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Machine Shop Safety Tips and Machine Shop Safety Guidelines

General Safety Tips:

- Safety glasses with side shields must be worn at all times.
- Do not wear loose clothing, loose neckwear or exposed jewellery while operating machinery.
- Do not work alone. The buddy system is mandatory.
- Pull back and secure long hair
- Do not wear thin fabric shoes, sandals, open-toed shoes, and high-heeled shoes
- A machinist's apron tied in a quick release manner should be worn ideally.
- Always keep hands and other body parts a safe distance away from moving machine parts, work pieces, and cutters.
- Use hand tools for their designed purposes only.
- Report defective machinery, equipment or hand tools to the lab machinery

Safety Guidelines:-

1) If guards or safety mechanisms are present do not remove or disable them.
2) Do not attempt to oil, clean, adjust or repair any machine while it is running. Stop the machine and lock the power switch in the "OFF" position
3) Do not operate any machine unless authorized to do so by the policy and professors currently in place.

4) Do not set up or operate machinery if you are not trained and familiar with that setup.

5) Even after the power is off, do not leave the machine until it has stopped running.

6) Do not try to stop the machine with your hands or body.

7) Check tools and machines before use to assure they are safe to use.

8) Always see that work and cutting tools on any machine are damped securely before starting to work.

9) Only one person should operate a given machine and its switches.

10) Do not lean against a machine.

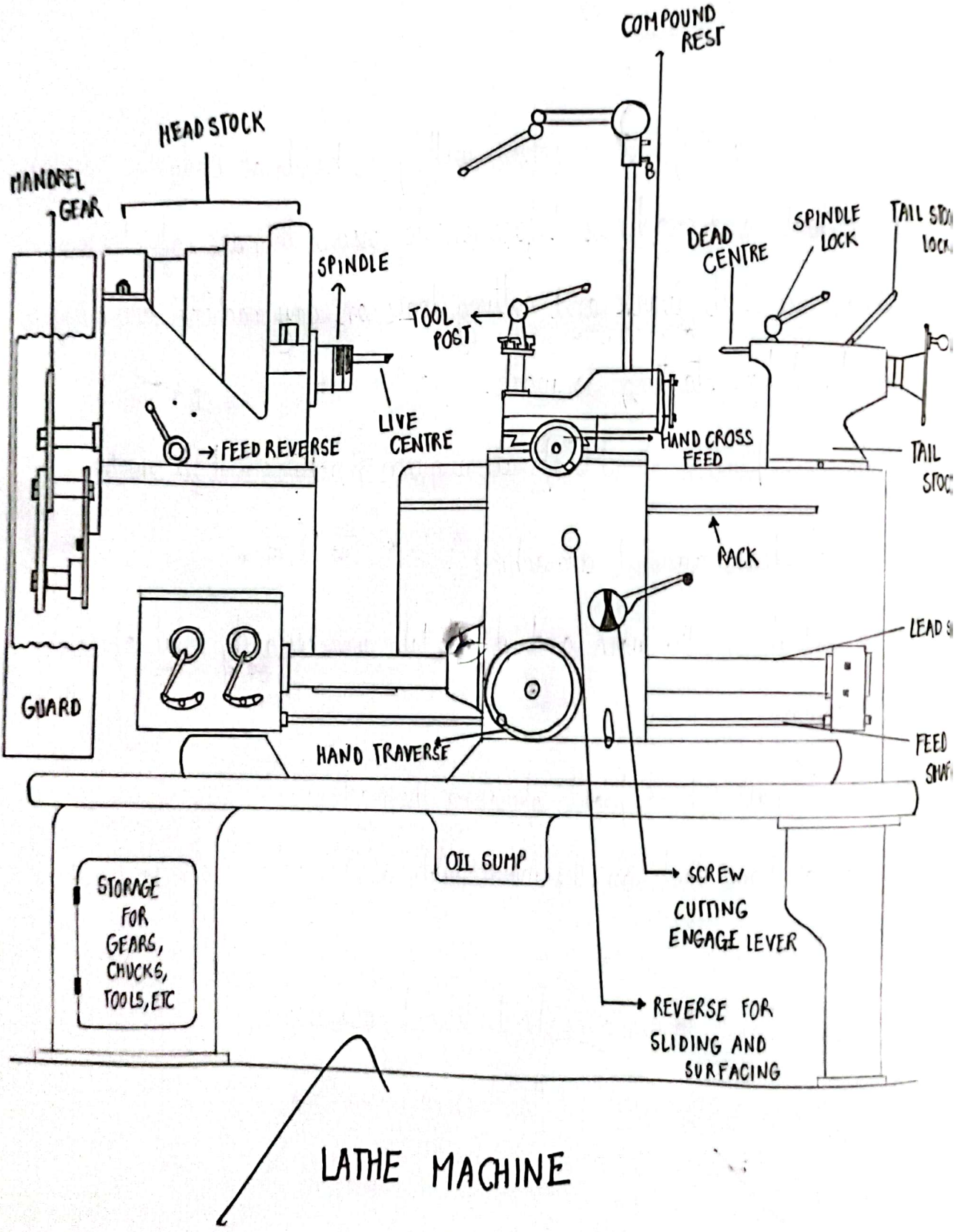
11) Concentrate on the work and don't talk unnecessarily while operating a machine.

12) Don't walk behind people operating the machine.

13) Do not leave tools on the work table of a machine even if the machine is not running.

14) Use a brush to remove short discontinous chips.

15) Never use compressed air to clean any machine.



LATHE MACHINE

Study of Lathe Machines

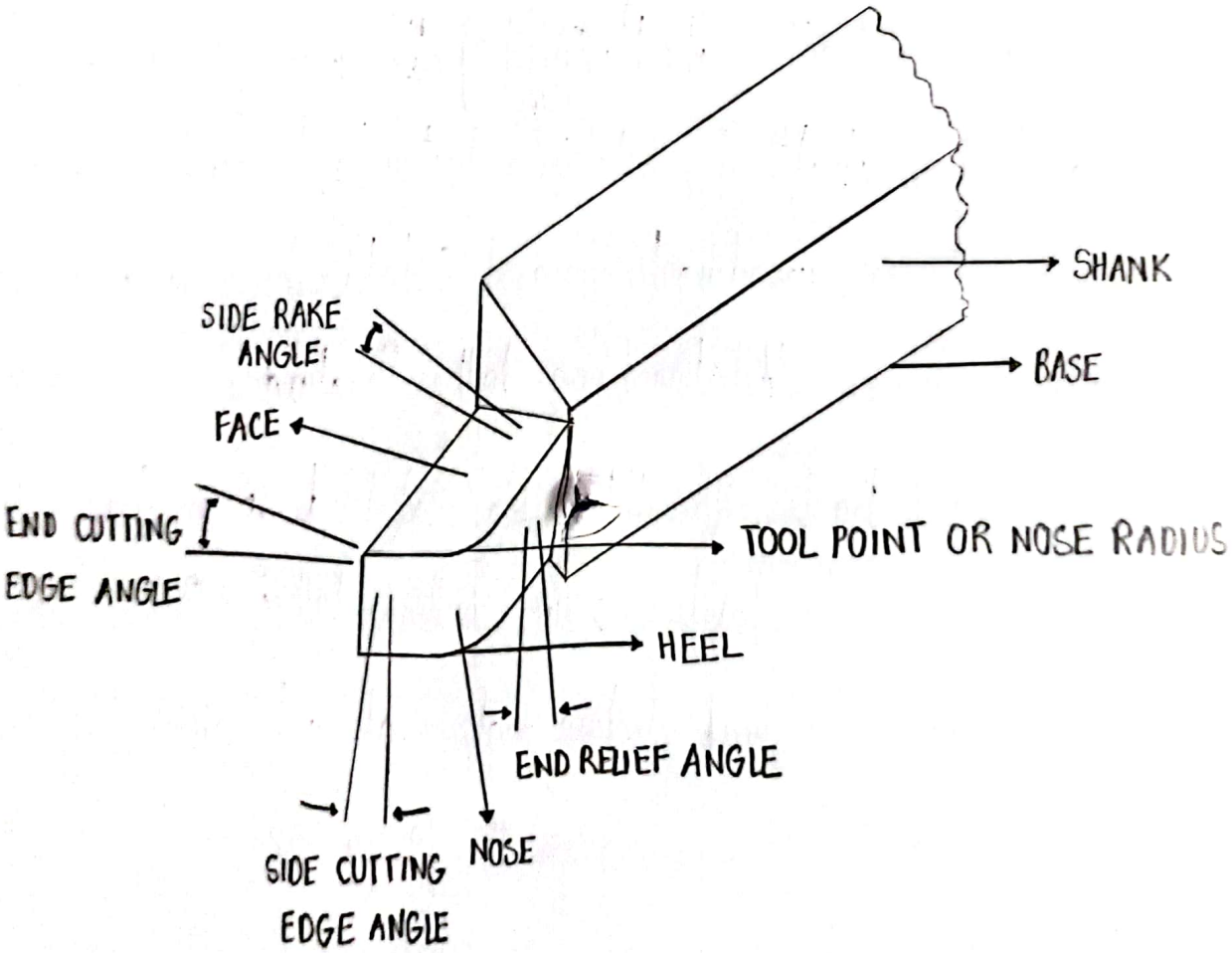
Introduction:

The lathe is an ancient tool, dating at least to the Egyptians and known and used in Assyria, Greece, the Roman and Byzantine Empires. The origin of turning dates to around 1300 BC when the Egyptians first developed a two person lathe. One person would turn the wood workpiece with a rope while the other used a sharp tool to cut shapes in the wood.

During the industrial revolution, mechanized power was applied to the lathe via steam engines and line shafting, allowing faster and easier work. The design of lathes diverged between woodworking and metalworking to greater extent than in previous centuries. Metalworking lathes evolved into heavier machines with thicker, more rigid parts. The application of lead screw, slide rests, and gearing produced commercially partial screw-cutting lathes. Between the late 19th and mid 20th centuries, individual electric motors at each lathe replaced line shafting as the power source. Beginning in the 1950's, servomechanisms were applied to the control of lathes and other machines tools via numeric control (NC), which was often coupled with computers to yield computerized numeric control (CNC). Today manually controlled and CNC lathes coexist in the manufacturing industries.

Working Principle:

In a lathe, work piece is held and rotated about its axis. A cutting force is applied on the work piece by a single point cutting tool and hence the material



SINGLE POINT CUTTING TOOL

is removed from the work piece. The amount of material removed from the work piece, in unit time is based on the depth of cut and feed. The single point cutting tool is made up of High Speed Steel (HSS), cemented carbides and polycrystalline diamonds (PCD).

Parts of lathe:-

a) Lathe Bed:

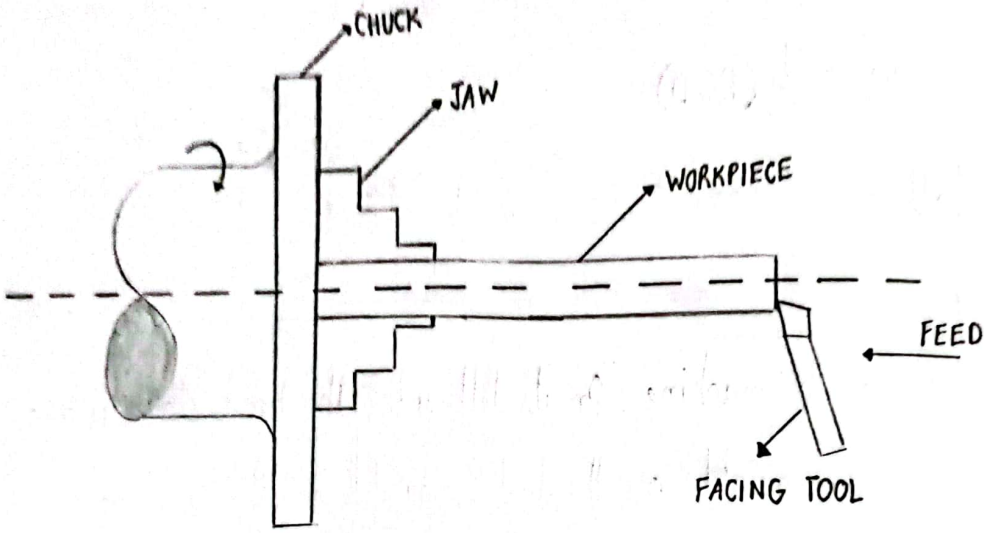
It is the base of the machine. On its left side, the head stock is mounted. The tailstock which is moveable on the bed, mounted on the right bed. The bed is made up of cast iron in order to resist the vibrations occuring during the machining operations.

b) Head Stock:

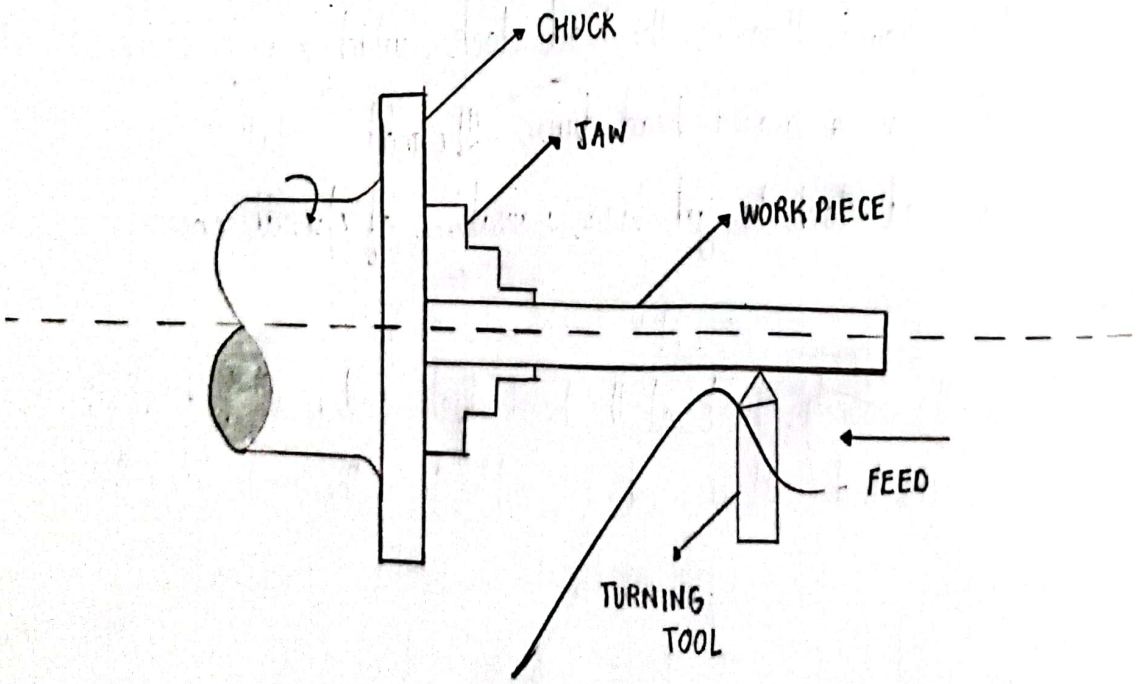
The head stock is permanently fastened on the inner ways at the left hand end of the bed. It serves to support the spindle and driving arrangements. All lathes recieve their power through the head stock, which may be equipped with a step-cone pulleys or a geared head drive. The modern lathe is provided with all-geared head stock to get large variations of spindle speeds.

c) Tail Stock:

The tail stock is the counter part of the head stock and is situated at the right handed of the bed. It is used for supporting the work when turning on centers or when a long component is to be held in a chuck. It is also used for holding and feeding the tools such as drills, reamers, taps, etc.



FACING OPERATION



TURNING OPERATION

d) Carriage :

In its simplest form the carriage holds the tool bit and moves it longitudinally (turning) or perpendicularly (facing) under the control of the operator. The operator moves the carriage manually via the hand wheel or automatically by engaging the feed shaft with the carriage feed mechanism. This provides some relief for the operator as the movement of the carriage becomes power assisted.

(i) Apron:

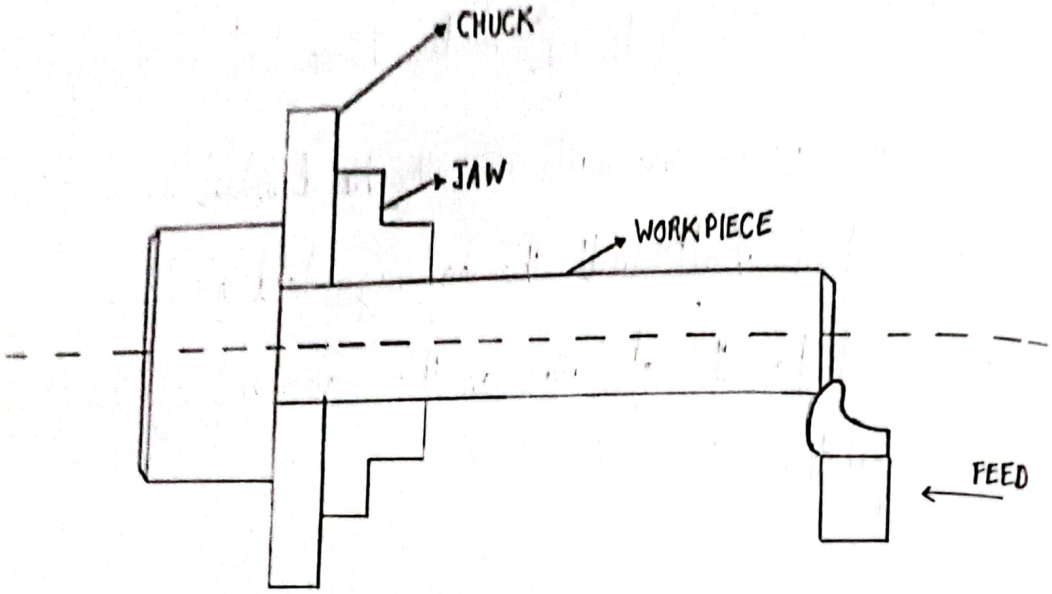
It is fastened to the saddle and hangs the tool bit and moves it longitudinally (turning) or perpendicularity (facing) under the control of the operator. The apron contains gears, clutches and levers for operating the carriage by hand and power feeds. The apron hand wheel can be turned to move the carriage longitudinally back and forth by hand.

(ii) Saddle :

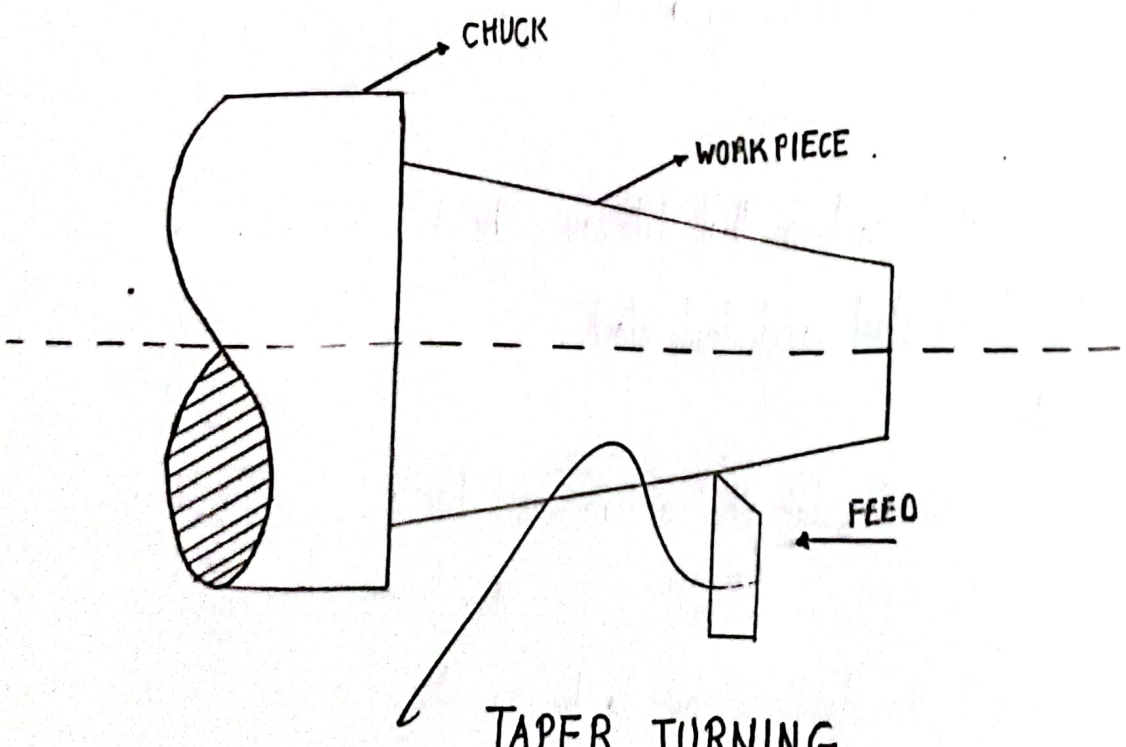
It is an H-shaped casting that fits over the bed and slides along the ways between the head stock and tail stock.

(iii) Cross-slide :

The cross-slide stands atop the carriage and has a feed screw that travels perpendicular to the main spindle axis. This permits facing operations to be performed, and the depth of cut to be adjusted. This feed screw can be engaged, through a gear train, to the feed shaft to provide automated power



CHAMFERING



TAPER TURNING

feed movement to the cross-slide. On most lathes, only one direction can be engaged at a time as an interlock mechanism will shut out the second gear train.

(iv) Compound rest:

The compound rest (or top slide) is the part of the machine where the tool post is mounted. It provides a smaller amount of movement along its axis via another feed screw. The compound rest axis can be adjusted independently of the carriage or cross-slide. It is utilized when turning tapers, to control depth of cut when screw nuts or precisions facing, or to obtain finer feeds (under manual control) than the feed shaft permits.

(e) Feed Rod:

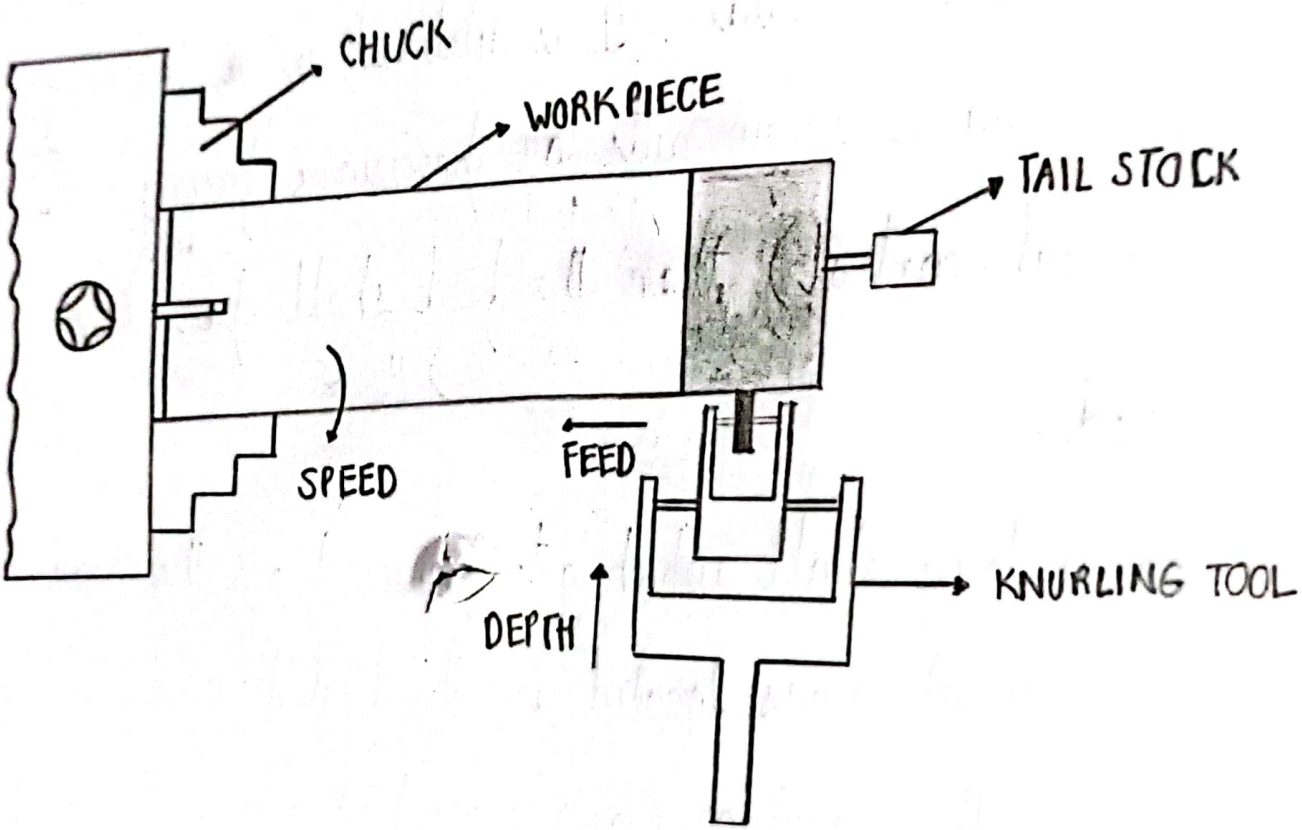
Feed rod is long shaft which gets power from the head stock spindle through large number of gears located in the feed box. It is used for the longitudinal movement of the carriage (or) cross feed movement of the cross slide.

f) Lead Screw:

A lead screw also known as a power screw or translation screw, is a screw designed to translate radial motion into motion. It is a long threaded shaft which is used during threaded cutting operations.

g) Tool post:

The tool bit is mounted in the tool post which may be of the American lantern style, traditional 4 sided square style, or in a quick change style such as the



KNURLING

multiflex arrangement pictured. The advantage of a quick change style such as the multiflex is to allow an unlimited number of tools to be used rather than being limited to 1 tool with the lantern style, or 3 to 4 tools with the 4 sided type.

Lathe Operations :-

a) Turning :

It is the operation of reducing the diameter of the work piece.

b) Facing :

It is the operation of reducing the length of the work piece.

c) Chamfering :

It is the operation of removing the sharp corners of the work piece to protect the edges of the job from getting damaged. It is done by keeping the tool at an angle of 45 degree to the lathe axis.

d) Taper Turning :

It is the operation of making uniform change in the diameter of the workpiece along its length or producing conical surface on the work piece.

e) Drilling :

It is the operation of making hole in the work piece. This can be achieved by fixing the drill bit in tail stock and fed in to the rotating work piece.

f) Boring :

It is operation of enlarging the already drilled hole.

g) Knurling:

It is the operation of making rough surface to get the grip on the work piece

Lathe Cutting Tools:-

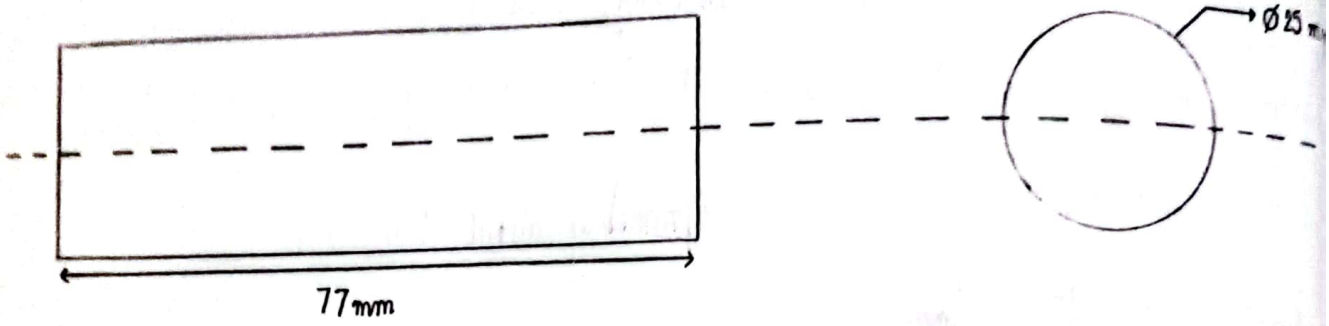
A lathe is a machine that rotates the workpiece about an axis of rotation to perform various operations such as turning, undercutting, knurling, drilling, facing, boring and cutting, with lathe cutting tools that are applied to the workpiece to create an object with symmetry about that axis.

a) Single Point Cutting Tool:

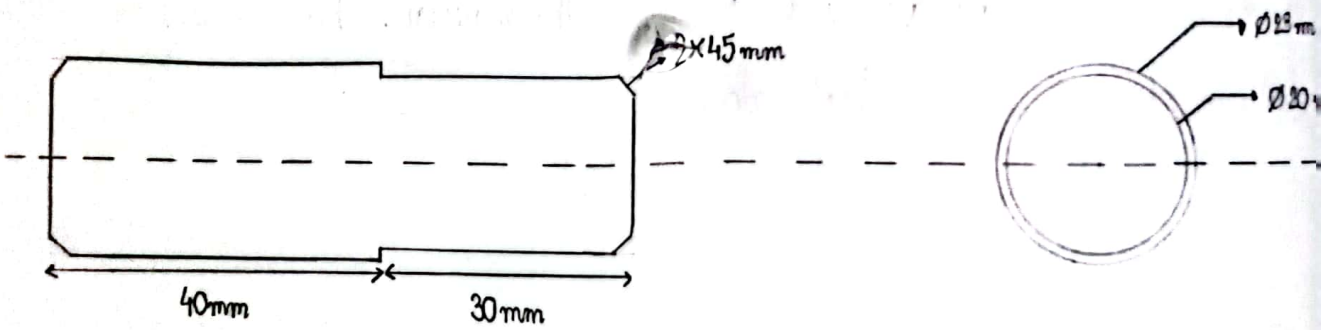
A non-rotary cutting tool used in metal lathes, shapers and planers

b) Multi Point Cutting Tool:

In this, multiple edges are used to remove the material. These are used in Milling, drilling, reamers, slotting tool, etc.



RAW MATERIAL



AFTER MACHINING

DATE: 16/8/22

Experiment - I

Step Turning on Lathe

Aim:

To make turning, facing, and chamfering on the given metal workpiece to get the required dimension.

Materials Required:

Chuck key, Tool post key, Single point cutting tool, Vernier Calliper, 14-15 double end spanner, Mild Steel Rod of 25 mm diameter × 77 mm length

Sequence of Operations:

a) Checking
b) Work piece setting
c) Tool setting
d) Facing
e) Turning
f) Chamfering

Working steps:

1) The given workpiece is checked for its given dimensions.
2) The workpiece is held in the three jaw chuck. Chuck key is used to tighten the job rigidly ensuring centering of the workpiece.

3) The single point cutting tool is fixed in the tool post of the lathe machine using tool post key and spanners.

4) Facing operations is done to reduce the length of the job.

5) Turning operation is done to reduce the diameter of the job.

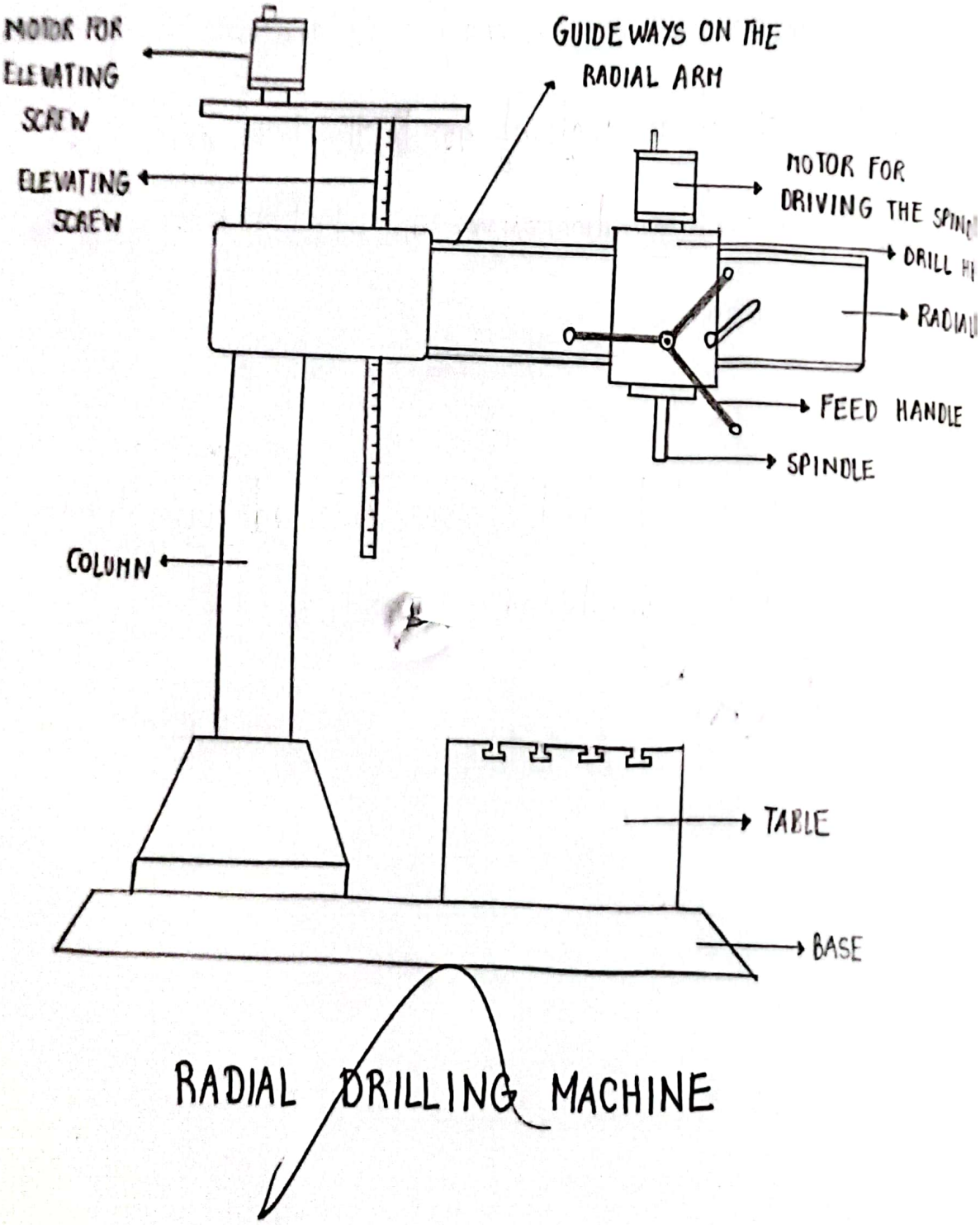
6) Chamfering is done to remove sharp edges and corners of the workpiece by keeping the tool at an angle of 45° to the lathe axis.

7) Finally the workpiece dimensions are checked to conform to the specifications given in the drawing.

Result:

Hence the required shape and size are obtained using turning, facing and chamfering operations on the given workpiece.

14/4/22



RADIAL DRILLING MACHINE

Study of Drilling Machine

Introduction:

Drilling machine is one of the most important machine tools in a workshop. It was designed to produce a cylindrical hole of required diameter and depth on metal workpieces. Though holes can be made by different machine tools in a shop, drilling machines are designed specifically to perform the operation of drilling and similar operations. Drilling can be done easily at a low cost in a shorter period of time in a drilling machine.

Drilling can be called as the operation of producing a cylindrical hole of required diameter and depth by removing metal by the rotating edges of a drill. The cutting tool known as drill is fixed into the spindle of the drilling machine. A mark of indentation is made at the point required with a center punch. The rotating drill is passed at the location and is fed into the work. The hole can be made upto a required length.

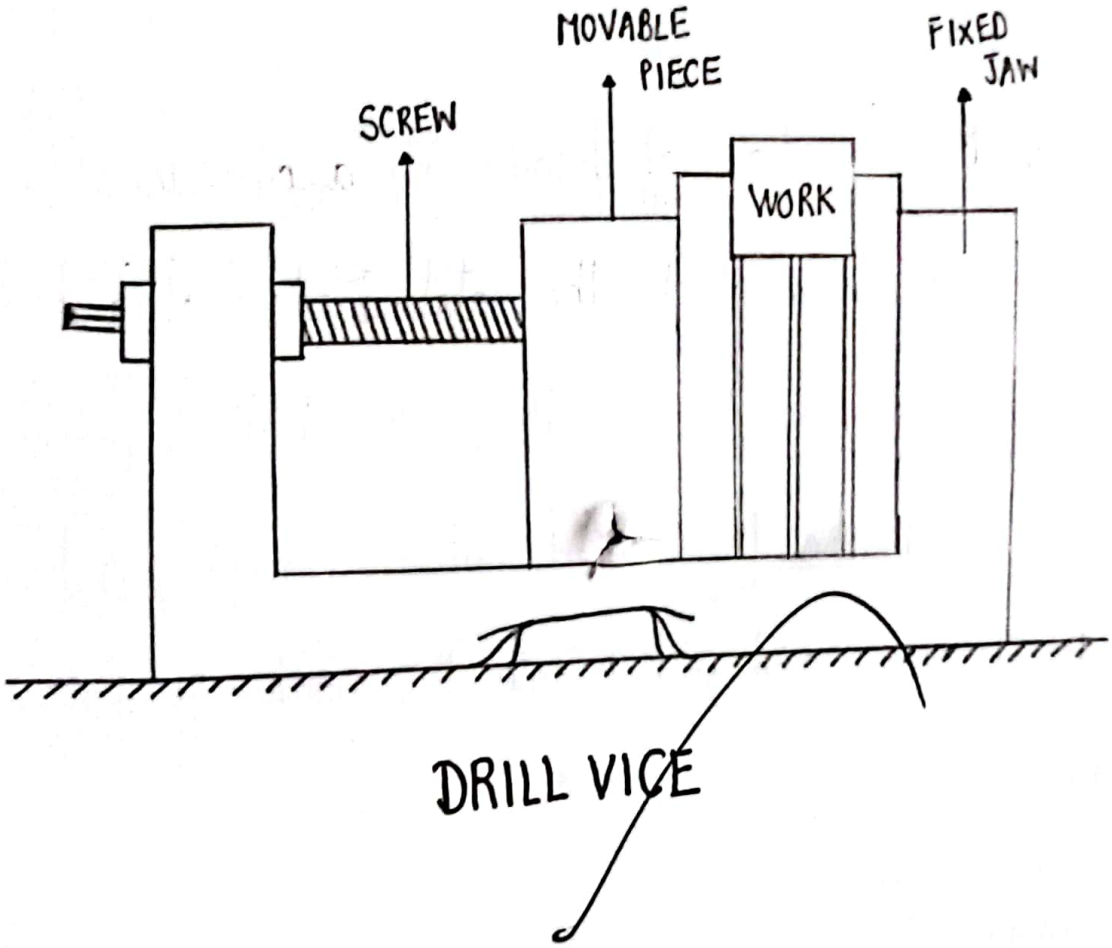
Types of Drilling Machine:-

1) Hand drilling machine:

These can be carried and used anywhere in the workshop. It is used for drilling holes on workpiece in any position.

2) Sensitive drilling machine:

It is designed for drilling small holes at high speeds in light jobs. High speed and hand feed are necessary for drilling small holes.



DRILL VICE

3) Upright drilling machine:

It is designed for handling medium size workpieces.

4) Radial drilling machine:

The radial drilling machine is intended for drilling on medium to large and heavy workpieces. It has a heavy round column mounted on a large base.

5) Gang drilling machine:

Has a long common table and a base. Four to six drill heads are placed side by side.

6) Multiple spindle drilling machine:

Used for drilling a number of holes in a workpiece simultaneously and for reproducing the same pattern of holes in a number of identical pieces.

7) Deep hole drilling machine:

As special machine and drills are required to drill deeper holes in barrels of guns, spindles and connecting rods.

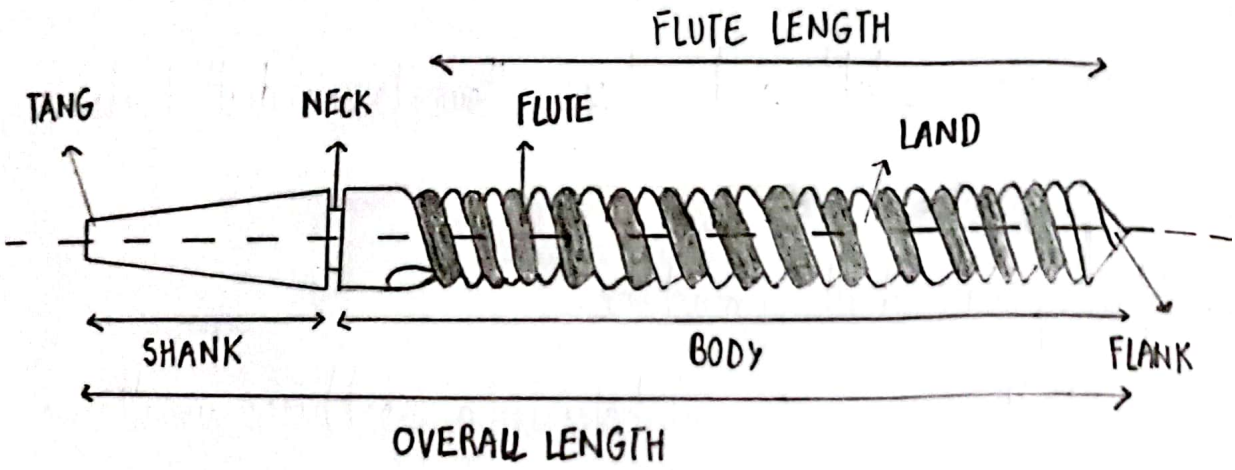
Parts of Drilling Machine:

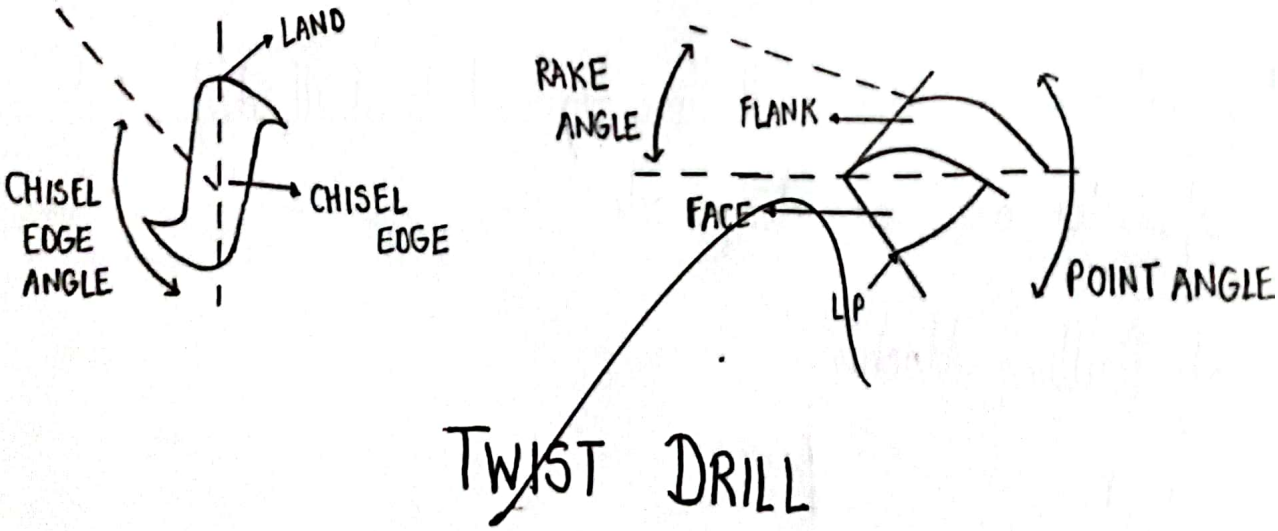
1) Drill Chuck:

It holds the straight shank cutting tools. Teeth are made inside the jaw to hold the drill easily. Keys are used to tighten the chuck jaw.

2) Head:

The top part of the drilling machine which has a spindle that moves in upward and downward directions.


FLUTE LENGTH
TANG
NECK
FLUTE
LAND
SHANK
BODY
FLANK
OVERALL LENGTH


LAND
CHISEL EDGE ANGLE
CHISEL EDGE
RAKE ANGLE
FLANK
FACE
LIP
POINT ANGLE

TWIST DRILL

3) Table:

Used to hold the workpiece or a job and can be adjusted by moving it in upward or downward direction.

4) Column:

Supports the table and head as well as other mechanisms attached to the head.

5) Spindle:

Used to hold and rotate the drill bits.

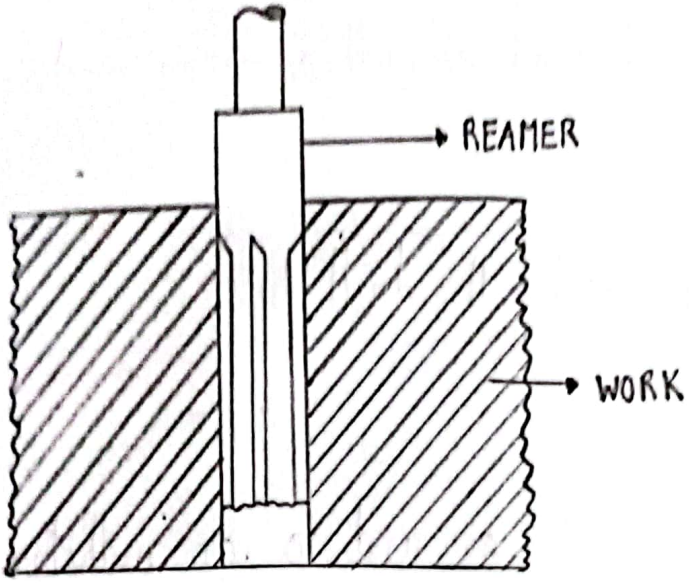
6) Drill Base:

The base is made of cast iron and so can withstand vibrations. It maybe mounted on a bench or on the floor.

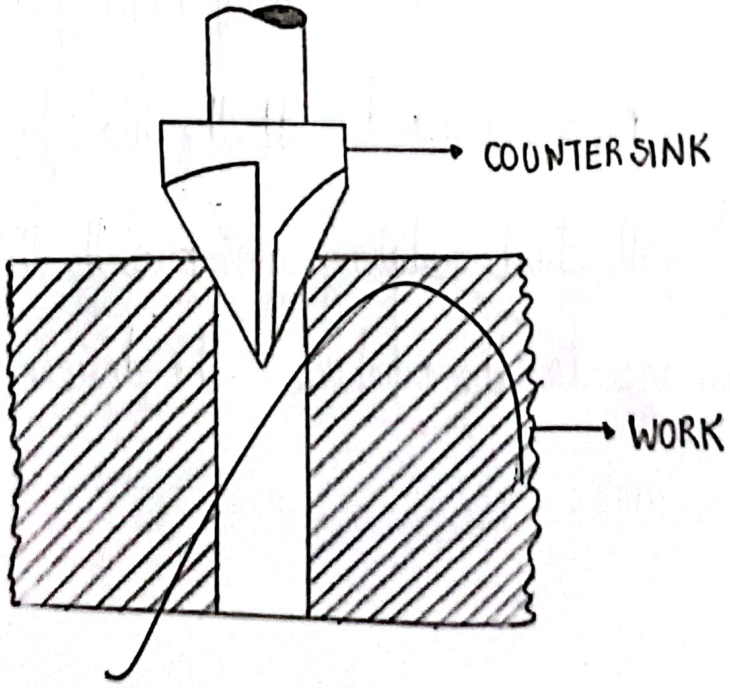
Work Holding Devices:

The work should be held firmly on the machine table before performing any operation on it. As the drill exerts very high quantity of torque while rotating, the work should be held by hand. If the workpiece is not held by a proper holding device, it will start rotating along with the tool causing injuries to the operator and damage to the machine. The devices used for holding the work in a drilling machine are:

→ Drill vice
→ 'T' bolts and clamps
→ Step block
→ V block



REAMING



COUNTER SINKING

→ Angle plate
→ Drill jigs

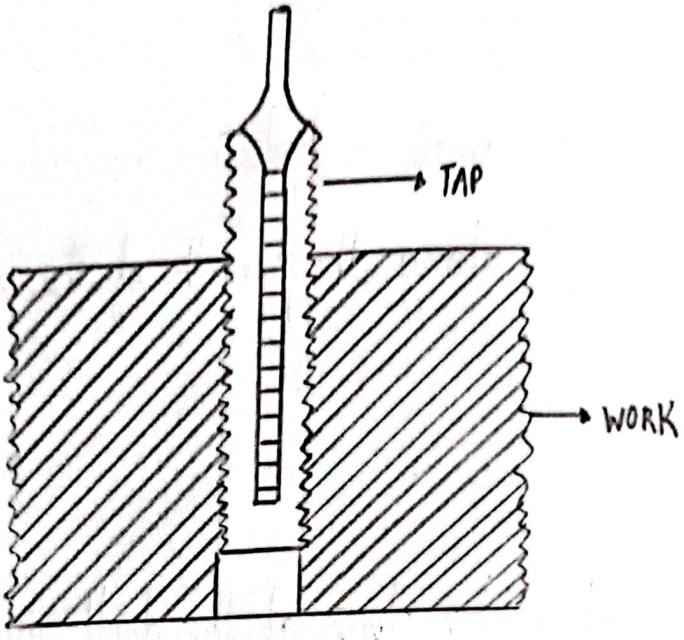
Drilling Tools :-

1) Drill :-

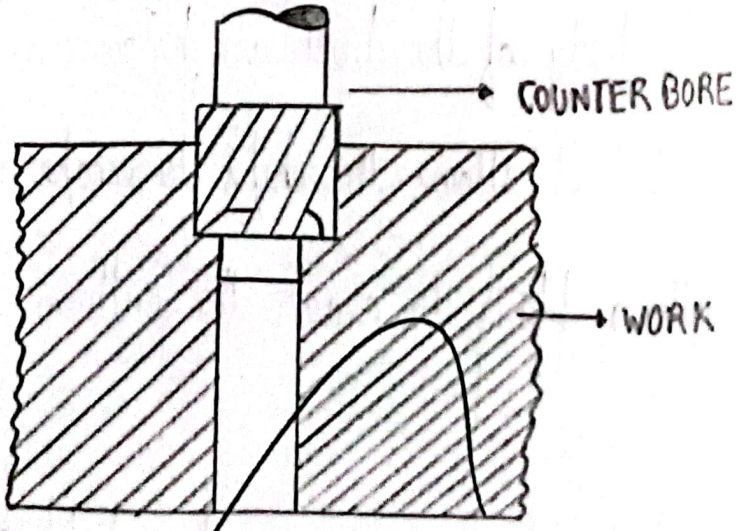
It is a tool used to originate a hole in a solid material. A helical groove known as 'flute' is cut along the length of the drill.

Parts :-

- **Axis :**
  It is the longitudinal centre line of the drill running through the centres of the tang and the chisel edge.
- **Body :**
  It is the part of the drill from its extreme point to the commencement of neck
- **Flutes :**
  The grooves in the body of the drill are known as flutes. Flutes form the cutting edges on the point. It allows the chips to escape and make them curl. It permits the cutting fluid to reach the cutting edges.
- **Shank :**
  It is the part of the drill by which it is held and driven. It is found just above the body of the drill. The shank may be straight or taper. The shank of the drill can be fitted directly into the spindle or by a tool holding device.



TAPPING



COUNTER BORING

→ Tang:

The flattened end of the taper shank is known as tang. It is meant to fit into a slot in the spindle or socket. It ensures a positive drive of the drill.

→ Neck:

It is the part of the drill, which is diametrically undercut between the body and the shank of the drill. The size of the drill is marked on the neck.

→ Point:

It is the sharpend end of the drill. It is shaped to produce lips, faces, flanks and chisel edge.

→ Lip:

It is the edge formed by the intersection of flank and face. There are two lips and both of them should be of equal length. Both lips should be at the same angle of inclination with the axis.

→ Land:

It is the cylindrical ground surface on the leading edges of the drill flutes adjacent to the body clearance surface. The alignment of the drill is maintained by the land. The hole is maintained straight and to right side.

Drilling Operations :-

1) Drilling:

When we need a circular hole in the workpiece of any size, we can use the drilling operation. By a drilling operation you form a hole of any size.

2) Boring :

When we need to enlarge the diameter of the existing hole you need to perform the boring operation.

3) Reaming :

Operation of finishing a drilled hole. It gives the hole a smoothly finished surface.

4) Counter - Boring :

It is the operation of boring a second hole of a large diameter but concentric with it.

5) Counter sinking :

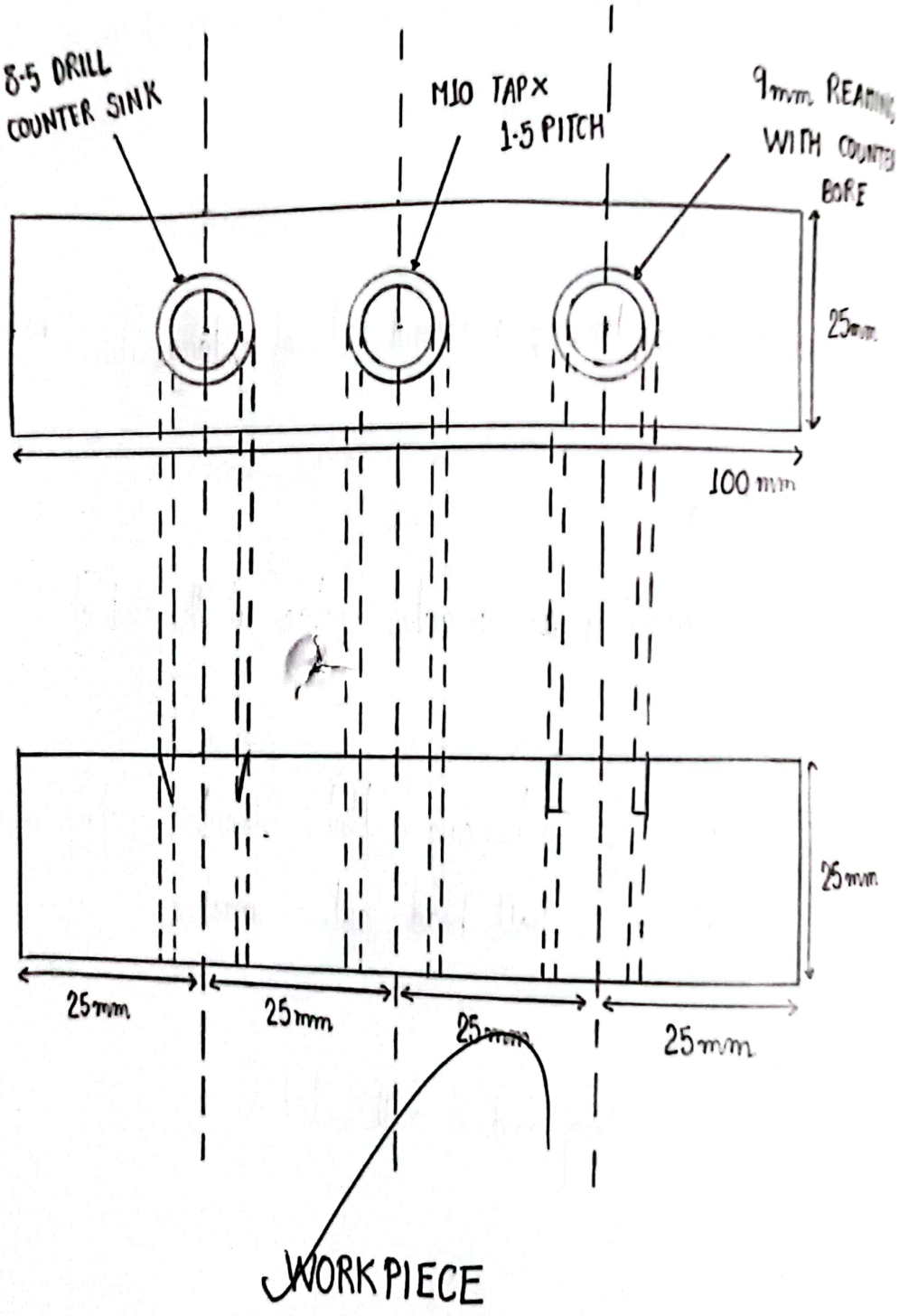
Operation of producing an angular surface at the end of the hole.

6) Spot facing :

It is the operation of machining a flat, circular surface around a whole to provide a seat for a bolt head, nut or washer.

7) Tapping :

Holes that are drilled and then threaded.


8·5 DRILL
COUNTER SINK
M10 TAP×
1·5 PITCH
9mm REAMING
WITH COUNTER
BORE
25mm
100 mm
25mm
25mm
25mm
25mm
25mm
WORK PIECE

DATE: 23/8/22

Experiment - II

Drilling Operation

Aim:

To drill the holes of required size.

Materials supplied:

Mild Steel block of 25×25×100mm

Tools required:

Center drill, 8.5 mm taper drill bit, 9mm reamer, 10 mm tap set, tap wrench, 12mm countersink tool, 12mm counter bore, drill set with key, Jenny calliper, Steel Rule, Dot punch with hammer.

Drill size = Tap size - (2×0.61× Pitch)

Tap size = 10mm

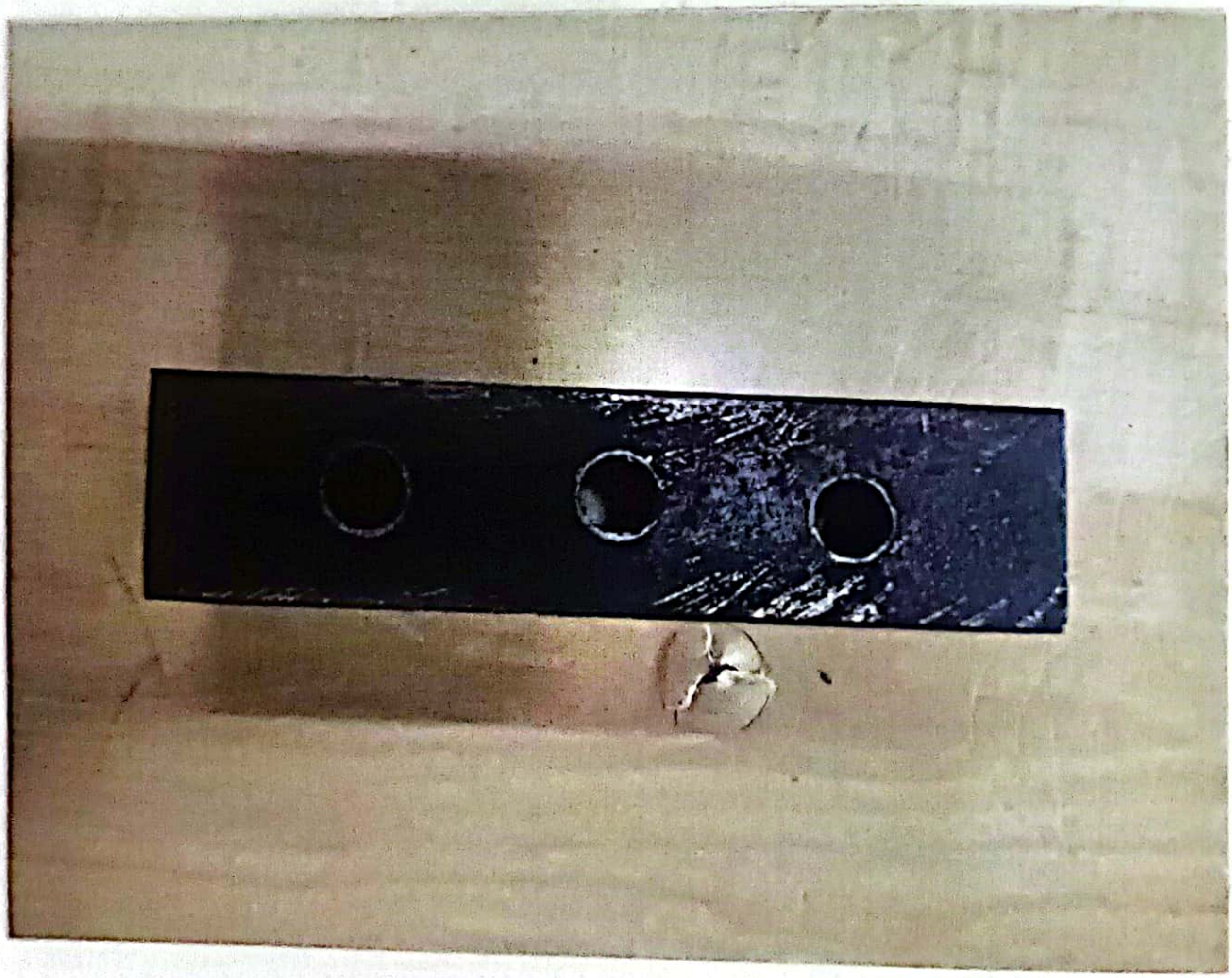
Pitch = 1.5mm

Drill size = 10 - 1.83

= 8.17mm

Sequence of Operation:

a) Checking
b) Work piece setting
c) Marking
d) Punching
e) Drilling

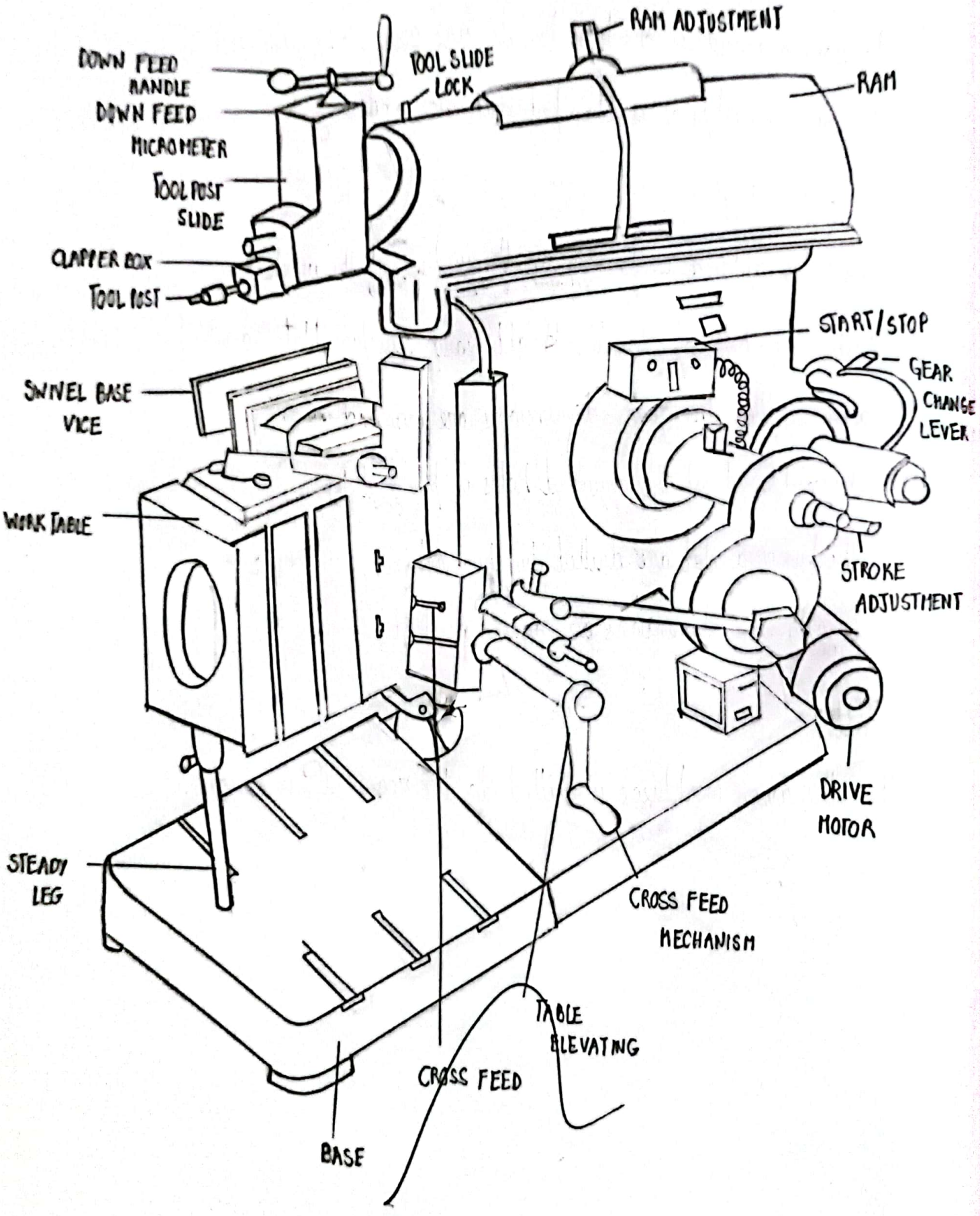


Working Steps :-

1) The raw material is checked for its size 25×25×100 mm using the steel rule.
2) The given workpiece is clamped in a vice and any two surfaces are filled to get right angle.
3) Chalk is applied uniformly on the surface of the work pieces.
4) With the help of Vernier Height Gauge, surface plate, angle plate, steel rule and scriber the given dimensions are marked.
5) The midpoint of the required holes is punched by using the dot punch.
6) The punched dot are drilled by the machine.
7) Finally the dimensions are again checked.

Result :

Thus the given workpiece is drilled to the required dimensions.



SHAPER MACHINE

Study of Shaper Machine

Introduction:

A shaper is a type of machine tool that uses linear relative motion between the workpiece and a single point cutting tool to machine a linear tool path. The shaper is a relatively simple machine. It is used fairly often in the tool room or for machining one or two pieces for prototype work. Tooling is simple, and shapes, and shapers do not require operation attention while cutting. A shaper machine is used to machine a flat surface. It can cut grooves, angles and many other shapes. The main function of shaper is to generate a flat surface by combination of linear movement of cutting tool and work piece.

Shaping is where the workpiece is fed at right angles to cutting motion between successive strokes of the tool. The workpiece is reciprocated and the tool is fed at right angles to the cutting motion.

Parts of a Shaper:-

Base:

It is a heavy and robust cast iron body. The base supports the column or pillar which supports all the working parts such as ram, work table, drive-mechanism etc.

Column:

The column is a ribbed casting of cellular construction. The ram slide ways are provided on top of the column while the table slide ways are machined on the front.

Ram:

Ram is a rigidly placed braced casting and is located on top of the column. The ram slides back and forth in dovetail or square ways to transmit power to the cutter.

Tool head:

It is the device which holds the tool. The tool head slides in a dovetail at the front of the ram by means of a T-bolt and is fastened to the ram on a circular plate that can be rotated for making angular cuts.

Clapper box:

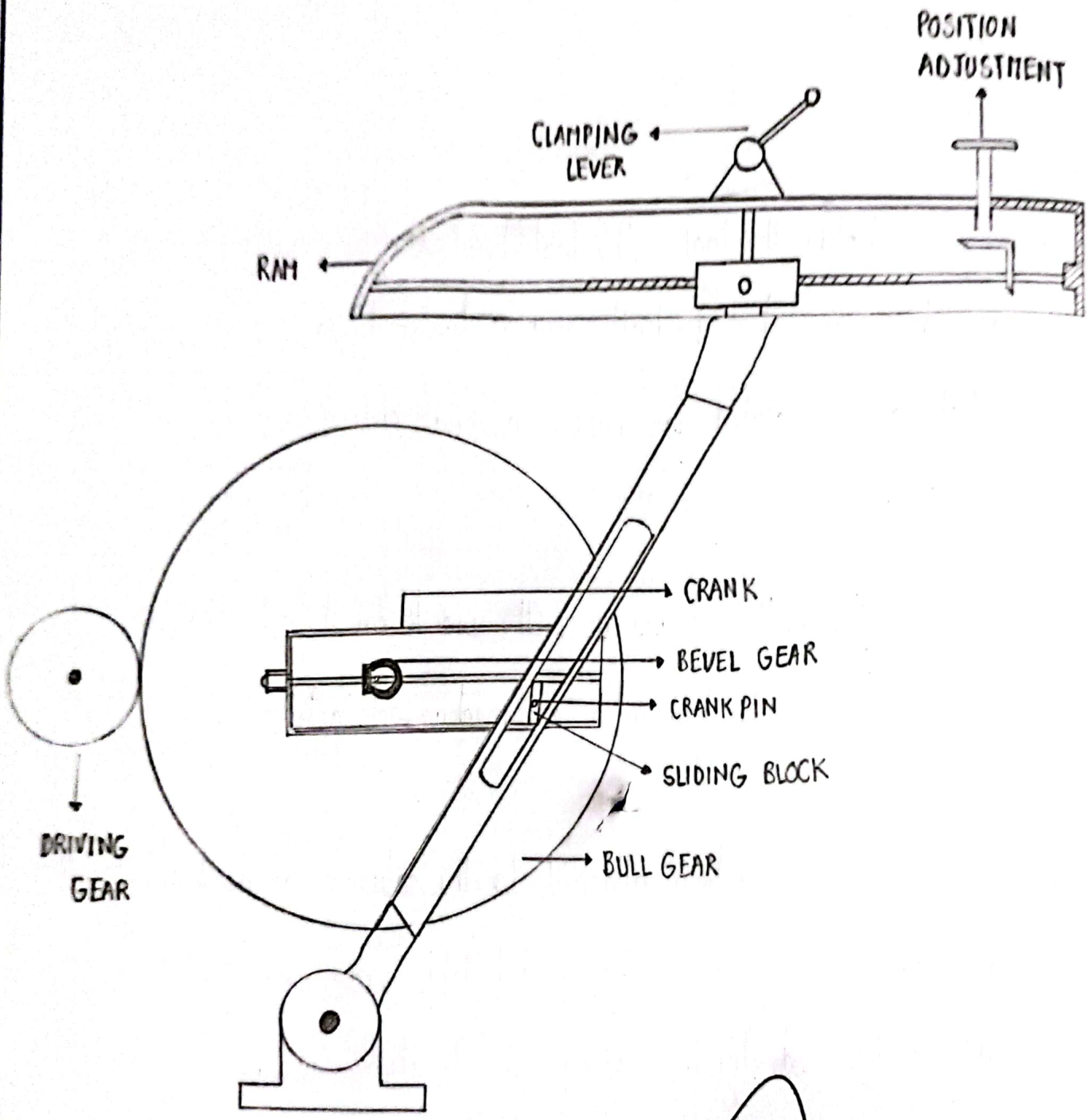
It is needed because the cutter drags over the work on the return stroke. It is often raised automatically by hydraulic or mechanical action.

Cross rail:

The cross rail is a heavy casting attached to the column at its front on the vertical guide ways. It carries the horizontal table side ways. The cross rail can be raised or lowered by means of an elevating screw in order to compensate for different thickness of work.

Table:

It is made of cast iron and has box type contruction. It holds and supports the work during the operation and slides along the cross rail to provide feed to the work.



QUICK RETURN MECHANISM

Saddle:

The saddle moves up and down, usually, manually, to set the rough position of the depth of cut. Final depth can be set by the hand crank on the tool head.

Tool holders:

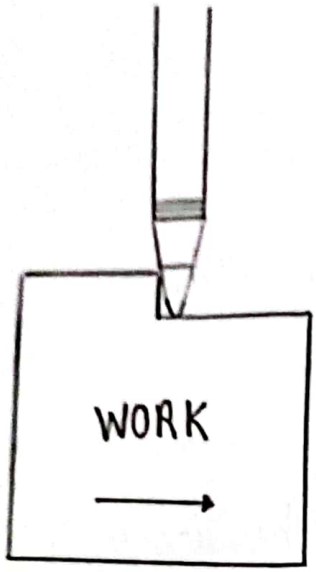
The cutter is sharpened with rake and clearance angles similar to the lathe tools though the angles are smaller because the work surface is usually flat. These cutters are fastened into the tool holders.

Work holding:

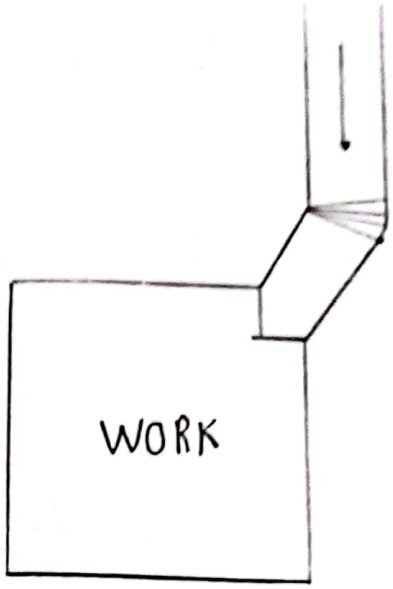
Workpiece holding is frequently done in a vice. The vice is specially designed for use in shapers and has long ways which allows the jaws to open up to 14" or more, therefore quite large work pieces can be held.

Quick Return Mechanism:

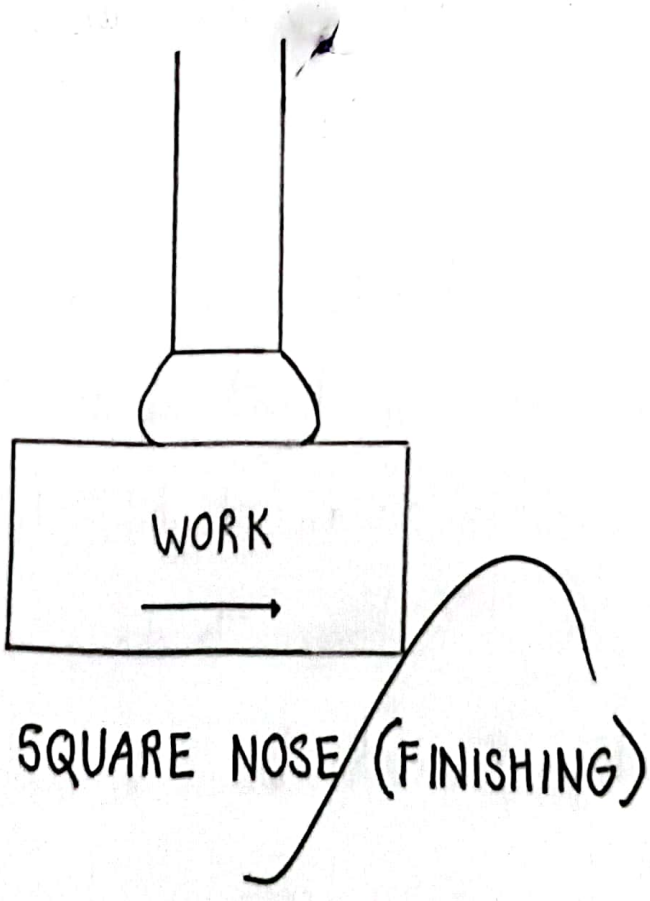
This the most common type of shaper in which a single point cutting tool is given a reciprocating equal to the length of the stroke desired while the work is clamped in position on an adjustable table. In contruction, the crank shaper employs a crank mechanism to change circular motion of a large gear called "bullgear" incorporated in the machine to reciprocating motion of the ram. The bull gear recieves power either from an individual motor or from an over head line shaft it is a belt driven shaper. The shaping machine is used to machine flat metal surfaces. The reciprocating motion of the mechanism



ROUND NOSE (ROUGHING)



DOWN CUTTING



SQUARE NOSE (FINISHING)

inside the shaping machine can be seen in the digram As the disc rotates the top of the mechanism machines moves forwards and backwards pushing a cutting tool. The cutting tool removes the metal from work within which is carefully bolted down.

Horizontal Shaper:

In a horizontal shaper, the ram holding the tool reciprocates in a horizontal axis. These are mainly used to produce flat surfaces.

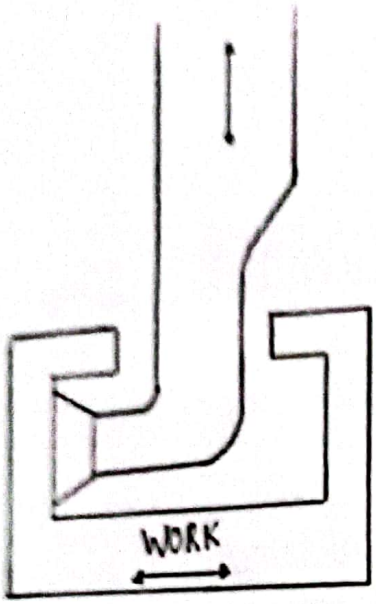
Vertical shaper:

The ram holding the tool reciprocates in a vertical axis. In some of the machines provision is made to allow adjustment of the ram to an angle of about 10 degrees from the vertical position.

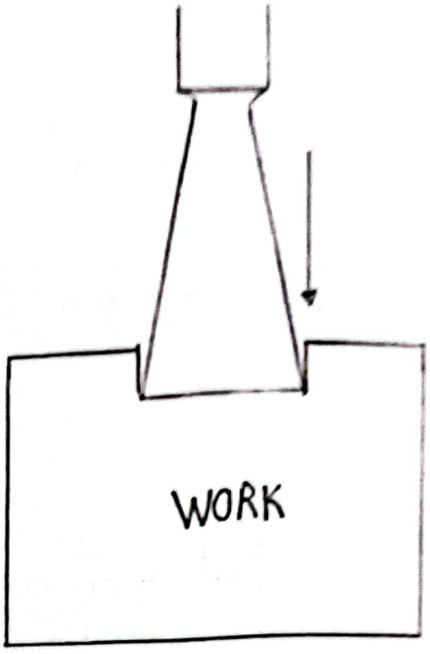
Vertical shapers are very convient for machining internal surface, keyways, slots or grooves. Large internal and external gears may also be machined by indexing arrangement of the rotary table.

Travelling Shaper:

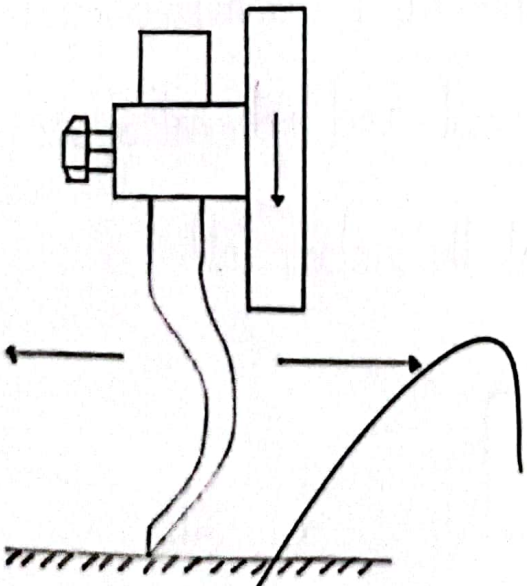
The ram carrying the tool while it reciprocates moves crosswise to give the required feed. Heavy and unwieldly jobs are held static on the base of the machine.



SIDE
RECESSING



PARTING OFF



GOOSE NECK

Shaper Specifications:-

→ Length of Stroke
→ Maximum Horizontal travel
→ Maximum Vertical travel
→ Maximum distance of table to ram
→ Maximum vertical travel of Tool slide
→ Length and Width of Table Top
→ Length and Depth of Table Slide
→ Power of Motor

Operations on Shaper:-

→ Machining Horizontal Surface:

The vice jaw's length is set perpendicular to ram movement. Hold the job length wise parallel to the tool stroke so that maximum stroke of the tool may be utilized. Hold the appropriate tool in the tool head. Set the proper inclination of the tool and depth of cut. Give cross feed to the tool initially by hand till the cut starts and then employs power feed.

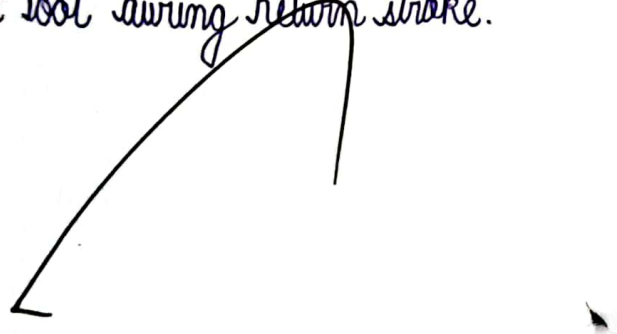
→ Machining Vertical Surface:

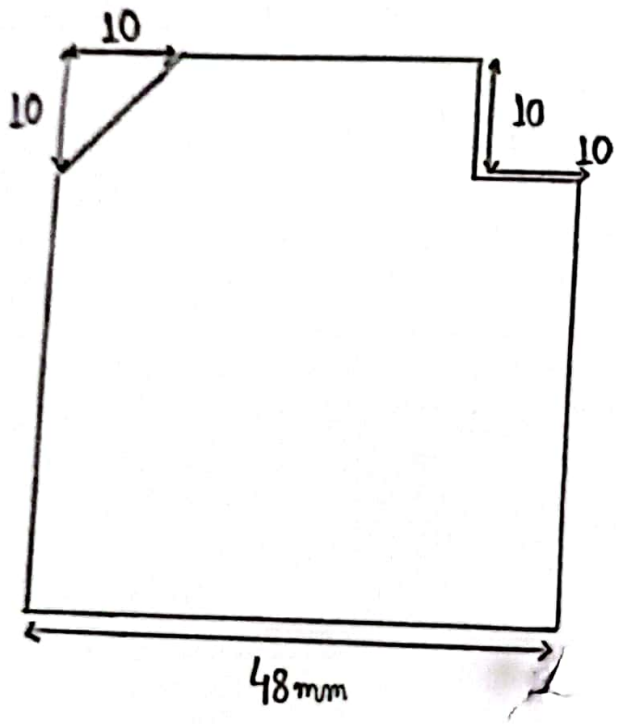
The tool is fed downward in vertical cutting so swivel the clapper box from the face of the work to be cut. The tool is fed downwards by rotating the down feed screw by hand at the end of return stroke. On the return stroke

the tool swings away from the work and gives clearance, which prevents the work from being scratched

→ Machining Angular Surfaces:

Set the swivel head to the required angle for shaping angular faces. The clapper box is to be swung away from the face to be machined. The tool is to be fed by the slide hand wheel. The apron top is also swiveled in the direction away from the surface to be maintained. Feed the tool during return stroke.





WORK PIECE

DATE: 30/8/22

Experiment - III

Shaping Machine Operations

Aim:

To machine a V-groove and angular groove on the given workpiece.

Tools Required:

Round nose tool, Grooving tool, Scriber, Vernier Height Gauge, Hammer, Center punch, double end spanner - 21, 23, Chalk piece and Surface plate.

Materials Required:

Mild Steel Square Block

Procedure:-

Sequence of Operation:

a) Checking

b) Marking

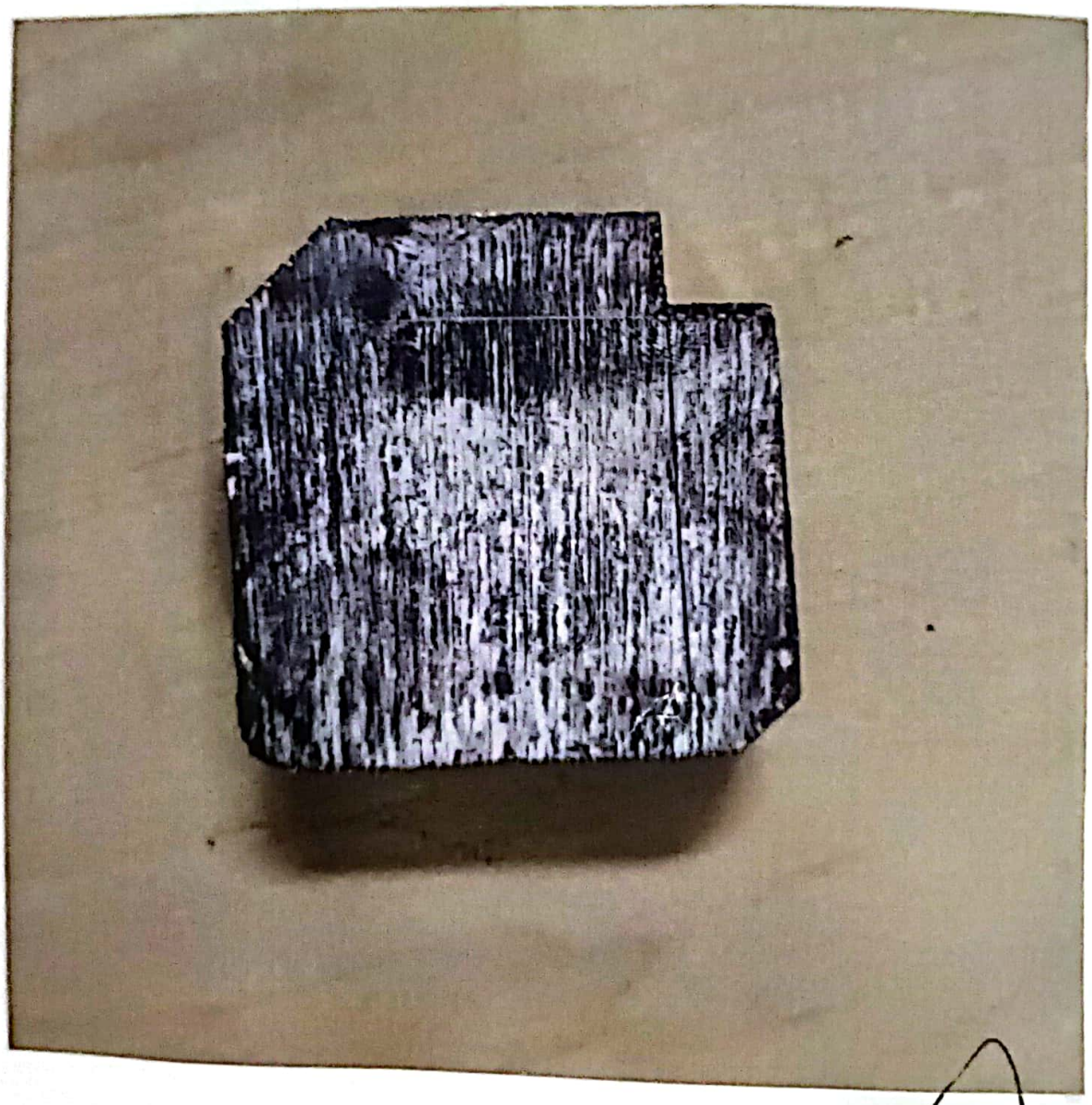
c) Punching

d) Work piece setting

e) Machining

Operations:

1) Apply chalk on the surface of the work piece where markings are to be done.
2) With the help of the Vernier height gauge, mark the required dimensions on the workpiece.



3) Using the protractor mark the lines along which the workpiece has to be cut.

4) Use a hammer and centre punch to make markings on the line created by the scriber.

5) Insert the workpiece in the machine vice and the tool in the tool post along with the supporting blocks.

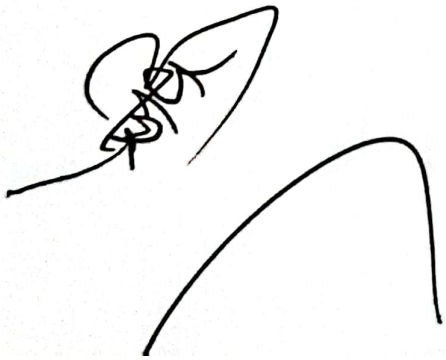
6) Adjust the feeding hand, feed and ram by moving the flywheel, cross-slide, etc.

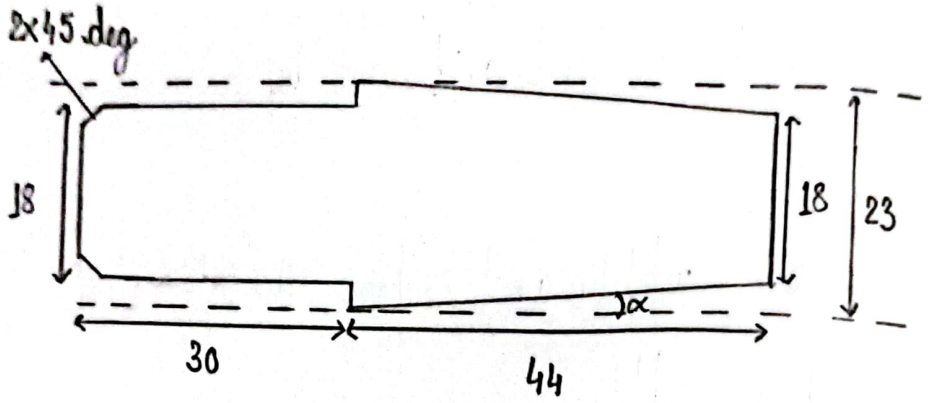
8) Switch on the power supply and perform the operations.

9) Switch off the power supply.

Result:

Thus the given workpiece is shaped to the desired dimensions.





$\alpha = 3.2519°$

TAPER TURNING

$$\tan\alpha = \frac{D-d}{2l}$$

$$\tan\alpha = \frac{23-18}{2\times44}$$

$$\alpha = \tan^{-1}\left(\frac{5}{88}\right)$$

$$= 3.2519°$$

Experiment - IV

DATE: 13/9/22

Taper Turning Operations on Lathe

Aim:

To perform turning, facing, chamfering and taper turning operations on the given metal workpiece to get the required dimensions.

Materials Supplied:

Mild Steel Rod 25 mm diameter x 75 mm length

Tools Required:

Single point cutting tool, vernier calliper, steel rule, chuck key, tool post key, wire brush.

Sequence of Operation :-

a) Checking

b) Work piece setting

c) Tool setting

d) Facing

e) Turning

f) Chamfering

g) Taper Turning

Working Steps:

1) The given workpiece is checked for its given dimensions.
2) The workpiece is held in three jaw chuck. Chuck key is used to tighten the jole ensuring centering of the workpiece.
3) The single point cutting tool is fixed in the tool post of the lathe machine using tool post key and spanners.
4) Facing operation is done to obtain the required length of the jole.
5) Turning operation is done to obtain the required diameter of the jole.
6) Chamfering is done to remove the sharp edges and corners of the work piece by keeping the tool at an angle of 45° to the lathe axis.
7) Taper angle is calculated using the formula:

$$\tan\alpha = \frac{D-d}{2l}$$

$\alpha \rightarrow$ Half of taper angle

$l \rightarrow$ Length of tapered portion

$D \rightarrow$ Taper large diameter

$d \rightarrow$ Taper small diameter

8) The compound rest is set at the angle calculated and the workpiece is cut

9) Finally the work piece dimensions are checked to conform to the dimensions.

Result :

Hence the required shape and size are obtained using turning, facing and chamfering operations on the workpiece

Study of the Slotter Machine

Introduction :-

A slotter machine is a machine tool in which material is removed for producing desired shapes. It is used for producing / machining cylindrical surfaces and flat surfaces.

Types of Slotter machine :-

1) Puncher Slotter machine :

The puncher slotter is a rigid and heavy machine designed mainly for the removal of a large amount of metal from large castings or forgings. The length of the puncher slotter is sufficiently large which may be as long as 1800 to 2000 mm

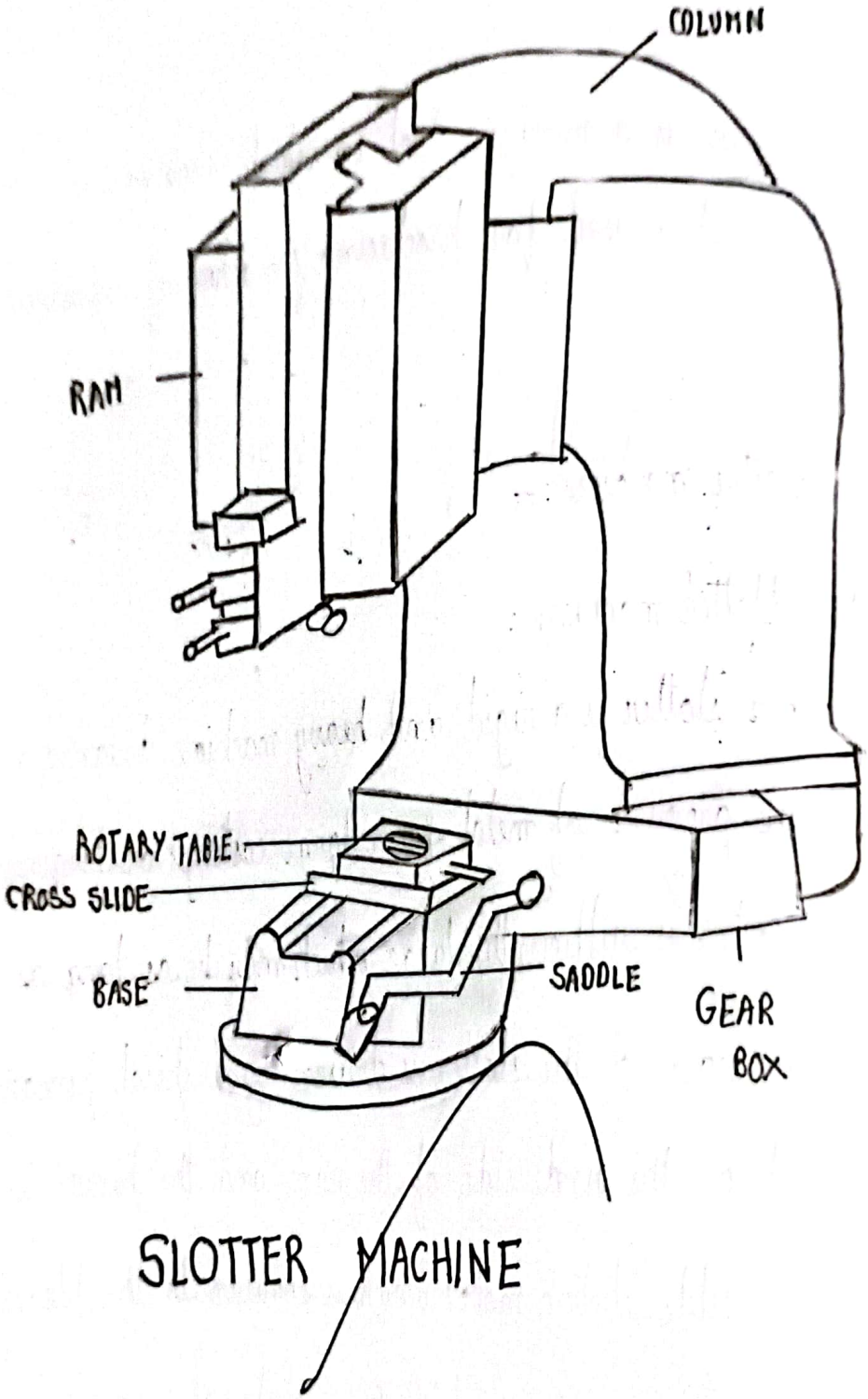
The ram of the slotter is driven by a spiral pinion meshing with the rack teeth cut on the underside of the ram and the pinion is driven by a variable speed reversible electric motor which is similar to the planar.

The feed is also controlled by electrical gears.

2) Precision Slotter Machine :

It is a simple and light machine. It is operated at high speeds and the machine is mainly designed to take light cuts for accurate surface finish.

The machine can handle a number of identical works on a production basis by using special jigs. These machines are fitted with a



SLOTTER MACHINE

Whit Worth Quick Return Mechanism.

Parts of a Slotter Machine :-

1) Base or Bed:

It is a rigid cast iron casting built to take up all the cutting forces and the entire load of the machine. The top surface of the bed is accurately machined to provide guideways on which the saddle is mounted and slides. These guideways are perpendicular to the column face.

2) Column:

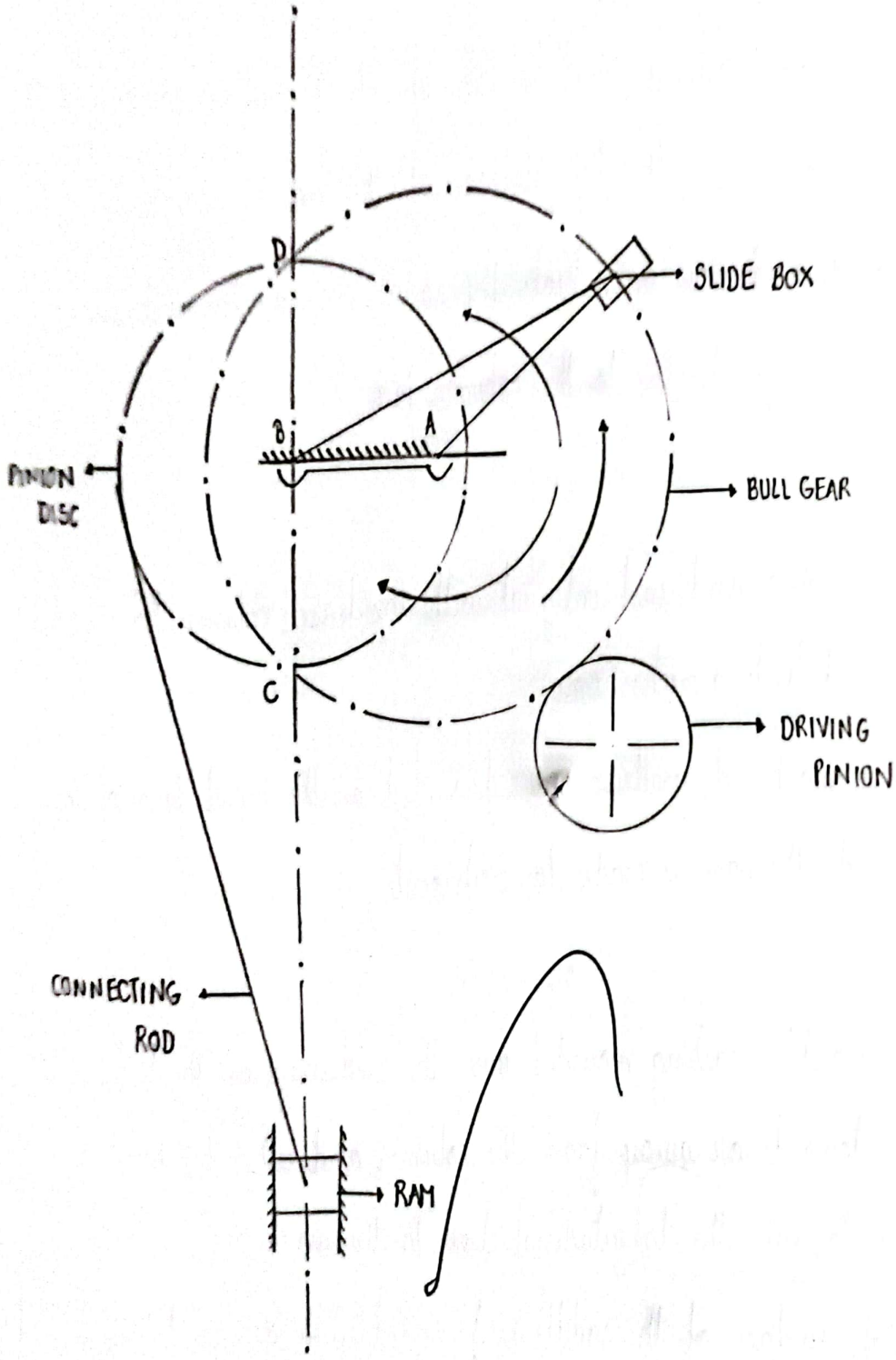
It is a vertical member and cast integral with the base. Column houses the ram drawing and feeding mechanisms.

Accurately machined guideways are provided on the front face of the column on which the ram is made to reciprocate.

3) Saddle:

The saddle is box-like casting mounted over the guideways on the bed surfaces, and it moves towards or away from the column and either by hand or power control to give the longitudinal feed to the work.

The top surface of the saddle is provided with accurately machined guideways perpendicular to the guideways on the bed for moving the cross-slide.



LINE DIAGRAM OF WHIT WORTH QUICK RETURN MECHANISM

4) Cross-slide:

It is mounted over the saddle guideways and made to move parallel to the column face. The movement of the slide may be controlled either by the power to give the cross feed.

5) Rotating or Rotary Table:

The slotter is provided with a circular table mounted on the top of the cross-slide. It can be rotated by rotating the worm which meshes with a worm gear connected at the underside of the table.

The table may be graduated in degree for indexing or dividing the periphery of the jobs. T-slots are cut on its top surface for holding the work by clamping devices. The rotation of the table may be effected either by hand or power.

6) Ram and Tool assembly:

The ram and tool head mounted on the guideways of the column and reciprocable by holding the tool at its bottom end of the tool head.

Slotter Machine Mechanism:-

1) Whitworth Quick Return Mechanism:

The bull gear is mounted on a fixed hub at the rear end of the machine

and it is rotated by a driving pinion from the motor. The driving plate is connected to the main shaft through the fixed hub.

It holds the crankpin with a sliding block and slides on a drawing plate, so that when the gear rotates, it imparts rotary motion to the drawing plate and shaft among 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.

2) Feed Mechanism:

In a slotter, machine, the feed is given by a table either by hand or power. The slotter table may have three movements.

→ Longitudinal feed:

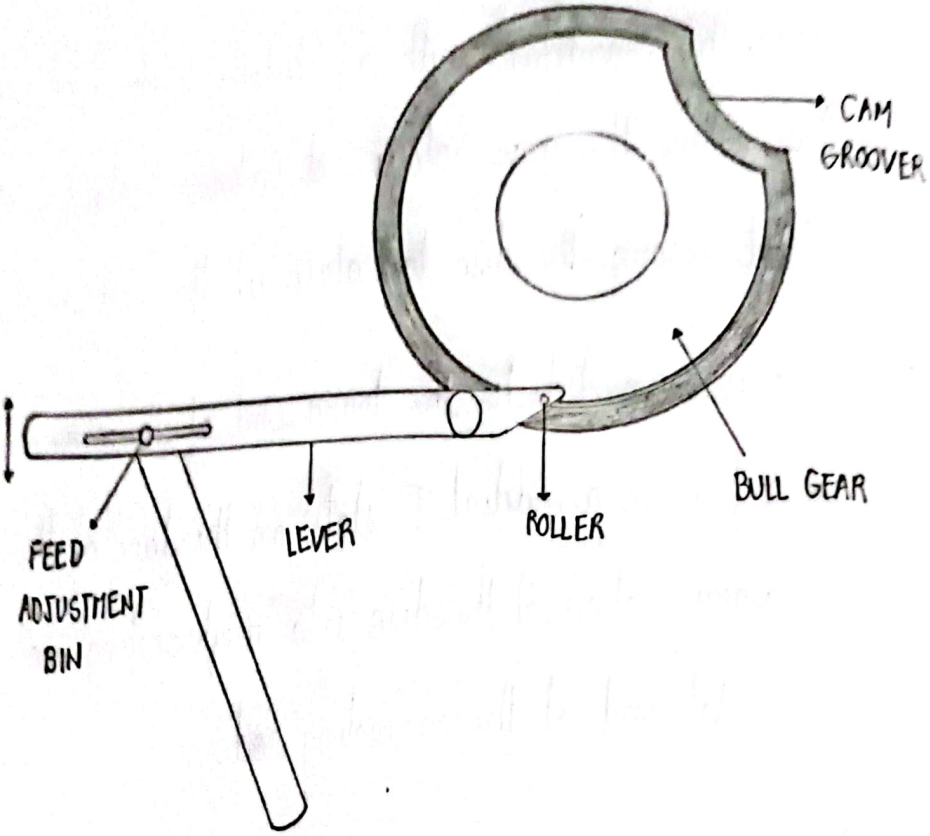
If the table is fed perpendicular to the column toward or away from its face is known as a longitudinal feed.

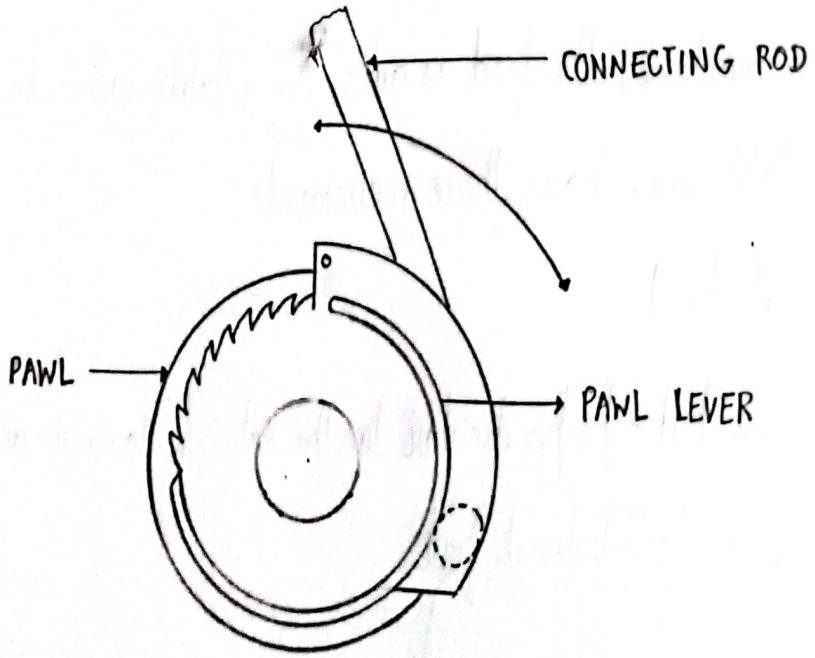
→ Crossfeed:

If the table is fed parallel to the face of the column is known as crossfeed.

→ Circular feed:

If the table is fed by rotating the table about the vertical axis.





POWER FEED MECHANISM

3) Power (Automatic) Feed System:

It consits of a bull gear with a cam groove in which there is a roller slide. When the bull gear rotates, the roller attached to the lever follows the contour of the cam groove and moves up and down only during a very small part of the revolution of the bull gear. The cam groove is so cut that the movement of the lever will take place only at the beginning of the cutting stroke.

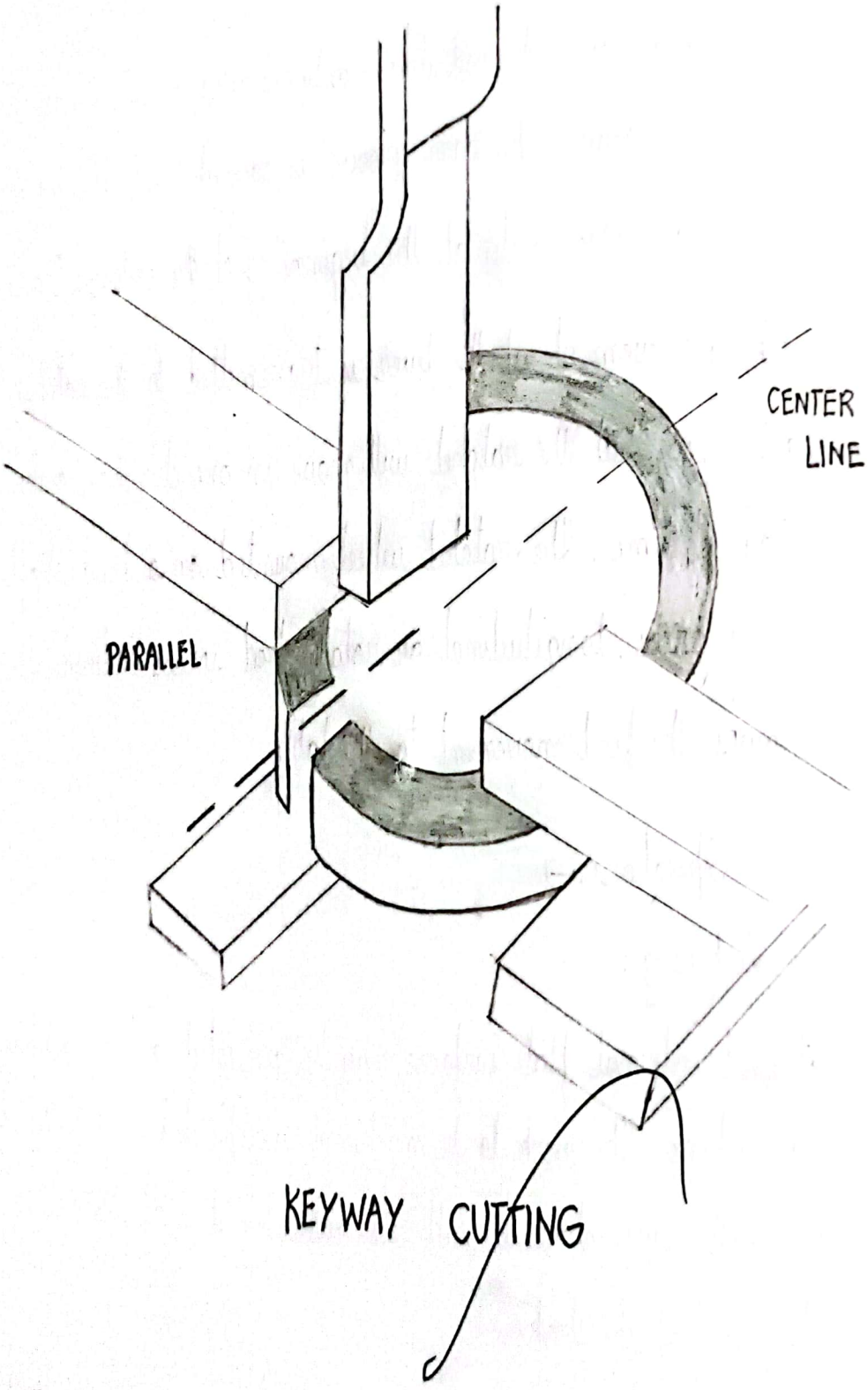
The rocking movement of the lever is transmitted to the ratchet and pawel mechanism so that the ratchet will move in one direction only during a short period of time. The ratchet wheel mounted on a feed shaft may be engaged with a cross, longitudinal or rotary feed screws individually or together it gives the feed movement to the table.

Slotter Machine Operations:-

1) Flat Surface Machining:

The external and internal flat surfaces may be generated on a workpiece easily in a slotting machine. The work to be machined is supported on parallel strips so that the tool will have clearance with the table when it is at the centre extreme downward position of the stroke.

The table is clamped to prevent any longitudinal or rotary level and the cut is started from one end of the work. The crossfeed is supplied at the beginning of each cutting stroke and the work is completed by using a roughing


CENTER
LINE
PARALLEL
KEYWAY CUTTING

and a finishing tool. While machining an internal surface, a hole is drilled into the workpiece through which the slotter tool may pass during the front cutting stroke.

2) Machining Circular Surfaces:

The external and internal surfaces of a cylinder can also be machined in a slotter machine. The work is placed centrally on the rotary table and packing pieces and clamps are used to hold the work securely on the table.

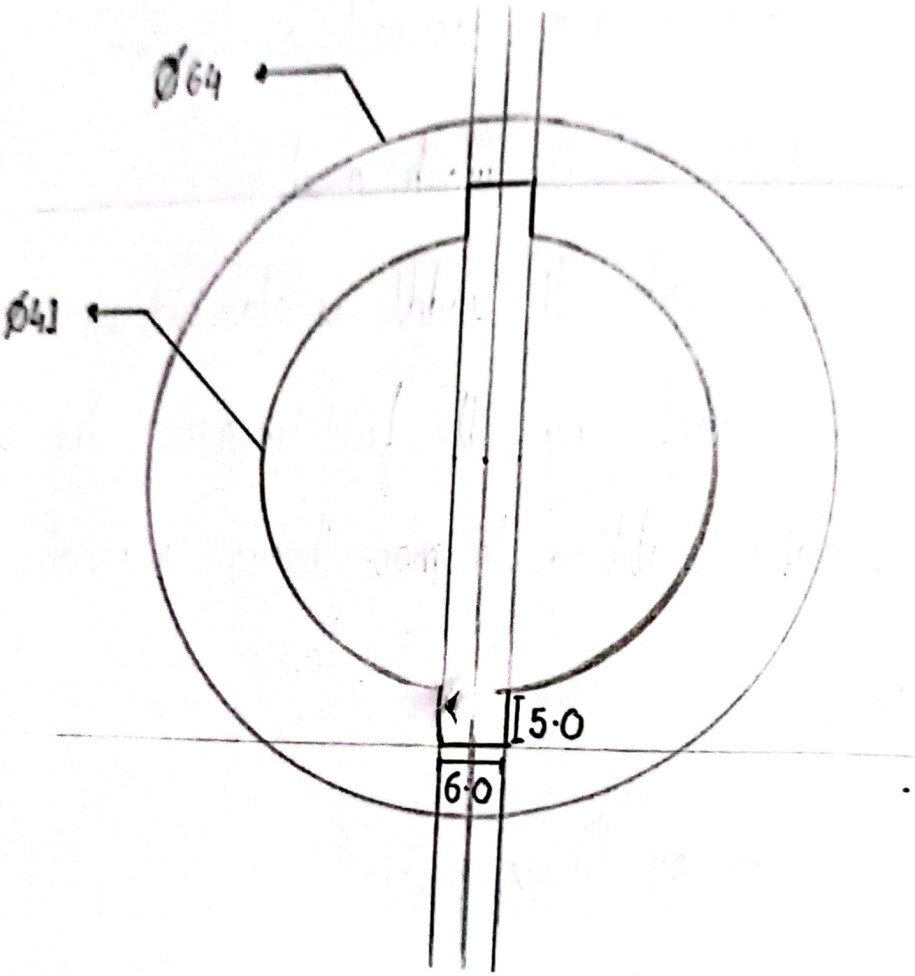
The tool is set radially on the work and necessary adjustments of the machine and the tool are made. The saddle is clamped in its position and the machine is started. While machining, the feed is given by the rotary table on the feed screw which rotates enabling to move through a small arc at the beginning of each cutting stroke.

3) Machining Irregular surfaces or Cams:

The work is set on the table and necessary adjustments of the tool and the machine are made as detailed in other operations. By combining cross, longitudinal and rotary feed movements of the table, any contoured surface can be machined on a workpiece.

4) Machining Grooves or Keyways:

Internal and external grooves are cut very conveniently machined. A slotter is specially intended for cutting internal grooves which are different to produce in other machines.



INTERNAL KEYWAYS SLOTTING

DATA: 27/9/22

Experiment - V

Internal Keyway Slotting on Slotter Machine

Aim:

To make a slot in a mild steel pulley as per the required dimensions.

Materials Required:

Mild steel pulley, Slotter machine

Apparatus Required:

5/32" L-key, V-Block, Surface plate, Try square, 10"-off round file, Dot punch with hammer, Vernier Height Gauge, Vernier Calliper, Rough Cutting tool, Grooving tool.

Sequence of Operation:

a) Checking
b) Marking
c) Punching
d) Work piece setting
e) Tool setting
f) Slotting

Procedure:-

1) The tool is fixed to the tool post such that the movement should be exactly perpendicular to the table.
2) The workpiece is then set in the vice such that the tool is just above the workpiece. Adjust the length of the stroke of the ram.
3) Then bring the tool to the initial position.
4) Rotate the work table by an angle 90° and continue the process for the second slot
5) Repeat the progess for the remaning slots.

Precautions:-

1) The workpiece should be set securely and rigidly in the vice.
2) Before starting the machine make sure that the work, vice, tool, and ram are securely fastened.
3) Make sure the workpiece axis is parallel to the line of action of tool.

Result:

The required internal keyways are slotted according to the required dimensions.

Study of the Grinding Machine

Introduction :-

Grinding is a metal cutting operation like any other process of machining removing metal in comparitively smaller volume. The cutting tool used is an abrasive wheel having many number of cutting edges. The machine on which grinding operation is performed is called a grinding machine.

Grinding is done to obtain very high dimensional accuracy and better appearance. The accuracy of the grinding process is 0·000025 mm. The amount of material removed from the work is very less.

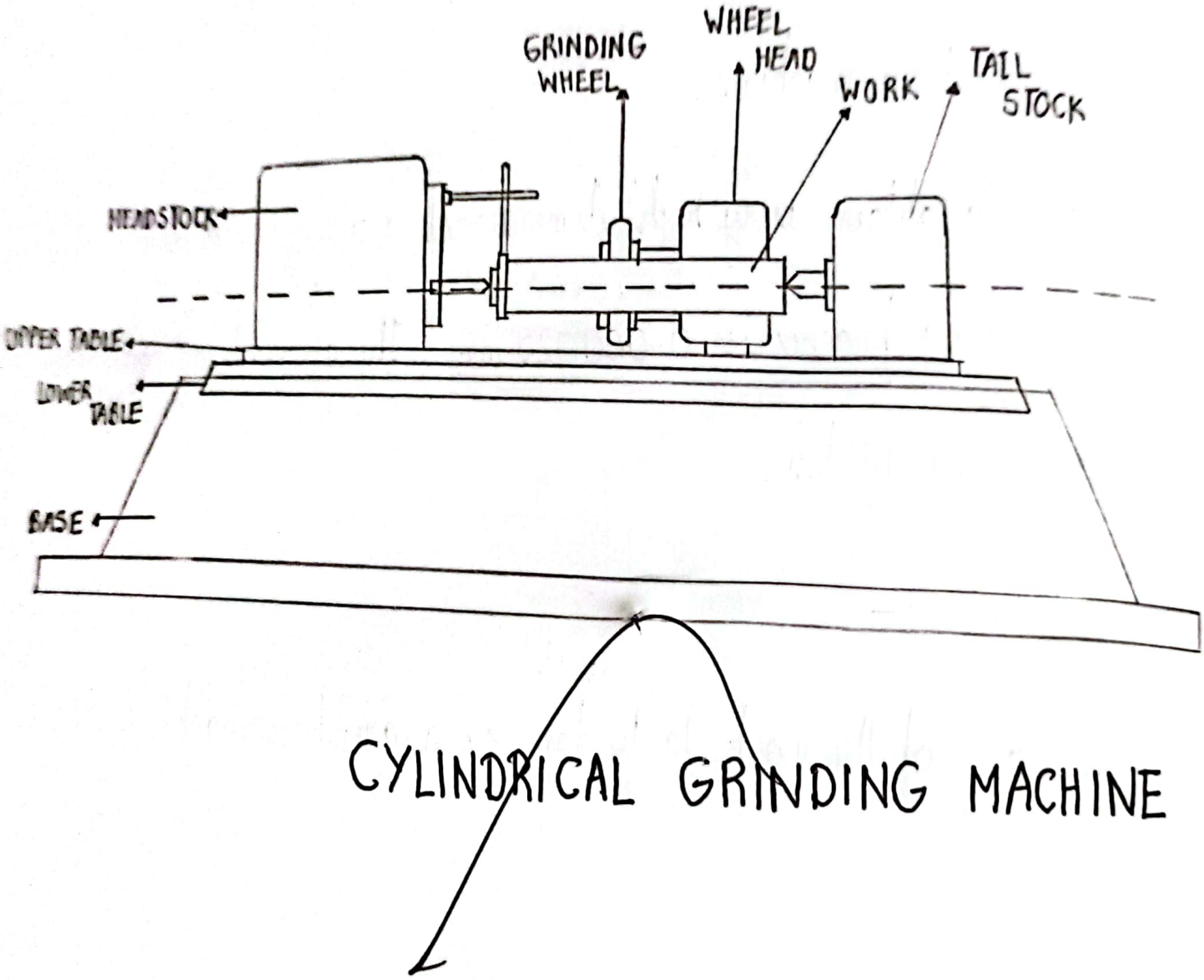
Types of Grinding Machines :-

According to the accuracy of the work to be done on a grinding machine, they are classified as:

1) Rough Grinding Machine:

The rough grinding machines are used to remove stock with no reference to the accuracy of results. Excess metal present on the cast parts and welded joints are removed by rough grinders. The main types of rough grinders are:

- Hand grinding machine
- Bench grinding machine



CYLINDRICAL GRINDING MACHINE

- Floor stands grinding machine
- Flexible shaft grinding machine
- Swing frame grinding machine
- Abrasive belt grinding machine

3) Precision Grinding Machine:

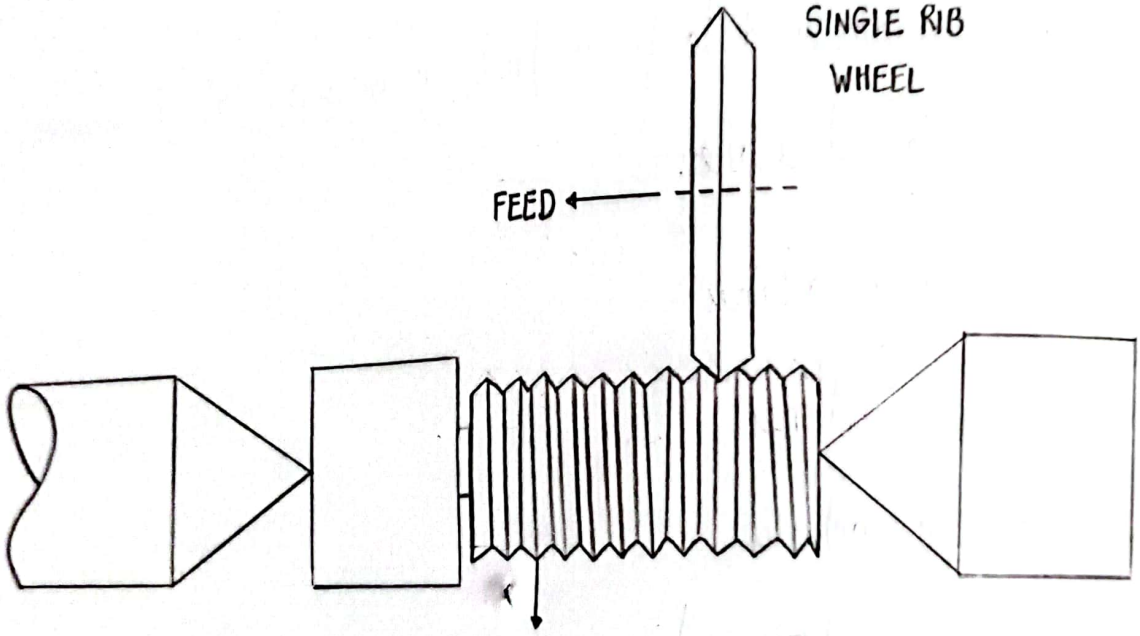
Precision grinders are used to finish parts to very accurate dimensions. The main types of precision grinders are:

- Cylindrical grinding machines
- Internal grinding machines
- Surface grinding machines
- Tool and cutter grinding machines
- Special grinding machines

Cylindrical Grinding Machine:

Cylindrical grinders are generally used to grind external surfaces like cylinders, taper cylinders, faces and should of work. There are two types of cylindrical grinding grinding machines and they are:

- External cylindrical grinding machine
- Internal cylindrical grinding machine



THREAD CUTTING OPERATION

Cylindrical grinding is performed by mounted and rotating the work between centres in a cylindrical grinding machine. The work is fed longitudinally against the rotating grinding wheel to perform grinding. The suffer table of the grinding machine is set at 0°C during the operation.

Cylindrical Grinding Wheel:-

A grinding wheel is a multitooth cutter made up of many hard particles known as abrasives having sharp edges. The abrasive grains are mixed with a suitable bond, which acts as a matrix to manufacture grinding wheels. According to construction, grinding wheels are classified under categories.

- Solid grinding wheels
- Segmented grinding wheels
- Mounted grinding wheels

Abrasives:-

Abrasives are used for grinding and polishing operations. It should have uniform physical properties of hardness, toughness and resistance to fracture. Abrasives may be classified into two principal groups

1) Natural Abrasives:

The natural abrasives are obtained from the Earth's crust. They include sandstone,

emery, corundum and diamond. Sandstone is used as an abrasive to grind softer materials only.

Emery is natural alumina. It contains aluminium oxide and iron oxide. Corundum is also a natural aluminium oxide. It contains greater percentage of aluminium oxide than emery. Both emery and corundum have a greater hardness and abrasive action that sandstone.

Diamond is the hardest available natural abrasive. It is used as making grinding wheels to grind cemented carbide tools.

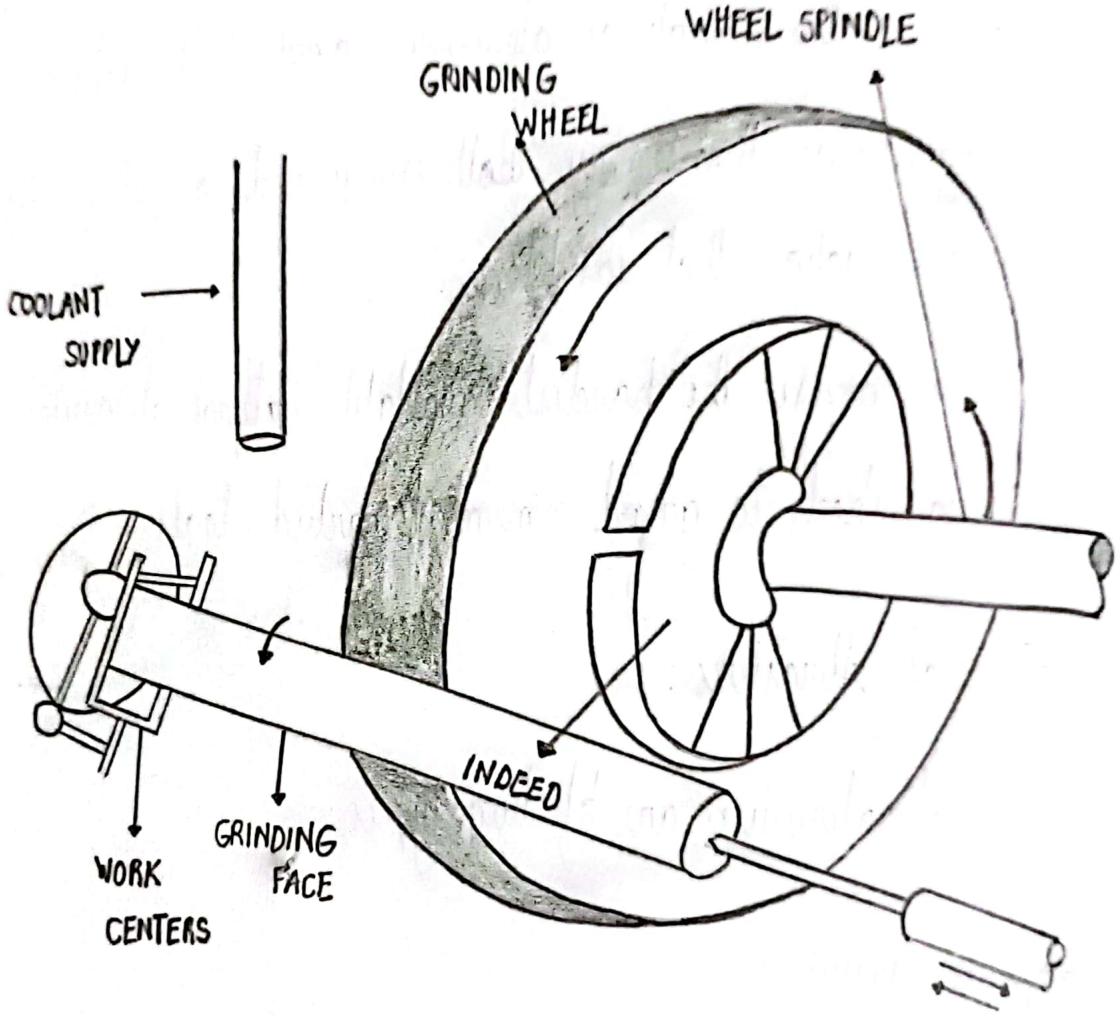
2) Artificial Abrasives:

Artificial abrasives are of two types:

- Silicon Carbide:

Silicon carbide is manufactured from 56 parts of silica, 34 parts of powdered coke, 2 parts of salt and 12 parts of sawdust in a long rectangular electric furnace of the resistance type that is built of loose brick work. There are two types of silicon carbide abrasives - green grit and black grit.

Silicon carbide abrasive is next to diamond in the order of hardness. But it is not as tough as aluminium oxide. It is used for grinding materials of low elastic tensile strength such as cemented carbides, ceramic materials, gray brass, bronze, copper, aluminium, vulcanized rubbers, etc.



CYLINDRICAL GRINDING

• Aluminium Oxide:

Aluminium oxide is manufactured by heating mineral bauxite, silica, iron oxide, titalium oxide, etc mixed with ground coke and iron bearing in arc type electric furnace. Aluminium oxide is tough and not easily fractured, so it is better adapted to grinding materials of high tensile strength such as most steels, carbon steels, high speed steels and tough bronze.

Types of bonds:

A bond is an adhesive substance that is employed to hold abrasive grains together in the form of grinding wheels. There are several types of bonds. Different grinding wheels are manufactured by mixing hard abrasives with suitable bonds.

Grain Size:

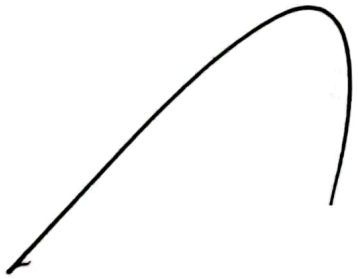
The grinding wheel is made up of thousands of abrasive grains. The grain size or grit number indicates the size of the abrasive grains used in making a wheel, or the size of the cutting tools teeth. Grain size is denoted by a number indicating the number of meshes per linear inch of the screen through which the grains pass when they are graded. There are four different groups of the main sizes namely, coarse, medium, fine and very fine. If the grit number is large, the size of the abrasive is fine and a small grit number indicates a large grain of abrasive.

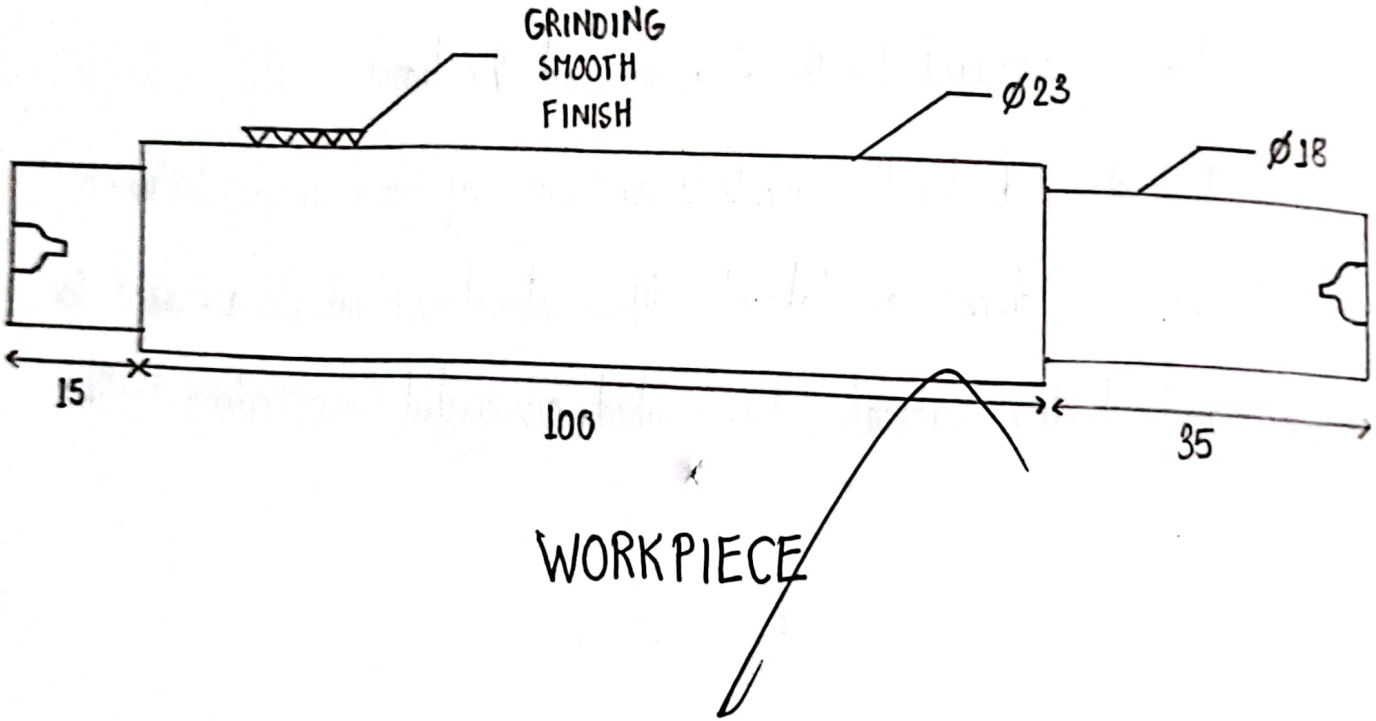
Grade:

The grade of a grinding wheel refers to the hardness with which the wheel holds the abrasive grains in place. It does not refer to the hardness of the grains. The term soft or hard refers to the resistance a bond offers to disruption of the abrasives.

Structure:

The relative spacing occupied by the abrasives and the bond is reffered to as structure. It is denoted by the numbers and size of void spaces between grains. It may be 'dense' or 'open'. Open structured wheels are used to grind soft and ductile materials. Dense wheels are useful in grinding brittle materials.




GRINDING
SMOOTH
FINISH
Ø23
Ø18
15
100
35
WORKPIECE

DATA : 1/10/22

Experiment - VI

Cylindrical Grinding

Aim:

To perform cylindrical grinding operation of the given workpiece.

Materials Required:

Grinding machine, Mild Steel Rod

Apparatus Required:

Coolant, Grinding wheel, spanner, Wooden thick sheet, Dog handle

Sequence of Operation:

a) Facing
b) Turning
c) Chamfering
d) Drilling
e) Work piece setting
f) Grinding

Procedure:-

1) The workpiece is mounted on a magnetic table, so that the time along the face of the grinding wheel coincides with the edge of the workpiece.
2) Depth of cut is given to workpiece by feed handle.

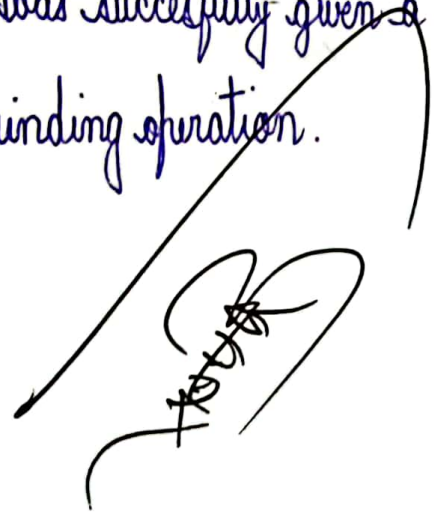
3) The workpiece is mounted / reciprocated under the attack wheel and the table feed axially between passes to produce flat surface and to get the required size.

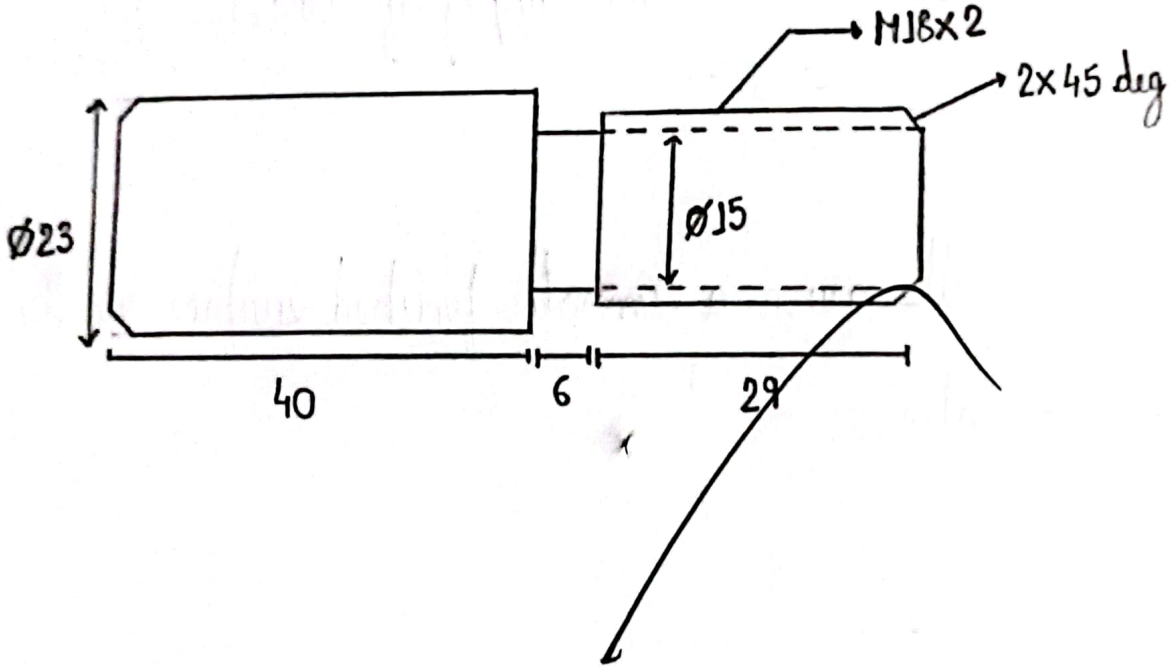
Precautions :-

1) Coolant usage is compulsory
2) Grinding tools need to be desired prior
3) Maintain the right feed
4) Work-wheel zone must recieve a constant suffly of coolant.

Result :

The workpiece was succesfully given a smooth finished surface by the cylindrical grinding operation.




M18x2
2x45 deg
Ø23
Ø15
40
6
29

DATE: 7/10/22

Experiment - VII

Thread Cutting Operations on Lathe

Aim:

To perform Thread cutting operation on lathe on the given workpiece

Materials Required:

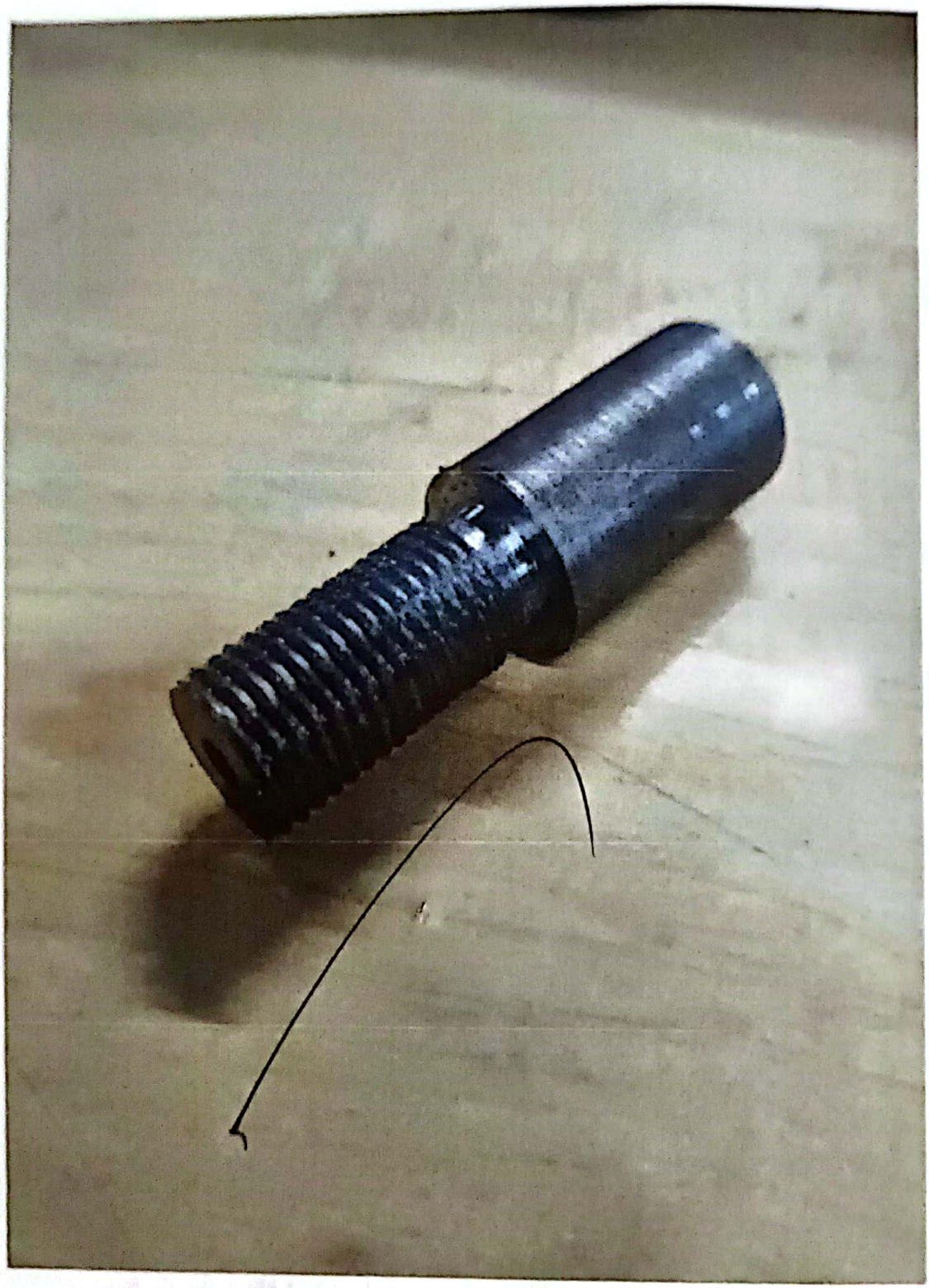
Mild Steel Rod of 25 mm diameter and 100 mm long

Tools Required:

Single point cutting tool, Grooving tool, Thread cutting tool, Center drill, Drill chuck with key, Revolving center, Chuck key, Tool post key, 14-15 double end spanner.

Procedure:-

1) The workpiece is fixed in a three jaw chuck with sufficient overhang.
2) Fixing the cutting tool in the tool post key
3) Facing is performed with giving longitudinal depth of cut.
4) Plain turning operation is performed to reduce the diameter
5) Chamfering operation is done according to the dimensions.
6) Grooving operation is done using the V-cutting tool
7) Reduce the speed of the spindle by engaging back gear and use Tumbler.



8) Feed reversing mechanism is employed to transmit power through lead screw

9) Calculate change in gear according to the pitch

10) Increase the depth of cut slowly going forward and backward.

Result:

Thus the required workpiece was formed according to the given dimensions.

Study of the Milling Machine

Introduction :

Milling machine is another most important machine today after the lathe machine tool and drilling machine. In this machine a multi-cutter is rotating against the workpiece and material is removed from the workpiece accordingly.

Milling is a process of metal removing by feeding the workpiece passes through the multi-point cutter. The metal removal rate is faster than the Lathe Machine.

Parts of a Milling Machine :-

1) **Base :**

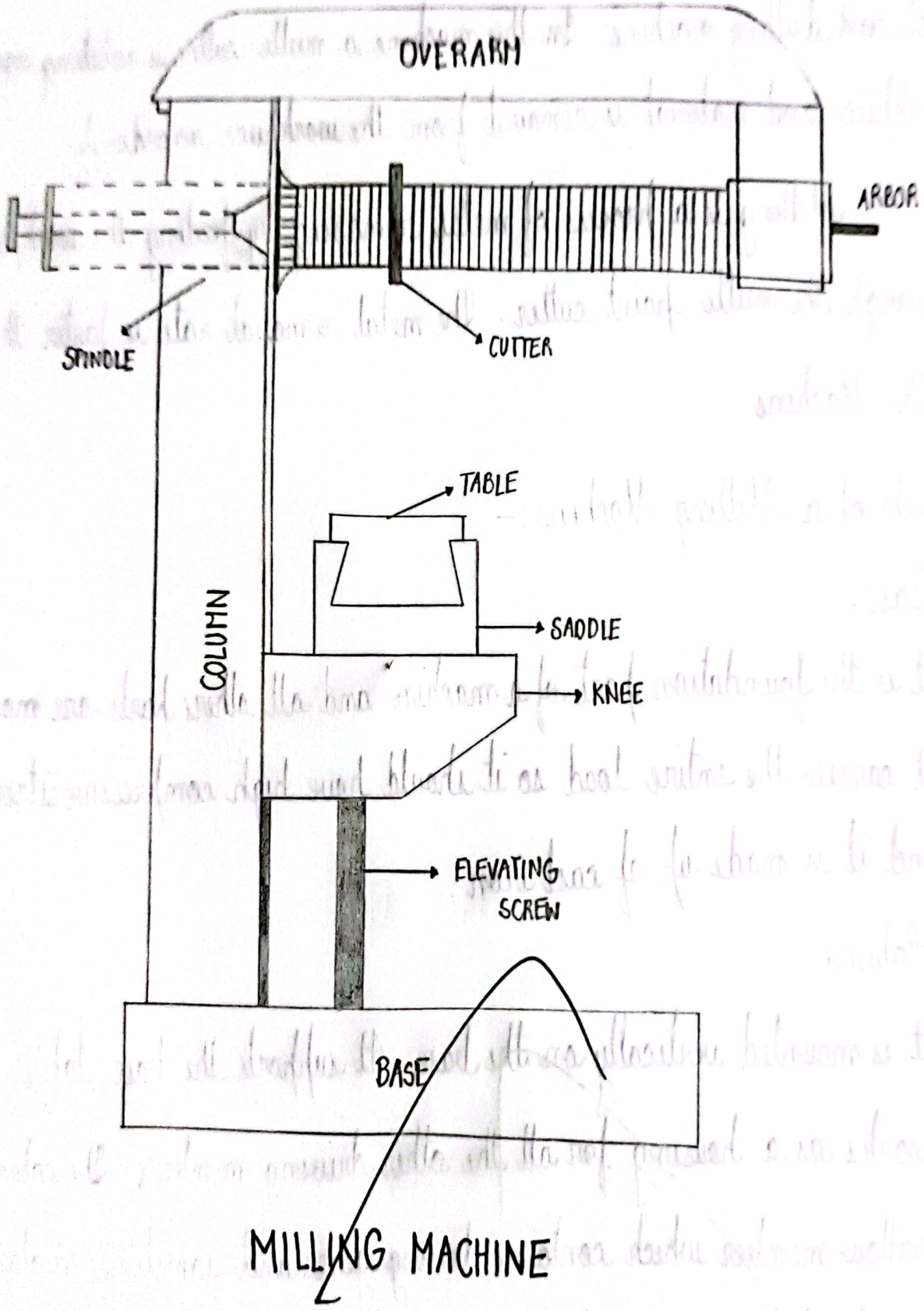
It is the foundation part of a machine and all others parts are mounted on it. It carries the entire load so it should have high compressive strength and it is made up of cast iron.

2) **Column :**

It is mounted vertically on the base. It supports the base, table, etc and works as a housing for all the other driving members. The column is a hollow member which contains driving gears and sometimes motors for the spindle and the table.

3) **Knee :**

It is a casting that supports the saddle and table. All gearing mechanism



MILLING MACHINE

is enclosed within the knee. It is fastened to the column by dovetail ways. The knee is supported and adjusted by a vertical positioning screw

4) Saddle:

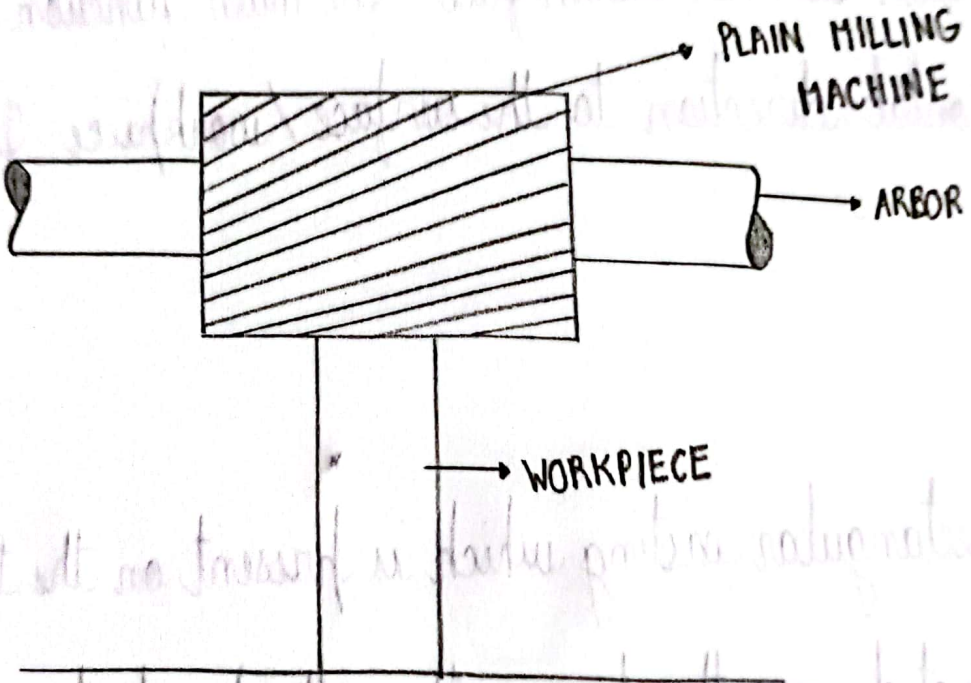
This is placed between the table and the knee, and works as an intermediate part between them. This can move transversally to the column face. This slides over the guideways provided situated on the knee which is perpendicular to the column face. The main function is to produce motion in a horizontal direction to the surface / workpiece. This is also made by cast iron.

5) Table:

This is a rectangular casting which is present on the top of the saddle. The table is situated over the knee. It is the point of a machine that holds the workpiece while machining. This made by cast iron and has T-slot cut over it. This provides vertical motion by moving the knee up and down. It provided horizontal motion by the feed screw. This provides a horizontal motion by moving the saddle.

6) Overhanging Arm:

The over arm is used to fasten the supports. It may consist of one or two cylindrical bars that slide through the holes in the column. It is made by cast iron.



PLAIN CUTTER

7) Spindle:

The spindle is the main part of the machine which holds the tools in the right place. The spindle provides the drive for cutters and attachments used on the machine.

8) Arbor:

This is a mechanical part used on extension part at the spindle in a horizontal mill machine. It is fitted on the spindle and used whenever required.

9) Arbor Supports:

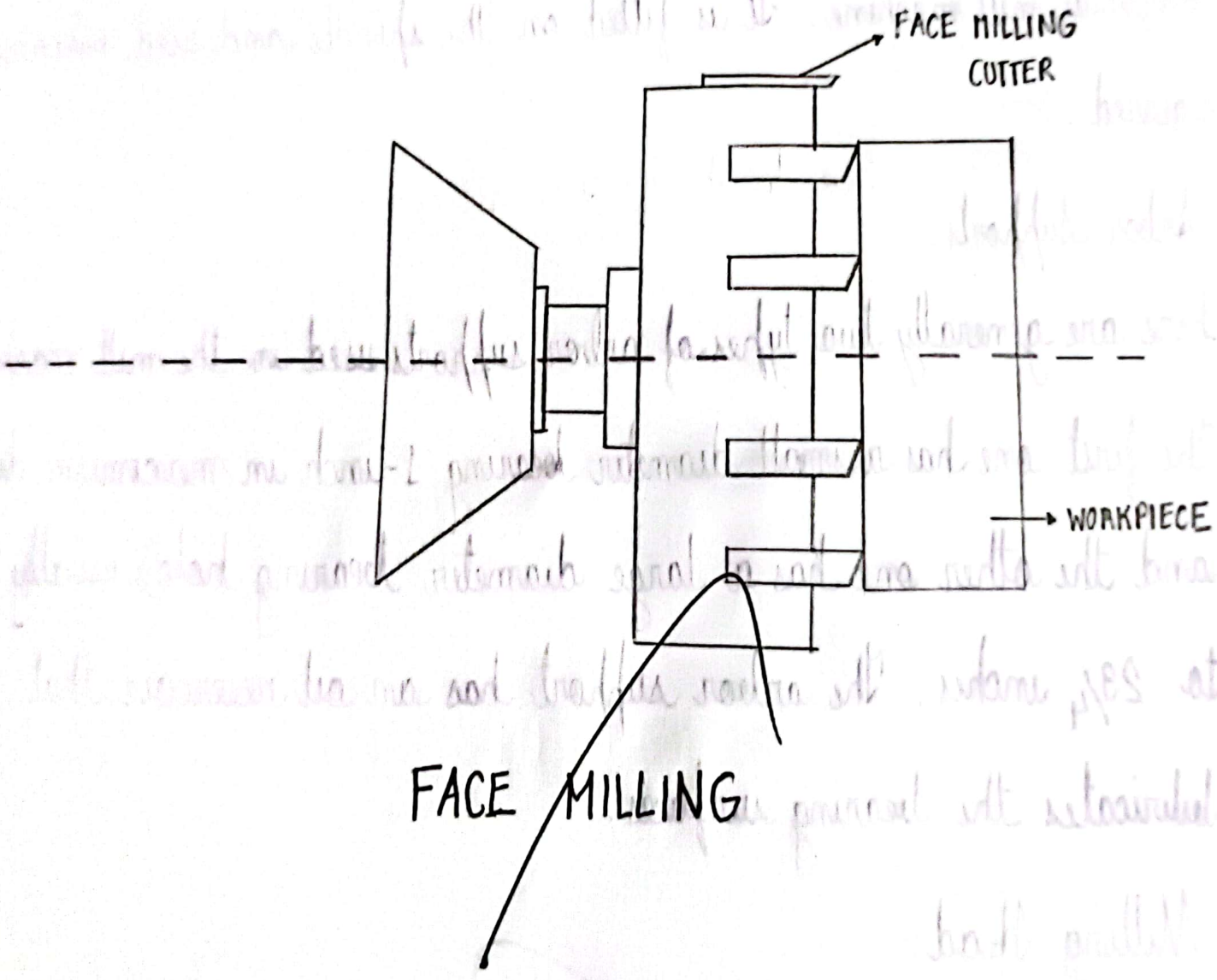
There are generally two types of arbor supports used in the mill machine. The first one has a small diameter bearing 1-inch in maximum diameter, and the other one has a large diameter bearing hole, usually up to $2\frac{3}{4}$ inches. The arbor support has an oil reservoir that lubricates the bearing surfaces.

10) Milling Head:

It is the upper section of a vertical mill machine. It consists of a spindle, driving motion and other controlling mechanisms.

11) Ram:

One end of the arm is attached to the column and the other end to the milling head.



FACE MILLING

Types of Milling Machines :-

1) Vertical milling machine:

The spindle is in the vertical position. No arbor is required in this machine. The cutter tool has a cylindrical shape and the cutting edges are situated as the circumference of the cylindrical face.

2) Horizontal milling machine:

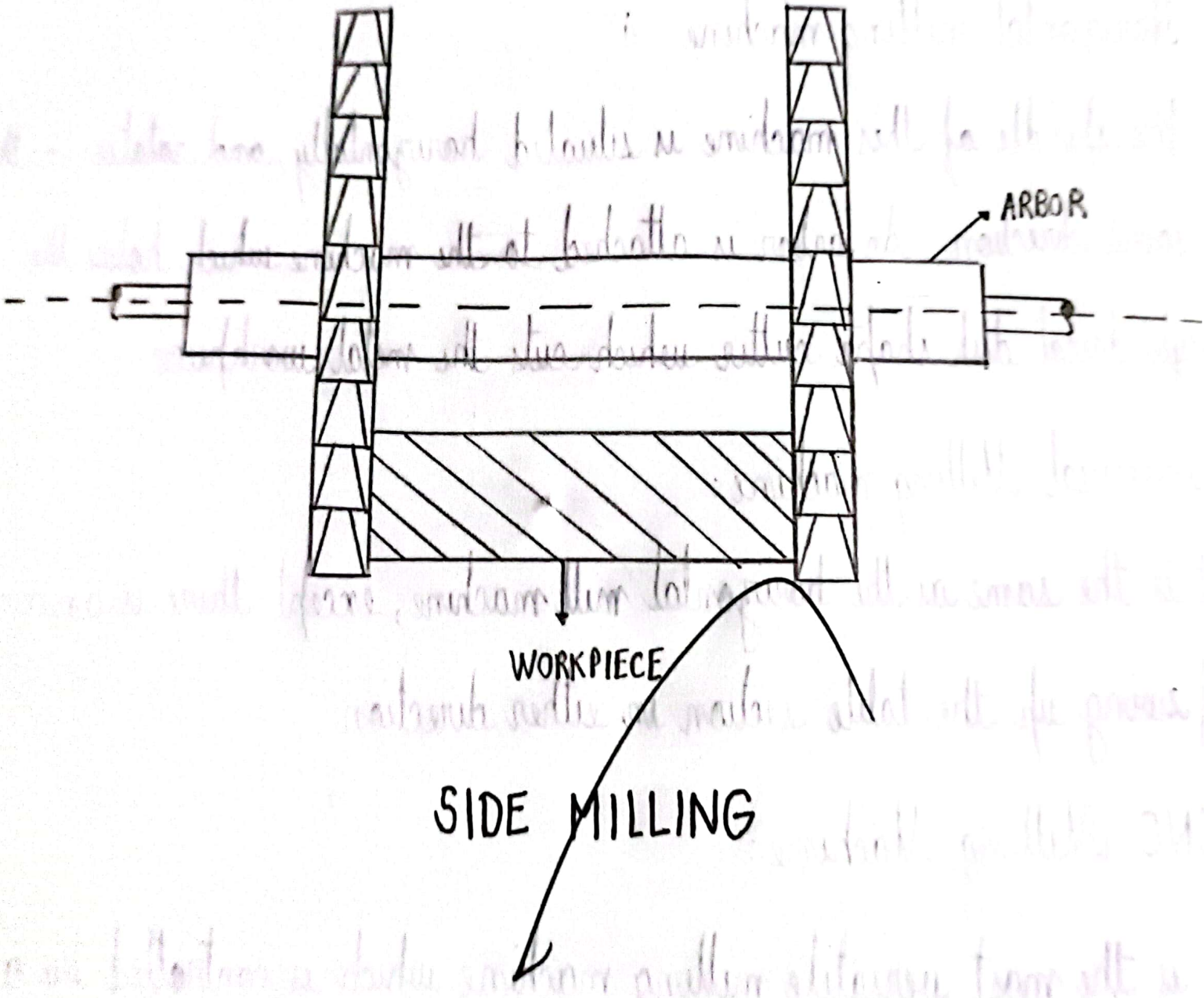
The spindle of this machine is situated horizontally, and rotates in the same direction. An arbor is attached to the machine which holds the cylindrical disk shape cutter which cuts the metal workpiece.

3) Universal Milling machine:

It is the same as the horizontal mill machine, except there is an arrangement of swing up the table section in either direction.

4) CNC Milling Machine:

It is the most versatile milling machine which is controlled by a computer. It is an upgraded version of the bed type mill machine, in which the spindle can move in all three directions and the table can rotate 360°. These all movements are hydraulically controlled which is commanded by a computer. In this way, any complex geometry can be machined on it.



SIDE MILLING

Working Principle:

The workpiece is holding on the workpiece worktable of the machine. The table movement controls the feed of workpiece against the rotating cutter. The cutter is mounted on a spindle or arbor and revolves at high speed. Except for rotation the cutter has no other motion. As the workpiece advances, the cutter teeth remove the metal from the surface of the workpiece and the desired shape is produced.

Milling Operations:-

1) Plain milling operation:

The operation to produce plain, flat, horizontal surfaces parallel to the axis of rotation.

2) Face Milling operation:

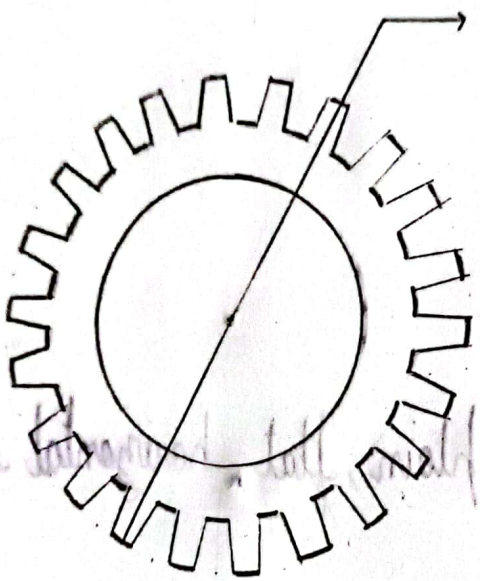
Operation performed by the face milling cutter on the surfaces which are perpendicular to the axis of the cutter.

3) T-slot milling operation:

The operation of producing T-slots on the workpiece by using the T-slots milling cutter.

4) Gear cutting operations:

Operation of producing gear tooth on the gear blank by using a form-relieved cutter in a milling machine.



MODULE = 2

CUTTER NUMBER = 5

NO. OF TEETH = 22

GEAR CUTTING OPERATION

Experiment - VIII

DATE: 14/10/22

Gear Cutting Operations on the Milling Machine

Aim:

To perform gear cutting using the universal milling machine on a work piece

Materials Supplied:

Cast iron pulley

Tools Required:

Main drill, Dog carrier, Vernier Height Gauge, Tool post key, 30-32" Spanner, 20-22" Spanner, Involuth cutter, Coolant oil (SAE 20).

Calculations:-

Outer diameter = $(Z+2)m$, where

$Z \rightarrow$ no. of teeth

$m \rightarrow$ module

Depth = $2.25 \times m$

1 Division = 0.02mm

1 Revolution = 50 div = 1mm

Cutter number:-

Z	CUTTER NO.
12-13	8
14-16	7
17-20	6
21-26	5

Z	CUTTER NO
27-34	4
35-54	3
55-134	2
135>	1

Available holes in hole circuit plate

39, 33, 29, 24, 21, 19, 17, 18, 15

Index → Works on worm wheel mechanism

→ Any round object will be equally divided by the index

Index = $\frac{40}{N}$, where N → no. of teeth

Outer dia = (Z+2)m

= 24×2 = 48mm

Depth = 2.25m = 4.5m

4.5mm ⇒ 225 DIV

Index = $\frac{40}{22} = \frac{20}{11} = 1\frac{9}{11}$

$\frac{9\times3}{11\times3} = \frac{27}{33}$ → No. of holes available in the circuit plate

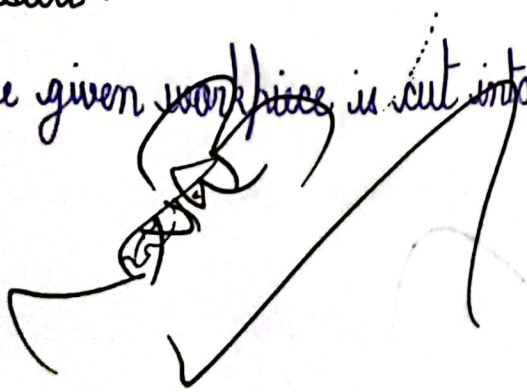
∴ Each indexing → 1 Crank revolution + 27 holes in 33 hole plate

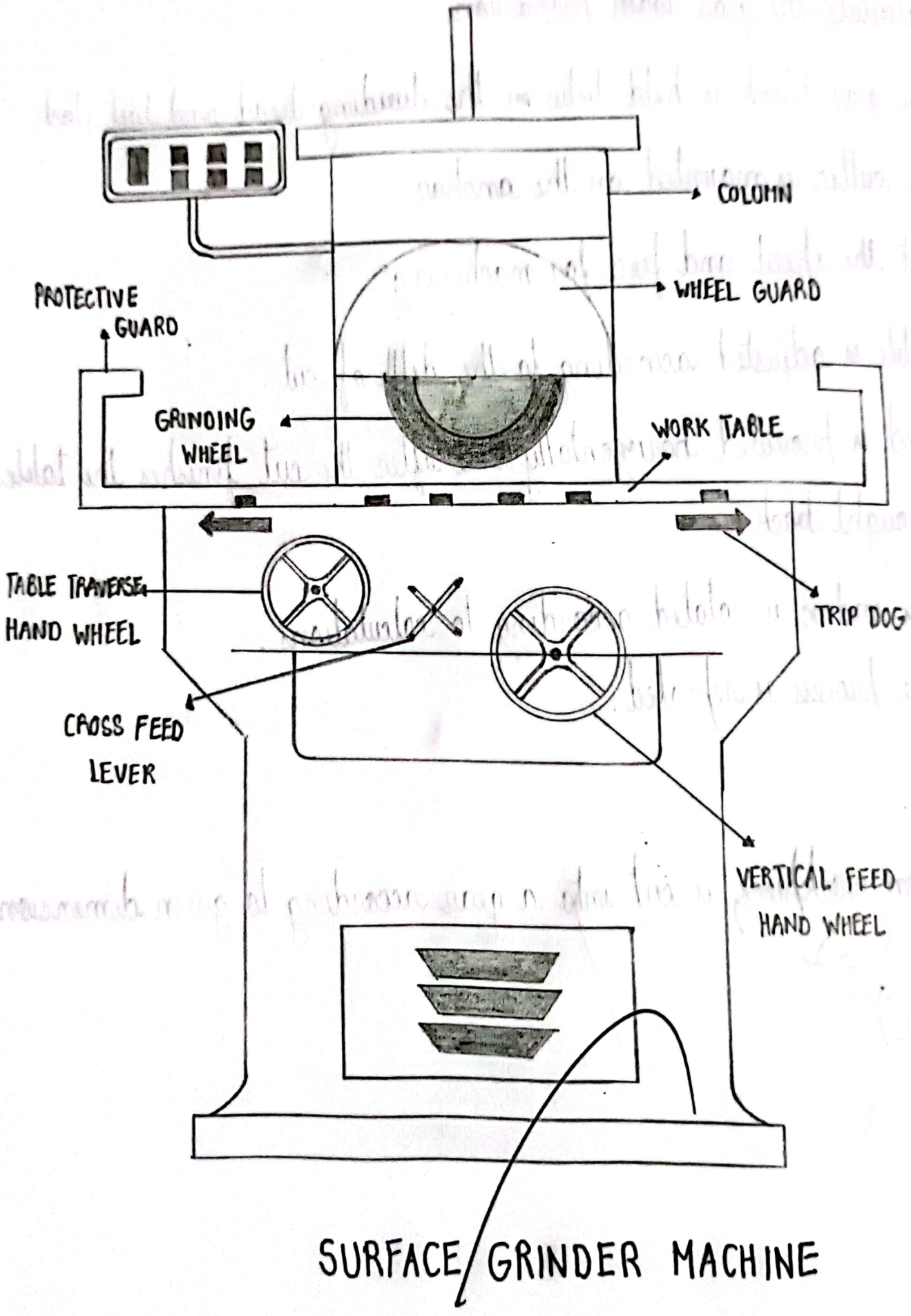
Procedure:-

1) Calculate the gear tooth proportions
2) The gear blank is held between the dividing head and tail stock
3) The cutter is mounted on the anchor
4) Set the speed and feed for machining.
5) Table is adjusted according to the depth of cut.
6) Feed is provided horizontally and after the cut finishes the table is brought back.
7) The index is rotated according to calculations.
8) The process is repeated.

Result:

The given ~~workpiece~~ is cut into a gear according to given dimensions.





SURFACE GRINDER MACHINE

Study of the Surface Grinding Machine

Introduction:

A grinding machine is a production machine tool used in the manufacturing industry in which the grinding wheel is attached in the tool post and the workpiece is fixed to the worktable and when the operation starts it removes the unwanted material to get the desired surface finish, correct usage, and accurate shape of the workpiece.

It is also known as the Abrasive Grinding Process, because the abrasives are placed on the surface to do the finishing process with much more accuracy.

The grinding machine is widely used for the finishing of the workpieces, because the work removal rate is low between 0.25 to 0.50 mm which gives an excellent precision.

Parts of a Grinding Machine:-

1) **Base or Bed:**

The base or bed is made up of cast iron. It is situated horizontally and it is the bottom part of the grinding machine, provides support to all the grinding parts. When machine operation starts some vibration occurs therefore base acts an absorber of vibrations.

2) Column:

Column is like a vertical pillar of the machine in this section the abrasive wheel, wheel head, and wheel guard are kept. The column is also made up of cast iron.

3) Headstock:

The headstock's work is to match the center and help to grip or hold the workpiece.

4) Tailstock:

Tailstock is also known as dead center. It also provides griffing to the workpiece.

5) Work Table:

In the new and improved grinding machines, the headstock and tailstock are replaced with worktables. A worktable is like a magnetic chuck that holds the workpiece.

6) Wheel Head:

In this action, the abrasive wheels which are our tool for operation are placed and this is moved vertically up and down. With the use of a feed hand, we can adjust the wheel head. Moving this wheel head down so that the grinding wheel can touch the workpiece. The wheel head consists of a grinding wheel and driving motor.

7) Grinding or Abrasive Wheel:

Grinding or Abrasive wheel is our main tool used here to remove the unwanted materials from the workpiece to get desired smoothness and surface finish. The wheels are coated with an abrasive particle. The abrasive wheel comes with various types and properties.

There are four commonly used abrasive materials for the surface of the grinding wheels are Aluminium oxide, silicon carbide, cubic boron nitride (CBN), and diamond.

8) Crossfeed:

Crosfeed is also an important part of this machine used for moving up and down or left and right of the wheel head and work table and so on.

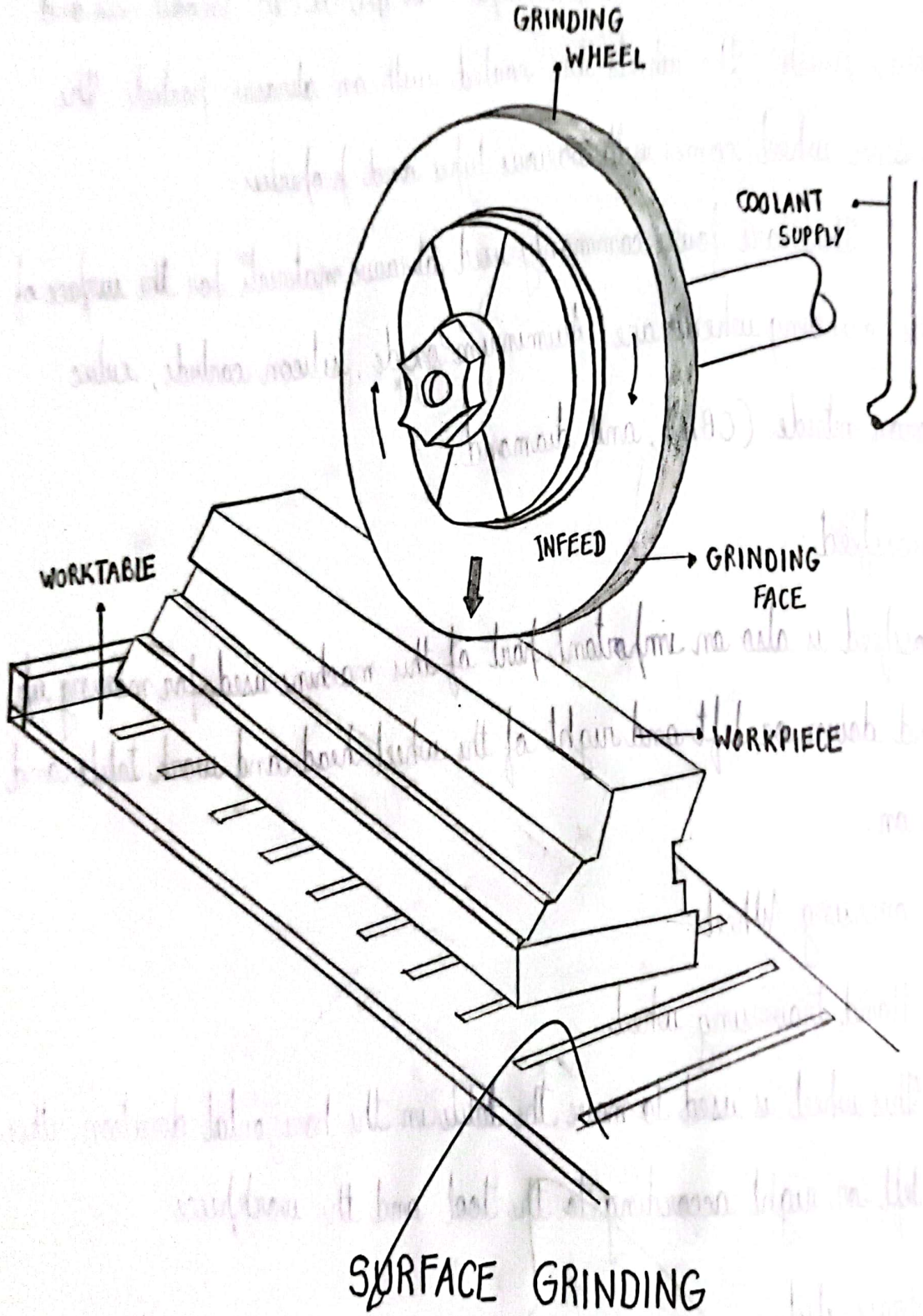
9) Traversing Wheel:-

a) Hand traversing wheel:

This wheel is used to move the table in the horizontal direction either left or right according to the tool and the workpiece.

b) Cross-slide:

It is used to move the worktable forwards and backwards.



SURFACE GRINDING

c) Vertical Feed Hand Wheel:

The vertical feed hand traversing wheel is used to move the wheel head in the vertically upward and downward direction.

10) Coolant Supply Nozzle:

The main work of the coolant supply nozzle is to cool or reduce the temperature generated while performation of the operation. If this part is not there then there are many chances of wear and tear happening because of the high temperature between the wheel and the workpiece. The coolant may be water or any other oil.

Working Principle:

The working of the Grinding Machine is the workpiece is fed against the rotating abrasive wheel. The action of rubbing or friction generates between the workpiece and tool and therefore the material is removed.

Grinding Machine Operations:-

1) Surface Grinding Operations:

Surfaces grinding involves grinding flat surfaces and is one of the most common grinding operations. Typically the workpiece is secured on a magnetic chuck attached to the worktable of the grinder. Non-magnetic naturals generally are held by vises, special fixtures,

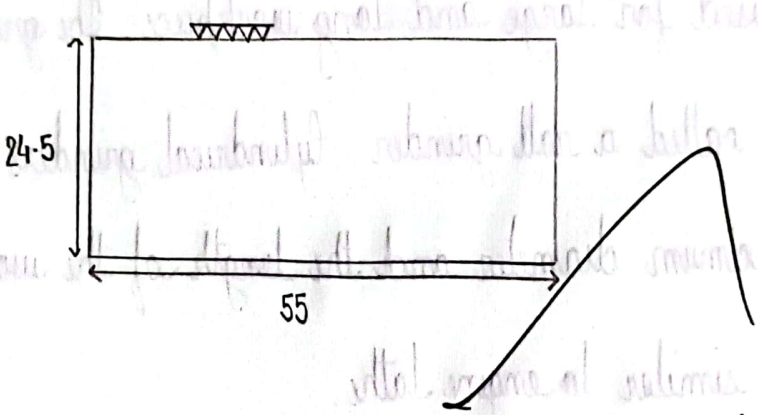
vacuum chucks. A straight wheel is mounted on the horizontal spindle of the grinder. Transverse grinding occurs as the table is reciprocating. In plunge grinding the wheel is moved radially into the workpiece as it is when grinding a groove.

2) Cylindrical Grinding Operation:

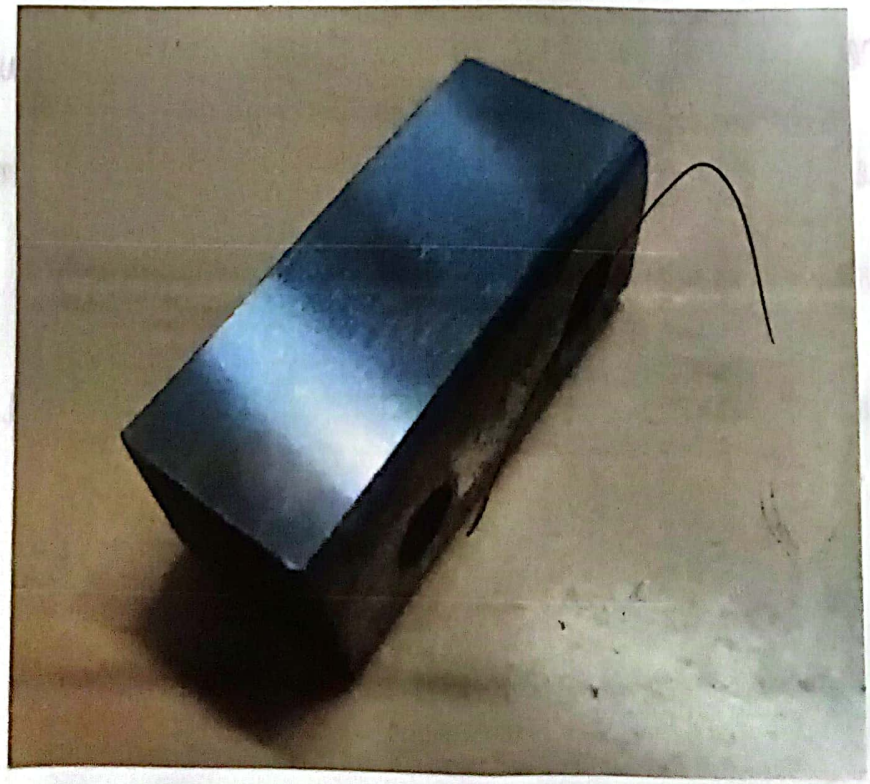
The rotating cylindrical workpiece reciprocates latterally along the axis in a grinder used for large and long workpiece. The grinding wheel reciprocates called a roll grinder. Cylindrical grinders are identified by the maximum diameter and the length of the workpiece that can be ground similer to engine lathe.

3) Thread Grinding operation:

It is done on cylindrical grinders with specially dressed while matching the shape of the thread as well as using a centerless grinder. Although costly thread produced by grinding is the most accurate of any manufacturing process and has a very fine surface finish.



SURFACE GRINDING OPERATION



Experiment - IX

DATE: 20/10/22

Surface Grinding Operations

Aim:

To perform surface grinding operations on the given workpiece

Materials Required:

Mild Steel block

Tools Required:

Grinding wheel, coolant

Procedure:-

1) Workpiece is fixed on the worktable
2) Now with the help of the traversing wheel we adjust the tool and workpiece and bring it into contact.
3) Make sure to check the coolant supply nozzle.
4) Supply power to the machine.
5) Gradually provide the feed as per the dimension you want.

Result:

Hence the given workpiece was surface grinded successfully