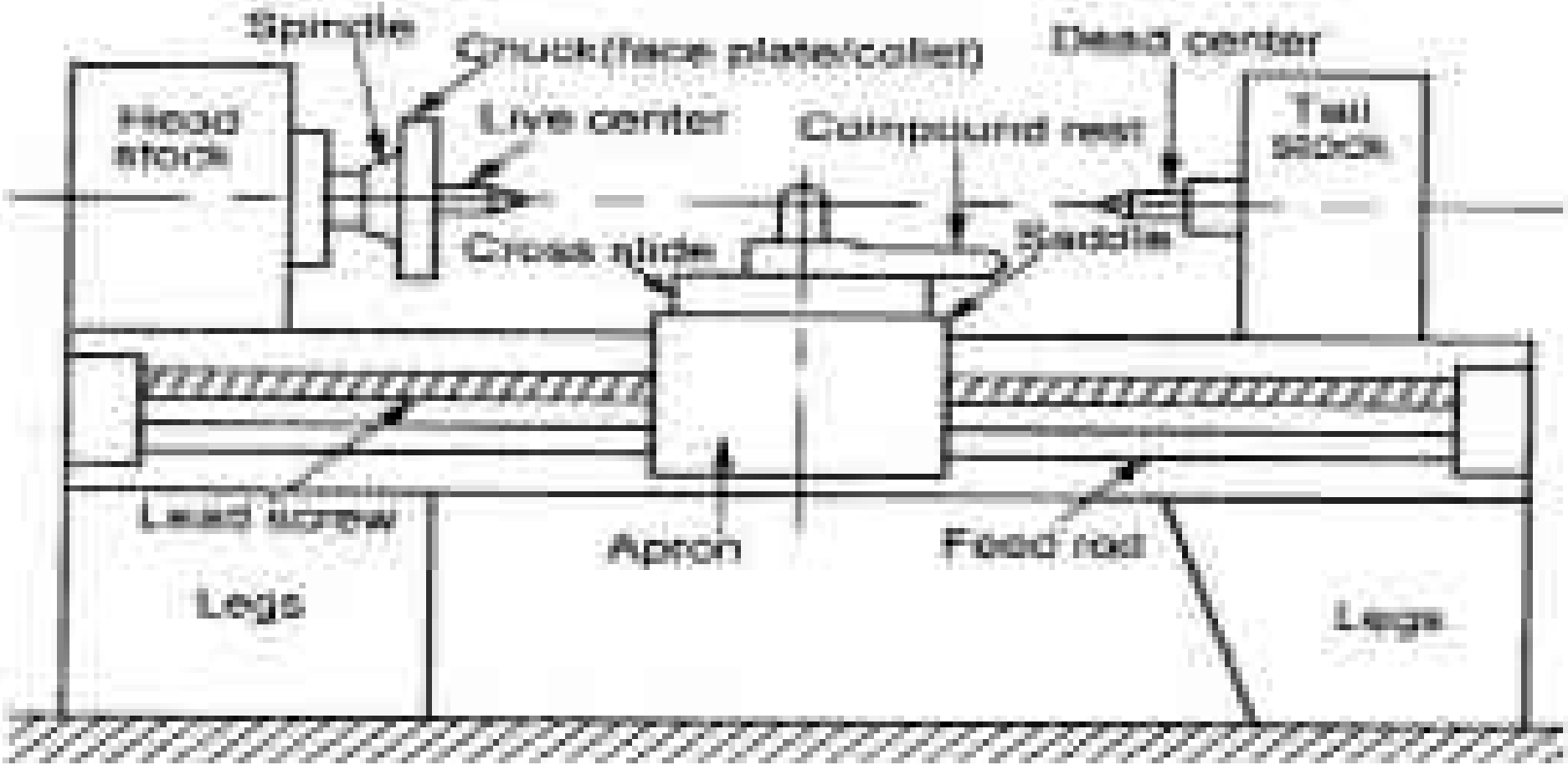
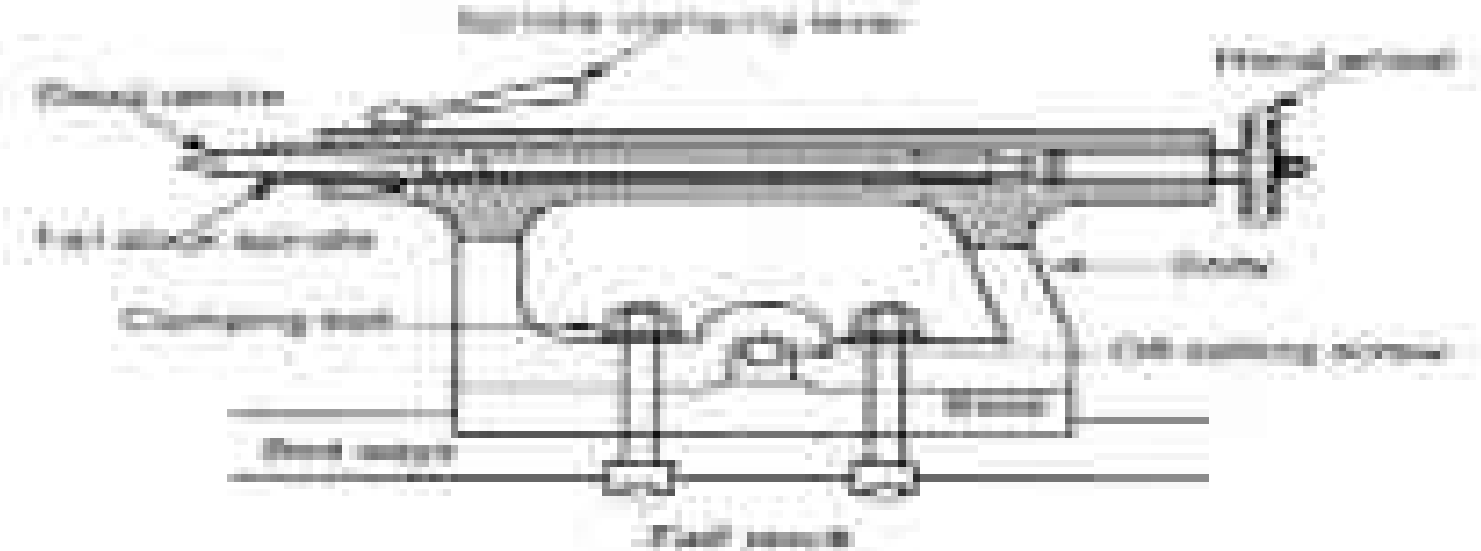
LATHE

A lathe is a father of all machine tools

The main function of a lathe is to remove metal from a piece of work to obtain the required shape and size. The parts of the lathe

- ✓ Bed
- ✓ Head stock
- ✓ Tail stock
- ✓ Carriage
- ✓ Feed mechanism


Spindle
Chuck(face plate/collet)
Dead center
Head stock
Live center
Compound rest
Tail stock
Cross slide
Saddle
Lead screw
Apron
Feed rod
Legs
Legs



SPECIFICATION OF LATHE

The size of the lathe is generally specified as follows:

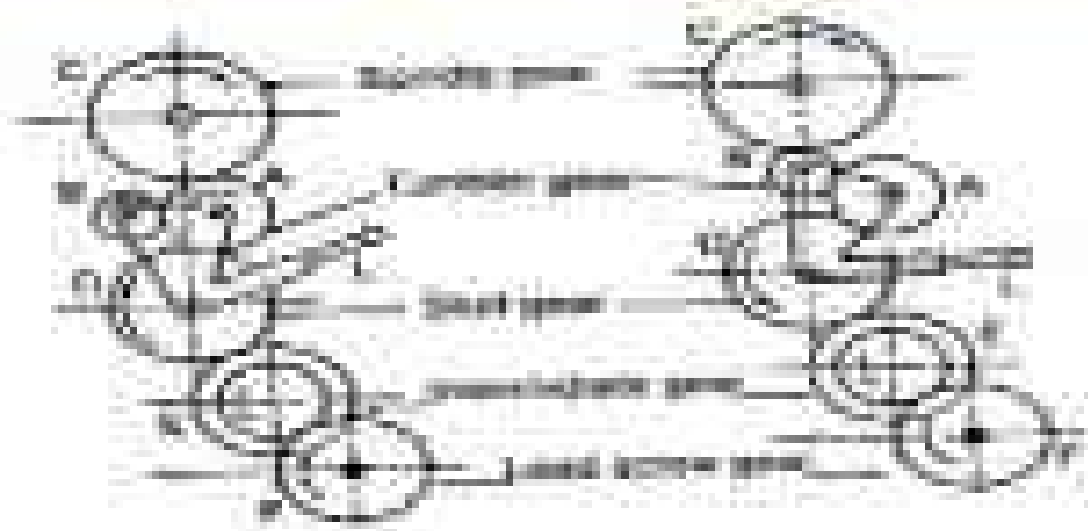
- The length of bed
- Maximum distance b/w chuck & live centre
- Types of bed i.e. straight, swan gap or gap type
- The height of centres from the bed
- Swing over the bed
- Swing over the cross section
- Width of the bed
- Spindle bore
- Spindle speed
- H.p. of main motor & rpm
- Number of spindle speed
- Spindle nose connector
- Feeds
- Floor space required

TYPES OF LATHE

1.Speed lathe
   a) Wood working lathe
   b) Metal spinning lathe
   c) Metal turning lathe
   d) Polishing lathe
2.Engine lathe
   a) Step cone pulley drive lathe
   b) Geared lathe
   c) Variable speed lathe
3. Bench lathe
4.Tool room lathe

5.Semi automatic lathe
    a) Capstan lathe
    b) Turret lathe
6.Automatic lathe
7.Special purpose lathe
    a) Crank shaft lathe
    b) Wheel lathe
    c) Duplicating lathe
8.Copying lathe

TUMBLER GEAR REVERSING MECHANISM

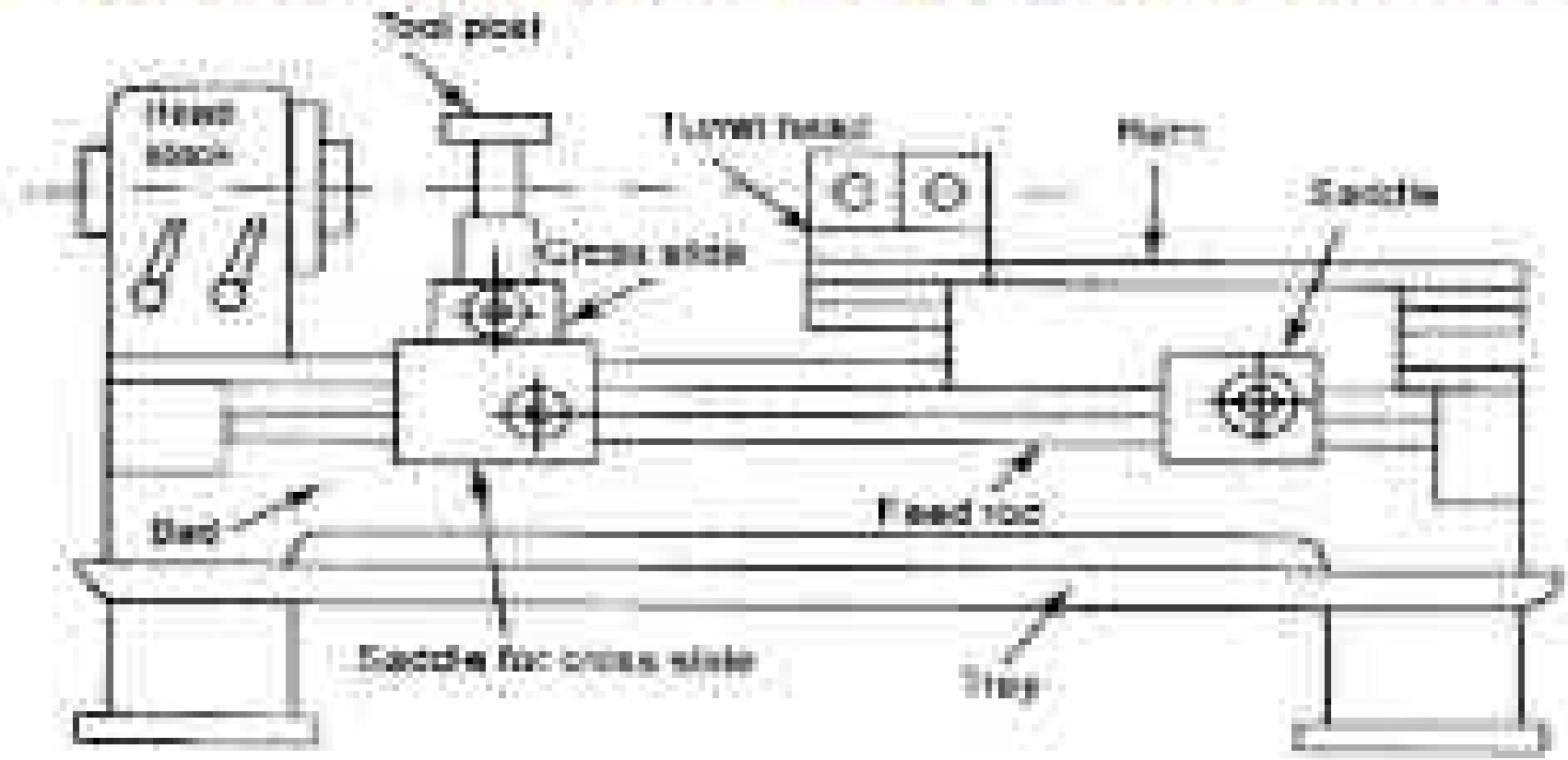


Tumbler gear mechanism is used to change the direction of lead screw and feed rod. By engaging tumbler gear, the carriage can be moved along the lathe axis in either direction during thread cutting or automatic machining

SEMI -AUTOMATIC LATHES

- ✓ In semi automatic lathe, the required tools are preset.
- ✓ More than one tool can be used at a time to perform the specific task
- ✓ It reduce tool- changing time, loading & unloading time & increases the rate of production

CAPSTAN AND TURRET LATHE



CAPSTAN LATHE	TURRET LATHE
Turret head is mounted on a ram which slides over the saddle	Turret head is directly mounted on saddle. But it slides on the bed
Turret movements is limited	Turret movement on the entire length of bed without any restriction
Shorter work piece can be machined	Larger work piece can be machined
Light duty application	Heavy duty application
Turret head can be moved manually	Turret head cannot be moved manually
Maximum size of 60mm diameter work can be accommodated	It can accommodate only from 125 to 200m

SHAPER

The shaper which is having a reciprocating type of machine tool with single point cutting tool used to produce flat surface. The flat surface may be horizontal, vertical or inclined. It has the three important parts such as

1. Table
2. Tool head
3. Ram

CLASSIFICATION OF SHAPERS

1. According to the type of driving mechanism
   a. Crank drive type
   b. Whitworth driving mechanism type
   c. Hydraulic drive type
2. According to the position of ram
   a. Horizontal shaper
   b. Vertical shaper
   c. Traveling head shaper
3. According to the table design
   a. Standard or plain shaper
   b. Universal shaper
4. According to the types of cutting stroke
   a. Push cut type
   b. Draw cut type

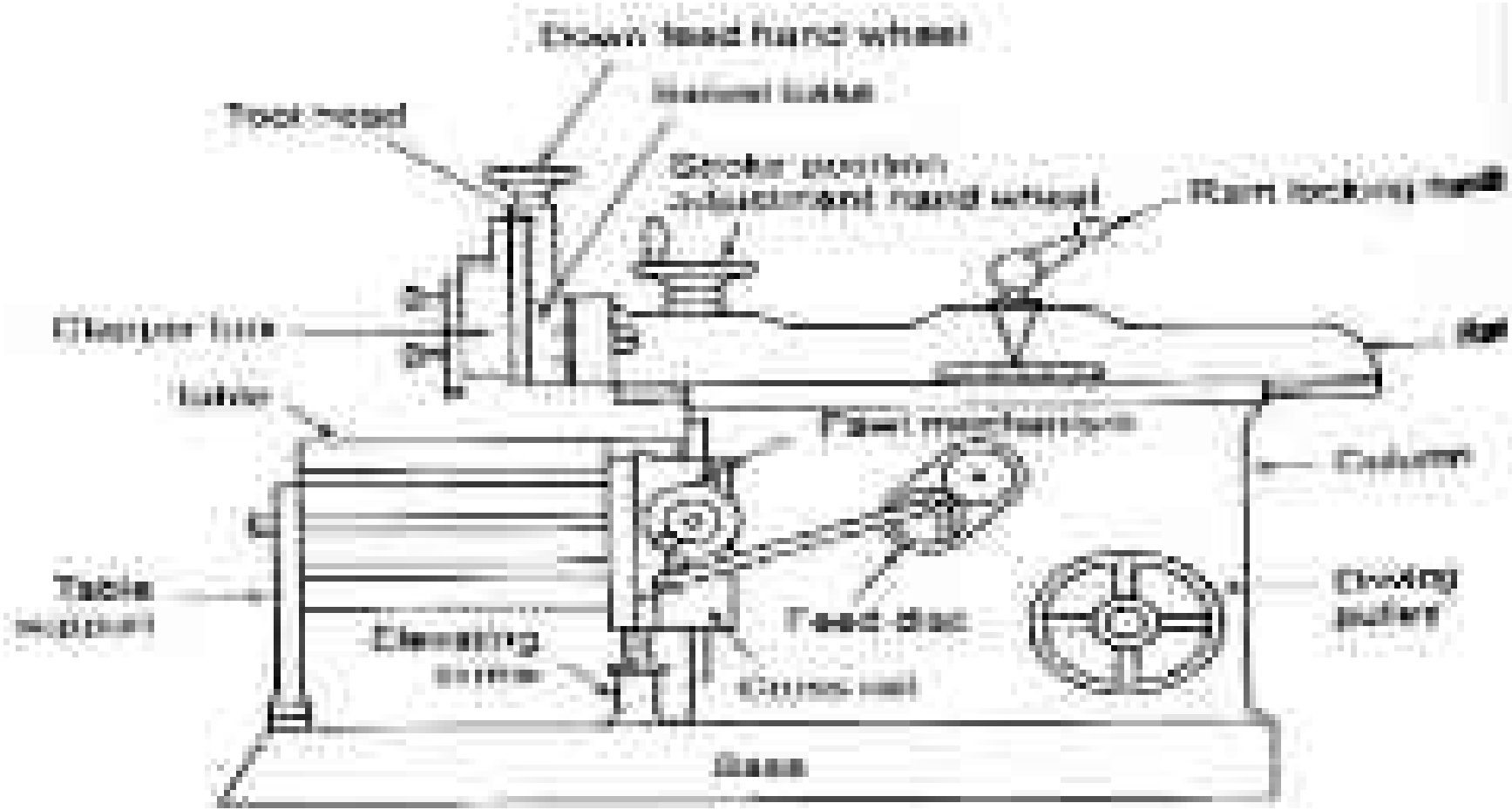
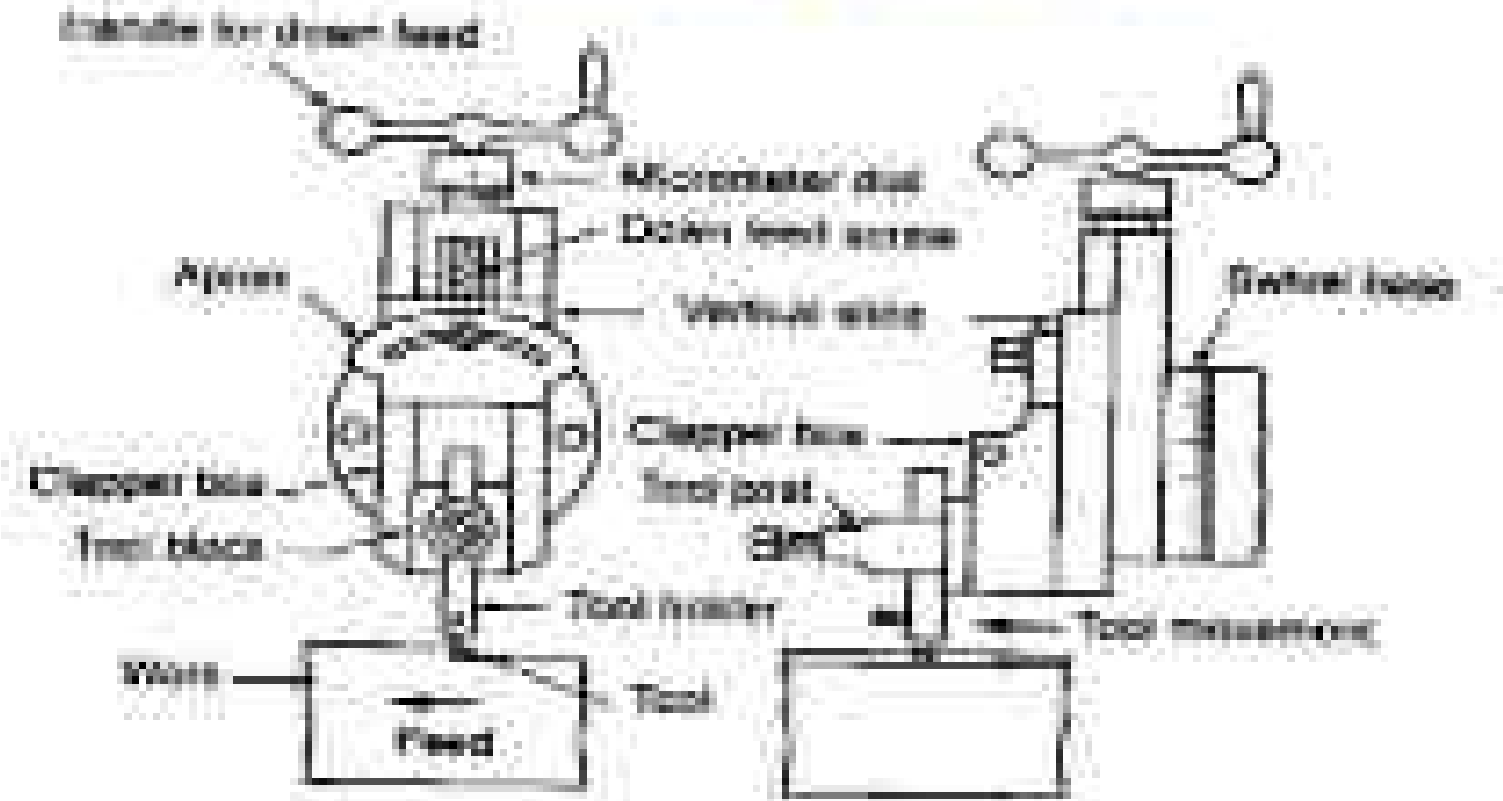


Table
Base

TOOL HEAD


Handle for down feed
Micrometer dial
Down feed screw
Apron
Vertical slide
Swivel base
Clapper box
Clapper box
Tool post
Tool block
Tool holder
Tool
Work
Feed

SPECIFICATION OF SHAPER

1. Maximum length of stroke.
2. Maximum crosswise movement of the table
3. Maximum vertical adjustment of the table
4. Types of driving mechanism
5. Power of the motor
6. Speed and feed available
7. Type of shaper- plain or universal
8. Floor space required
9. Total weight of the shaper
10. Ratio of cutting stroke time to return stroke time

DRIVES

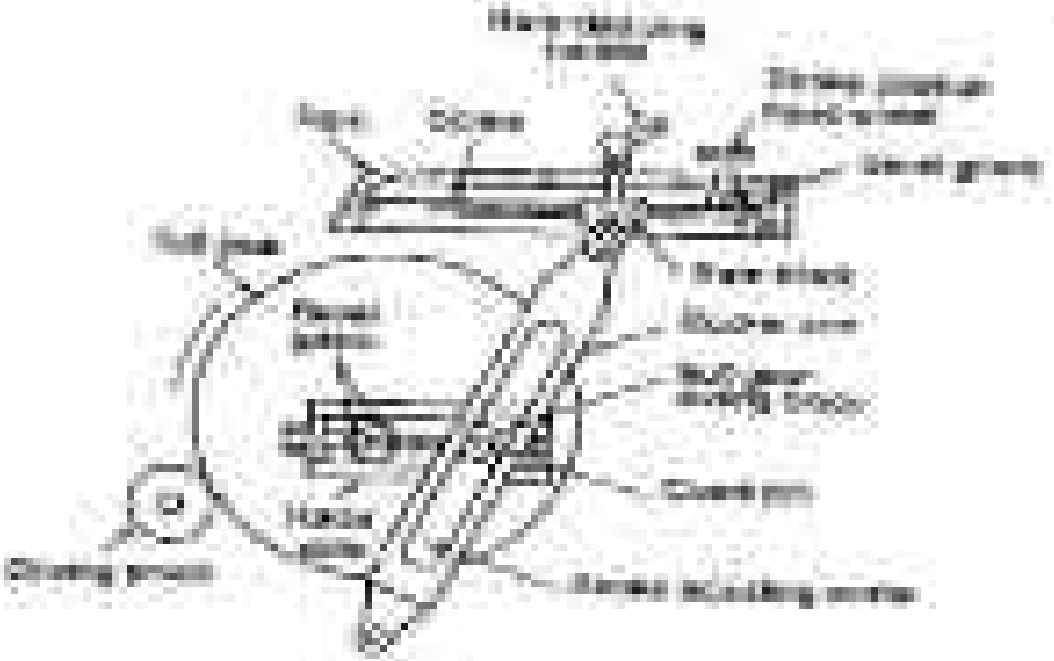
- To convert rotary motion into reciprocating motion of the tool, the various types of drives are provided in shaper because the metal is removed in the forward stroke. But no metal is cut during the return stroke

- Due to this, the time taken for the return stroke should be reduced by making the return stroke faster than the cutting stroke. This is achieved by some quick return mechanism

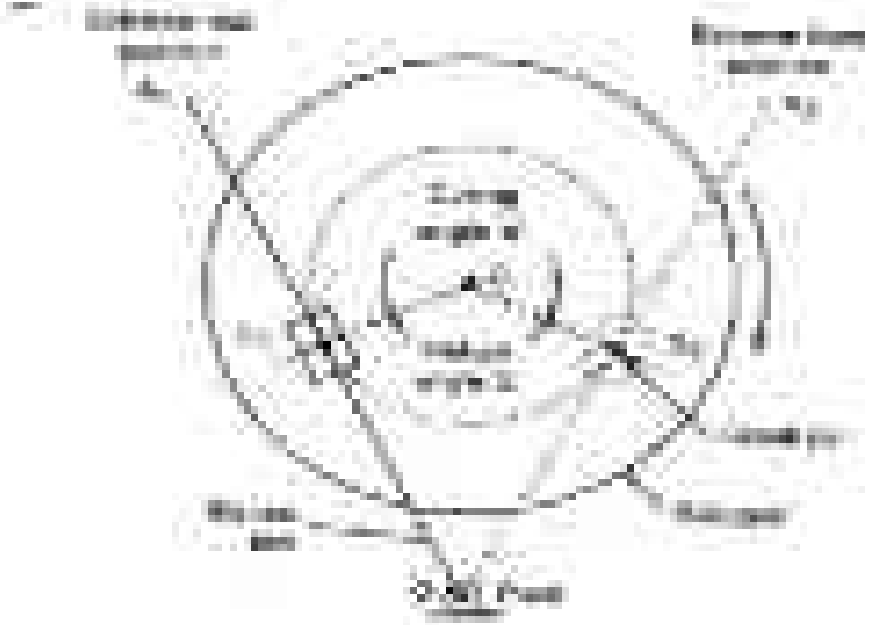
TYPES OF QUICK RETURN MECHANISM

- ✓ HYDRAULIC DRIVE
- ✓ CRANK AND SLOTTED LINK MECHANISM
- ✓ WITHWORTH QUICK RETURN MECHANISM

CHANGING AND SHIFTING MECHANISM



QUICK RETURN MECHANISM



REASION FOR MAKING THE STROKE LENGTH GREATER THAN WORK LENGTH

1. To obtain the good surface finish.
2. To avoid rubbing of the tool on the work surface
3. To allow sufficient time for giving cross feed
4. To allow sufficient time for the clapper box to attain its proper seat for cutting
5. To allow the ram for obtaining the proper cutting speed

TYPES OF TOOL

The tools are classified as

1. According to the shape
   a. Straight tool
   b. Cranked tool
   c. Goose neck tool
2. According to the direction of cutting
   a. Left hand tool
   b. Right hand tool
3. According to the finish required
   a. Roughing tool
   b. Finishing tool

4. According to the type of operation

a. Down cutting tool
b. Parting off tool
c. Squaring tool
d. Side machining tool

5. According to the shape of the cutting edge

a. Round nose tool
b. Square nose tool

SHAPING OPERATIONS

1. Machining horizontal surface
2. Machining vertical surface
3. Machining angular surface
4. Machining slots, grooves & keyway
5. Machining irregular surface

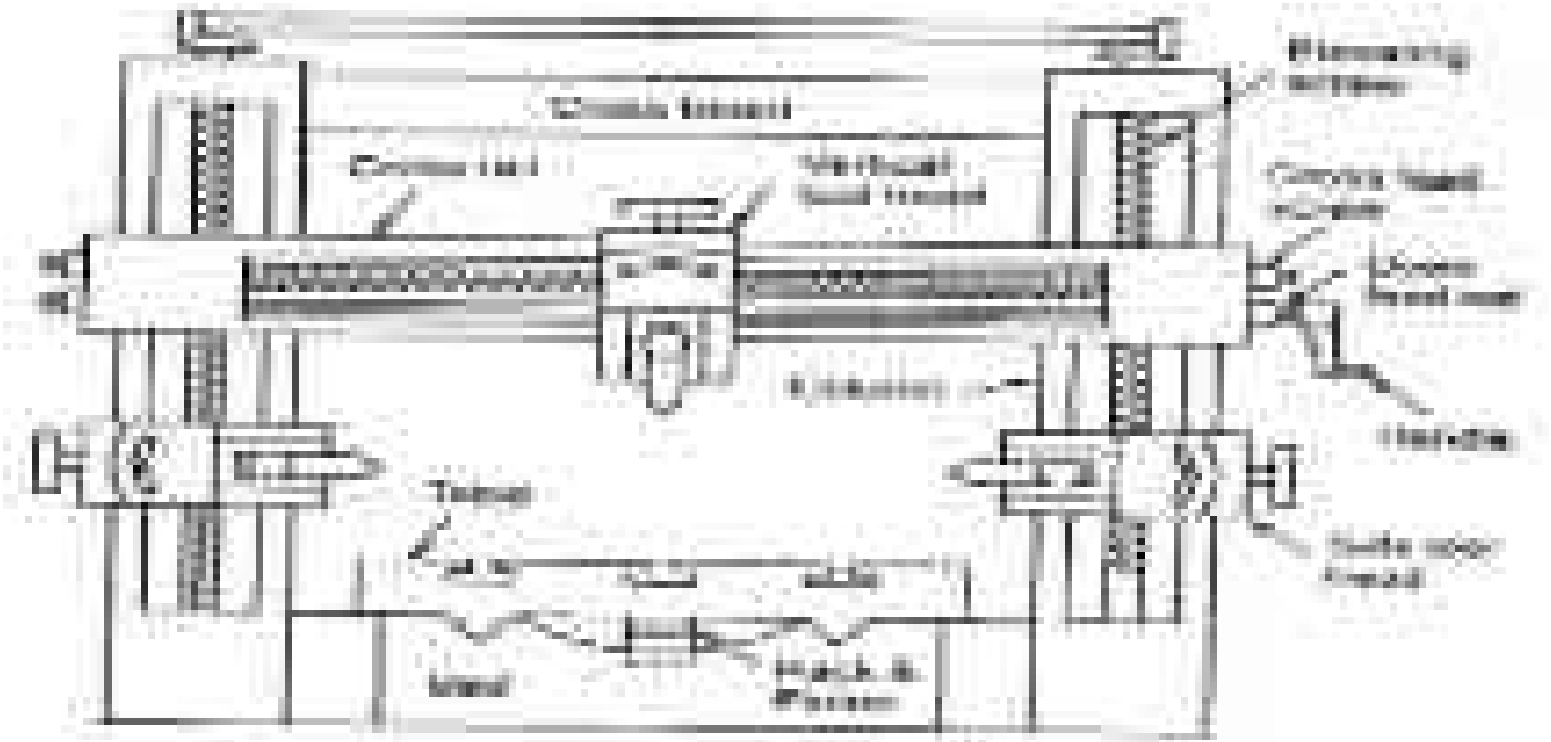
PLANER

- ✓ In planner the work piece mounted on the table reciprocates but the tool is stationary
- ✓ The machining surface may be horizontal, vertical or inclined surface
- ✓ The metal is removed during the cutting stroke called forward stroke
- ✓ No metal is removed during the return stroke

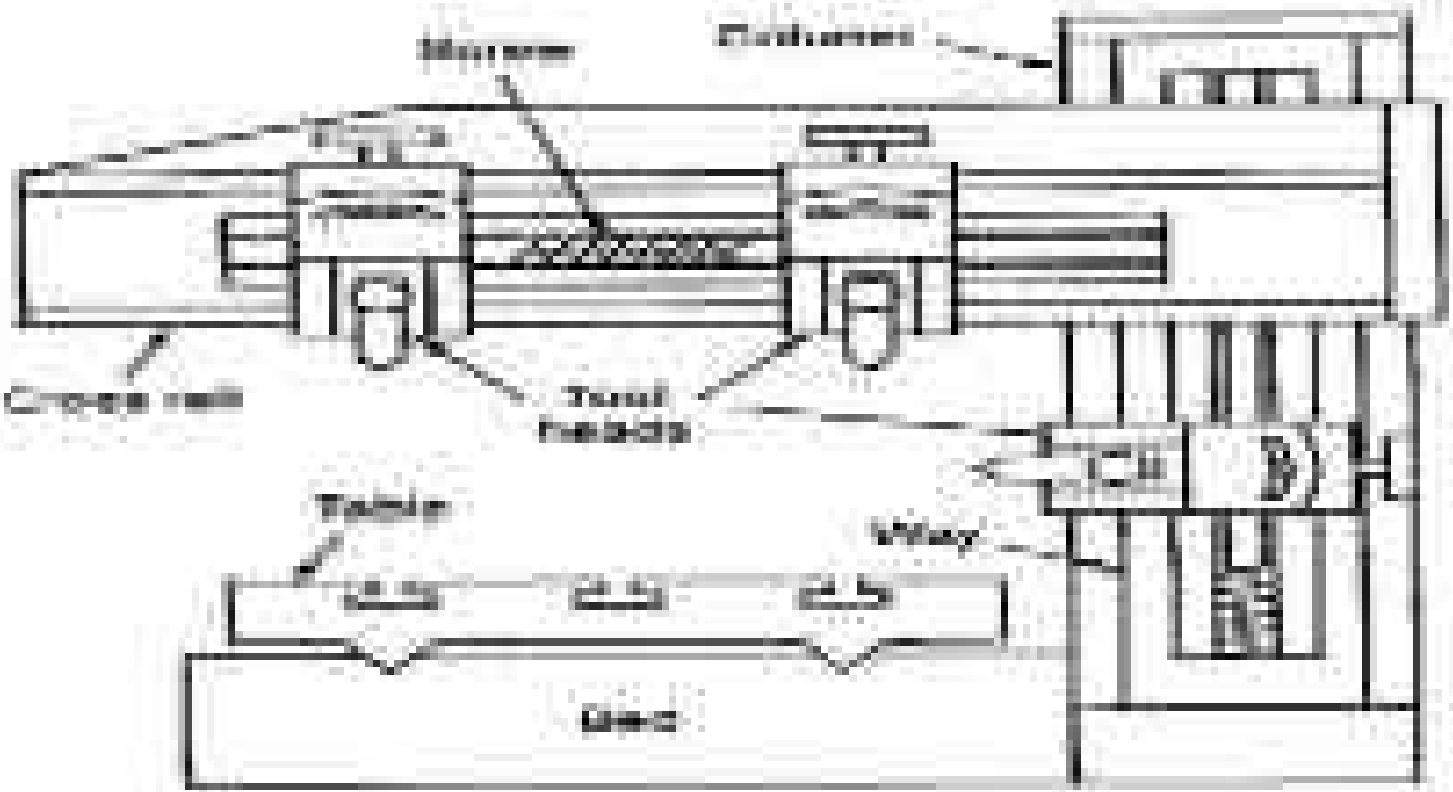
TYPES OF PLANER

1. Double housing planer
2. Open side planer
3. Pit planer
4. Edge planer
5. Divided table planer

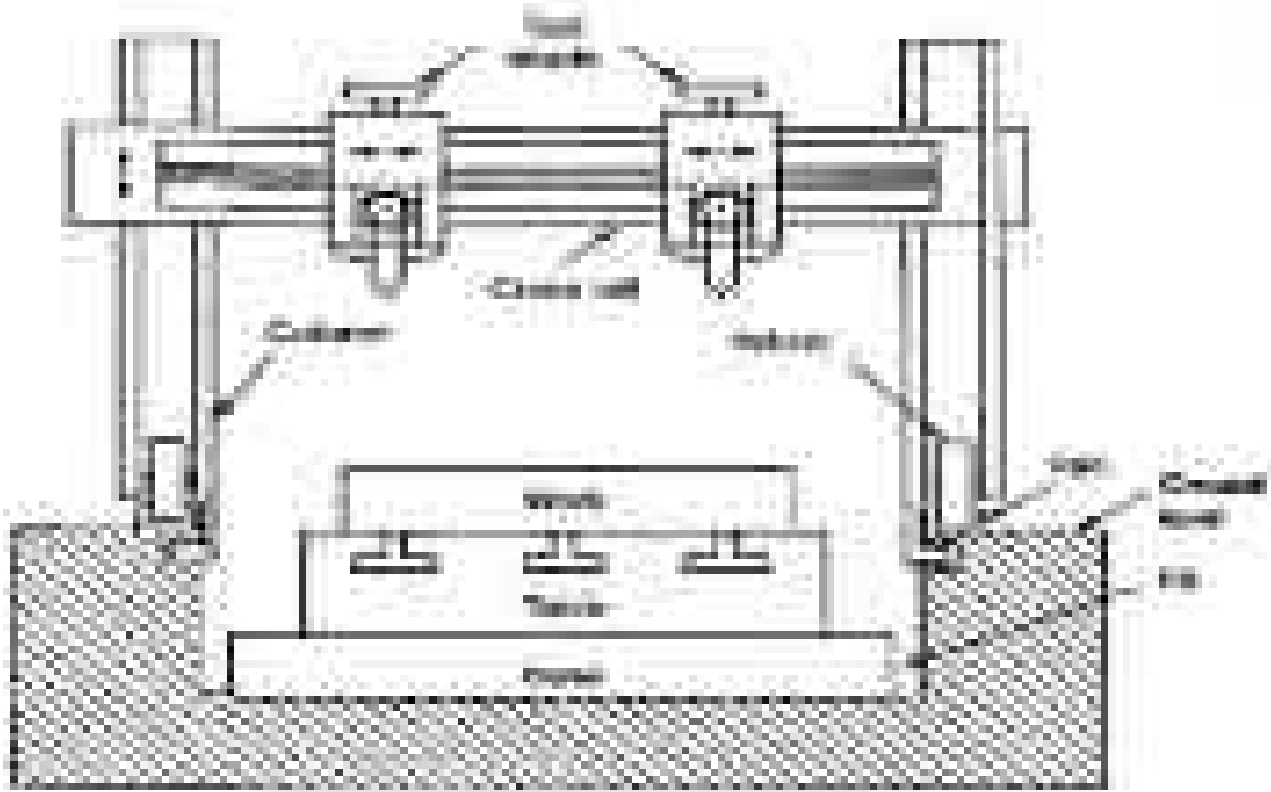
DOUBLE HOUSING PLANER



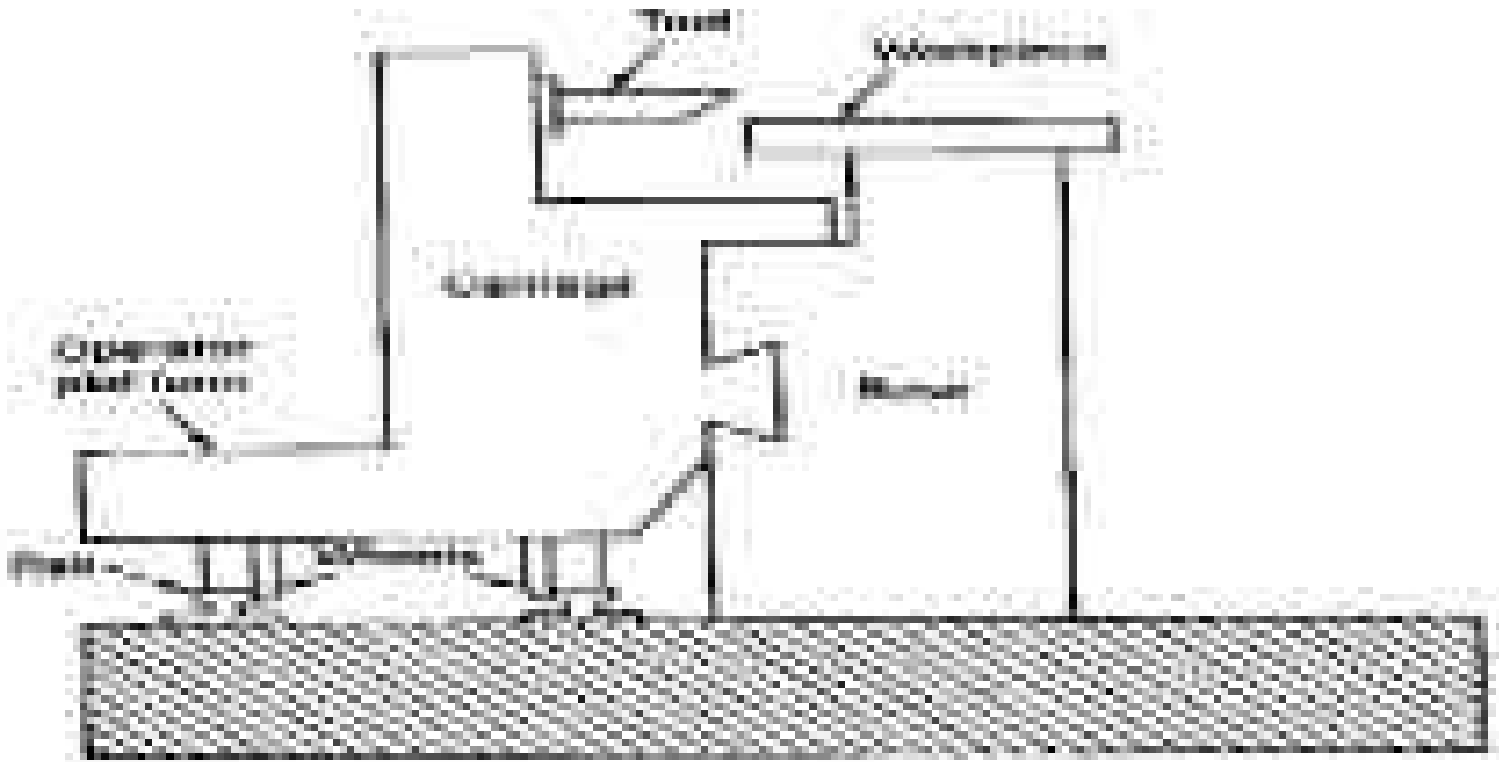
OPEN SIDE PLANER



PIT PLANER



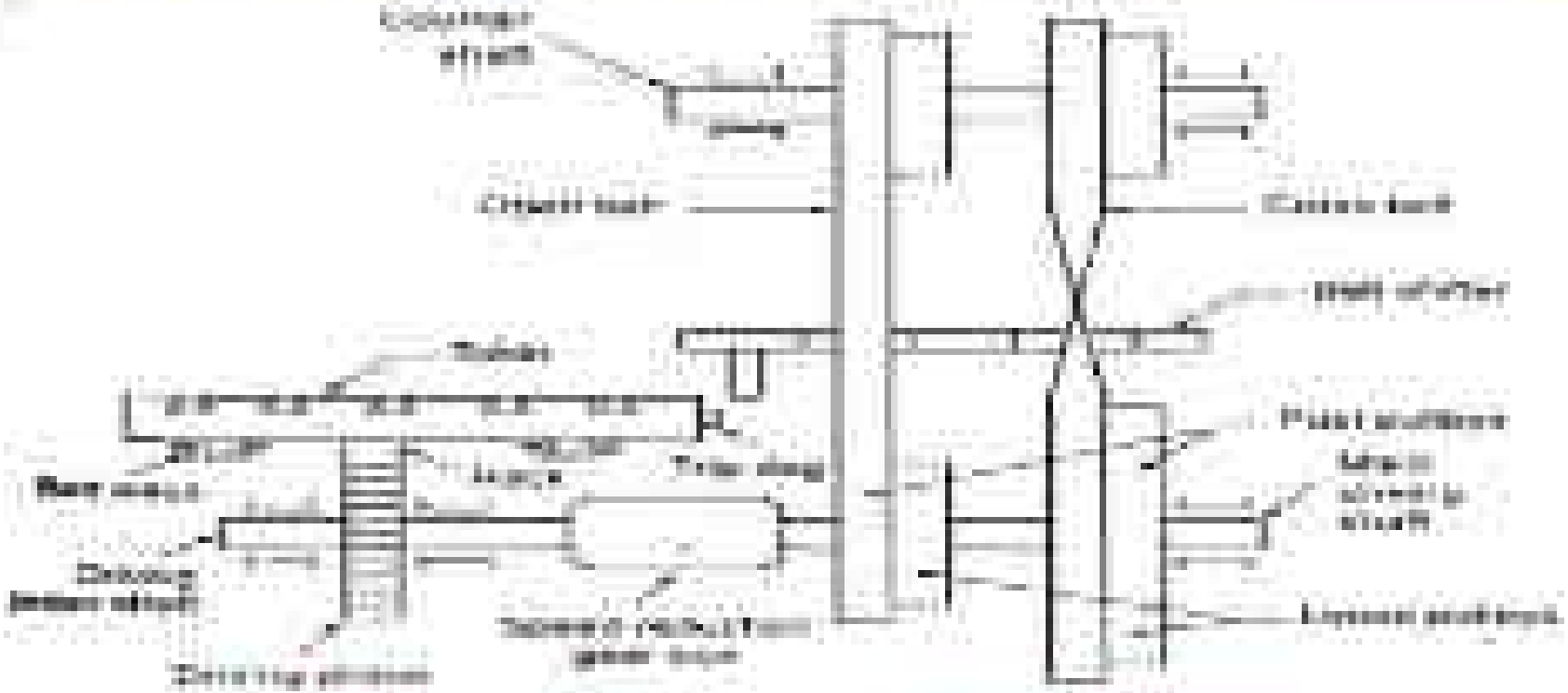
EDGE PLANER



SPECIFICATION OF PLANER

- ✓ The distance between two columns
- ✓ Stroke length of the planer
- ✓ Radial distance between the top of the table and the bottom most position of the cross rail
- ✓ Maximum length of the table
- ✓ Power of the motor
- ✓ Range of speeds and feed available
- ✓ Type of drives required

QUICK RETURN MECHANISM



Open & cross belt drive

PLANER	SHAPER
Tool is stationary & work reciprocate :	Tool reciprocates & work is stationary
This machine is used for machining large & heavy work piece	This machine is used for machining medium & small work piece
more accuracy	Less accuracy
Work setting requires more skill	Work setting is easier
Heavy cut can be given	Heavy cut cannot be given
Production time is more	Production time is less

MILLING

Milling is the process of removing metal by feeding the work past a rotating multipoint cutter.

- The ratio of metal removal in the form of small chips.
- In milling operation, the ratio of metal removal is rapid as the cutter rotates at a high speed and has many cutting edges.

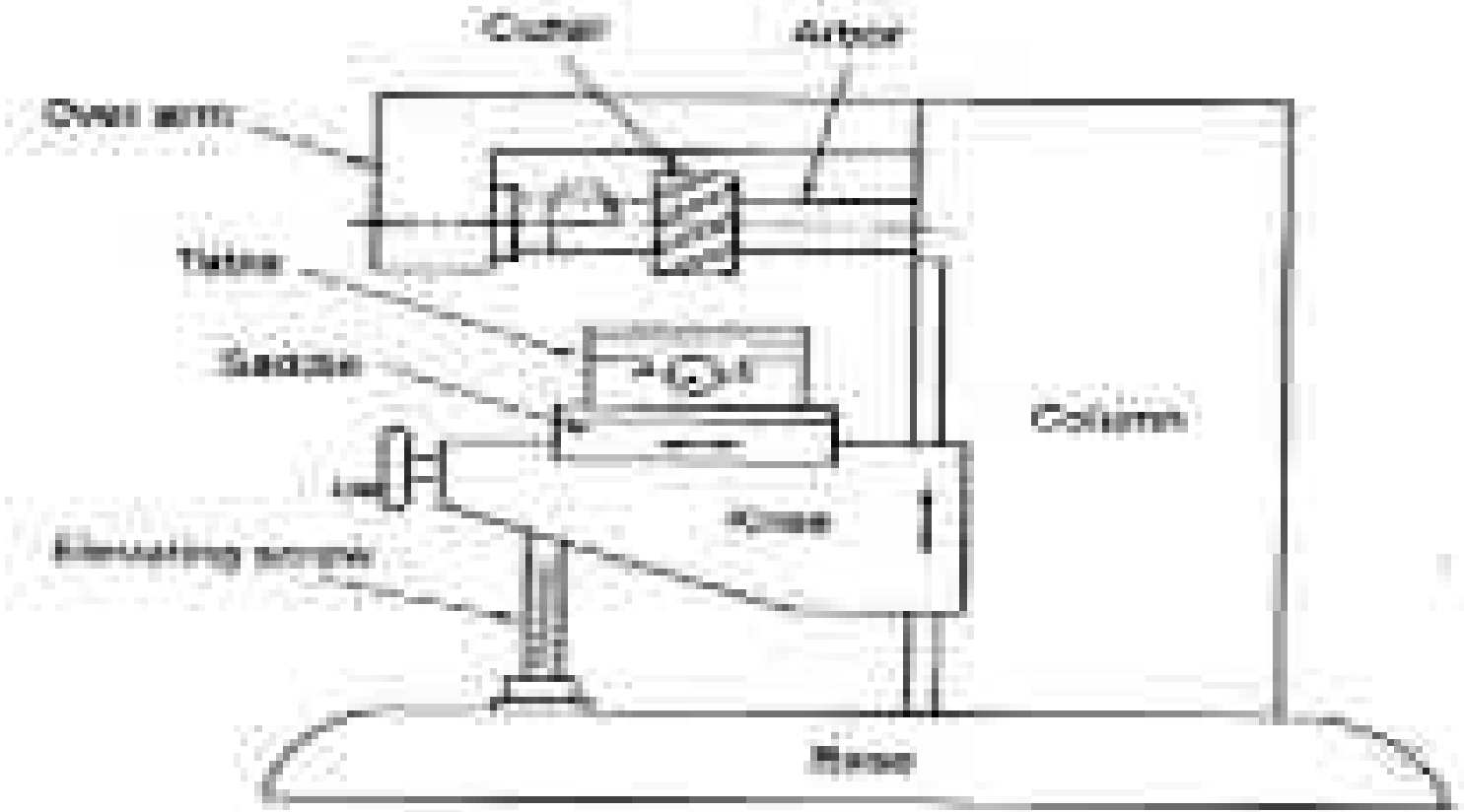
SPECIFICATION OF MILLING MACHINE

- The table length & width
- Maximum longitudinal cross and vertical travel of the table
- Number of spindle speeds & feeds
- Power of driving motor
- Floor space & net weight
- Spindle nose taper size
- Type of milling machine

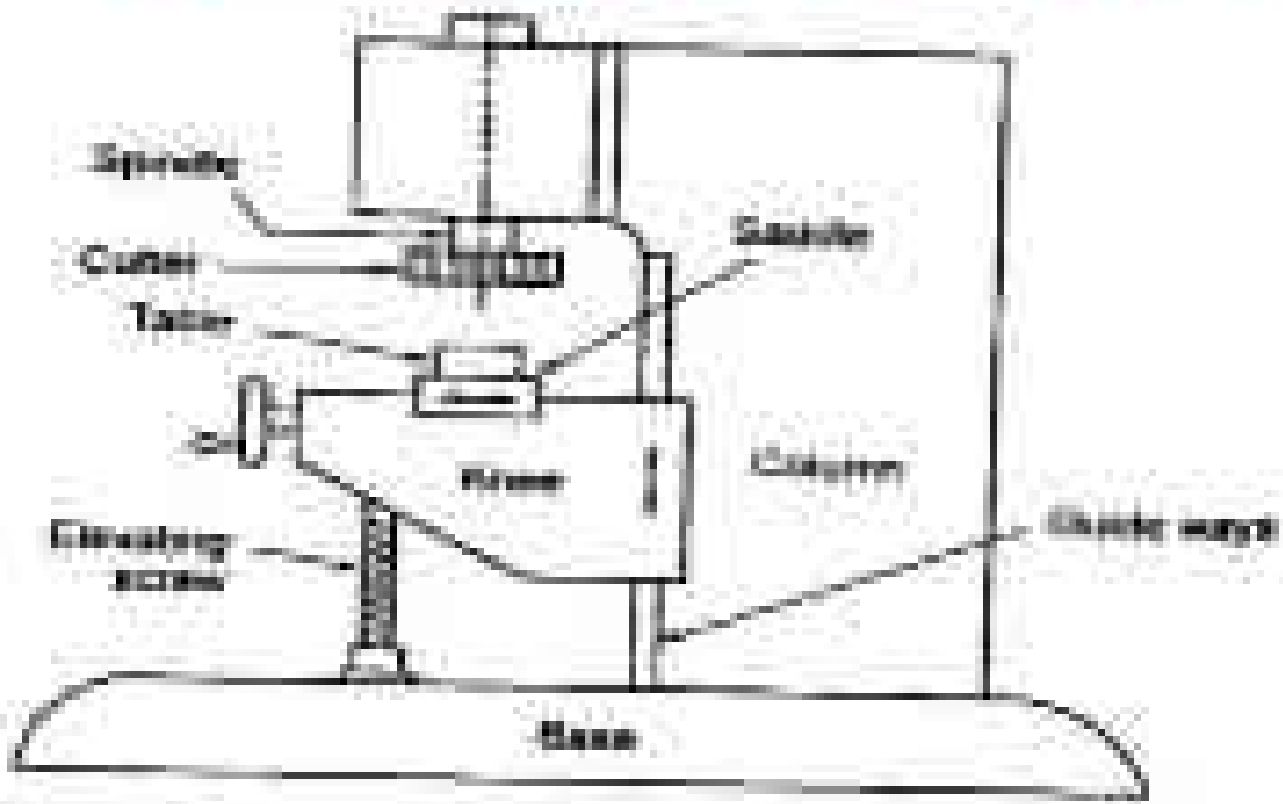
CLASSIFICATION OF MILLING MACHINE

1. Column and knee type
   a. Plain milling machine
   b. Special milling machine
   c. Universal milling machine
   d. Ram type milling machine
   e. Omniversal milling machine
2. Bed type milling machine
   a. Simplex milling machine
   b. Duplex milling machine
   c. Triplex milling machine
3. Plano type milling machine
4. Special purpose milling machine
   a. Rotary table milling machine
   b. Drum milling machine
   c. Profile milling machine

PLAIN OR HORIZONTAL MILLING MACHINE



VERTICAL MILLING MACHINE



MILLING OPERATION

- ✓ Plain or slab milling
- ✓ Face milling
- ✓ Angular milling
- ✓ Straddle milling
- ✓ Gang milling
- ✓ Form milling
- ✓ End milling
- ✓ T-slot milling
- ✓ Gear milling

DRILLING MACHINE

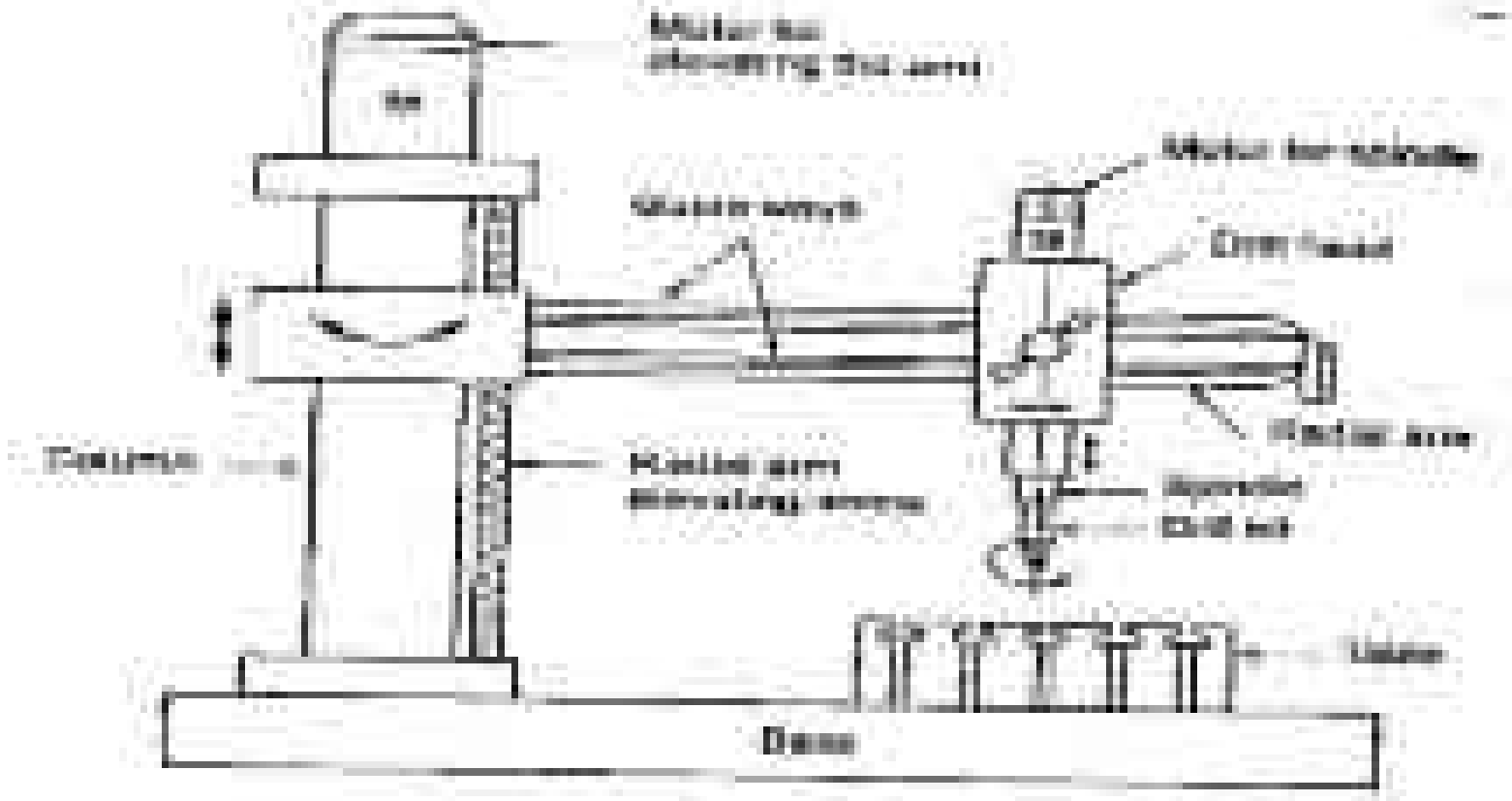
Drilling is the process of producing hole on the work piece by using a rotating cutter called drill. The machine on which the drilling is carried out is called drilling machine.

Classification of drilling machines:

1. Portable drilling machine
2. Sensitive drilling machine
    a. Bench type
    b. Floor type

3. Upright drilling machine
    a. Round column type or pillar type
    b. Box column type or square section type
4. Radial drilling machine
    a. Plain type
    b. Semi- universal type
    c. Universal type
5.Gang drilling machine
6.Multiple spindle drilling machine
7. Automatic drilling machine
8. Deep hole drilling machine

RADIAL DRILLING MACHINE



1. Plain type

The following adjustments are available in this type

- Vertical movement of the radial arm with respect to the column
- Circular movement of the radial arm about column
- Horizontal movement of the tool along the arm ways

2. semi- universal type

In additional to above three movements as in case of plain type, the fourth movement of the tool post can be swung about a horizontal axis perpendicular to the arm. This arrangement permits for drilling a hole inclined at any angle to the horizontal plane.

3. Universal type:

The drill movement of the radial arm is rotating (tilted) on a horizontal axis.

All these movements enable the universal drilling machine to drill on a job at any angle either in horizontal plane or in vertical plane or in both the planes.

SPECIFICATION OF DRILLING MACHINE

- ✓ Maximum size of the drill in mm that the machine can operate
- ✓ Maximum spindle travel in mm
- ✓ Number of spindle speed & range of spindle speeds in r.p.m
- ✓ Power input of the machine H.P
- ✓ Floor space required in m^2
- ✓ Net weight of the machine in Tonne

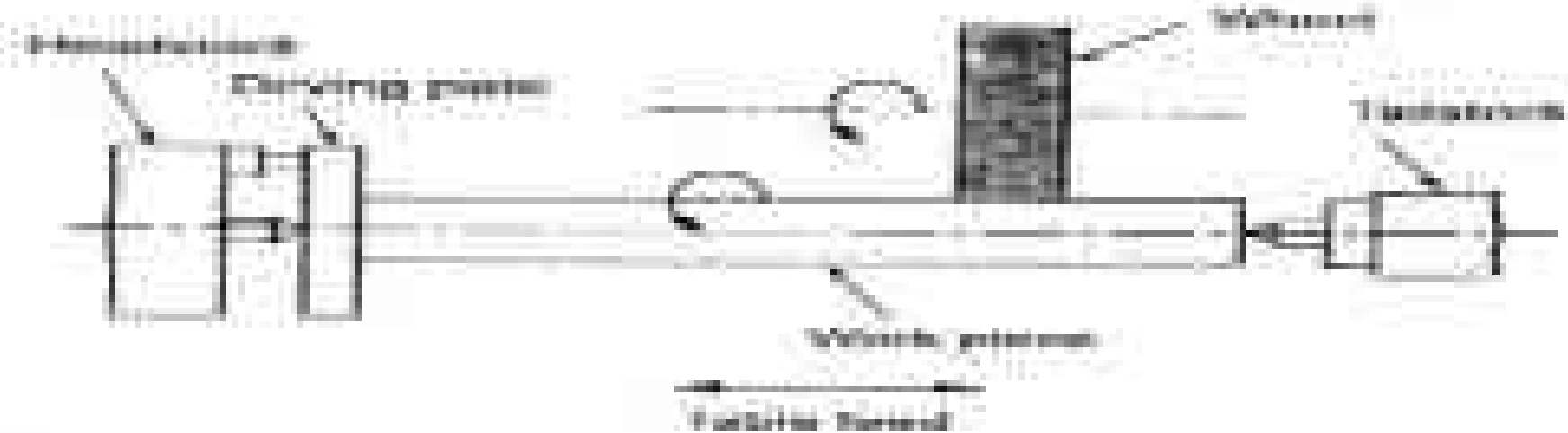
GRINDING

Grinding is a metal removing process in which the metal is removed with the help of rotating grinding wheel.

Grinding is usually used for following purposes:

- To remove small amount of metal from work piece and finish them to close tolerances.
- To obtain a better surface finish
- To machine hard surfaces that cannot be machined by high speed steels
- Sharpening of cutting tools
- Grinding of threads
- Sometimes, it is used for removing bigger stocks of metals

CYLINDRICAL GRINDER



Types of operations in cylindrical grinding

Two types of grinding operations are carried out.

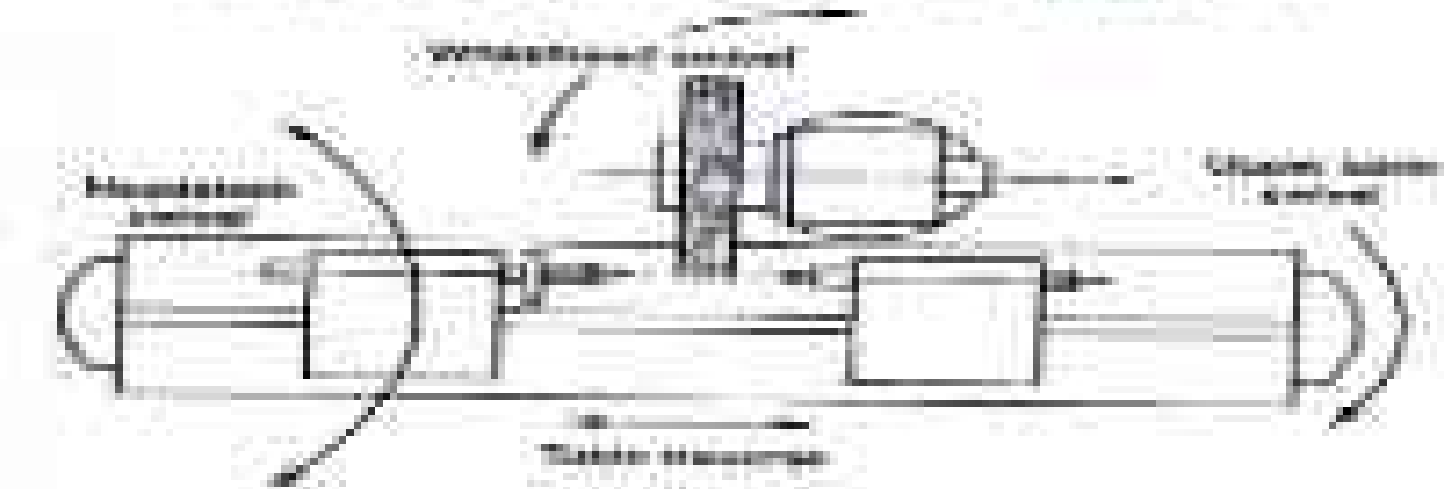
(i) Traverse grinding.

(ii) Plunge grinding.

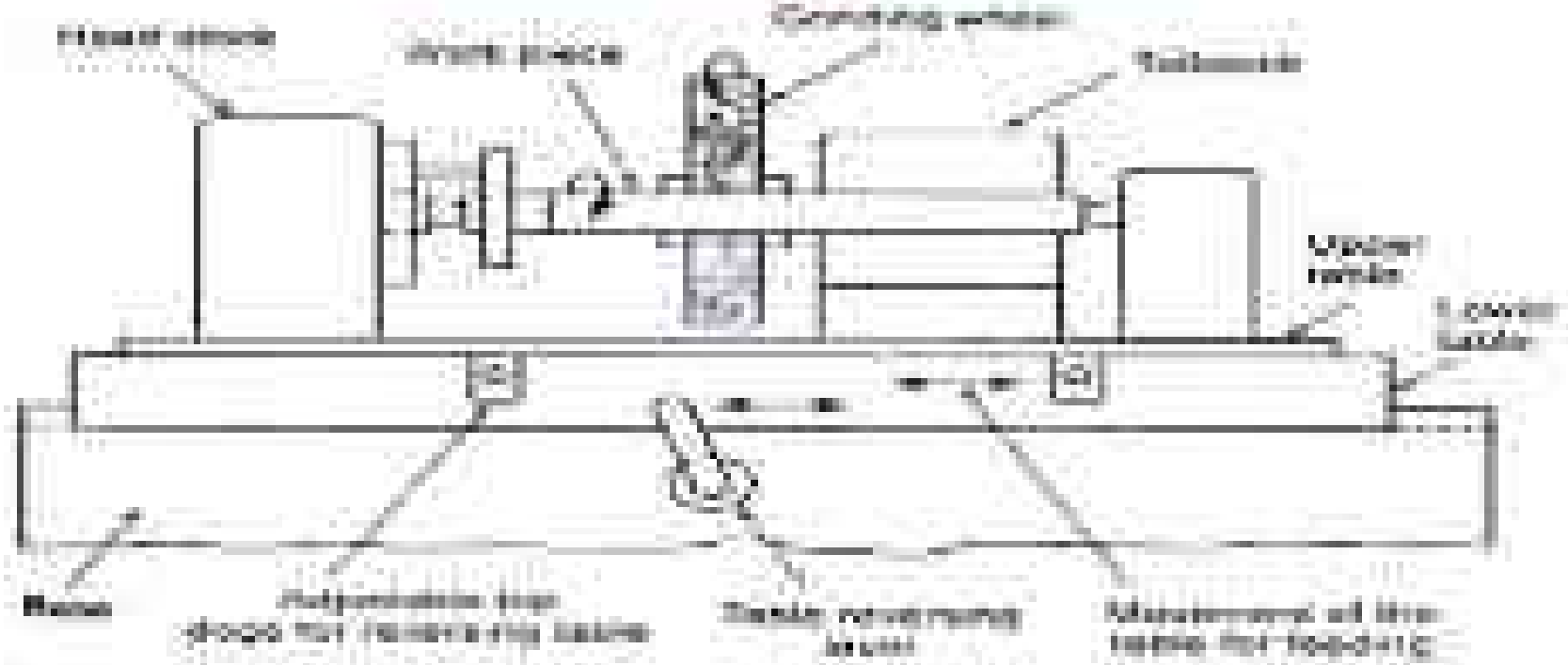
TYPES OF CYLINDRICAL GRINDING

1. Plain centre type cylindrical grinding machine
2. Centre type universal grinder

Centre type universal grinder

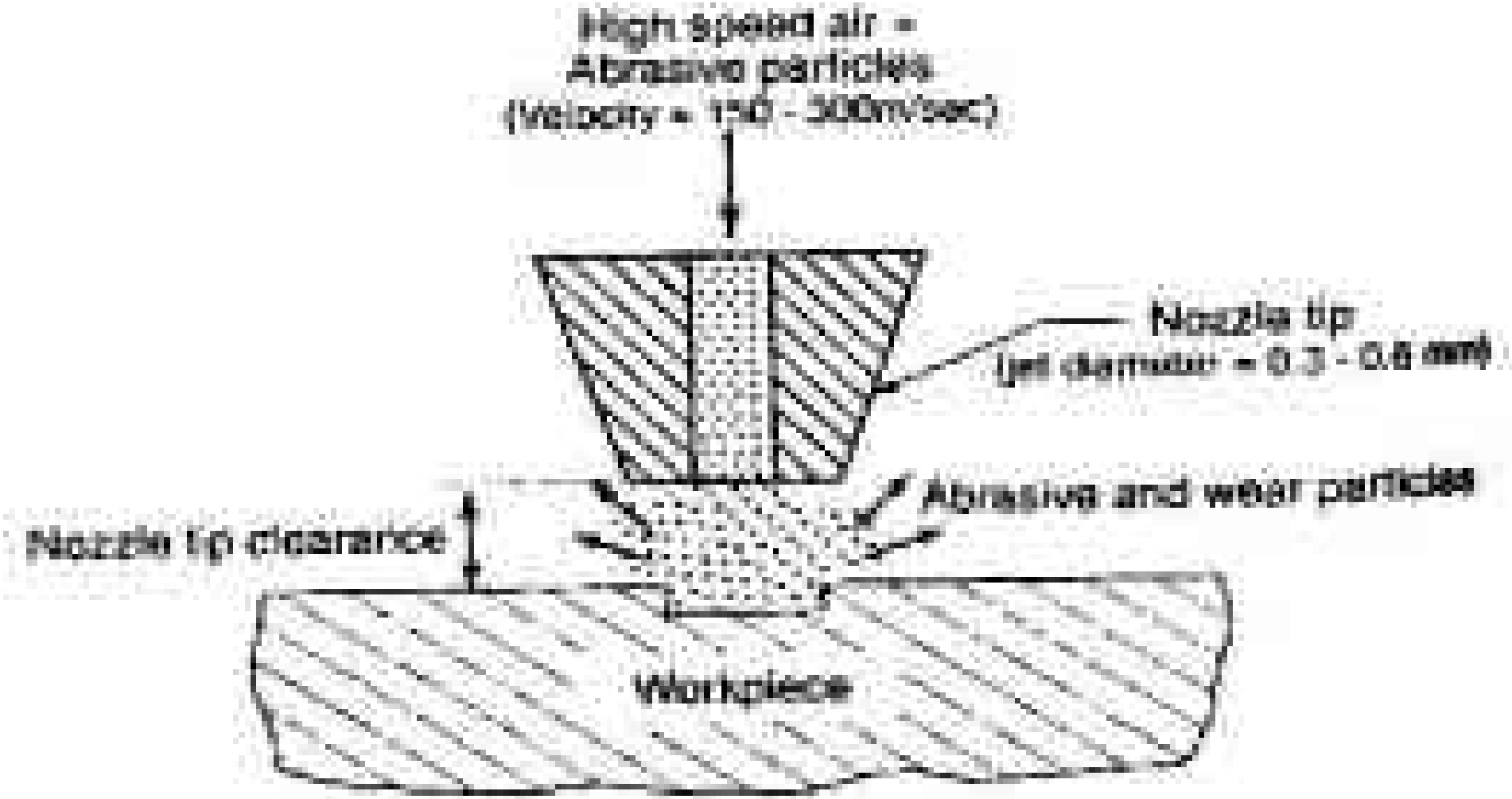


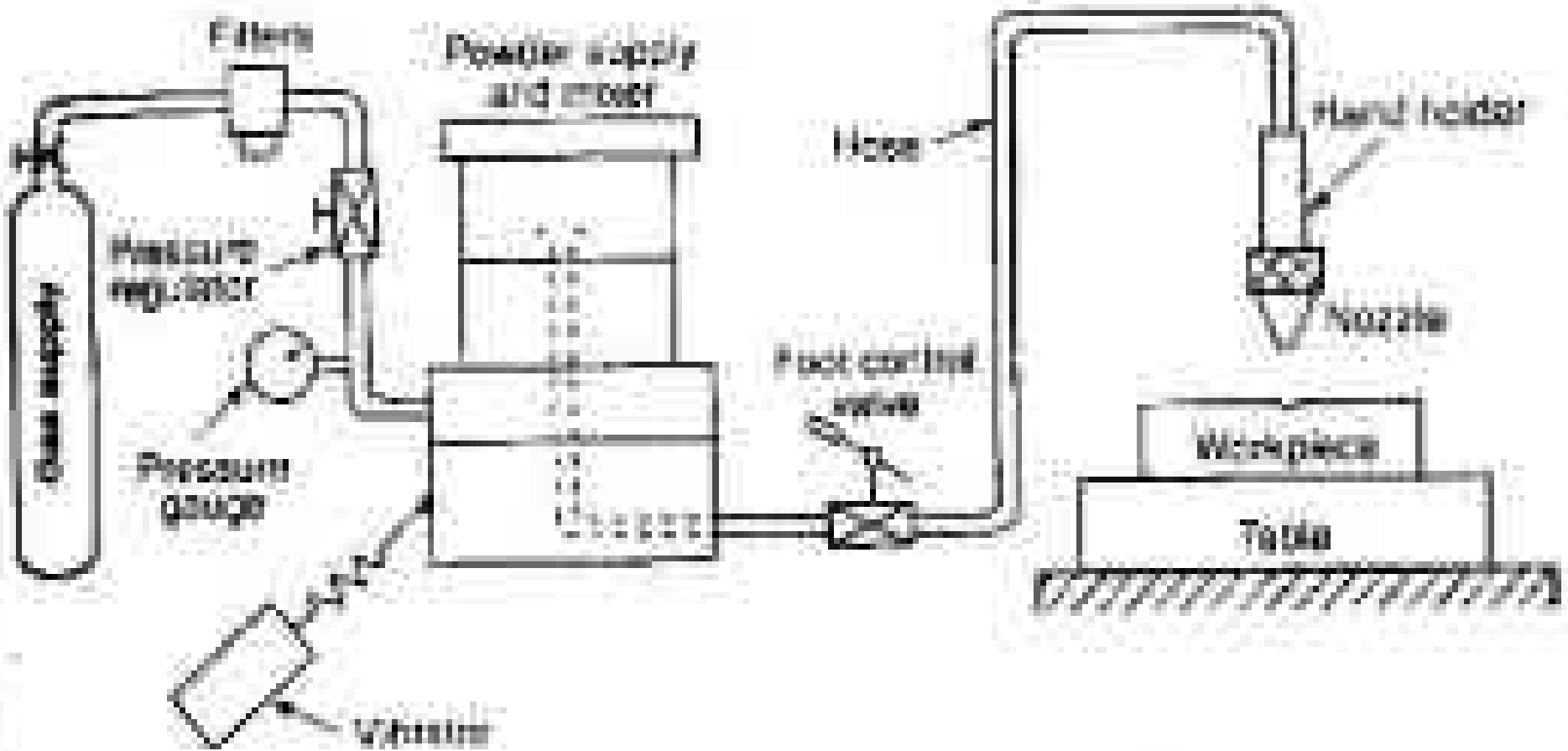
Plain centre type cylindrical grinding machine



ABRASIVE JET MACHINING(AJM)

- ✓ In AJM the metal removal takes place due to the impingement of fine abrasive particles propelled through a nozzle by a high pressure gas.
- ✓ In this process a high velocity jet of dry air (mostly nitrogen or carbon dioxide) containing abrasive particles is aimed to the workpiece surface under controlled conditions.


High speed air +
Abrasive particles
(Velocity = 150 - 300m/sec)
Nozzle tip
Abrasive and wear particles
Nozzle tip clearance
Workpiece


Filters
Powder supply and mixer
Hose
Hand holder
Pressure regulator
Nozzle
Foot control valve
Pressure gauge
Workpiece
Table
Vibrator

- ✓The filtered gas is supplied under high pressure of 850kpa to the mixing chamber containing abrasive powder.
- ✓The abrasive powder is made of various particles such as aluminimum oxide, silicon carbide, glass powder, dolomite & specially prepared sodium-bi-carbonate.
- ✓The average particle sizes vary from 10 to 50 μm.
- ✓The vibrator vibrates at 50HZ

- ✓ The average life of nozzle made of tungsten carbide is 10 to 20hrs while nozzle of ceramics are last for about 300hrs of operation.
- ✓ Nozzle tip should be kept at a distance of 0.25 to 0.75mm from the work surface.
- ✓ Nozzle tip (jet diameter is 0.3 to 0.5mm)

Applications of AJM

1. Machining small holes, slots, or intricate patterns in very hard or brittle metallic and non-metallic materials such as quartz, glass, ceramics etc.
2. Deburring or removing small flash from parts.
3. Trimming and beveling of resistors of hybrid power amplifier circuits.
4. Removing oxides and other surface films from workpieces.
5. General cleaning and polishing of plastics, nylon and Teflon components with irregular surfaces.
6. Cutting and machining of fragile materials such as germanium, silicon etc.
7. Drilling and cutting thin sections of metal.

Advantages of AJM

1. AJM is suitable for cutting all materials. Even diamond can be cut by using diamond powder as abrasive.
2. No heat is generated during machining process, and hence, fragile and heat-sensitive materials can also be cut without damage.
3. Capital cost is low.
4. Very thin and brittle materials can be cut without any risk of breaking.

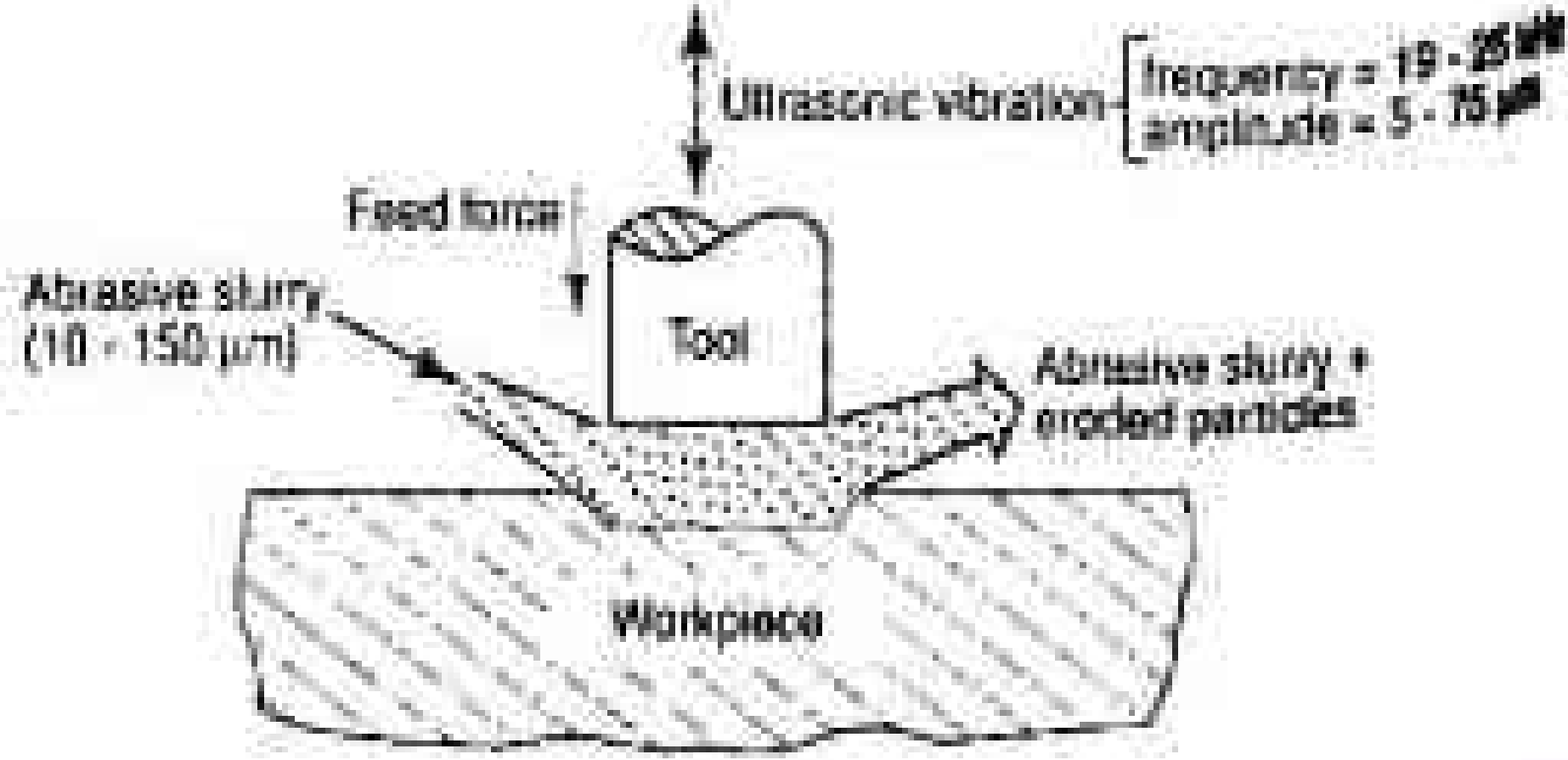
Disadvantages of AJM

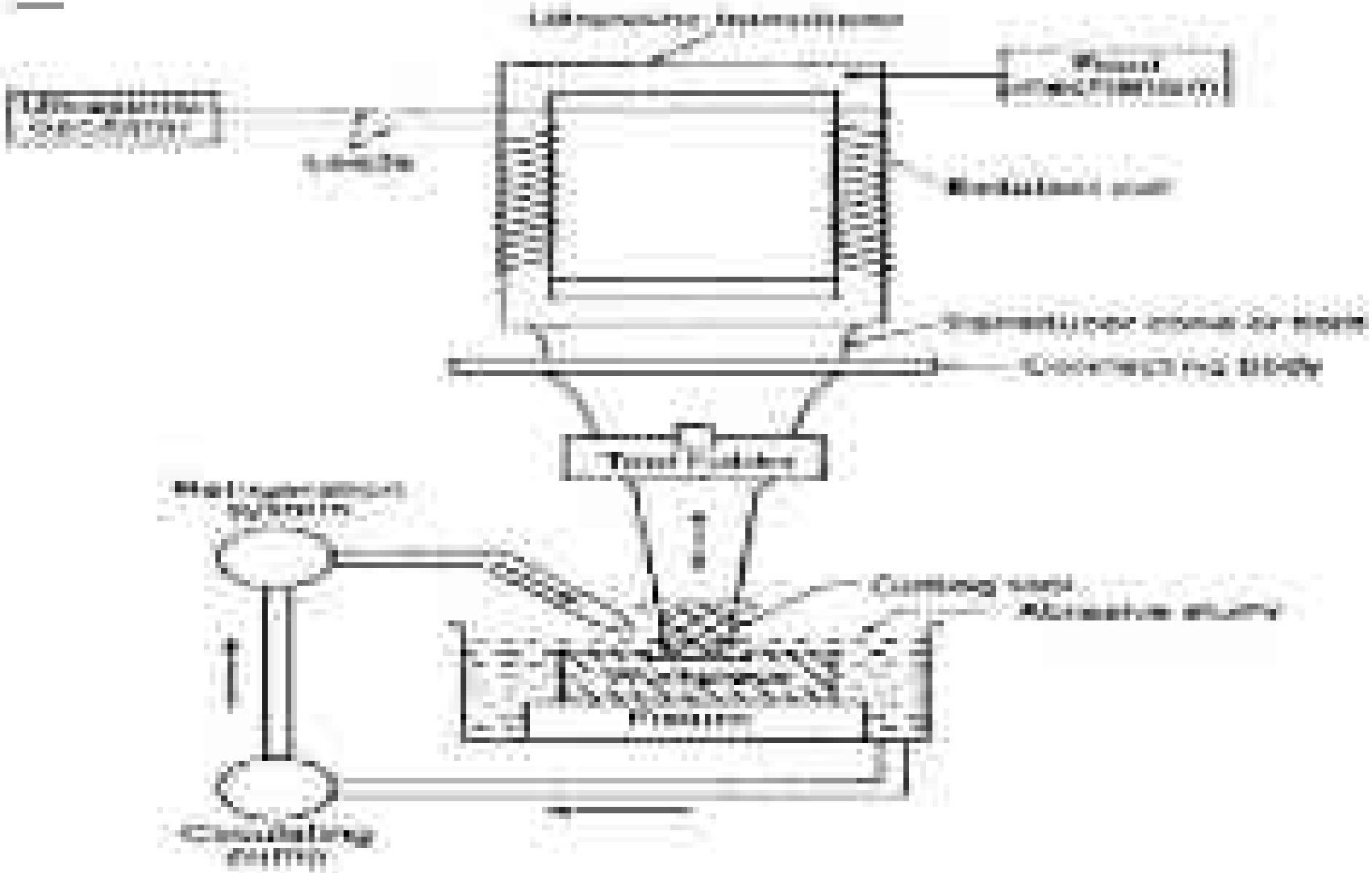
1. Metal removal rate is very low, therefore, it has limited applications.
2. Machining accuracy is poor.
3. Nozzle wear rate is high.
4. Soft materials cannot be machined.
5. Abrasive powder cannot be reused.

ULTRASONIC MACHINING (USM)

- ✓The basic USM process involves a tool vibrating with a very high frequency and a continuous flow of abrasive slurry in the small gap between tool & workpiece

- ✓The material from work surface is removed by repetitive impact of abrasive particles in the slurry under the action of a high frequency vibrating tool


Ultrasonic vibration
frequency = 19 - 25 kHz
amplitude = 5 - 75 μm
Feed force
Abrasive slurry
(10 - 150 μm)
Tool
Abrasive slurry +
eroded particles
Workpiece



- The acoustic head is the most important part of the machine. Its function is to produce a vibration in the tool. It consists of a generator called ultrasonic oscillator.

- The ultrasonic oscillator for supplying high frequency electric current an ultrasonic transducer to convert electrical energy into mechanical motion in the form of a high frequency vibration.

- The feed mechanism is to apply the work force during machining operation. The different feed mechanisms are counter weight type, spring type, pneumatic & hydraulic type, motor type.

- ✓ The tool holder is made of titanium alloy, monel, aluminimum, stainless steel etc.....
- ✓ The common abrasives are boron carbide, silicon carbide, aluminimum oxide, diamond & boron silicon carbide.
- ✓ Ultrasonic oscillator it converts the electrical energy at low frequency to high frequency of about 20kHz.

- ✓ The vibration are generated in the ultrasonic transducer of the order of 20kHz to 30kHz.
- ✓ The abrasive slurry is circulated to the work tool interface by a circulating pump.
- ✓ A refrigerated cooling system is used to cool the abrasive slurry to a temperature of 5 to 6°C

Applications of USM

1. Manufacturing complicated dies and punches of hard alloy steel.
2. Machining holes of any shape.
3. Machining semi-conducting materials such as germanium and silicon.
4. Coining of glass and ceramics.
5. Machining ferrite and other special metallo-ceramic materials.
6. Making instruments and optical parts of glass, quartz, fluoride, and barium titanate.
7. Cutting of industrial diamonds.
8. Threading by properly rotating the workpiece.

Advantages of USM

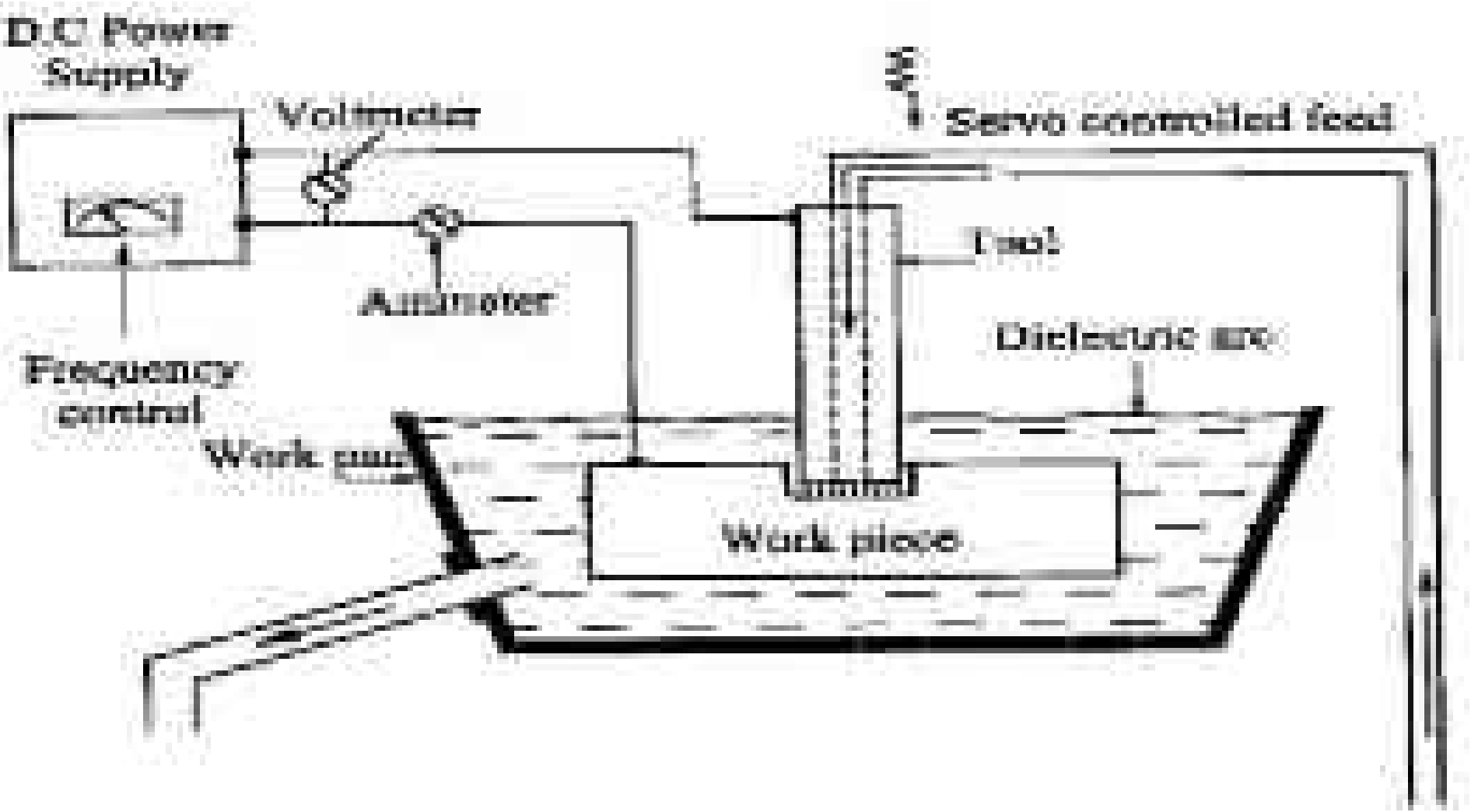
1. High accuracy and very good surface finish can be obtained.
2. Little or no heat is generated during machining process.
3. Extremely hard and brittle materials can be easily machined.
4. Equipment is safe to operate.
5. The cost of metal removal is low.
6. No toxic fumes are produced and hence, no health issues.
7. Less residual stresses are produced in the workpiece during machining.
8. Electrically non-conducting materials such as glass, ceramics etc., can also be machined.

Disadvantages of USM

1. The rate of moral removal it low.
2. Wear rate of tool is high.
3. Softer materials are difficult to machine.
4. Overall cost of machining is high.
5. The cost of tool is high.
6. The size of cavity that can be machined is limited.
7. Power consumption is high.
8. Frequent replacement of abrasive material in slurry is needed for efficient machining.

ELECTRIC DISCHARGE MACHINING (EDM) OR SPARK EROSION OR ELECTRO EROSION MACHINING

- ✓ The metal is removed from the surface of the work piece due to erosion.
- ✓ The erosion is caused by an electric spark produced between the workpiece and the tool.
- ✓ The workpiece is held in a fixture and placed inside a tank


D.C Power Supply
Voltmeter
Servo controlled feed
Tool
Ammeter
Dielectric in
Frequency control
Work piece

- ✓ The tank contains a die- electric fluid. kerosene, mineral oil; white spirit & paraffin are some of the die- electric fluids.
- ✓ The die electric fluids does not conduct electricity.
- ✓ The work piece is connected to the +ve terminal of a D.C supply (50 to 440V).
- ✓ The tool is made of copper, brass, tungston or graphite.

- ✓ The tool, is connected to −ve terminal of the D.C supply.
- ✓ The gap b/w tool & work piece is 0.005 to 0.05mm
- ✓ The die electric fluid is forced with pressure through the gap b/w the tool & work piece.
- ✓ The electric spark is produce b/w the tool and work piece.

- ✓ The spark is high heat of about 1200°C is produced in the gap.
- ✓ Thousands of sparks occur per second across the gap.
- ✓ A servo mechanism is used to feed the tool & maintain a constant gap b/w the tool & work piece
- ✓ The die electric fluid also act as a coolant.

Applications of EDM

1. It can be used for die sinking.
2. It is used for precision drilling of very small holes, slots, etc. in diesel fuel injection nozzles.
3. It can be used for producing profiles and cavities on very hard and brittle materials such as tungsten carbide and satellites.
4. It is used for machining intricate shapes.

5. It is used for blanking of parts from sheets.
6. It is used to cut of rods.
7. It can be used for sharpening of tools, cutters and broachers.
8. It can be used wire electrodes small holes up to 0.1 mm diameter can be produced.

Advantages of EDM

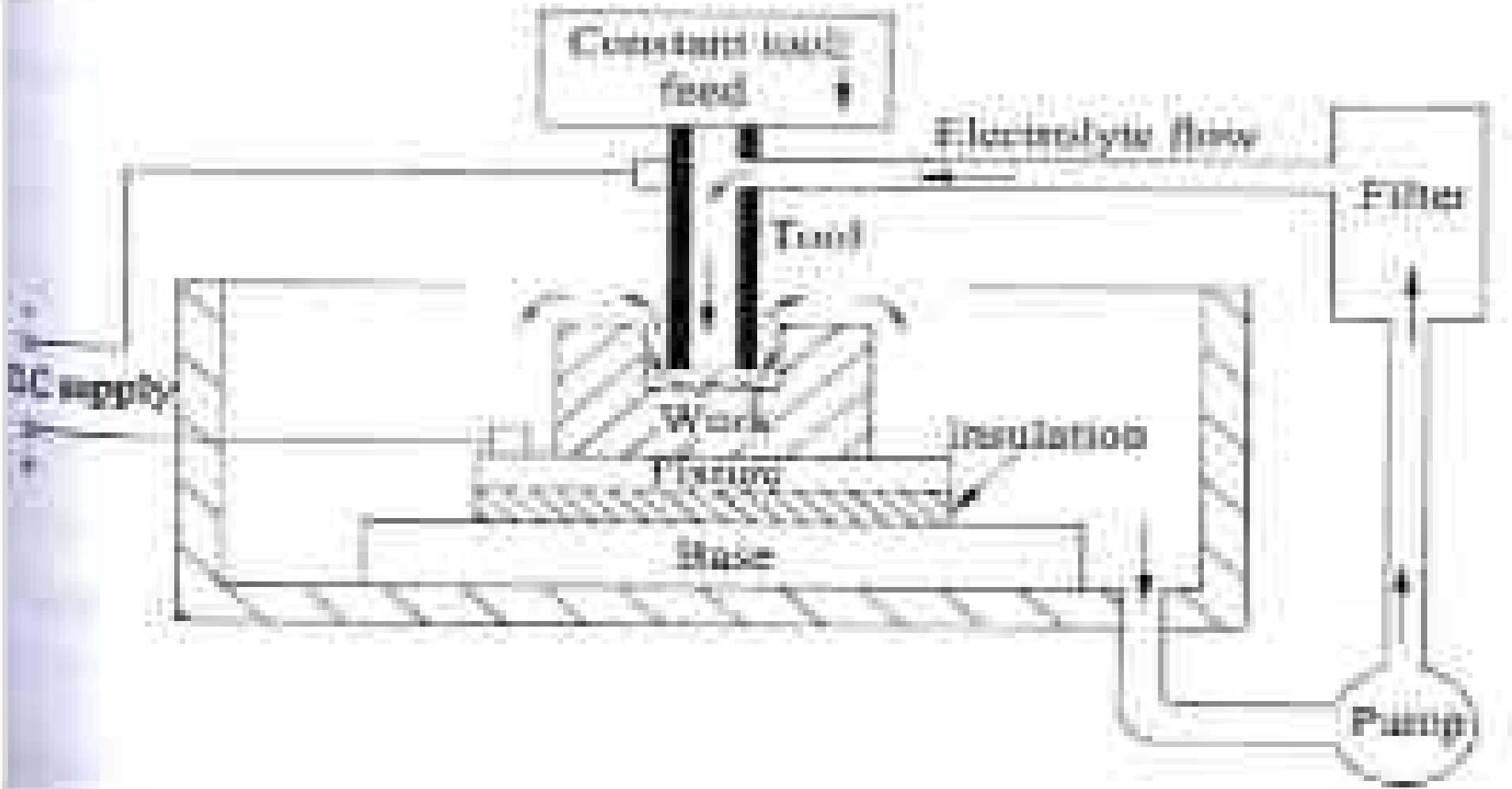
1. Any electrically conductive material can be machined.
2. Mechanical properties of the workpiece do not affect the machining.
3. The surface finish with an accuracy of 0.2 microns is possible.
4. There is no stress on the workpiece, as there is no cutting force. So, thin workpiece can be machined.
5. Any complicated shape that can be made on the tool can be produced in the workpiece.
6. It takes lesser time.
7. High accuracy (normally 0.05mm, special cases 0.01 mm)
8. The hardness of the workpiece is not factor. As long as the material can conduct current, it can be machined.

Disadvantages of EDM

1. Power consumption is high.
2. Only electrically conductive materials can be machined.
3. Perfectly square corners cannot be produced.
4. There is need of redressing of tools for deep holes.
5. EDM levels a recast at the surface of the cut.
6. It is slow when compared to conventional or even electro chemical machining.
7. It produces excessive tool wear.
8. Machining heats the workpiece and affects the metallurgical properties of the workpiece.

ELECTRO CHEMICAL MACHINING (ECM)

1. It is the reverse process of electroplating process
2. The work piece becomes anode +ve & tool become cathode –ve.
3. The shape of the tool depends on the shape to be produced on the workpiece
4. A small gap of about 0.2mm is maintained between the workpiece & the tool.


Constant tool feed
Electrolyte flow
Filter
Tool
DC supply
Work
Insulation
Fixture
Base
Pump

- ✓ An electrolyte usually, sodium chloride, sodium nitrate or sodium chlorate is passed through the hollow tool
- ✓ The tool is fed towards the workpiece automatically to maintain the gap between the work piece and tool surface
- ✓ The temperature of the electrolyte is maintained between 25° and 60°.

Applications of ECM

1. It is used for machining gas turbine blades, aircraft fuel components and pump impellers.
2. It is used for die sinking.
3. It is used to produce complex shapes in very hard materials.
4. It is used to machine blind holes, through holes, irregular shaped holes and complex external shapes.
5. It is used for rough machining of heavy forgings.
6. It is used for machining rock boring bits, gears, etc

Advantages of ECM

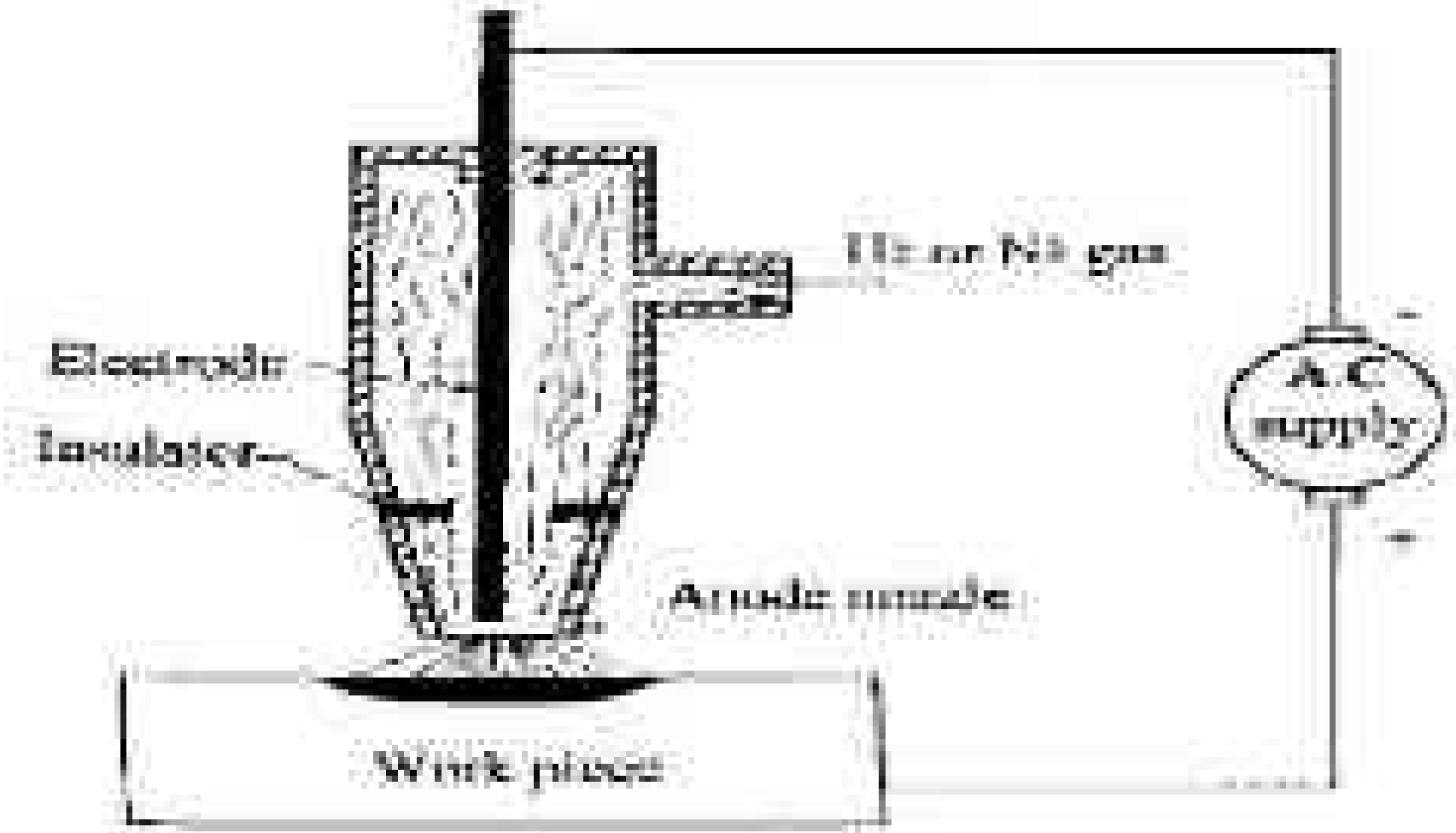
1. It is simple and faster method.
2. There is no thermal and mechanical stress on the workpiece.
3. Very thin sections can be machined.
4. It can be used for all metals irrespective of their mechanical properties (strength, hardness, etc.)
5. Any complex profile can be machined.
6. A very good surface finish is obtained (upto 0.4)
7. There is no tool wear. Hence, it has longer tool life.
8. The faster metal removal could be achieved.
9. Dimensional accuracy of 0.01 mm can be achieved.
10. No sharp corners and burrs will be in the component.

Disadvantages of ECM

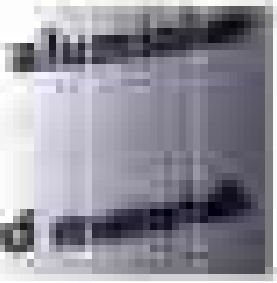
1. Power consumption is high.
2. It cannot be used for machining non conducting materials.
3. It leads to corrosion in machine parts.
4. Rigid fixtures are required to withstand high flow of electrolyte.
5. It is an expensive process.

PLASMA ARE MACHINING

- ✓ When a flowing gas is heated to a very high temperature about 11000°C, it becomes ionized gas (Plasma gas)
- ✓ The tungsten electrode is connected to the –ve terminal of a 400v 200A dc D.C. supply
- ✓ When the supply is given, an arc is produced between the tungsten electrode (cathode) & copper nozzle (anode).
- ✓ The rate of metal removal can be increased with increase in gas flow


Electrode
Insulator
A.C supply

Applications of PAM



1. It is used for cutting stainless steel and aluminium alloys.
2. It is used for profile cutting and slitting in hard materials such as super alloy steels.

Advantages of PAM

1. This process can be used to cut any metal.
2. The cutting action is faster.
3. It is possible to cut thick material up to 150 mm.

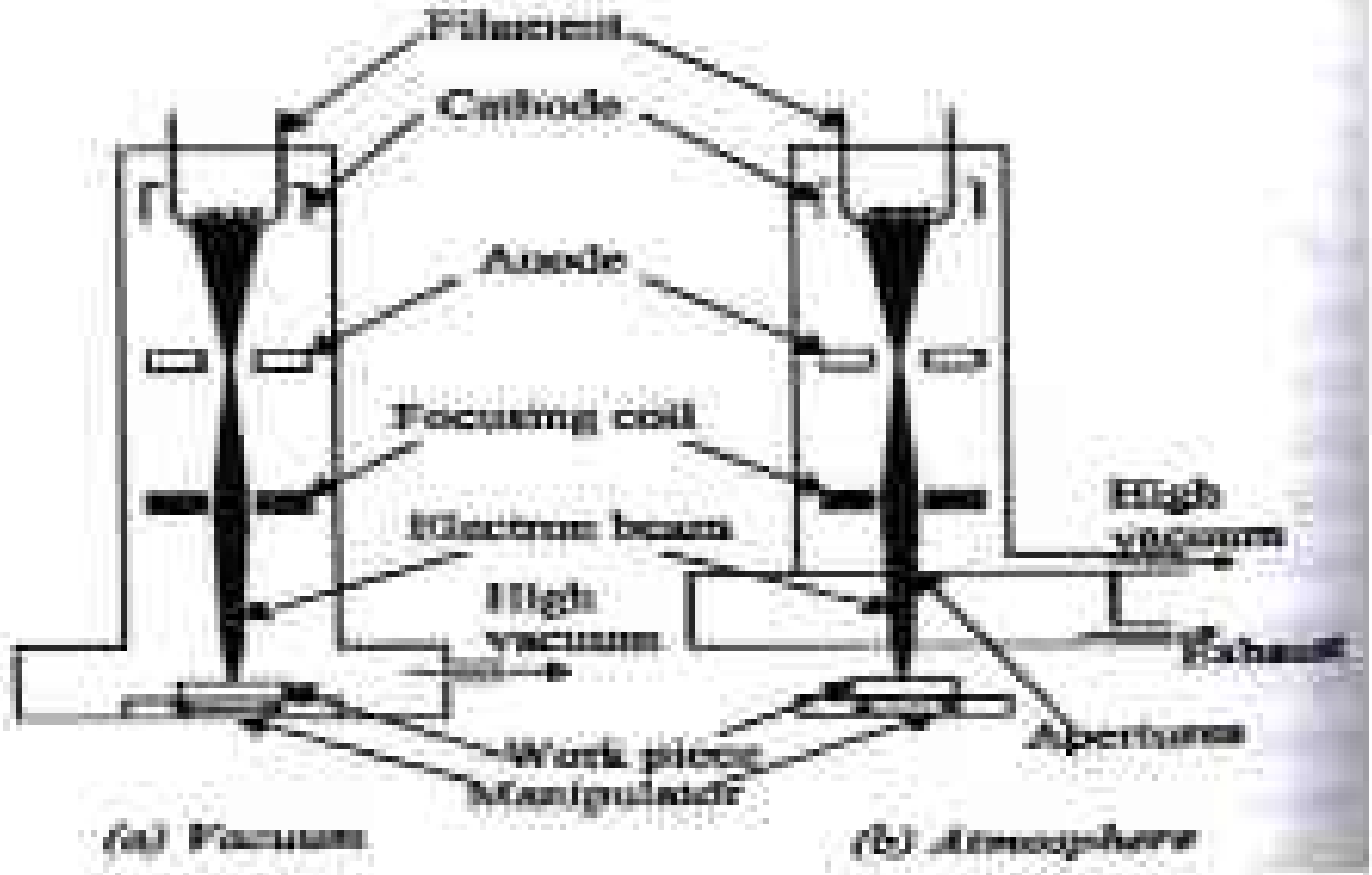
Disadvantages of PAM

1. Because of the high heat, metallurgical change takes place on the workpiece.
2. The process is unsafe. Safety precautions are necessary.

ELECTRON BEAM MACHINING(EBM)

- ✓ EBM uses electrical energy supplied by power supply to produce thermal energy for the metal removal in workpiece.

- ✓ High speed electrons of 200(0)Hz in the form of pulsating stream produced by the generator are focused by electrostatic & electromagnetic fields to increase their density on a very small area of the work where the machining is needed.


Filament
Cathode
Anode
Focusing coil
Electron beam
High vacuum
High vacuum
Exhaust
Aperture
Work piece
Manipulator
(a) Vacuum
(b) Atmosphere

- ✓ The velocity of electron beam is 1.5 times of the speed of the light. It is around 160000km/s.

- ✓ EBM process can be used in stainless steel, cobalt alloys, copper, aluminimum, titanium, ceramic, leather & plastics can be processed by EBM.

- ✓ The electron beams density can be increased on spots to make holes as small as 0.0127mm in diameter.

Applications of EBM

1. It is mainly used for various machining operations such as cutting, drilling or milling processes on workpieces.
2. It is also used for drilling fine holes in wire drawing dies and gas orifices.
3. It is used for metering holes such as round shape or shaped to a particular profile.
4. It is used for high speed drilling of round holes.
5. It is used for drilling holes through thin sheet metal.

Advantages of EBM

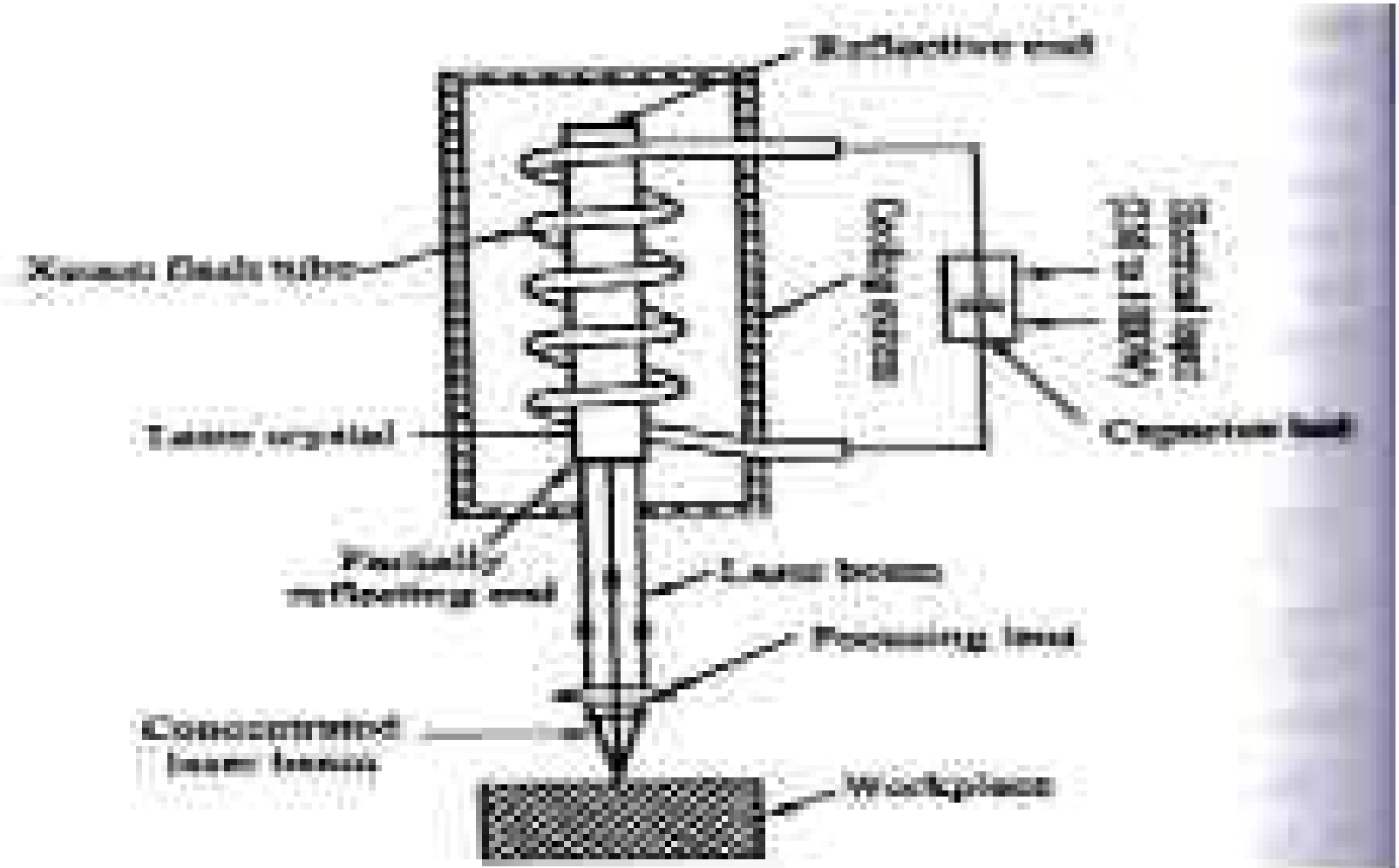
1. EBM process can drill any material.
2. There is no mechanical or thermal distortion during machining process.
3. It has the ability to drill deep and high aspect ratio holes (Aspect ratio is around 15:1).
4. Extremely close tolerance on the hole diameter are obtained.
5. The process can be easily automated.

Disadvantages of EBM process

1. The cost of EBM equipment is high.
2. The pump down time for producing vacuum is slightly long and there is no machining operation during pump down time.
3. EBM is more suitable for thin parts.
4. Sometimes, thermal effects will remain on the work.

LASER BEAM MACHINING

- ✓ The word "LASER" stands for "Light Amplification by Simulated Emission of Radiation".
- ✓ Laser produces monochromatic light which is in the form of a collimated beam.
- ✓ It is also capable of producing very high power density.
- ✓ It can optically be focused on to very small spots of less than 0.002mm diameter.


Reflective end
Xenon flash tube
Trigger crystal
Partially reflecting end
Laser beam
Focusing lens
Concentrated laser beam
Workpiece

- ✓ The electromagnetic radiation with wavelength radiation with wavelength varying from 0.7 — 70μm.

- ✓ There are several types of laser used in manufacturing operation they are pulsed or continuous wave, neodymium: yttrium-aluminimum- garnet, glass, ruby & excite laser.

- ✓ The most commonly used laser is a man- made ruby. It is one type of solid state laser.

- The capacitor is charged and a very high voltage is applied to the triggering electrode for initiation of the flash. The electric power of 250 to 1000W may be needed for this operation.

- The light energy from the flash tube is passed into the ruby rod, the chromium atoms in the ruby rod are exited to high energy levels.

- The chain reaction is started and a powerful coherent, monochromatic beam of red light, called laser beam.

7.3. Applications of LBM

1. It is widely used in drilling and cutting metals, non-metals and composite materials.
2. Useful in machining very small holes. Holes upto 250μm diameter can be easily drilled with dimensional accuracy of ±0.025mm.
3. It is increasingly used in the electronics and automotive industries. For example, bleeder holes for fuel-pump covers and lubrication holes in transmission tubes are being drilled with lasers.
4. It is also used in welding, cutting and small-scale heat treatment of metals and ceramics.
5. Engraving and partial cutting are also possible with lasers.
6. Micro-welding and micro-machining are possible.

7.4. Advantages of LBM

1. Any solid material including non-metal can be cut or machined with the laser beam.
2. There is no direct contact between the tool and the workpiece.
3. There is no tool wear.
4. Heat affected zone is small because of the collimated beam.
5. Micro-holes can be drilled.
6. Dissimilar metals can be welded easily.
7. Process can be easily controlled and automated.
8. Drilling and cutting of areas are not readily accessible.
9. Soft materials such as rubber and plastics can be machined.
10. Laser beam can be sent to long distance without diffusion.

47.5. Disadvantages of LBM

1. Its overall efficiency is extremely low (10 to 15%
2. It requires high capital cost.
3. The process is limited to thin sheet plates.
4. It has low rate of metal removal.
5. The machined holes are not round and straight.
6. Highly skilled operators are needed.
7. Life of flash lamp is short.
8. Certain materials such as fibre glass, reinforced materials, phenolics etc, cannot be worked by laser as these materials burn, char and bubble.
9. Safety procedures should be be followed strictly.
10. Output energy from laser is difficult to control precisely.