%.

A. Babu
14.1.20

Chapter-2

Cutting Tool

In the context of machining, a cutting tool or cutter is any tool that is used to remove some material from the workpiece by means of sheare deformation. Cutting may be accomplished by single point or multipoint tools.

Single point tools are used in turning, shapping, planning and similar operations and remove material by means of one cutting edge. Milling and drilling tools are obtain multipoint tools.

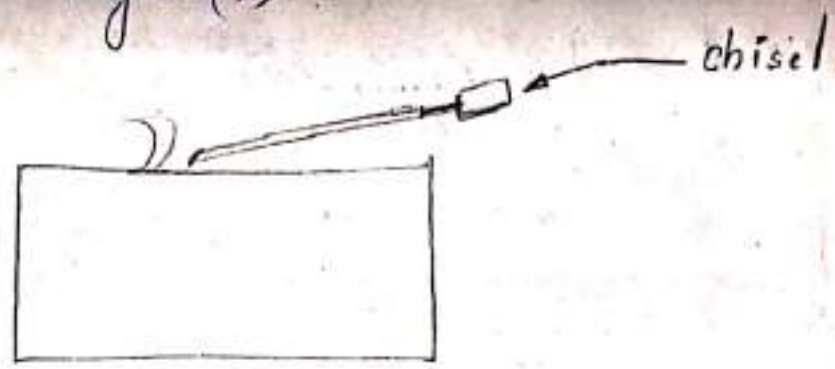
Cutting action various hand tools

Chisel

- A flat cold chisel is a single point tool used as the bench and the point is considered as a wedge.

- A diagram of the chisel point at the in the action of cutting is shown in fig (1).
- Where the angle of rack and wedge angle are indicated.
- For MS a rack angle of 30° and wedge angle of 60° are recommanded.
- The chisel of 60° a is seen flat on the work and there is no clearance angle.
- This ensures that the depth of cut can be maintained. It should be understand that the clearance angle take some actual part in the cutting or shearing action. But is given on a tool to remove the loss of energy caused by frictional resistance.

Figure (1)



Hacksaw Blade

- A hacksaw blade is a multipoint tool. It is originally made for cutting metal.
- The equivalent saw for cutting wood is usually called bow saw.
- Most hacksaws are handsaws with a 'C' shaped frame that holds a blade under ~~certain~~ tension. Such hacksaws have a handle, usually a pistol grip, with pins for attaching a narrow disposable blade.
- The frames may also be adjustable to accomodate blades of different sizes.
- A screw or other mechanism is used

to put the thin blade under tension

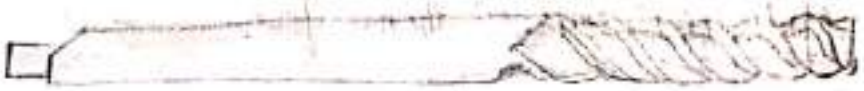
Figure-(2)

Hacksaw

Reamer

- A reamer is a type of rotary cutting tool used in metal working.
- Precision reamers are designed to enlarge the size of a previously formed hole by a small amount but with a high degree of accuracy to leave a smooth size.
- There are also non precision reamers which are also used for more basic enlargment holes for removing burrs.

- The process of energing the whole is called reamming.



Turning Tool Geometry

Geometry of single point turning tools

i). Both material and geometry of the cutting tools play very important roles on their performance on achering effectiveness, efficiency and overal economy of machinning.

ii) Cutting tools may be classified according to the number of major cutting edges and points involved as follows.

Single point

e.g. turning tools, shapping, planning and slotting tools and boaring tools.

Double or two point

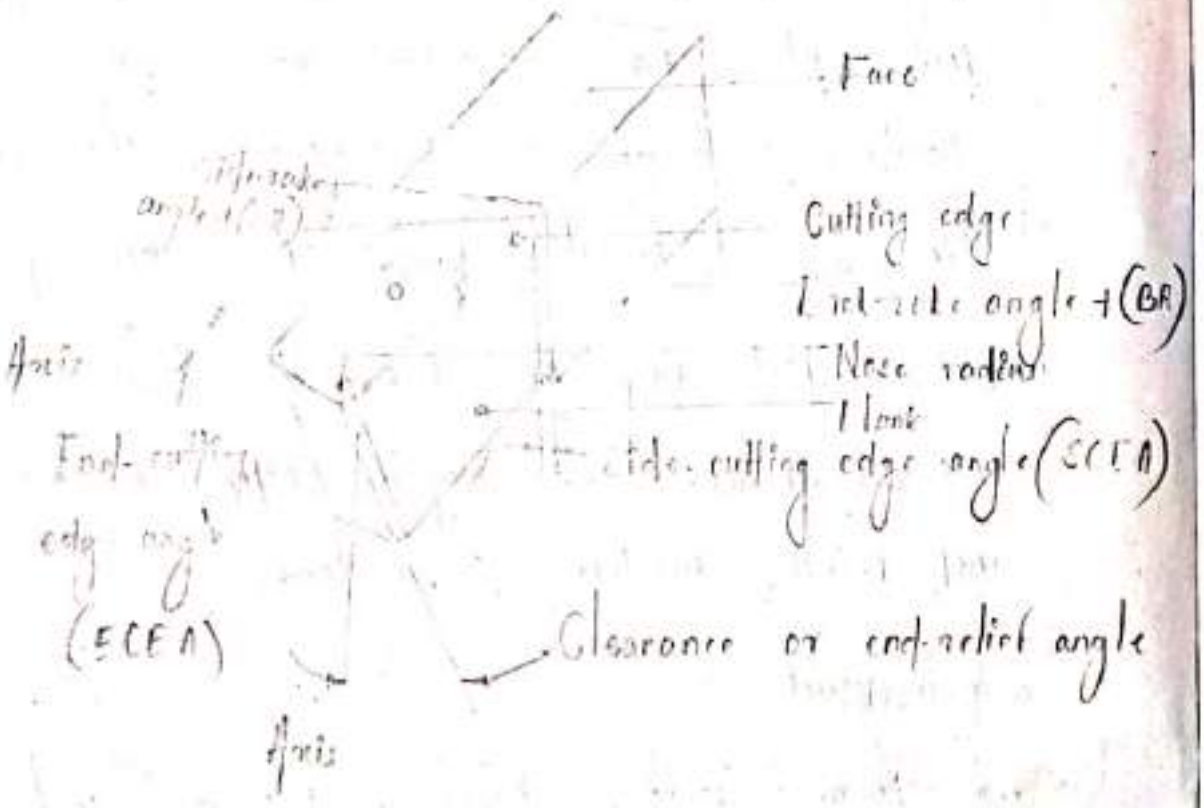
e.g. : drills.

Multipoint more than two

e.g. Milling, Broaching

Gear shapping, cutter, etc.

Concept of clearance angle cutting tools



Angle of inclination or clearance flank surface from the finished surface.

- Clearance angle is essentialy provided to avoid rubbing of the tool (flank) with the machined surface which causes loss of energy and damage of both the tool and job surface. Hence, clearance angle is must and must be positive (3° to 15°) depending upon tool work materials and type of the machining operations like turning, drilling, boring) etc.

Terminology of single point cutting tool

Back rack angle

- If viewed the side facing the end of the workpiece it is the angle formed by the face of the tool and a line parallel to the floor.
- A positive back rack angle tilted the

tool has back, and a negative angle tilted it forward and up.

End Cutting Edge Angle

- If viewed from above looking down on the cutting tool it is the angle formed by the end flank of the tool and a line parallel to the workpiece centre line.
- Increase the end cutting edge angle tilts the end cutting edge away from the ~~expose~~ workpiece.

End-relief angle

- If viewed from the side facing the end of the workpiece. It is the angle formed by the flank of the tool and vertical line down to the floor. Increasing the end relief angle tilts the angle

from the workpiece.

Face

- The flat surface of a single point tool into which the workpiece rotates during a turning operation.
- On a typical turning setup, the face of the tool is positioned upwards.

Flank

- A flat surface of a single-point tool that is adjacent to the face of the tool. During turning, the side flank faces the direction that is the tool is fed into the workpiece, and the end flank passes over the newly machined surface

Lead Angle

A common name for the side cutting edge angle, if a tool holder is built with dimensions that shift the angle of

consideration.

Side rake angle

-If viewed behind the tool down the length of the tool holder, it is the angle formed by the face of the tool and the centerline of the workpiece. A positive side rake angle tilts the tool face down toward the floor, and a negative angle tilts the face up and forward the workpiece.

Side Relief Angle

-If viewed behind the tool down the length of the tool holder, it is the angle formed by the side flank of the tool and a vertical line down to the floor.

Machining process parameters :-

Cutting speed and feeds :

The cutting speed of a cutting tool may

be defined as the speed of which the cutting edge passes over the material cutting speed is ordinarily expressed in meter per minute, often refered to as surface speed in meter per minute.

The feed of cutting tool is the distance the tool advances into or along the workpiece each time the tool point passes a certain position in its travel over the surface. In the case of turning on a lathe, the feed is the distance that the tool advances in one revolution of the workpiece on a shapper, the feed is the distance the work is moved relative to the tool for each cutting stroke. For single points tools, feed is specified in millimeters per revolution, milimeters per stroke, etc. It is also may be expressed as milimeters per ~~batte~~

tooth for milling cutters and broaches.

Feed and depth of cut:

The tool if life is influenced by the feed rate also with a fine feed the area of chip passing over the tool face is greater than that of a coarse feed for a given volume of swarf removal, but to offset this chip will be greater. Hence the resultant pressure will nullify the advantage, it is however, possible to balance the two opposing influences to obtain an optimum feed rate.

The effect of feed and depth of cut on tool life is given by:

$$V = \frac{257}{T^{0.19} \times S^{0.36} \times t^{0.08}} \text{ m per min}$$

Where, S = feed in mm per min.

t = depth of cut in mm

Cutting fluids as coolant :-

Cutting fluids are very important in machining processes. They are used to reduce the effects of friction. They are also used to carry away heat in machning operations. Excessive heat can damage the microstructure of metals. Proper use of coolants can make higher metal removal rates possible coolants can also help improve part quality and dimensional accuracy. To increase tool like, better surface finish and increase machining speed, the cutting fluids must be needed for cooling the surface for machining.

A. Babu
14.1.20

Dt: 12/03/20

Drilling

→ Drilling is a cutting process that uses a drill bit to cut a hole of circular cross-section in solid materials.

→ Drill bit is a rotary cutting tool and often multipoint.

→ The drill bit is pressed against the workpiece and rotates at rates from ~~thousand to hundred to~~ 100 - 1000 of revolutions for minute.

→ Drilling machine is of three types

- Bench drilling
- Pillar drilling
- Radial drilling

Bench Drilling

- It is used to drill light weight material.
- Here, hand vise is used which is held in the hand.
- On and Off buttons are established on the left-side of the machine.
- Two handles are used to control the movement of ~~work table~~ drilling interface.
- Height of the table is set by adjusting the height adjuster.
- Here, a foot switch is arilable for emergency condition.

Safty Precution

→ Wearing goggles or glass.

→ Not clamp by hand.

-

Pillar drilling

- It has a work-table to perform drilling operations.
- It is a free standing machine that uses a rigid pillar to hold the machine.
- Here, drill bit can be used to cut holes of different dimeters into different types of material such as wood and metal.

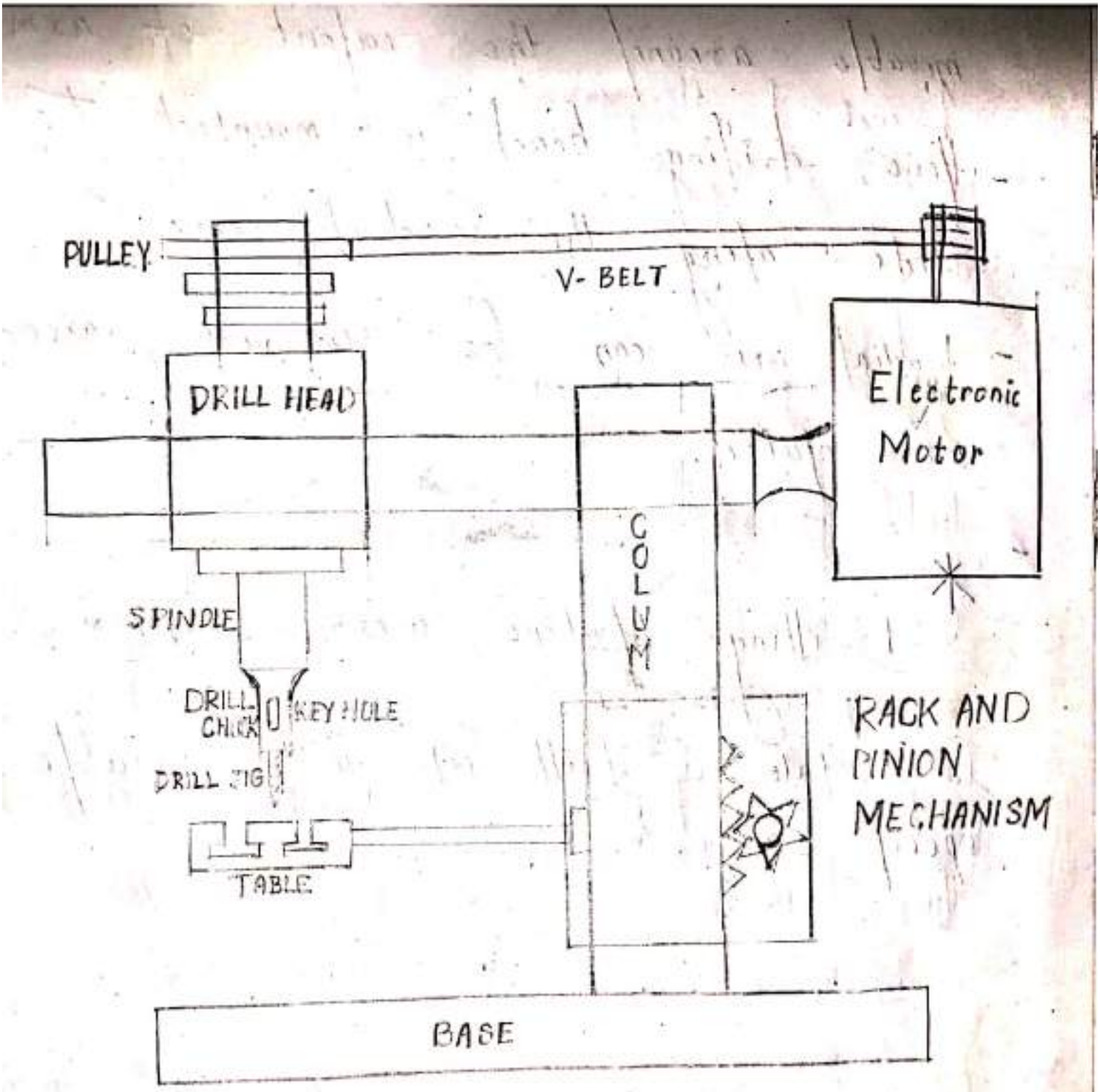
-

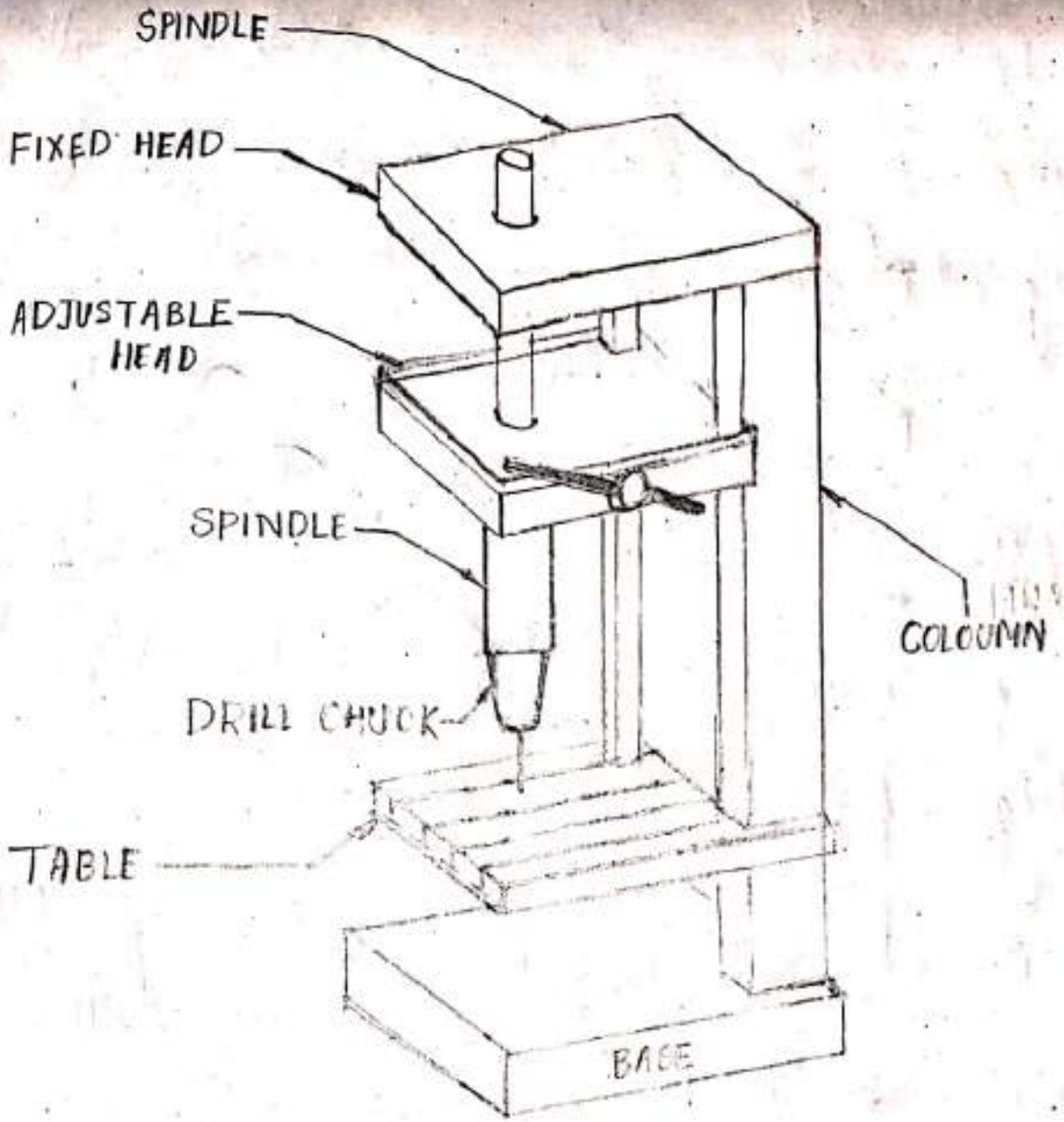
Radial Drill

- Here, a radial arm or a radial drill press is used which is

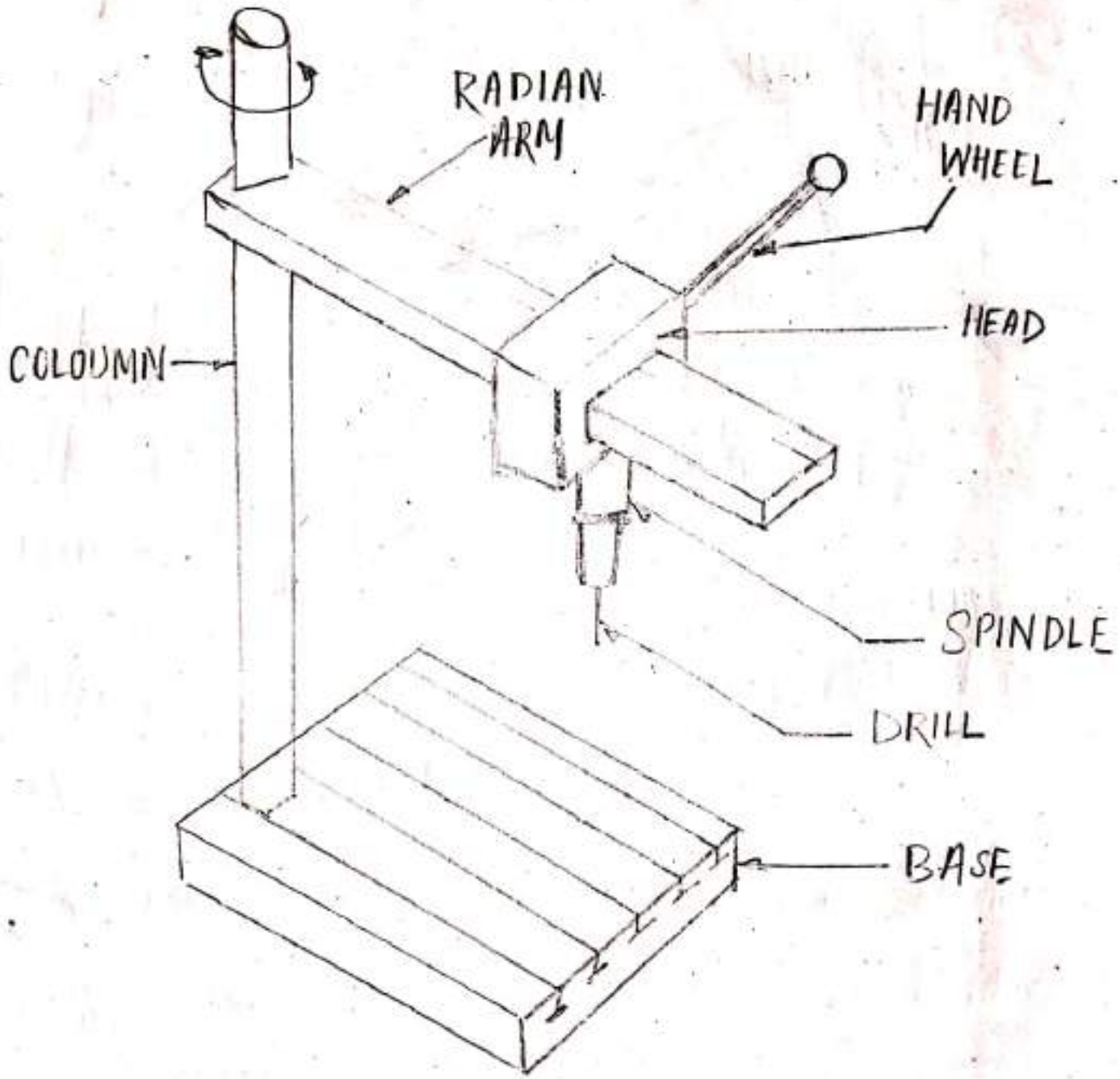
movable around the extent of arm
- Here, drilling head is mounted to slide along the radial arm.
- Radial arm can be lowered, raised or rotated.

6 * Drilling Machine uses a motor to rotate a drill bit with variable speed range.





PILLAR DRILLING MACHINE



RADIAL ARM DRILLING MACHINE

Surface finish

→ It is also known as surface texture, is the nature of a surface as defined by three-characteristics. That are :

lay, surface roughness and waviness.

Taylor - hobson surface tester machine

→ Surface finish of a material can be significantly affect their friction, wear, corrosion and positioning accuracy.

→ It is important factor for manufacturing process and quality control.

Super finishing

→ It is also known as micro machining process that improves surface finish

and workpiece geometry.

→ To remove grinding defects and to improve geometrical shape the finishing/ superfinishing proces are used.

→

Lapping

→ It is mainly down on the rough surface/ mating surface.

→ Here, abrasive compounds or solid bonded abrasive is used.

→ In this process less accuracy is obtained rather than machining and super finishing.

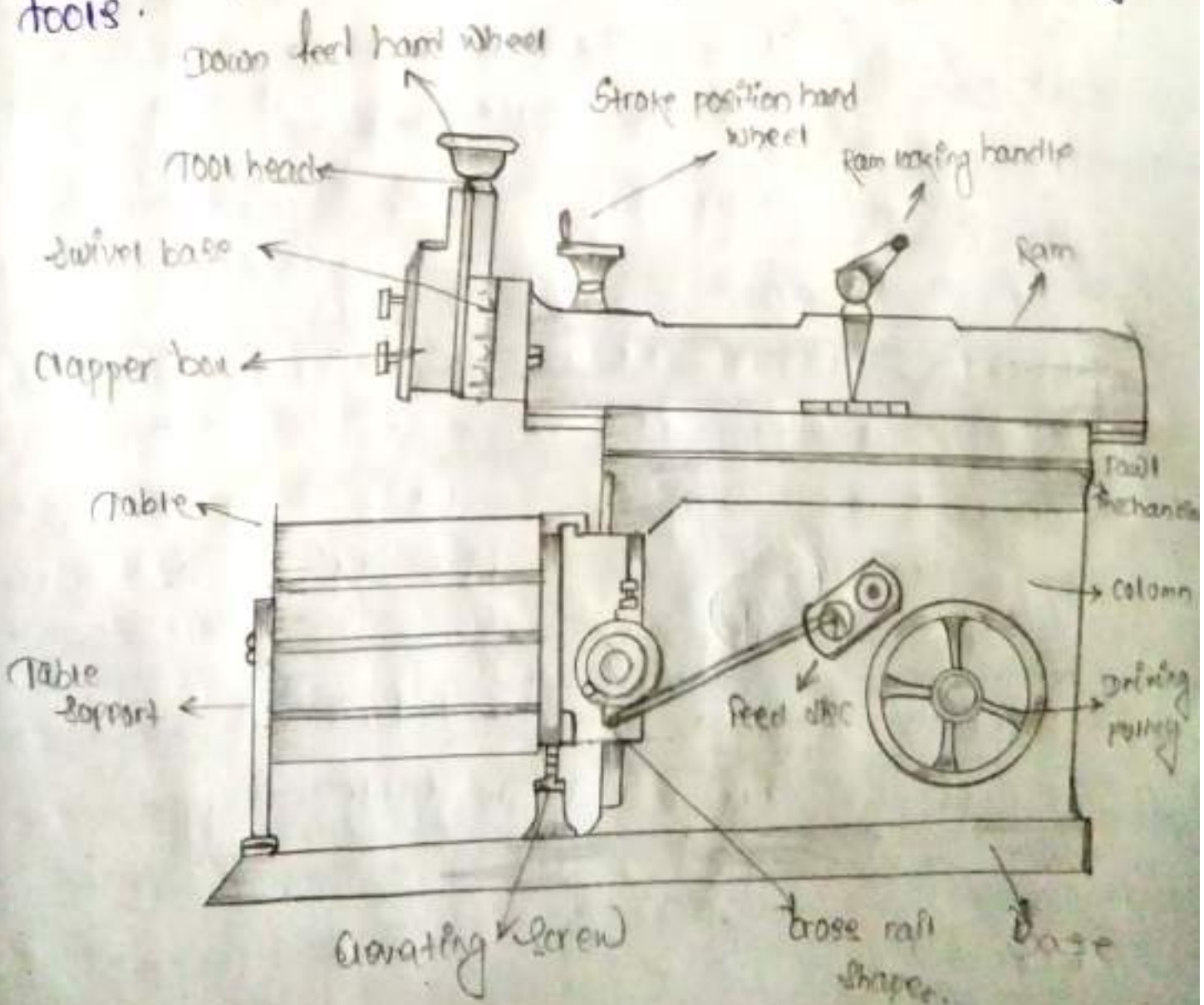
CHAPTER - 04

SHAPER

1836 - James - Nasmyth

SHAPER MACHINE :-

The shaper ~~machin~~ is a reciprocating type of machine tool basically used to produce horizontal, vertical or inclined flat surface by means of straight line reciprocating single-point cutting tools.



Major Components & their function :-

BASE :-

- The Base is designed to take the entire load of machine tool & it is bolted to the floor of the shop.
- This is made of Gray cast iron to resist vibration & to take the compressive load.

COLUMN :-

- The column is a Box like casting made up of cast iron & mounted on a base.
- It is provided with accurately machined guideways on the top on which the ram reciprocates.
- The guideways are also provided on the front vertical face for the movement of cross rail.
- The column encloses the ram driving mechanism.

CROSS-RAIL :-

- The cross-rail is mounted on the ground vertical guideways of the column.
- It consist of two parallel guideways on it's top perpendicular to the ram axis is called as a

- The table can be raised or lowered to accomodate different sizes of the Job by rotating elevating screw which causes the cross-rail

to the side up & down on the vertical face of the column.

SADDLE →

→ It is mounted on the cross-rail to hold the table firmly on its top.
→ The cross-wise movement of the saddle causes the table to move crosswise direction by rotating the cross-feed screw.

TABLE →

→ It is mounted on the saddle.
→ It can be move crosswise by rotating crossfeed rod & vertically by rotating the elevating screw.
→ The table is a box like casting with accurately machined top & side surface. These surfaces having T-slots for clamping the work.
→ In universal shaper, the table may be swiveled on a horizontal axis & its upper part may be tilted up or down.
→ In heavy shaper, the front face of the table is supported by adjustable table support to give more rigidity.

RAM →

→ It is a reciprocating members of the shaper which holds the tool & the reciprocates on

the top of the column by means of quick return mechanism.

→ It rouses the screwed shaft to altering the positio of the RAM with respect to the work. The RAM is in semi-cylindrical from & heavily ribbed inside to make it more rigidity. Rigid.

TOOL HEAD →

→ The tool head hold the cutting tool firmly & provides both vertical & angular movement to the tool with the help of down feed screw handle.

→ The head allows the tool to have an automatic relief during the return stroke.

→ The vertical slide of a tool head consists of a swivel base which is graduated in degrees. So the vertical slide can set at any angles with the work surface.

→ The amount of feed or depth of cut may be adjusted by a micrometer dial on top of the down feed scre

(*) A tool head consists of →

→ Apron

→ Clapper box & clapper block.

⊙ Apron consisting of clapper box & tool post is clamped on the vertical slide by the screw.

⊙ The apron can be swivered upon the apron

swivel pin towards left or right.

⊙ the clapper box houses the clapper block by means of a hinge pin.

⊙ the tool post is mounted on the clapper block.

Specification of Shaper Machine →

- → Maximum length of stroke ram.
- → Type of the drive (crank, Gear & hydraulic drive)
- → Power input of the machine.
- → floor space required to establish the machine.
- → weight of the machine in tonne.
- → feed.
- → cutting to return stroke ratio.
- → Angular movement of the table.

Working Principle of shaper Machine :-

→ A shaper machine holds the single-point cutting tool in ram & workpiece is fixed over the table.

→ the ram holding the tool reciprocate over the workpiece & metal is cut during the forward stroke &.

⇒ No metal is cut during the return stroke so it is called an ideal stroke.

→ the feed is given at the end of the cutting stroke

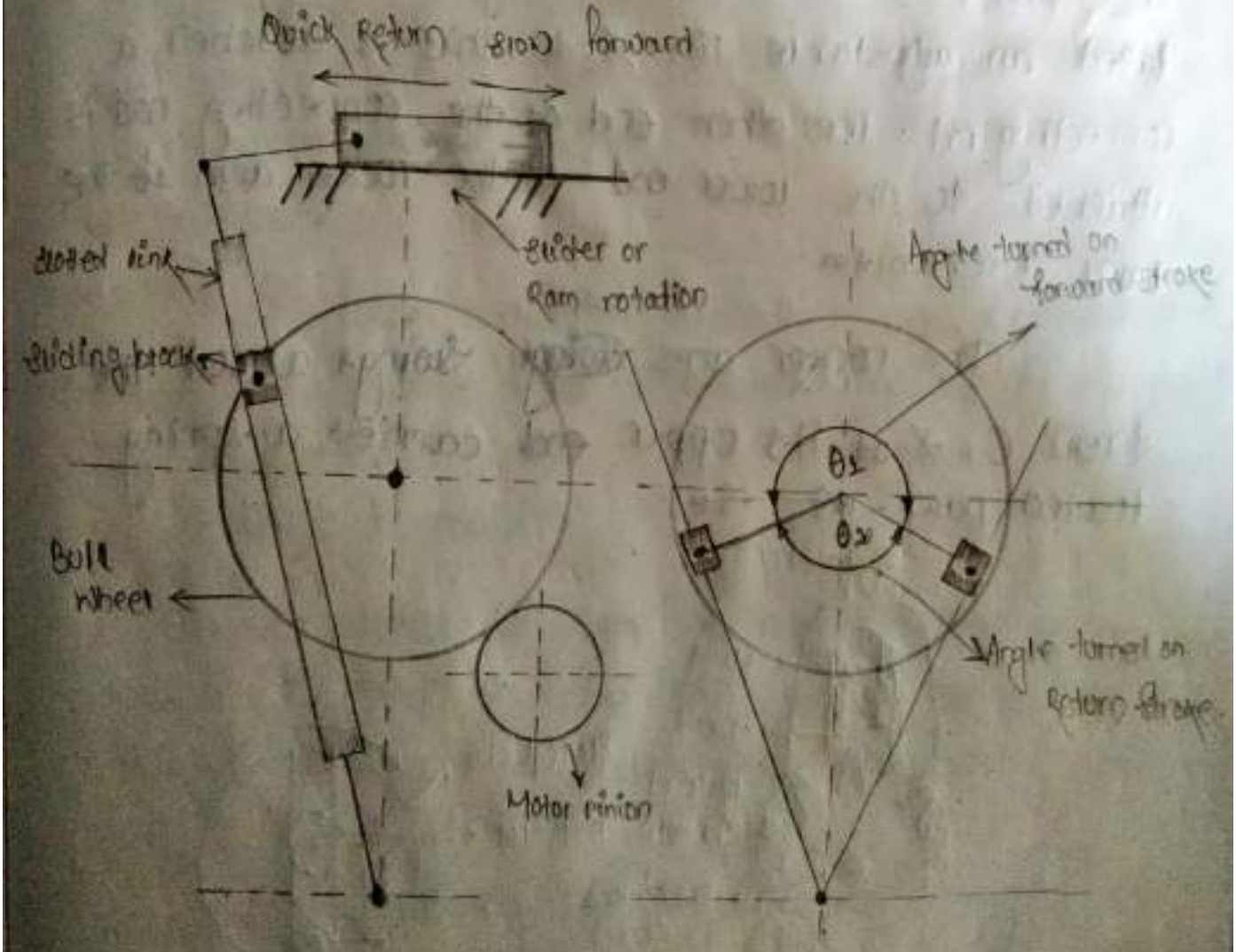
→ Generally, the cutting stroke is carried out at

slow speed & the idle stroke is carried at high speed with the help of quick return mechanism.

⋆ QUICK RETURN MECHANISM :

> In the forward stroke, the slider moves fast & removing the material from the workpiece.

> Whereas the return stroke, the slider moves faster than the forward stroke that means quick return, & takes less time to return, called a return stroke.



Quick Return Motion Mechanism of shaper machine.

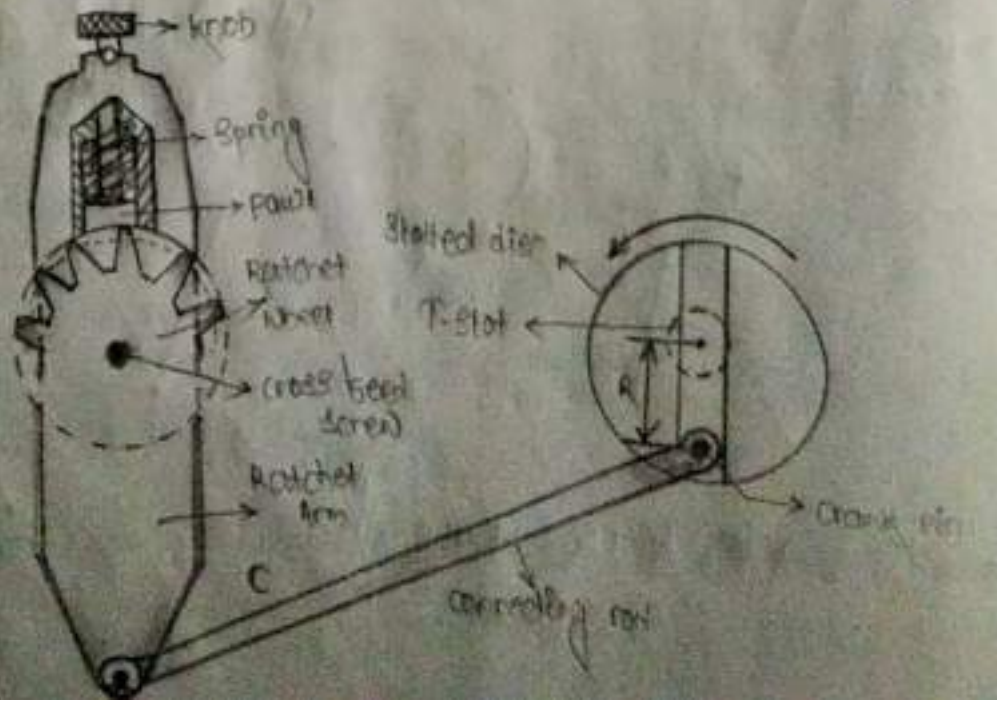
AUTOMATIC TABLE FEED MECHANISM :-

The Automatic feed Mechanism of the table is very simple. This is done by rotating a ratchet wheel, mounted at the crossfeed screw. This enables a corresponding equal rotation of the crossfeed screw each stroke.

Arrangement of Parts :-

It consists of a slotted disc, which carries a T-slot, as shown in the figure. In this slot is fitted an adjustable pin A to this is attached a connecting rod. The other end of the connecting rod is attached to the lower end of the rocker arm of the pawl mechanism.

The rocker arm swings about the screw C, at its upper end carries a spring loaded pawl - as shown.



WORKING :-

This arrangement helps the power feed to operate in either direction, but the same should be set to operate during the return stroke only. If otherwise, the mechanism will be subjected to a severe stress. In some latest types of shapers, cam driven feed mechanism are provided which are more efficient & provide a wider range of feed.

Variation in the feed can be provided by varying the distance R between the disc centre & the centre of the adjustable pin, Longer the said distance greater will be the feed & vice versa. The amount of feed to be given depends upon the type of finish required on the job.

For rough machining heavier cuts are employed, & thus, a coarse feed is needed. Against this, a finer feed is needed. Against this, a finer feed is employed in finishing operations.

The slotted disc at the back carries a spur gear which is driven by the bull gear. As the disc rotates through this gear the adjustable pin, being eccentric with the disc centre.

This causes the connecting rod to reciprocate. This, in turn, makes the rocker arm to swing about the screw G to moves the pawl over one or more teeth. These transmit an intermittent motion to the cross feed screw which moves the table.

CHAPTER - V

PLANNING MACHINE

inventor → Jeneral Bantham

A planer machine is a type of metal working machine that uses linear relative motion (reciprocation) between the workpiece & single-point cutting tool to cut the work piece.

→ the work table is moved back & forth on the bed beneath the cutting head either by mechanical means, such as a rack & pinion gear, or by a hydraulic system.

WORKING PRINCIPLE OF PLANNER MACHINE :-

In a planer machine the job is fixed rigidly on the machine table. A single point cutting tool held propely in the tool post is mounted on the reciprocating ram.

The reciprocating motion of the ram is obtained by a quick return motion mechanism.

As the ram reciprocates, the tool cuts the metarial during it's forward stroke.

In return stroke, there is no cutting action & this stroke is called the idle stroke.

Applications of planner Machine :-

Below are some most common application of planner machine.

* cutting slots & grooves
* Generating accurate flat & curved surfaces
* cutting at an angle & maching devetails
* cutting vertical surfaces & horizontal surfaces.

→ cutting horizontal surfaces →

While machining horizontal surface, the work is given a reciprocating movement along with the table & the tool is fed across wise to complete the cut. Both the railheads may be used for simultaneous removal of the metal from two cutting edges.

→ cutting vertical surfaces →

This type of work is cutting/planned by adjusting the saddle horizontally along the cross rail until the tool is in a position to give the required depth of cut. The vertical slide, is adjusted perpendicular to the planer table & the apron is swivelled in a direction so that the tool will swing clear out of the machined surface during the return stroke.

Cutting slots & grooves →

Slots or grooves are cut by using reciprocating tools. The operations is similar to that of a shaper.

TYPES OF PLANNER MACHINES →

Below are some common types of planer machines.

- → Divided table planer
- → Edge or plate planer
- → pit planer
- → Open side planer
- → Standard or Double housing planer.

Difference between shaper & planer ?

- → In a planer, work piece reciprocates over the stationary cutting tool, whereas in a shaper, the cutting tool reciprocates.
- → It is bigger than shaper machine.

SHAPER

- → In this machine tool work table is stationary & tool reciprocates
- → Used for smaller work piece.
- → can not take deeper cut.
- → At a time one tool will work.
- → It is light, less, rigid & cheaper machine tool.
- → Low machining accuracy
- → Simple in construction.
- → A low rate power consumption.
- → It requires less floor space

PLANNER

- → In this machine tool work table reciprocates & tool is stationary.
- → Used for large work piece.
- → Planner can take deeper cut.
- → More than one cutting tools at a time.
- → It is heavier, more rigid & costlier machine tool.
- → High machining accuracy
- → It is complicated in construction
- → A high rate power consumed.

COMPONENTS OF PLANING MACHINE & THEIR FUNCTI...

:-

(1) BED :-

- Bed of planer is large in size & heavy in weight.
- It supports the column & all other moving parts of machine.
- It is made slightly longer than twice the length of the table so that the full length of the table may be moved on it.
- There is a 'V' shaped ways on the bed which help to reciprocate or back & forth motion to the table.
- Smooth movement need to proper oil on table & bed 'V'- shape surface. So oil is provided by oil reservoir.

(2) TABLE OR PLATEN :-

- Table supports the work & reciprocates along the bed.
- Table is made from good quality cast iron.
- The top face of the table is accurately finished in order to locate the work correctly.
- T- slots are provided on the entire length of the table so that the work & work holding devices may be bolted upon it.

(3) COLUMN :- HOUSING

- These are rigid box like vertical structure placed on each side of the bed & table.

→ they are heavily ribbed to trace up severe force due to cutting.
→ It also facilitate tool head mechanism.
→ the cross rail may be made to slide up & down for accommodating different heights of work.

(IV) CROSS RAIL :-

→ It is rigid-box like casting connecting the two columns
→ It may be raised or lowered on the face of housing & can be clamped at a desired position by manual or electrical clamping devices.
→ It should be remain absolutely parallel to the top surface of the table.

(V) TOOL HEAD :-

→ According to construction it is similar to the shaper machine tool head.
→ tool head are mounted on the cross rail by saddle.
→ the saddle may be made to move transversely on the crossrail to give cross feed.
→ the clapper ~~box~~ block is hinged at hinge pins to the clapper block & it holds the tool post in which the tool is clamped by straps.

TABLE DRIVE MECHANISM :-

A planer drive mechanism provides the longitudinal to & fro motion of the planer work-table. The following method are employed for the said purpose.

a) Open & cross belt drive.

b) Gear drive

c) Reversible motor drive.

a) OPEN & CROSS BELT DRIVE :-

Two belts, one open & one crossed operate on loose & tight pulleys. crossed belt is used for forward or cutting stroke & the open belt for return motion. The crossed belt making a greater arc of contact on the pulley is considered better for driving the table on the cutting stroke.

There are two tight pulleys & two loose pulleys. Larger tight pulley - cutting stroke & smaller tight pulley - quicker return stroke.

crossed belt drive mechanism permits operation of the gear train in such a manner that the table will travel slowly on the cutting stroke & travel faster on the return stroke. pulleys ~~freely on the shaft~~ keyed to the drive pinion shaft are called tight pulleys & those which turn freely on the shaft are called loose pulleys. During cutting stroke, the crossed belt is on the tight

Pulley, the open belt is on the loose pulley & the position is reverse during the return stroke.

DRIVE MECHANISM :-

For obtaining continuous forward & return motion of the planer table both the open & crossed belts run continually & are shifted back & forth by the belt shifter which is linked to the reverse lever. Trip dogs are provided, one each at both ends of the planer table. At the end of each stroke, the trip dog meets against the reverse lever, actuates, the belt shifter & thus the table movement is reversed.

c) REVERSIBLE MOTOR DRIVE :-

The reciprocating motion of the planer table is obtained by driving through a worm on to a rack attached to the length of the underside of the table. The reversal of the drive is obtained by reversing the motor either by field or phase changing. commonly used on modern planers as it provides a wider range of table speeds & a better ctrl.

Most planers are driven direct by a coupled motor in place of the old method of open & crossed belt drive.

CHAPTER - VI

SLOTTER MACHINE

Brunel - 1800

Definition →

→ The slotter machine falls under the category of the reciprocating type of machine tool similar to a shaper or a planner.

→ It operates almost on the same principle as that a shaper.

→ The major difference between a slotter machine & a shaper machine is that in a slotter the ram holding the tool reciprocates in the vertical axis. whereas in a shaper the ram holding the tool reciprocates in a horizontal axis.

→ A vertical shaper & slotter machines are almost similar to each other as regards their construction, operation & use.

The slotter machine used for →

* Cutting grooves, keyways & slots of various shapes.
* Used for making regular & irregular surfaces both internal & external.
* For handling large & awkward work piece.
* For cutting internal or external gears, & many other operations which cannot be easily machined in any other machine tool described before.

TYPES OF SLOTTER MACHINE :-

There are Mainly two types of slotter machine :-

1. puncher slotter
2. Precision slotter.

① PUNCHER SLOTTER :-

This machine is a heavy, rigid machine designed for removal of a large amount of metal from large forgings or castings.

The length of stroke of a puncher slotter is sufficiently large. It may be as long as 1800 - 2000 mm.

The puncher slotter ram is usually driven by a spiral pinion meshing with the rack teeth cut on the underside of the ram. The pinion is driven by a variable speed reversible electric motor similar to that of a planner.

The feed is also effected by electrical gears.

② Precision SLOTTER :-

It is a lighter machine & is operated at high speeds. The machine is designed to take light cuts giving the accurate finish.

Using special jigs, the machine can handle a number of works on a production basis.

The precision slotter machine are also used for general purpose work & are usually fitted with whitworth quick return Mechanism.

MAJOR COMPONENTS & THEIR FUNCTION of SLOTTER MACHINE

→ Different types of Parts are →

1- Base
2- column
3- Saddle
4- cross-slide
5- Rotating table
6- Ram & tool head assy
7- Ram drive mechanism
8- Feed mechanism.

① BASE OR BED →

→ The base is rigidly built to take up all the cutting forces & entire load of the machine.
→ The top of the bed is accurately finished to provide guideways on which the saddle is mounted.
→ The guideways are perpendicular to the column face.

② COLUMN →

The column is the vertical member which is cast integral with the base & houses driving mechanism of the ram & feeding mechanism. The front vertical face of the column is accurately finished for Providing ways on which the ram reciprocates.

③ SADDLE →

The saddle is mounted upon the guideways & may be moved toward or away from the column either by power or manual control to supply longitudinal feed to the work.

- The top face of the saddle is accurately finished to provide guideways for the cross-slide. These guideways are perpendicular to the guideways on the base.

④ CROSS-SLIDE →

- The cross-slide is mounted upon the guideways of the saddle & may be moved parallel to the face of the column.
- The movement of the slide may be controlled either by hand or power to supply cross feed.

⑤ ROTARY TABLE →

- The rotary table is a circular table which is mounted on the top cross-slide.
- The table may be rotated by rotating a worm which meshes with a worm gear connected to the underside of the table.
- The rotation of the table may be effected either by hand or power. ~~In some~~.
- In some machines the table is graduated in degrees that enables the table to be rotated for indexing or dividing the periphery of a job in equal number of parts.
- T-slots are cut on the top face of the table for holding the work by different clamping devices.
- The rotary table enables a circular or countered surface to be generated on the workpiece.

⑥ RAM & TOOL HEAD ASSY →

→ The ram is the reciprocating member of the machine mounted on the guideways of the column.

→ It supports the tool at it's bottom end on a toolhead

→ A slot is cut on the body of the ram for changing the position of stroke.

→ In some machines, special type of tool holders are provided to relieve the tool during it's return stroke

⑦ RAM DRIVE MECHANISM →

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

→ The reduce the idle return time, quick return mechanism is incorporated in the machine.

→ The usual types of ram drive mechanisms are

1) Whitworth quick Return Mechanism.
2) Variable speed reversible motor drive mechanism
3) Hydraulic drive mechanism.

1) WHITWORTH QUICK RETURN MECHANISM :-

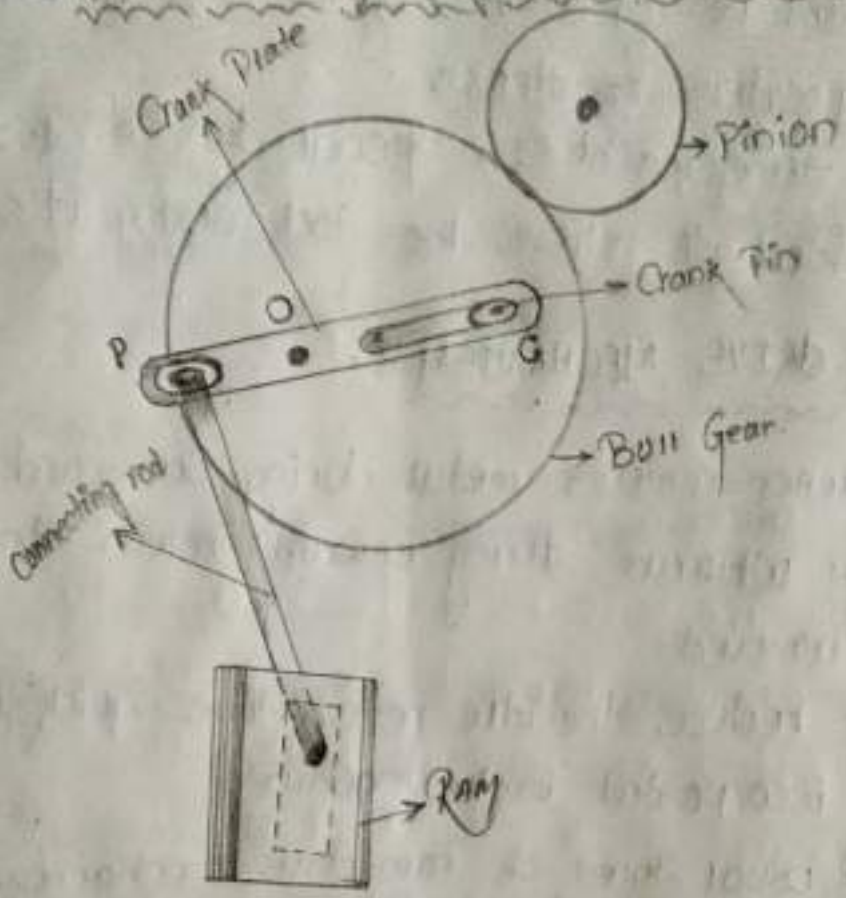
~~The bull gear is~~

→ This mechanism is most widely used in a medium sized slotting machine for driving the ram.

→ The bull gear is mounted on a fixed hub at the rear end of the machine & it is rotated by a driving

driving pinion from the motor. The driving plate is connected to the main shaft through the fixed hub. The main shaft is placed eccentrically with respect to the bull gear centre.

With neat Quick Return Mechanism in a slotted



The bull gear holds the crankpin with sliding block & slides in a driving plate. So that when the bull gear rotates, imparts rotary motion to the driving plate & shaft causing the disc to rotate at the end of the main shaft.

The disc is connected to the lower end of the connecting rod eccentrically by means of a pin in a radial T-slots on the face of the disc which converts the rotary motion of the disc into

reciprocating motion of the ram connected to the top end of the connecting rod.

WORKING OF SLOTTER MACHINE → just remember.

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 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 & rotary feed motion.

TOOLS USED IN SLOTTER →

* A slotter machine tools differs widely from a shaper or a planer tool as the tool in a slotter removes metal during its vertical cutting stroke.
* The rake & the clearance angle of a slotter tool apparently look different from a lathe or a shaper tool as these angles are determined with respect to a vertical plane rather than the horizontal.
* Slotter tools are provided with top rake, front clearance & side clearance, but no side rake is given.
* The slotter tools are robust in cross-section & are usually of forged type - of course, bit type tools fitted in heavy duty tool holders are also used.
* Keyway cutting tools are thinner at the cutting edges.
* Round nose tools are used for machining circular or contoured surfaces.
* Square nosed tools are used for machining flat

MILLING MACHINE

MILLING :-

It is a metal cutting operation in which the excess material from the workpiece is removed by rotating multipoint cutting tool called milling cutter.

MILLING MACHINE :-

It is a machine tool that removes metal as the work is fed against a rotating multipoint cutter.

- The milling cutter rotates at high speed and it removes metal at a very fast rate with the help of multiple cutting edges.
- One or more numbers of cutters can be mounted simultaneously on the milling machine. This is the reason that a milling machine finds wide application in Production work.
- Used for machining flat surfaces, contoured surfaces, external & internal threads.
- As the workpiece moves against the cutting edges of milling cutter, metal is removed in form chips.
- Machined surface is formed in one or more passes of the work.
- The work to be machined is held in a vice, a rotary table, a three jaw chuck, an index head, in a special fixture or bolted to a machine table.
- In many applications, due to its higher production rate & accuracy, milling machine has even replaced shapers & slotters.

WORK HOLDING ATTACHMENT :-

PLANE VICE →

→ It is the most common work holding device.
→ It can be bolted directly on the milling table.
→ Here workpiece can be clamped between fixed & moveble jaws.

SWIVEL VICE →

→ It is used for angular cutting or angular milling operation.
→ It has a circular base with graduation in degrees.
→ vice is unbolted at settled to a required angle & bolted again.
→ Here workpice can be milled angularly without removing workpiece from the vice.

ANGLE PLATE →

→ It is made up of cast iron or steel.
→ It is machined accurately at an angle 90°.
→ It is used to mill workpiece at an right angle to another face of the workpiece.

'V' BLOCK →

→ It is used for holding the workpiece on the milling table.

TYPES OF MILLING MACHINE >

(a) Hand Milling Machine
(b) Horizontal Milling Machine.
(c) Universal Milling Machine.
(d) Vertical Milling Machine.

> HORIZONTAL MILLING MACHINE >

> The horizontal milling machine has a spindle that is parallel to the shop floor & an overarm that extends over the workpiece.
> The overarm supports the arbor, which holds the milling cutter.
> ON the horizontal Mill, the arbor is the component that rotates the milling cutter.

> VERTICAL MILLING MACHINE >

> Spindle is vertical or perpendicular to the work table.
> It has all the movements of the table for proper setting & feeding the work.
> Spindle head may be swiveled at an angle, permitting the milling cutter mounted on the spindle to work on angular surfaces.
> In some machines, spindle can also be adjusted up or down relative to the work.
> Adopted for machining grooves, slots & flat surfaces

8. Difference between Horizontal & vertical milling machine

Horizontal milling machine	vertical milling machine
→ spindle is horizontal & parallel to the workpiece.	→ spindle is vertical & perpendicular to the workpiece.
→ cutter can not be moved up & down.	→ cutter can be moved up & down
→ cutter is mounted on the arbor.	→ cutter is directly mounted on the spindle.
→ spindle can not be tilted.	→ spindle can be tilted for angular cutting.
→ operations such as plain milling, gear cutting, form milling, straddle milling, gang milling etc.. can be performed.	→ operation such as slot milling, T-slot milling, angular milling, face milling etc.. can be performed & also drilling, boring & reaming can be carried out.

→ UNIVERSAL MILLING MACHINE →

Difference from plain horizontal machine is addition of table swivel housing permits table to be swiveled 45° in either direction in a horizontal plane used for milling of helical grooved in twist drills milling cutters & gears.

CHAPTER = 08

GRINDING →

Significance of Grinding Operations →

→ Grinding is a material removal & surface generation process, used for shape & finish components made up of metals & other materials.

→ The surface obtained through grinding is 10 times better than any other machining like turning & Milling.

Manufacturing of Grinding Wheels →

→ The wheels are generally made from a composite material consisting of cross-particle aggrigate pressed & bonded together by a cementing materia to form a solid circular shape.

→ Various profiles & cross sections are available depending on the intended usage for the wheel.

→ They may also be made from a solid steels or aluminium disc with particles bonded to the surface.

→ Today most grinding wheels are artificial composites made with artificial aggregates.

→ Earlear grinding wheels are made of natural composite stones such as these used for millstone

→ Grinding wheel is composed of an abrasive compound.

→ The manufacture of these wheels is a precise & tightly controlled process, due not only to the inherent safety risks of a spinning disc, but also the composition & uniformly required to prevent that disc from exploding high stresses produced on rotation.

Selection of Grinding Wheels →

a) Constant factors
b) variable factors.

a) Constant factor Include →

(1) Work Material → It should be rembered that for grinding a soft material hard wheel should be used & vice versa.

SELECTION OF GRINDING WHEELS →

The proper selection of grinding wheels is very important for getting good results (i.e obtaining better finish & at the same time having more life of the wheel).

selection mainly depends upon the following factors →

1 → Properties of material to be machined, i.e, its hardness, toughness, strength etc.
2 → quality of surface finish required.

3 → Dimensional accuracy required.
4 → Method of grinding i.e wet or dry.
5 → Rigidity, size & type of machine.
6 → Relative sizes of wheel & job.
7 → Type of grinding to be done.
8 → Wheel speed & feed.
9 → Amount & Rate of stock removal.

Ans

Grinding Machine →

It is used to finish workpieces of high surface quality, accuracy of shape & size.

Grinding Wheel →

→ A Grinding wheel is a wheel, which is composed of an abrasive material & used for various grinding machine.
→ A Grinding wheel consists of hard abrasive grains called grits, which perform the cutting or metal removal.
→ A Grinding wheel commonly identified by the type of the abrasive material is used.
→ A Grinding wheel basically made up - Aluminium oxide, silicon carbite, dimond dust & CBN (cubic Boron Nitride) wheels fall in the category of super abrasive wheel.

Specification's of Grinding Wheels :-

A Grinding wheel is specified by the standard wheel markings like diameter of the wheel, bore, diameter of the wheel, thickness of the wheel type (shape) of the wheel.

Each marking consists of 6 symbols, denoting the following characteristics. →

* - Abrasive
* - Grain size
* - Grade
* - Structure
* - Bond type
* - Manufactures record

WA 30 I 4 V 17

Here,

→ W (prefix) - Manufacture abrasive type symbols.

→ A (Abrasive) = [A - Aluminium oxide], [C - Silicon carbide], [D - Diamond].

→ 30 (grain size) - 4 types of grain size

* coarse - 10, 12, 14, 16, 20, 24
* medium = 30, 36, 46, 54, 60
* fine = 80, 100, 120, 150, 180
* very fine = 220, 240, 280, 320, 400, 500, 600

> I (Grade) = Grade categories in to 3 parts.

* Soft = A, B, C, D, E, F, G, H
* Medium = I, J, K, L, M, N, O, P
* Hard = Q, R, S, T, U, V, W, X, Y, Z

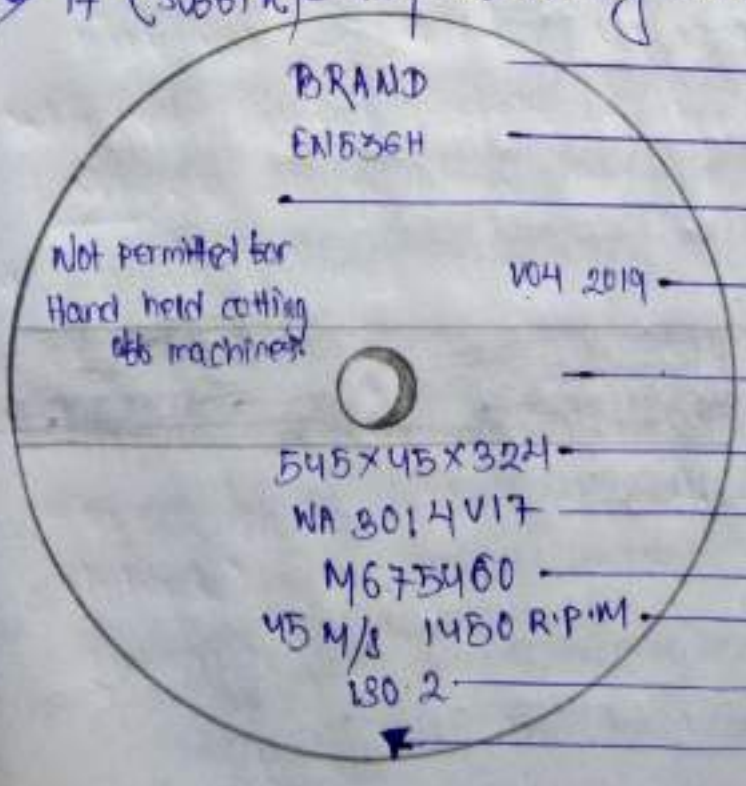
> 4 (structure) = structure categories in 2 parts

* Dense = 1, 2, 3, 4, 5, 6, 7, 8
* open = 9, 10, 11, 12, 13, 14, 15

> V (Bond type) = Vetrified Bond. (glass type - 75% used)

* V = vetrified.
* B = Resionid
* R = Rubber.
* E = shellac
* S = Silicon
* O = oxychloride.

> 17 (Suffix) = Manufacturing abrasive type symbol.



Trade Mark
Test record
Restrictions & use
Exping date.
Speed stripe.
Dimensions in mm.
Specification Mark
Code number.
Maximum operating speed
ISO type NO (Shape)
Mounting instruction.

Grinding Process :-

Grinding Process carried out with a grinding wheel which is made up of abrasive grains (it's means hard material) for removing very fine quantities of material from a work piece surface.

Different types of Grinding Machines or Grinding Process :-

Basically three grinding Process or grinding machine are their →

* . Cylindrical grinding
* . Surface grinding
* . Centerless grinding.

* . Cylindrical Grinding →

→ Cylindrical grinding generally used for genrating external cylindrical surface.

→ The machine used for cylindrical grinding is very similar to a centre lathe machine.

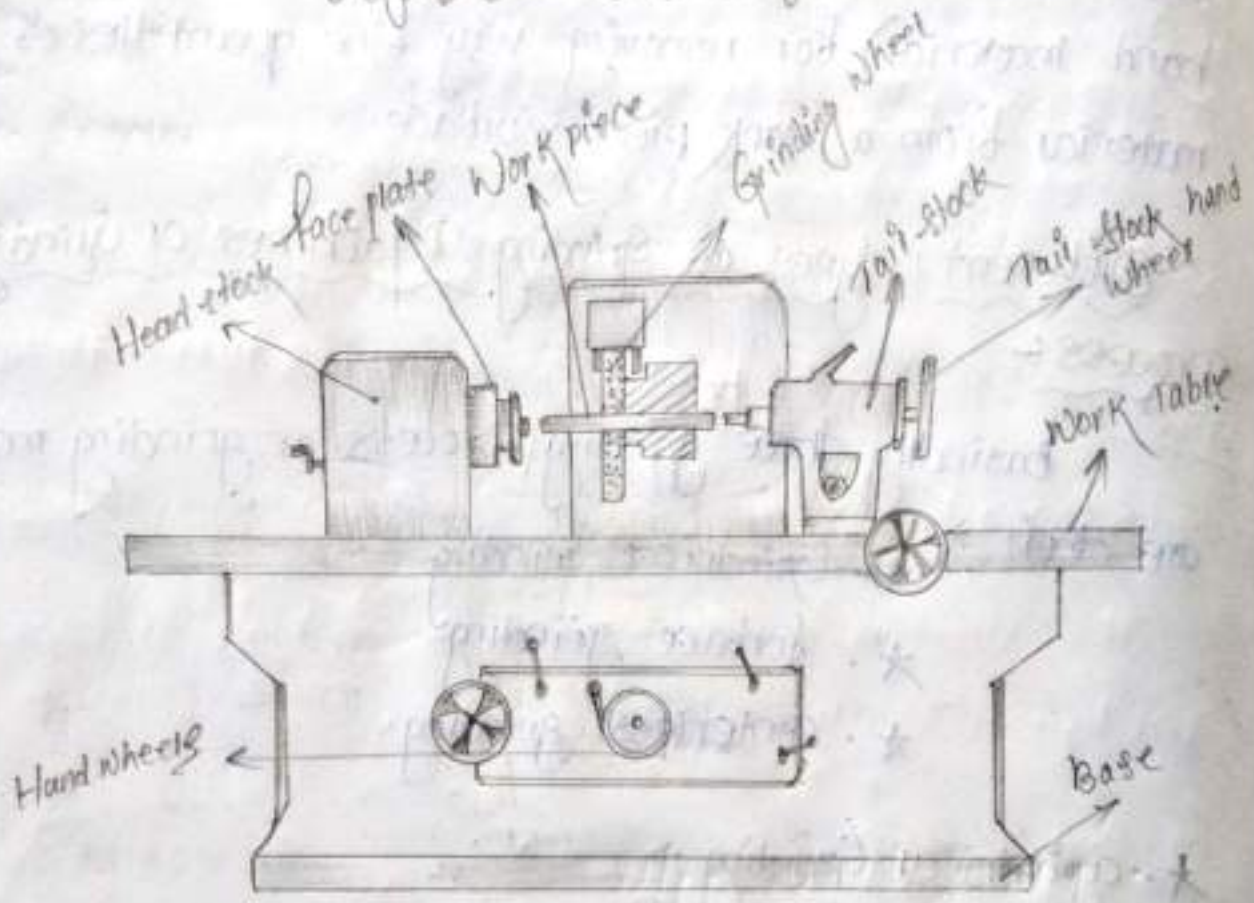
Operation →

→ The grinding wheel is located similar to the tool post, with an motor which rotate wheel at very high speed.

→ The work piece are normaly held between the center with the help of spindle.

→ Both the wheel & work piece are in contact & both rotates counter clock wise. The abrasive practice remove the material from the work piece.

Cylindrical Grinding Machine



Surface Grinding Machine →

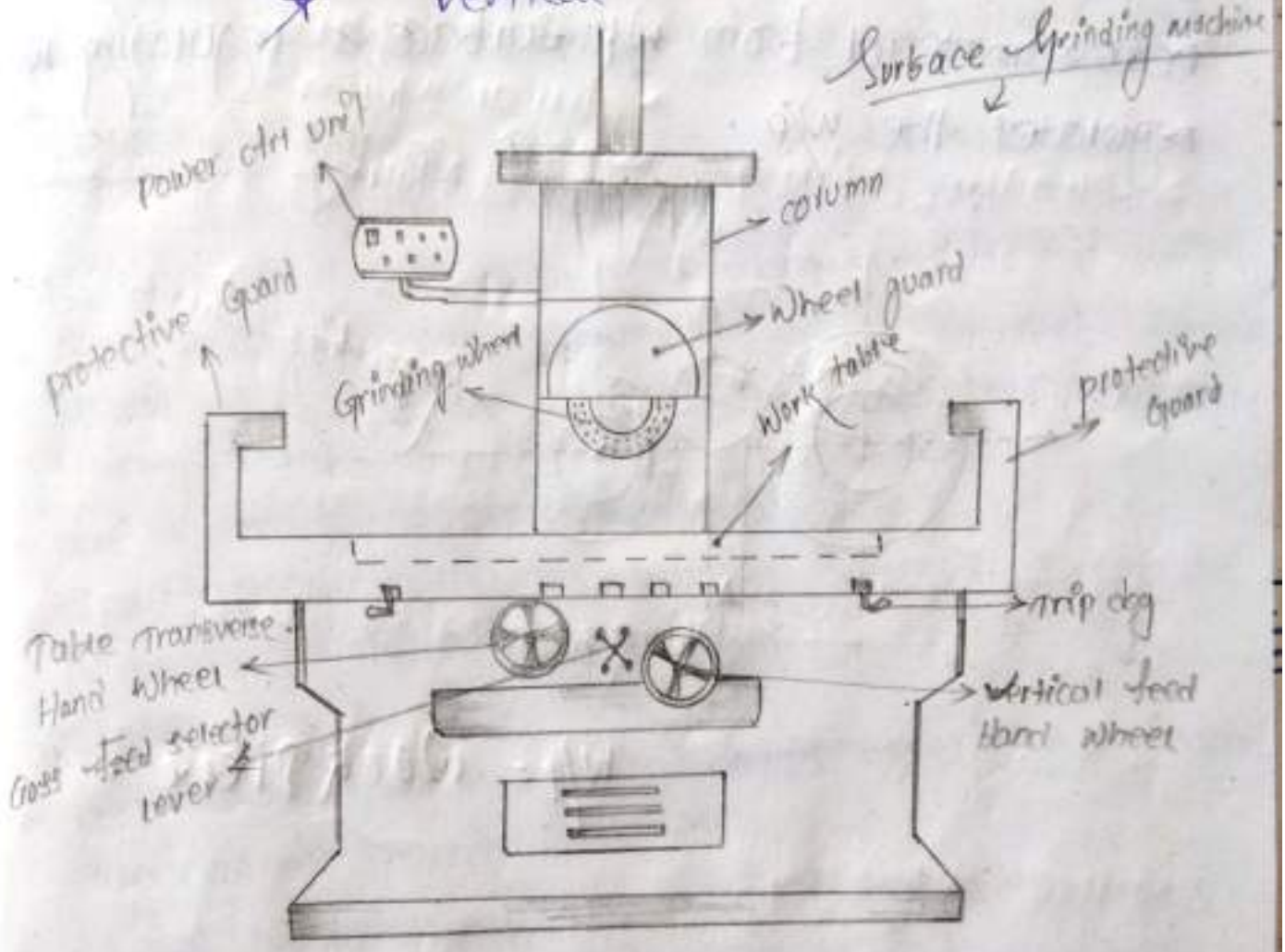
This machine may be similar to a milling machine used mainly to grind flat surface.

However, some types of surface grinders are also capable of producing contour surface with formed grinding wheel.

Basically there are four types of surface grinding machines characterised by the movement

& their tables & the orientation & grinding wheel spindles as follows →

* Horizontal spindle & reciprocating table.
* Vertical spindle & " "
* Horizontal spindle & rotary table.
* Vertical " " " "

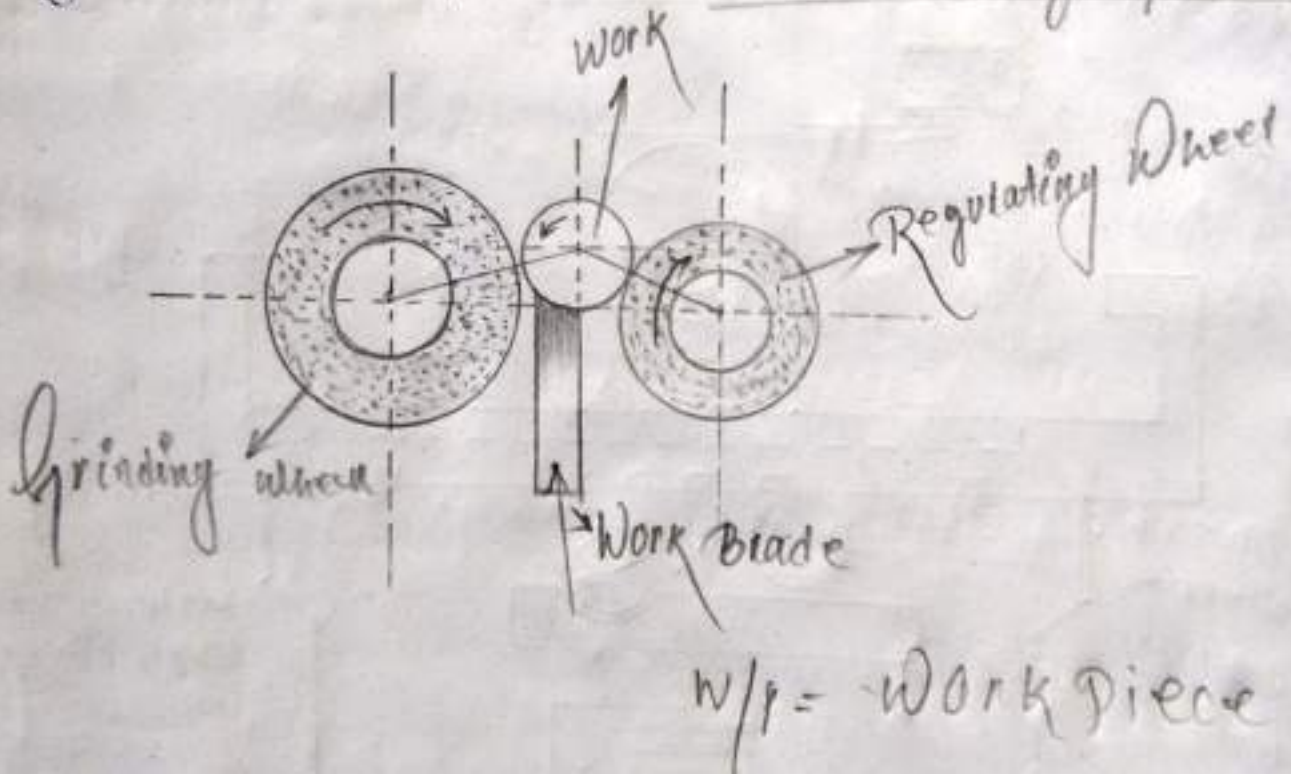


~~Centre~~ CENTRELESS GRINDING MACHINE :-

In this type & grinding the workpiece is not held in between centres, so it is called as centreless grinding. This method & grinding is used for mass production & similar objects. It is used to grind cylindrical, tapered & formed surfaces on workpieces.

Principle → The workpiece is placed on work rest blade between two wheels namely grinding & regulating wheel, which are rotating in clockwise & workpiece rotates counter clockwise. Grinding wheel remove material from w/p surface & regulating wheel regulates the w/p.

Centre Grinding Machine



w/p = Work Piece.

BROACHING →

Broaching is one of the metal machining operations done by a multipoint cutting tool called broaching tool or broach.

Types of Broaching →

Their are mainly five types of Broaching operation →

(I) Internal or Hole broaching
(II) External or surface broaching
(III) Push broaching
(IV) Pull broaching
(V) Continuous Broaching

(III) PUSH BROACHING :-

→ Workpiece is held in the broching machine in stationary position & broach is pushed through the portion of workpiece to the machined.
→ Normally push broching is done by hand & arber presses (hydraulic presses).
→ This method is also recommended for internal broaching like for sizing & finishing the holes cavities & key ways.

(IV) Pull broaching →

→ Workpiece is clamped to the broaching machine in stationary position & the broach is pulled through the work.

Scanned with CamScanner

→ Broaches are usually long & are held by special head.
→ pull broaching is mostly used for internal Broach

Advantages of broaching →

→ High production rate.
→ Good surface finish.
→ Close tolerances.
→ Internal & External machining can be done.
→ 0.8 micron finishing can be obtained.
→ Making High precision accuracy.
→ Roughing & finishing can be done in a single stroke.
→ commonly machined surfaces include circular & non-circular holes, keyways, gears & flat surfaces.
→ High skilled operator is not required.

Applications of broaching →

→ The example of components produced by broaching are as follows →

1 - Bearing caps.
2 - Bearing bodies.
3 - Cylinder blocks.
4 - Connecting rod.
5 - Gears & turbine.
6 - Keyways.
7 - [illegible]

Scanned with CamScanner

DRILLING	BORING	REAMING
Drilling is performed to originate/make a hole.	Boring is a process of enlarging dia. of a hole which has been already drilled.	It is a process of finishing a hole surface & improve tolerance.
Cutting tool is used for drilling is known as drill bit.	Cutting tool is used for boring is known as boring bar.	Cutting tool is used for reaming is known as reamer.
Drill bit is a multipoint cutting tool.	Boring bar is a single point cutting tool.	Reamer is a multi point cutting tool.
Drilling is the 1st phase of hole in fabrication.	A pre-drilled hole is mandatory for ~~making~~ performing boring	Similar to boring ~~drilling~~ reaming can be performed only if ~~a~~ hollow part or hole exists.
Drilling can increase length of the hole but not dia. (Limited to drill dia.)	Boring can increase dia. of an existing hole but not ~~for~~ length.	Neither diameter nor length can be increased by reaming
Surface quality of drilled hole is not very good.	Here surface quality is better than drilling.	Reaming produce highly finished surface.
Material Removal Rate (MRR) in drilling operation is higher.	MRR is lower than drilling but higher than Reaming.	MRR is poor, In fact MRR is not an issue in Reaming.

BORING → It is a process of making or enlarging hole, which is already been drilled.

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