LABORATORY

MANUAL ON

WORKSHOP PRACTICE-III

OF

4TH SEMESTER

MECHANICAL ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

GOVT. POLYTECHNIC SAMBALPUR

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COURSE OBJECTIVES

Students will develop ability towards

1. Preparing components and jobs using foundry, welding and machining

2. Realizing process parameters involved and their effects.

This laboratory manual provides practical knowledge to the students for understanding different instruments, tools & machines used in mechanical workshop and the use of different measuring instruments as such.

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+ SAFETY IN SHOP +

Observe the following safety to avoid injury to your self and co-workers

1. Be well dressed i.e., avoid loose garments, roll up sleeves, put on suitable footwear and remove watch and ring.
2. Keep the work place neat and clean i.e., place the tools at proper position. The scraps and chips should be dropped in waste bins.
3. Concentrate on your job and avoid talking with co-workers.
4. The shops are no place to play. Running and pushing in the shop may cause accidents.
5. Understand the use of tools and machines before handling.
6. Never use dull tools. The use may damage the tools completely or may lead to injury.
7. In case you are in doubt contact the instructor.
8. Always chuck the fitting of the handle in the hammerhead.
9. Be familiar with the locations of First Aid Box and Fire Extinguisher in the shop. In case of emergency one should reach them quickly.
10. Laziness and carelessness are your deadly enemies. Always be active and careful in the shop

FOUNDRY

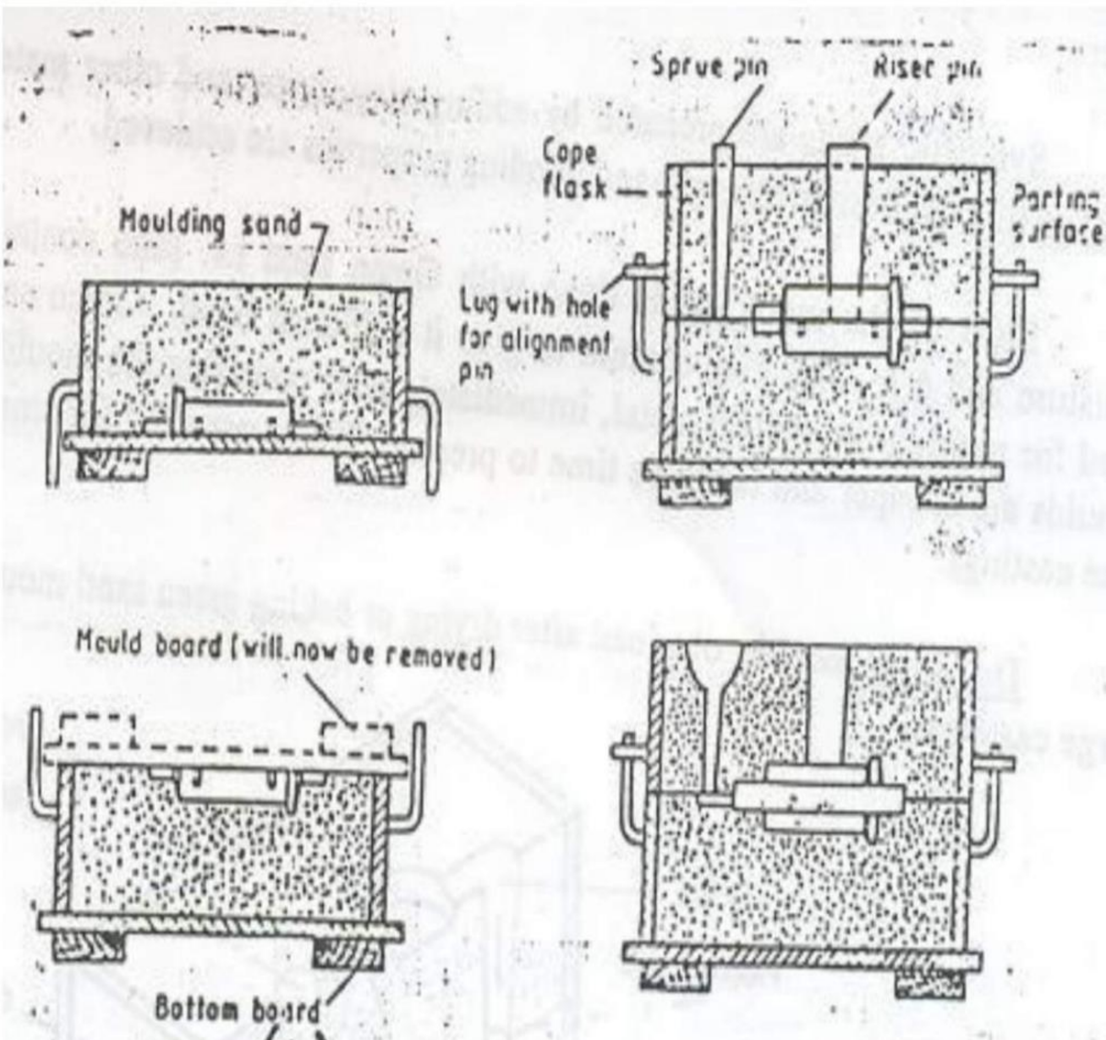
INTRODUCTION:

Metal casting is the process of forming metallic objects by melting metal, pouring it into the shaped cavity of a MOULD and allowing it to solidity. The process of casting involves the basic operations of pattern making, sand preparation, MOULDING, melting of metal, pouring in moulds, cooling, shake-out, felting, heat treatment, finishing and Inspection.The casting process involving the use of sand as moulding medium can be classified as sand moulding processes. The stages involved in the sand moulding processes are: Sand preparation, pattern making, core making (if required), moulding and closing.

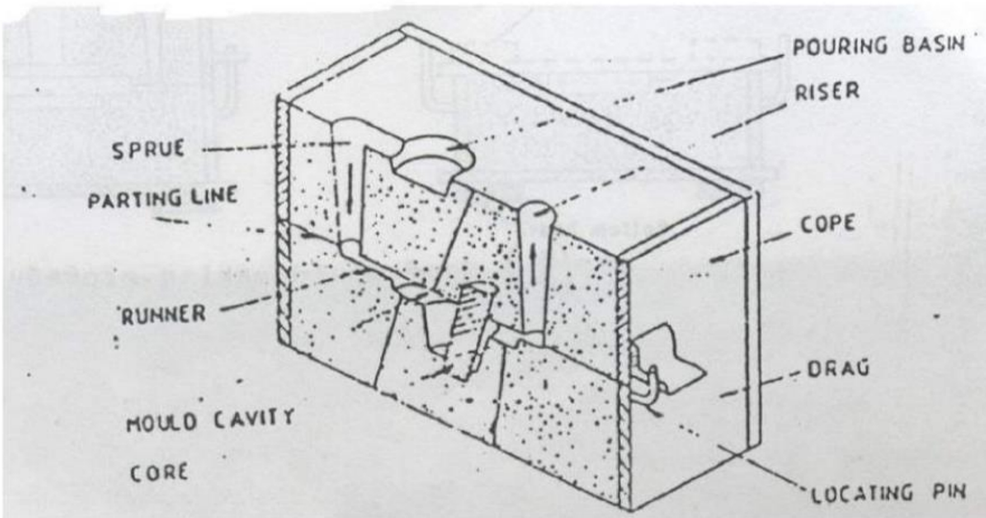
PREPARATION OF A MOULD (fig 1)

1. The following are the steps used in making a simple mould using a hollow split pattern with core prints on both sides:
2. Place the bottom half of the pattern on the moulding board, with its flat side on the board.
3. Place the drag over the board.
4. Sprinkle the pattern and the moulding board with parting sand.
5. Allow facing sand, over the pattern, until it is covered to a depth of 2 to 3 cm.
6. Pack the moulding sand around the pattern into the corners of the flask with fingers.
7. Place backing sand in the flask and ram the sand in the moulding box with a rammer.
8. Use first the peen end and then the butt end of the rammer.
9. Strike off the excess sand from the top surface of the drag with strike off bar.
10. Turn the drag upside down.
11. Blow-off the loose sand particles with the bellows and smoothen the upper surface.
12. Align top half of the pattern with the bottom half by means of dowel pins.
13. Place the cope on the top of the drag in position, Locate riser on the highest point of the pattern.
14. Place the sprue pin 5 to 6cm away from the pattern on the other side of the riser pin.
15. Sprinkle the upper surface, over and around the pattern with the parting sand.
16. Repeat steps 4 to 7, appropriately.
17. Make holes with the vent rod to about 1cm from the pattern.
18. Remove the sprue and riser pins by carefully drawing them out. Make a funnel shaped hole at the top of the sprue hole, called the pouring basin.
19. Lift the cope and place it aside on its edge.

20. Insert the draw pin into the pattern. Wet the edges around the pattern, loosen the pattern by
21. rapping. Then draw the pattern straight up.
22. Repeat the above step for withdrawing pattern straight up.
23. Repair the mould by adding bits of sand, if necessary.
24. Cut gate in the drag from the sprue to the mould; blow-off any loose sand particles in the mould.
25. Set the core carefully in the locations provided by the core prints.
26. Close the mould by placing cope over the drag.
27. The mould is ready for pouring the molten metal.



FIG(1) Sand mould making procedure



MOULING SAND:

Sand is the principal material used in a foundry. The principal ingredients of moulding sands are (i) Silica Sand (ii) Clay and (iii) Moisture, clay imparts the necessary bonding strength to the moulding sand. Moisture when added in correct proportion provides the capacity to clay for binding the silica sand. Special additives are also added to develop certain properties to the moulding sands.

- Natural moulding sand is either available in river beds or dug from pits. They posses an appreciable amount of clay and are received, with the addition of water.
- Synthetic sands are prepared by adding clay, water and other materials to silica sand, so that the desires strength and bonding properties are achieved.
- Most of the moulding is done with Green sand i.e. sand containing 6 to 8% moisture and 6 to 10% clay content to give it sufficient bond. Green sand moulds are used for pouring the molten metal, immediately after preparing the moulds Green sand moulds are cheaper and take less time to prepare. These are used for small and medium size castings.
- Dry sand moulds, obtained after drying or baking green sand moulds are used for large castings.
- Parting sand which is clay free, fine grained silica sand, is used to keep the green sand from sticking to the pattern and also to prevent the cope and drags from clinging.
- Core sand is used for making cores. This is silica sand mixed with core oil and other additives. Core is a shape made in core sand placed in a mould to produce an accurate hollow shape or cavity in a casting when liquid material is poured in the

mould, it occupies all the empty spaces restricted on outside by mould and internally by core, finally forming the casting.

PATTERN: A pattern is the replica of the desired casting, which when packed in a suitable material, produces a cavity called the mould. This cavity when filled with molten metal, produces the desired casting after solidification.

Types of patterns: (fig 2) Wood or metal patterns are used in foundry practice. Single piece, split, loose piece, multipiece and cored patterns are some of the common types.

Single piece, solid pattern: It is the simplest of all the patterns. This has a flat surface on the cope side. This makes possible a straight line parting on the joint between the cope and the drag of the mould.

- **Split pattern:** Split patterns are adopted for intricate castings, where removal of the pattern from the mould is difficult. The two halves of the patterns are put together by dowel pins. If the two pieces are similar in size and shape, it is called a split pattern, otherwise, it is known as a two-piece pattern.
- **Loose piece pattern:** When a pattern cannot be withdrawn from the mould due to its complexity, loose pieces are provided to facilitate this. However, only two moulding boxes are required for making a mould in this case.
- **Multi-piece pattern:** This type of pattern is made in three or more parts. The parts that make-up the pattern are held together with dowel pins. The number of moulding boxes required will be equal to the number of pieces on the pattern.
- **Cored pattern:** When a casting with holes or recesses is to be made, a cored pattern is needed. This type of pattern is made with core prints added to the surface. After moulding, the core prints leave impressions in the sand for positioning a dry sand core. A sand core is prepared separately, dried and then positioning a dry sand core. A sand core is prepared separately dried and then positioned in the mould before it is closed. When molten metal is poured into the mould, a cavity or recess is formed in the casting, the shape of which is determined by that of the core.
- **Core Print:** An impression in the form of a recess is made in the mould, to support a core in the mould. This is obtained with the help of a projection, suitably added to the pattern.This projection on the pattern is known as the core print. Depending upon the casting shape, core print may be horizontal or vertical.

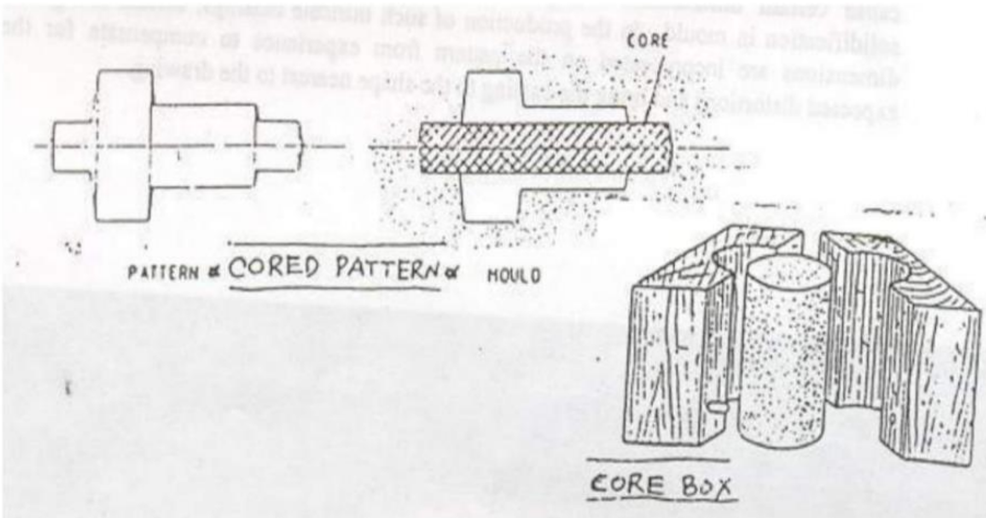


Fig : 2

Core box: A core box is made of either wood or metal, into which sand is packed to form the core. Wood is commonly used for making a core box; but metal boxes are used when cores are to be made in large number. Specially prepared core sand is used in making cores.

PATTERN DESIGN: While designing a pattern, the following must be considered.

1. Avoid abrupt changes in cross section. This is to avoid certain defects in the casting.
2. Avoid sharp corners and edges to enable smooth flow of molten metal in the mould cavity.
3. Provide the following pattern allowances.

- Shrinkage (Contraction) Allowance: Liquid metal which fills the mould-cavity entirey when poured, normally shrinks or contracts in solid stste from solidus temperature to liquidus reducing dimensions. To compensate for this, pattern should be made correspondingly lager than the final casting dimensions. Tis additional allowance which is upto 2% over the casting dimensions depending on the metal poured is incorporated in the pattern layout in all dimensions.For making patterns special scales called contraction scales are used. There will be a special scale for each type of metal to be poured.
- Machining Allowance: The final casting needs to be machined on many external/internal faces for better dimensional accuracy and finish. Accordingly, additional material has to be provided on all such faces requiring later, on the rough casting and so on the pattern. The amount of machining allowance depends on the size of the casting, the quality requirements and the nature of the casting metal.
- Draft (taper) Allowance: To facilitate easy withdrawl of pattern from the rammed mould, normally the vertical contact on the pattern are given a small taper or draft.

The amount of draft depends upon the depth of the pattern the material and finish of pattern, and should be minimum to keep the casting dimensions closer to the final drawing sizes, deeper patterns (500 mm) may have drafts even up to 8 mm. Draft is sometimes given as inclination in degrees (1 to 2) from the vertical faces. For deeper faces, it may be given for half height positive and other half, negative.

- Distortion Allowance: In long, thin and curved castings, the contraction stresses may cause certain dimensional changes which distort the overall configuration, during solidification in mould. In the production of such intricate castings, certain changes in dimensions are incorporated on the pattern from experience to compensate for the expected distortions and bring the casting to the shape nearest to the drawing.

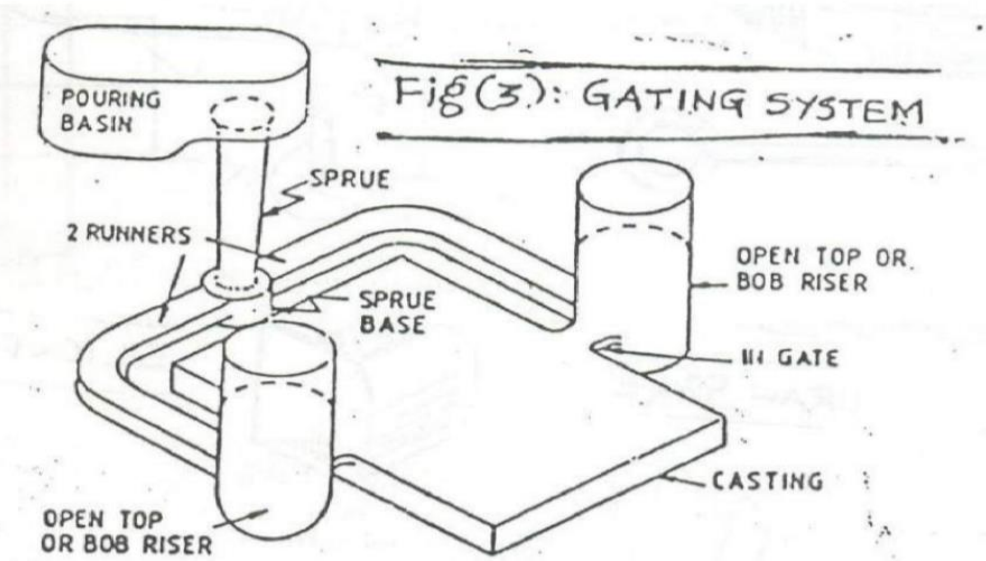
GATING SYSTEM: (fig 3) The elements of a gating system includes pouring basin, sprue, runner and in-gates and finally, the riser as shown in fig. and the function of each is as described below.

Pouring basin: It is a cup shaped reservoir on the top of a cope in which the molten metal is poured. The purpose of which is to minimize splash and turbulence and promote the entry of clean metal only into the sprue.

Sprue: This is a tapered passage in the cope through which molten metal from pouring basin reaches the sprue from which it in turn enters the runner.

Runner & in-gates: This is a channel in the drag which is always full of molten metal feeds the required amount of metal into the mould cavity through in-gates

Riser: This is also a tapered passage in the cope into which molten metal rises and the same is fed to the casting to compensate the shrinkage



Fig(3): GATING SYSTEM

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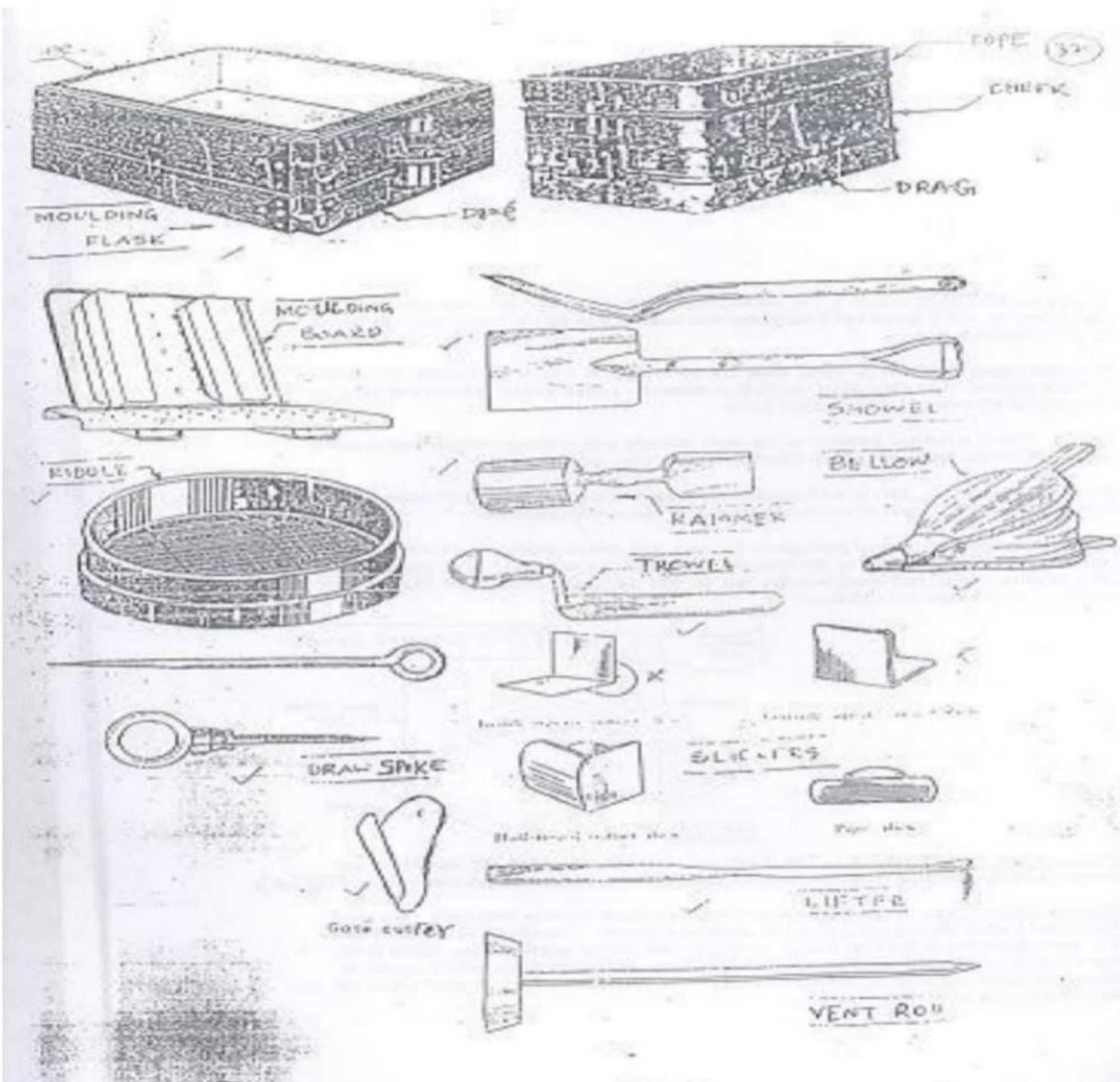
TOOLS AND EQUIPMENT: The tools and equipment needed for moulding are: moulding board, moulding flasks (boxes), bellows, showel, riddle, and moulder's tools (fig 4)

- **Moulding Flask(Box):** It is a box made of wood or metal, open at both ends. The sand is rammed in after placing the pattern to produce a mould. Usually,it is made of two parts. Cope is the top half of the mould having guides for the aligning pins. Draft is the bottom half of the flask, having aligning pins. Cheek, is another flask, which comes in between the cope and drag in the case of a three box mould. Check is used when the pattern consists of more than two parts.
- **Moulding Board:** It is a wooden board with smooth surface. It supports the cope and drag boxes and the pattern, while the mould is being made.
- **Shovel:** It is used for mixing and tempering moulding sand and for transferring the sand into the flask. It is made of steel blade with a wooden handle.
- **Riddle:** Hand riddle consist of a wooden frame fitted with a screen of standard wire mesh at its bottom. It is used for hand riddling (sieving) of sand to remove coarse sand particles and other foreign material of bigger size from the foundry sand.
- Rammer: It is used for packing or ramming the sand around the pattern.One of its ends,called the open end, is wedge shaped and is used for packing sand in spaces, pockets and corners in the early stages of ramming. The other end, called the butt end, has a flat surface and is used for compacting the towards the end of moulding.
- **Striking edge or strike-off bar:**It is a piece of metal or wood with straight edge.It is used to remove the excess sand from the mould after ramming to provide a level surface.
- **Trowel:** It consists of a metal blade fitted into a wooden handle. It is used to smoothen the surface of the mould. It may also be used for repairing the damaged portion of the mould. Trowels are made in many diffrnt styles and sizes, each one suitable for a particular job.
- **Spike or draw pin:** It is a pointed steel rod with a loop at the other end.It is used to remove the pattern from the mould. A draw screw, with a threaded end, may also be used for the purpose.
- **Slick:** It is a small ended tool having a flat on one end and a spoon on the other. It is used for mending and finishing small surfaces of the mould.

- Lifters: Lifters are made of thin sections of various widths and lengths, with one end bent at right angles. These are used for cleaning and finishing the bottom and sides of the deep and narrow pockets of the mould.
- **Gate Cutter:** It is a semi-circular piece of tin sheet, used to cut gates in the mould. Gates are meant for providing necessary passages for flow of molten metal into the mould cavity.
- **Bellows:** It is a hand tool, used to blow air, to remove the loose sand particles from the mould cavity.
- **Vent Rod:** It is a thin rod used for making vents or holes in the sand mould to allow the escape of mould gases generated during the pouring of molten metal.



Fig(4) TOOLS AND EQUIPMENTS

EXP: 01 **MOULD FOR A SOLID** **Date:**

Aim: To prepare a sand mold, using the given single piece pattern.

Raw material required: Moulding sand, Parting sand, facing sand, baking sand, single piece solid pattern, bottom board, moulding boxes etc.

Tools Required:

1. Molding board
2. Drag and cope boxes
3. Molding sand
4. Parting sand
5. Rammer
6. Strike-off bar
7. Bellows
8. Riser and sprue pins
9. Gate cutter
10. Vent rod
11. Draw spike
12. Wire Brush

Sequence of operations:

1. Sand preparation
2. Placing the mould flask(drag) on the moulding board/ moulding platform
3. Placing the pattern at the centre of the moulding flask
4. Ramming the drag
5. Placing runner and riser
6. Ramming the cope
7. Removal of the pattern, runner, riser
8. Gate cutting

Procedure: Mould Making

1. First a bottom board is placed either on the molding platform or on the floor, making the surface even.
2. The drag molding flask is kept upside down on the bottom board along with the drag part of the pattern at the centre of the flask on the board.
3. Dry facing sand is sprinkled over the board and pattern to provide a non-sticky layer.
4. Freshly prepared molding sand of requisite quality is now poured into the drag and on the pattern to a thickness of 30 to 50 mm.
5. Rest of the drag flask is completely filled with the backup sand and uniformly rammed to compact the sand.

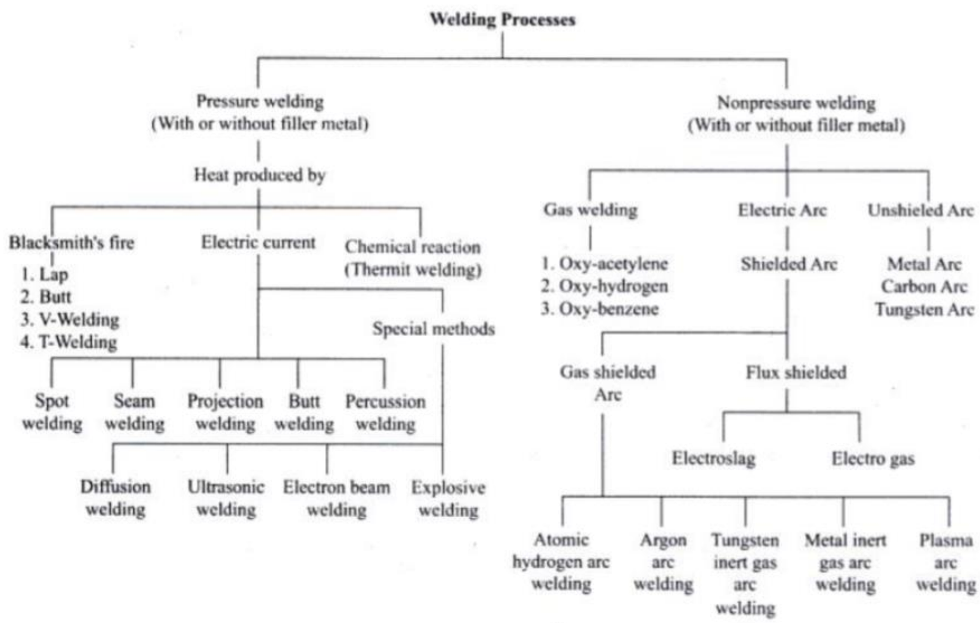
6. After the ramming is over, the excess sand in the flask is completely scraped using a flat bar to tl level of the flask edges.
7. Now with a vent wire which is a wire of 1 to 2 mm diameter with a pointed end, vent holes are ii the drag to the full depth of the flask as well as to the pattern to facilitate the removal of gases during casting solidification. This completes the preparation of the drag.
8. Now finished drag flask is rolled over to the bottom board exposing the pattern.
9. Using a slick, the edges of sand around the pattern is repaired
10. The cope flask on the top of the drag is located aligning again with the help of the pins of the dra box.
11. Sprue of the gating system for making the sprue passage is located at a small distance of about 5 mm from the pattern. The sprue base, runners and in-gates are also located as shown risers are also placed. Freshly prepared facing sand is poured around the pattern.
12. The moulding sand is then poured in the cope box. The sand is adequately rammed, excess sand scraped and vent holes are made all over in the cope as in the drag.
13. The sprue and the riser are carefully withdrawn from the flask
14. Later the pouring basin is cut near the top of the sprue.
15. The cope is separated from the drag any loose sand on the cope and drag interface is blown off with the help of the bellows.
16. Now the cope and the drag pattern halves are withdrawn by using the draw spikes and rapping tl pattern all around to slightly enlarge the mould cavity so that the walls are not spoiled by the withdrawing pattern.
17. The runners and gates are to be removed or to be cut in the mould carefully without spoiling the mould.
18. Any excess or loose sand is applied in the runners and mould cavity is blown away using the bellows.
19. Now the facing paste is applied all over the mould cavity and the runners which would give the finished casting a good surface finish.
20. A dry sand core is prepared using a core box. After suitable baking, it is placed in the mould cavity.
21. The cope is placed back on the drag taking care of the alignment of the two by means of the pins
22. The mould is ready for pouring molten metal. The liquid metal is allowed to cool and become solid which is the casting desired.

Result: The required mould cavity is prepared using the given Single /solid Pattern.

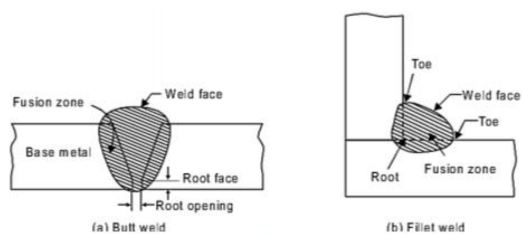
WELDING

Welding is a process for joining two similar or dissimilar metals by fusion. It joins different metals/alloys, with or without the application of pressure and with or without the use of filler metal. The fusion of metal takes place by means of heat. The heat may be generated either from combustion of gases, electric arc, electric resistance or by chemical reaction.

Welding provides a permanent joint but it normally affects the metallurgy of the components. It is therefore usually accompanied by post weld heat treatment for most of the critical components. The welding is widely used as a fabrication and repairing process in industries. Some of the typical applications of welding include the fabrication of ships, pressure vessels, automobile bodies, off-shore platform, bridges, welded pipes, sealing of nuclear fuel and explosives, etc.



Most of the metals and alloys can be welded by one type of welding process or the other. However, some are easier to weld than others. To compare this ease in welding term 'weldability' is often used. The weldability may be defined as property of a metal which indicates the ease with which it can be welded with other similar or dissimilar metals.



Terminology of welding process

Elements of welding process used with common welding joints such as base metal, fusion zone, weld face, root face, root opening toe and root are depicted in Figure.

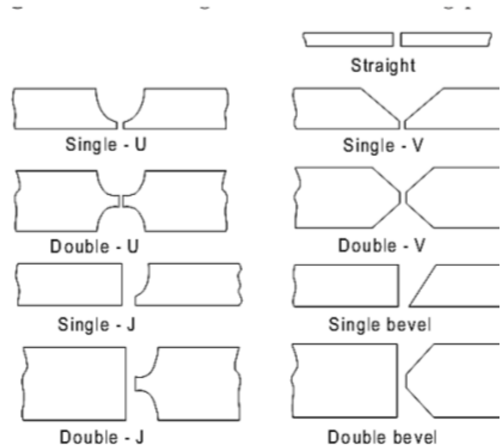
Edge preparations

For welding the edges of joining surfaces of metals are prepared first. Different edge preparations may be used for welding butt joints, which are given in Figure.

Welding joints

Some common welding joints are shown in Figure. Welding joints are of generally of two major kinds namely lap joint and butt joint. The main types are described as under.

1. Lap weld joint



Single-Lap Joint

This joint, made by overlapping the edges of the plate, is not recommended for most work. The single lap has very little resistance to bending. It can be used satisfactorily for joining two cylinders that fit inside one another.

Double-Lap Joint

This is stronger than the single-lap joint but has the disadvantage that it requires twice as much welding.

Tee Fillet Weld

This type of joint, although widely used, should not be employed if an alternative design is possible.

2. Butt weld joint

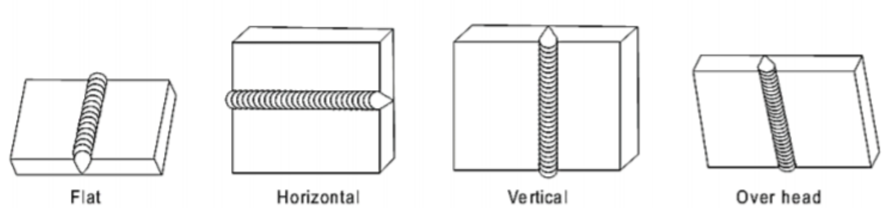
a. Single-Vee Butt Weld
It is used for plates up to 15.8 mm thick. The angle of the vee depends upon the technique being used, the plates being spaced approximately 3.2 mm.

b. Double-Vee Butt Weld
It is used for plates over 13 mm thick when the welding can be performed on both sides of the plate. The top vee angle is either 60° or 80°, while the bottom angle is 80°, depending on the technique being used.

Welding Positions

As shown in Fig. 17.4, there are four types of welding positions, which are given as:

a. Flat or down hand position
b. Horizontal position
c. Vertical position
d. Overhead position



Flat or Down-hand Welding Position

The flat position or down hand position is one in which the welding is performed from the upper side of the joint and the face of the weld is approximately horizontal.

Horizontal Welding Position

In horizontal position, the plane of the workpiece is vertical and the deposited weld head is horizontal. This position of welding is most commonly used in welding vessels and reservoirs.

Vertical Welding Position

In vertical position, the plane of the work-piece is vertical and the weld is deposited upon a vertical surface. It is difficult to produce satisfactory welds in this position due to the effect of the force of gravity on the molten metal.

The overhead position is probably even more difficult to weld than the vertical position. Here the pull of gravity against the molten metal is much greater.

ARC WELDING PROCESSES

The process, in which an electric arc between an electrode and a work-piece or between two electrodes is utilized to weld base metals, is called an arc welding process. The basic principle of arc welding is shown in Figure1. However the basic elements involved in arc welding process are shown in Figure2. Most of these processes use some shielding gas while others employ coatings or fluxes to prevent the weld pool from the surrounding atmosphere.

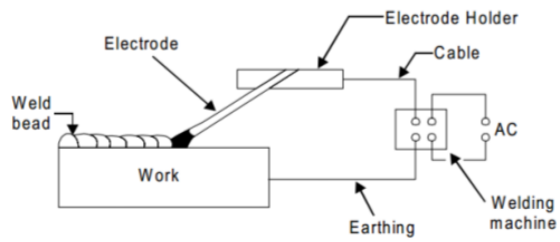


Fig1.The basic principle of arc welding

1) Switch box.
2) Secondary terminals
3) Welding machine.
4) Current reading scale.
5) Current regulating hand wheel.
6) Leather apron.
7) Asbestos hand gloves.
8) Protective glasses strap
9) Electrode holder.
10) Hand shield
11) Channel for cable protection.
12) Welding cable.
13) Chipping hammer.
14) Wire brush.
15) Earth clamp.
16) Welding table (metallic).
17) Job.

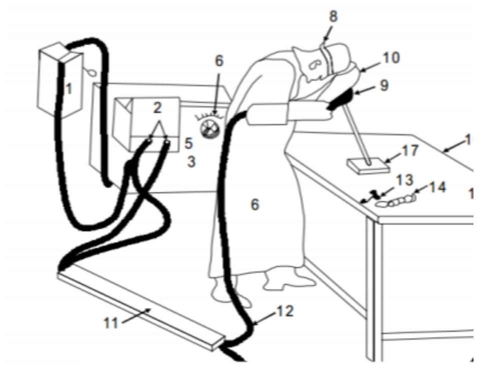


Fig2.The basic elements of arc welding

Arc Welding Equipment

Arc welding equipment, setup and related tools and accessories are shown in Figure. However some common tools of arc welding are shown separately through Figure. Few of the important components of arc welding setup are described as under.

1. Arc welding power source

Both direct current (DC) and alternating current (AC) are used for electric arc welding, each having its particular applications. DC welding supply is usually obtained from generators driven by electric motor or if no electricity is available by internal combustion engines. For AC welding supply, transformers are predominantly used for almost all Arc-welding where mains electricity supply is available. They have to step down the usual supply voltage (200-400 volts) to the normal open circuit welding voltage (50-90 volts). The following factors influence the selection of a power source:

a. Type of electrodes to be used and metals to be welded
b. Available power source (AC or DC)
c. Required output
d. Duty cycle
e. Efficiency
f. Initial costs and running costs
g. Available floor space
h. Versatility of equipment

2. Welding cables

Welding cables are required for conduction of current from the power source through the electrode holder, the arc, the work piece and back to the welding power source. These are insulated copper or aluminum cables.

3. Electrode holder

Electrode holder is used for holding the electrode manually and conducting current to it. These are usually matched to the size of the lead, which in turn matched to the amperage output of the arc welder. Electrode holders are available in sizes that range from 150 to 500 Amps.

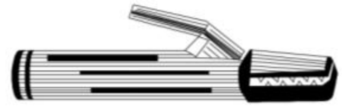


Fig. Electrode Holder

4. Welding Electrodes

An electrode is a piece of wire or a rod of a metal or alloy, with or without coatings. An arc is set up between electrode and workpiece. Welding electrodes are classified into following types-

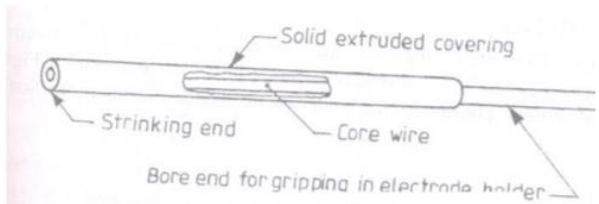


Fig. Parts of a electrode

(i) Consumable Electrodes
(a) Bare Electrodes
(b) Coated Electrodes
(ii) Non-consumable Electrodes
(a) Carbon or Graphite Electrodes
(b) Tungsten Electrodes

Consumable electrode is made of different metals and their alloys. The end of this electrode starts melting when arc is struck between the electrode and workpiece. Thus consumable electrode itself acts as a filler metal. Bare electrodes consist of a metal or alloy wire without any flux coating on them. Coated electrodes have flux coating which starts melting as soon as an electric arc is struck. This coating on melting performs many functions like prevention of joint from atmospheric contamination, arc stabilizers etc.

Non-consumable electrodes are made up of high melting point materials like carbon, pure tungsten or alloy tungsten etc. These electrodes do not melt away during welding. But practically, the electrode length goes on decreasing with the passage of time, because of oxidation and vaporization of the electrode material during welding. The materials of non-consumable electrodes are usually copper coated carbon or graphite, pure tungsten, thoriated or zirconiated tungsten.

5. Hand Screen

Hand screen used for protection of eyes and supervision of weld bead.

6. Chipping hammer

Chipping Hammer is used to remove the slag by striking.

7. Wire brush

Wire brush is used to clean the surface to be weld.

Fig. Earth Clamp

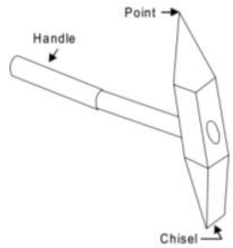


Fig. Chipping Hammer

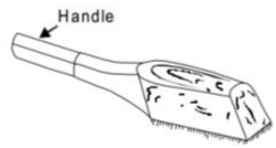


Fig. Wire Brush

8. Protective clothing

Operator wears the protective clothing such as apron to keep away the exposure of direct heat to the body.

Safety Recommendations for ARC Welding

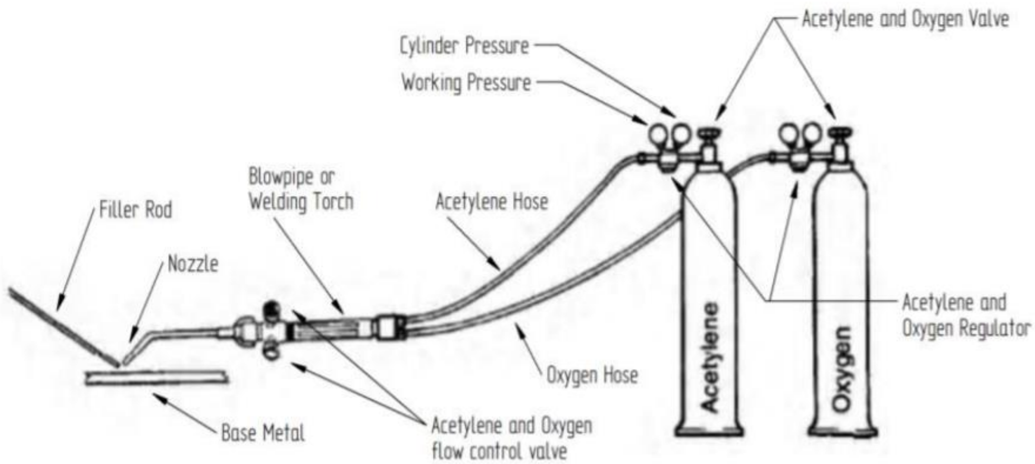
The beginner in the field of arc welding must go through and become familiar with these general safety recommendations which are given as under.

1. The body or the frame of the welding machine shall be efficiently earthed. Pipe lines containing gases or inflammable liquids or conduits carrying electrical conductors shall not be used for a ground return circuit All earth connections shall be mechanically strong and electrically adequate for the required current.
2. Welding arc in addition to being very is a source of infra-red and ultra-violet light also; consequently the operator must use either helmet or a hand-shield fitted with a special filter glass to protect eyes
3. Excess ultra-violet light can cause an effect similar to sunburn on the skin of the welder
4. The welder's body and clothing are protected from radiation and burns caused by sparks and flying globules of molten metal with the help of the following:
5. Gloves protect the hands of a welder.
6. Leather or asbestos apron is very useful to protect welder's clothes and his trunk and thighs while seated he is doing welding.
7. For overhead welding, some form of protection for the head is required
8. Leather skull cap or peaked cap will do the needful.
9. Leather jackets and 1ather leggings are also available as clothes for body protection.
10. Welding equipment shall be inspected periodically and maintained in safe working order at all times.
11. Arc welding machines should be of suitable quality.
12. All parts of welding set shall be suitably enclosed and protected to meet the usual service conditions.

- Heat is released when the carbon breaks away from hydrogen to combine with O_2 and burn.

$$C_2H_2+O_2 = 2CO+H_2+Heat$$

GAS WELDING EQUIPMENT



Advantages of gas welding

1. The equipment is inexpensive, uncomplicated.
2. It is portable.
3. Useful for welding light metals and for repair jobs.
4. Gas welding can be used with all the common metals.

Disadvantages

1. Acetylene is explosive.
2. Gas welding is slower than electric arc welding.
3. Heated areas are larger and cause more distortions.
4. The process is not satisfactory for heavy section.

EXPT NO: 01 **BUTT JOINT**

Aim: To make a Butt joint using the given two M.S pieces by arc welding.

Material Required:

Mild steel plate of size 100X50X5 mm – 2 No's

Welding Electrodes: M.S electrodes 3.1 mm X350 mm

Welding Equipment: Air cooled transformer
Voltage-80 to 600 V 3 phase supply, amps up to 350

Tools and Accessories required:

1. Rough and smooth files.
2. Protractor
3. Arc welding machine (transformer type)
4. Mild steel electrode and electrode holder
5. Ground clamp
6. Tongs
7. Face shield
8. Apron
9. Chipping hammer.

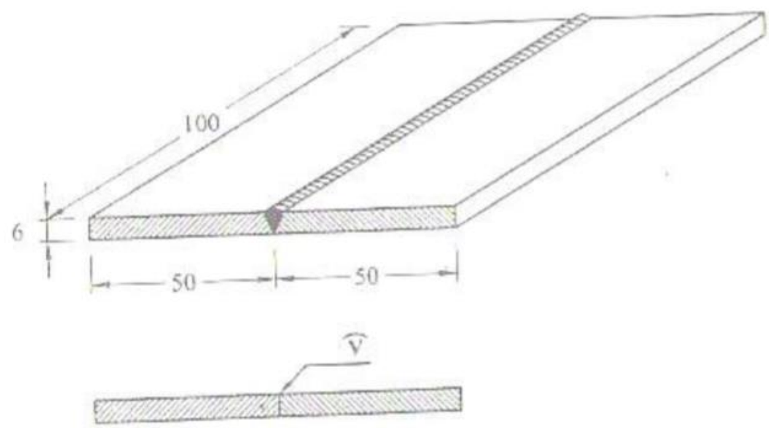
Sequence of operations:

1. Marking
2. Cutting
3. Edge preparation (Removal of rust, scale etc.) by filling
4. Try square leveling
5. Tacking
6. Welding
7. Cooling
8. Chipping
9. Cleaning

Procedure:

1. The given M.S pieces are thoroughly cleaned of rust and scale.
2. One edge of each piece is believed, to an angle of 30^0, leaving nearly ¼ th of the flat thickness, at one end.
3. The two pieces are positioned on the welding table such that, they are separated slightly for better penetration of the weld.
4. The electrode is fitted in the electrode holder and the welding current is ser to be a proper value.
5. The ground clamp is fastened to the welding table.
6. Wearing the apron and using the face shield, the arc is struck and holding the two pieces together; first run of the weld is done to fill the root gap.
7. Second run of the weld is done with proper weaving and with uniform movement. During the process of welding, the electrode is kept at 15^0 to 25^0 from vertical and in the direction of welding.
8. The scale formation on the welds is removed by using the chipping hammer.
9. Filling is done to remove any spanner around the weld.

DRAWING:



Welded Joint Representation

Result:

The single V-butt joint is thus made, using the tools and equipment as mentioned above.

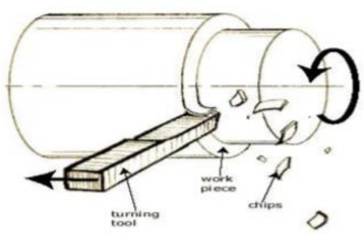
2. LATHE

2.1 Introduction

A lathe is a machine tool which spins a block of material to perform various operations such as cutting, sanding, knurling, drilling, etc. or deformation with tools that comes in contact with the work piece to create an object which has symmetry about an axis of rotation. Lathes are used in woodturning, metalworking, metal spinning, and in glass working. Lathes can be used to shape pottery as well. Most suitably metalworking lathes can be used to produce most solids of revolution, plane surfaces and screw threads or helices. The material can be held in place by either one or two centers, at least one of which can be moved horizontally to accommodate varying material lengths. Ornamental lathes can produce three-dimensional solids of incredible complexity. Machine shop personnel must be thoroughly familiar with the lathe and its operations to perform various tasks.

2.2 Principal of Operations

The lathe is a machine tool used principally for shaping articles of metal (and sometimes wood or other materials) by causing the work piece to be held and rotated by the lathe while a tool bit is advanced into the work causing the cutting action. The basic lathe that was designed to cut cylindrical metal stock has been developed further to produce screw threads, tapered work, drilled holes, knurled surfaces, etc. The typical lathe provides a variety of rotating speeds and a means to manually and automatically move the cutting tool into the work piece.



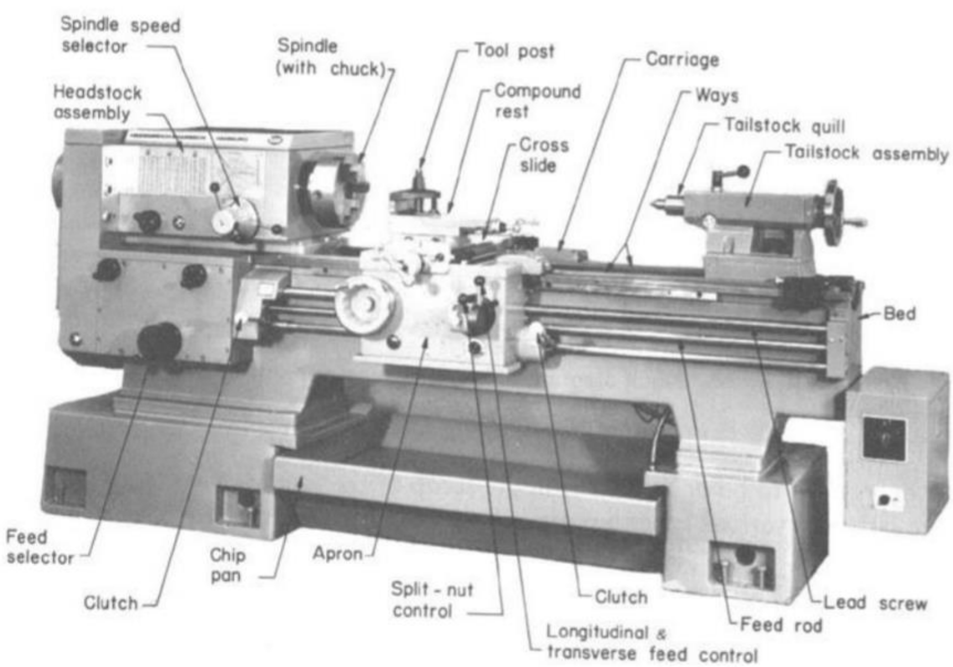


Fig.8 Engine Lathe

2.3 Lathe and its Parts

Headstock	Contains the spindle in two preloaded ball bearings
Spindle	The spindle is inside the headstock and is driven with a belt running from the motor pulley to a pulley on the rear end of the spindle shaft. The nose of the spindle is treaded on the outside to receive chucks and tapered on the inside to receive other accessories.
Chucks	A 3-jaw or 4-jaw chuck threads onto the spindle nose to hold your work, a drill chuck are used on the tailstock to center drill your part.
Tool Post	Attaches to the lathe table and holds a 1/4" square cutting tool
Cross Slide Table	Also sometimes spelled "cross slide," it is the table with two T-slots that holds the tool post.
Cross Slide Gib	A tapered plastic wedge that is held in place by a gib lock. It fits between the angled surfaces of the dovetail and is used to adjust for wear. As wear occurs and the table develops "slop," the lock is loosened and the gib is pushed further into the gap, taking up any play. This allows the machine to always be kept in peak adjustment.
Tail Stock spindle	Has a #0 Morse internal taper for holding chucks and other tools. A hand wheel moves it in and out for drilling
Tail Stock Locking Screw	Locks the tailstock in place on the bed to keep it from moving. When loosened, the tailstock can be slid up and down the bed.
Bed	The dovetailed steel bar that the saddle and tailstock are moved back and forth on.
Saddle	The part that supports the cross slide table and is moved up and down the bed using the lead screw hand wheel.
Saddle Gib	Functions like the cross slide gib to keep the saddle in tight adjustment against the dovetailed bed.
Lead Screw	The threaded screw under the bed that controls movement of the saddle. A "saddle nut" underneath attaches the bed to the leadscrew. Turning the lead screw hand wheel moves the saddle down the bed.
Tail Stock Gib	A brass part attached to the base of the tailstock that runs on one of the bed dovetails. The brass part is expected to wear rather than the more expensive bed and can be adjusted for tightness as it wears.
Lathe Base	The cast metal base upon which the lathe bed and headstock sit.
Drawbolt	Goes through the hole in the spindle to draw chucks and other accessories into the headstock taper inside the spindle. A special washer locates it on center in the spindle hole.

#1 Morse Arbor	The tailstock drill chuck normally has a #0 Morse arbor threaded into the back of it for use in the tailstock spindle. That arbor can be removed and replaced with the #1 Morse arbor so the drill chuck can be used in the headstock.
Dead Centers	#1 and #0 Morse arbors have a 60° point and are used to locate and hold work "between centers" on the lathe. The #1 Morse arbor rotates with the headstock, but because the tailstock spindle does not rotate, the rear #0 Morse arbor is called a "dead" center. This needs to be kept lubricated because it creates friction with the moving part it is locating. Most machinists eventually replace this with a "live" center that turns on a ball bearing.
Tommy Bars	Round steel bars used to tighten and loosen chucks and other spindle accessories. Sometimes called "Spindle Bars."
Faceplate	A cast plate that threads onto the spindle nose. A work piece can be bolted to it as an alternative to using a chuck. It has three slots to drive a drive dog.
Drive Dog	Also called a "Lathe Dog," this part is attached to a piece of bar stock by means of a screw that goes through the side and the long point is placed into one of the slots in the faceplate. The part is located between the lathe centers (live or dead) and when the faceplate turns, the dog actually drives the piece to rotate it for cutting. It also acts as a universal joint when turning a part between centers when the headstock is rotated to a slight angle, allowing a tapered part to be cut.
Head Stock Locking Screw	Holds the headstock in place. The screw is a pointed set screw. The point engages a tapered groove in the pin that sticks up out of the lathe bed. When the screw is tightened, it pulls the headstock down onto the alignment key and holds it tight against the lathe bed.
Alignment Key	A precision ground key that fits in slots in the top of the bed and bottom of the headstock to keep the headstock aligned straight with the tailstock. Removing this key and rotating the headstock allows tapers to be cut.
V-belt	A Kevlar-reinforced Urethane belt that drives the spindle by means of the pulleys.
2-Position Pulley	The motor turns a maximum of about 6000 RPM. Putting the drive belt in the normal (rear) position gears the motor down about 2:1 for a maximum speed of about 2800 RPM. The "High Torque" position (closest to the headstock) gears it about 4:1 for lower speed but more torque when needed for heavy cuts.
Variable Speed Control Knob	Controls motor speed from 0 to 2800 RPM

2.5 Types of Lathes:

1. **Engine Lathe**
   The most common form of lathe, motor driven and comes in large variety of sizes and shapes.
2. **Bench Lathe**
   A bench top model usually of low power used to make precision machine small work pieces.
3. **Tracer Lathe**
   A lathe that has the ability to follow a template to copy a shape or contour.
4. **Automatic Lathe**
   A lathe in which the work piece is automatically fed and removed without use of an operator. Cutting operations are automatically controlled by a sequencer of some form.
5. **Turret Lathe**
   Lathes which have multiple tools mounted on turret either attached to the tailstock or the cross-slide, which allows for quick changes in tooling and cutting operations.
6. **Computer Controlled Lathe**
   Highly automated lathes, where cutting, loading, tool changing, and partunloadingare automatically controlled by computer coding.

2.6 Machining Parameters:

Cutting Speed:

The speed in surface feet per minute or meters per minute at which the metal may be machined efficiently

Lathe Cutting Speed:

It may be defined as the rate at which a point on the work circumferences travels past the cutting tool. When work is machined in a lathe, it must be turned at a specific number of revolutions per minute(r/mint), depending on its diameter, to achieve the proper cutting speed.
Cutting speed is always expressed in feet per minute (ft/mint) or in meters per minute (m/mint).

Lathe Feed:

The feed of a lathe may be defined as the distance the cutting tool advances along the length of work for every revolution of spindle.
Feed of the lathe is dependent on the speed of the lead screw or feed rod. Speed is controlled by the change gears in the quick – change gear box.

Cutting Speed:

Cutting speed is how fast the metal comes into contact with the tool at thecutting point. On a lathe, it is the rate at which the surface of the job passesthe cutting tool. This takes into account the diameter of the job.The general formula for a cutting speed is as follows:

Feed:

The feed of a lathe may be defined as the distance the cutting tool advances along the length of the work for every revolution of the spindle.

2.7 Various operations performed on Lathe machine

Turning	:	Produces straight, conical, curved, or grooved work pieces
Facing	:	Produces a flat surface at the end of the part
Boring	:	To enlarge a hole
Drilling	:	To produce a hole
Cutting off	:	To cut off a work piece
Threading	:	To produce threads
Knurling	:	Produces a regularly shaped roughness
Profiling	:	To turn cylindrical work pieces with rough and finished cuts
Grooving	:	To make furrows or channels

2.8 Operations on a Lathe:

Turning:
cutting tool is moved parallel to the axis of the work piece to produce a cylindrical surface by removing the unwanted material in the form of chips. Here depth of the cut is given by moving the tool perpendicular to the lathe axis.

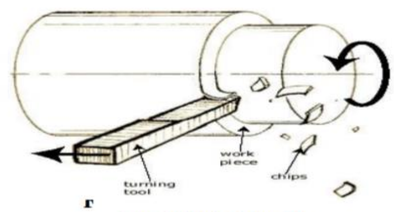


Fig.10 Plain Turning

Facing:
It is an operation to produce flat surface on the ends of the work piece.Here the cutting tool is fed against the rotating work piece perpendicular to the lathe axis and the depth of the cut is given by moving the tool parallel to the lathe axis.

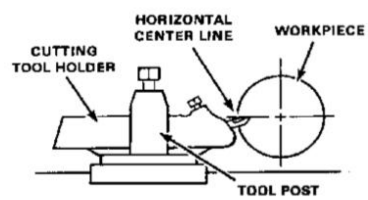


Fig.11 Facing operation

Taper Turning :
It is an operation to produce conical surface on the work piece.
Methods for taper turning.

- ✓ By swivelling the compound rest
- ✓ By offsetting the tail stock
- ✓ By taper turning attachment
- ✓ By using form tool

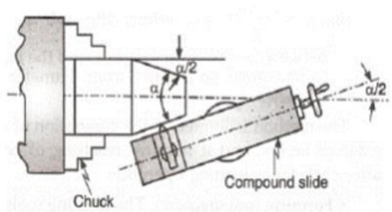
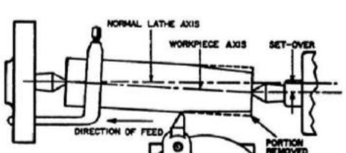


Fig.12 Swivelling of Compound Rest



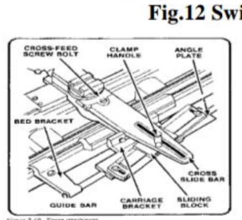


Fig.13 Using Offsetting the Tail stock

Fig.14 Using Taper Turning Attachment

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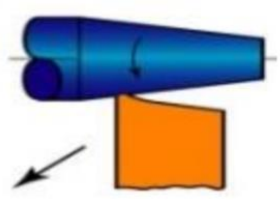


Thread Cuting:

A thread is a helical groove formed on a cylindrical surface of the work piece. The shape o the groove will be normally v or shape which are called as vee- thread or squarThrea cutting cannot be done in single pass. It will be carried out in many passes with incrementa depth, till the required thread is formed. A typical thread cutting operation is shown in th figure. Thread cutting can be performed both on external and internal surfaces.

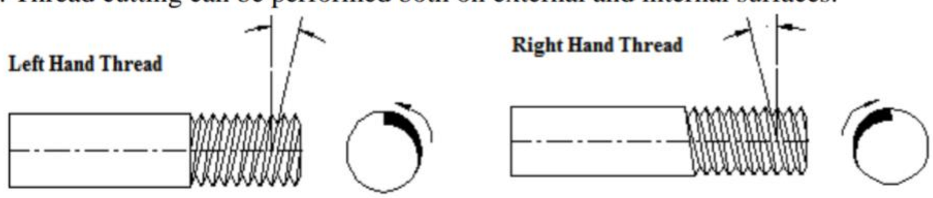
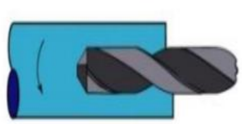


Fig. Left Hand Tread curring **Fig. Right Hand Treaad cutting**

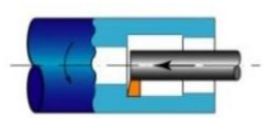
Fig.16 Threading Operations

Drilling:

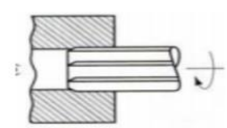
Drilling operation is performed by fixing twist drill bit on the tail stock and advancing th tool towards the workpiece and making hole to the desired length. Other operations lik Boring, Centre Drilling, Counter Boring, Counter Sinking, Reaming, Tapping, etc can als be performed using suitable tools



Drilling



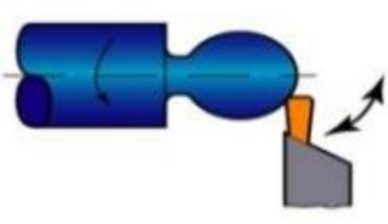
Borling



Reaming

Fig.17 Types of Drilling operations performed on Lathe Machine

Profile Turing:



Profile turning is performed when curve surfaces are required on the given job. The skills of the operator plays a very important role as this operation is very difficult to be performed. Here carriage assembly and

Fig.18 Profile Turning

Parting/Cutting Off/slotting/grooving operation:
This operation is used to cutoff the finished part from the lengther workpiece or to make groove on the workpiece. Flat cutting tool is used for this opeartion.

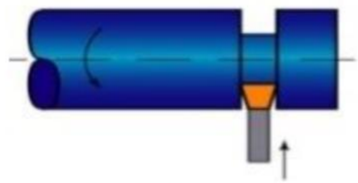


Fig.19 Profile Turning

Forming Opeartion:
A tool which is in the shape of the impression to be made on the work piece is fixed to the tool post and is advanced towards the work piece. This operation saves time and is costly.

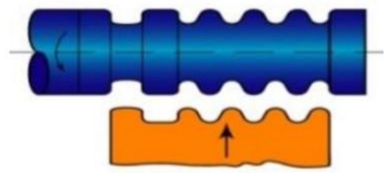


Fig.20 Forming Operation

Knurling Operation:
Knurling is an operation performed on the lathe to generate serrated surface on the work piece. This is used to produce a rough surface for griping like the barrel of the micrometer.
This is done by a special tool called knurling tool. Which has a set of hardened roller with the desired serrations.There are 3 different knurling operations such as diamond, angled and straight.

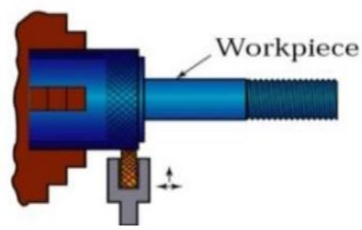


Fig.21 Knurling Operation

2.9 Work Holding Devices

The self-centering chuck (3 – Jaw Chuck)

This is the most convenient and most used method of work holding. This can take wide range of diameters. When adjusting jaws move equal amount light cuts should carry out, because the work may slip in the jaws. In addition, the work should be firmly round to fix in this chuck.

Fig.22Three Jaw Chuck

The independent centering chuck (4 – Jaw Chuck)

Each jaw is individually adjust and moves along its own slot. One advantage of this four-jaw chuck is that work can be located in the centre to run true or off centre. One of the most useful applications of this type is to hold square or rectangular material positioned either centrally or off centre. Setting time is greatly increased when compared to three-jaw chuck. However, for highly accurate work, this is the most suitable method.

Fig.23Four Jaw Chuck

DO's & DON'TSFOR THE LATHE

DO's

- ✓ Do Become Acquainted with the function of the important parts of lathe
- ✓ Do keep your machine properly lubricated
- ✓ Do keep machines clean and orderly. A dirty machine is not conducive to good workmanship.
- ✓ Do thoroughly understand & plan the job before starting to work on machine.
- ✓ Do keep the cutting tool sharp, dull cutting tools require a longer time to do the same job and give a poor finish and put the machine under an unwarranted strain.
- ✓ Do take as heavy a cut as a machine, work and cutting tool will permit. A series of light cuts wastes time and make necessary work for the operator.
- ✓ Do take interest in your work with responsibility.

DON'TS

- × Don't wear loose fitting shop coats or aprons when operating any machine.
- × Don't ever leave the chuck wrench in the chuck.
- × Don't push any lever or turn any handle on a lathe unless you know what will happen as a result.
- × Don't wear long ties, finger rings while operating machine.
- × Don't try to run a machine & engage in conversation at the same time. If you must talk then shut down the machine.
- × Don't be afraid to wear goggles when turning work which produces flying chips.
- × Don't attempt to check the hole when boring, without first covering the boring tool to guard against arm and hand injuries.
- × Don't put your hand or fingers on any revolving work or toll at any time.
- × Don't go away and leave your machine running. If you must leave then shut down.
- × Don't drop chucks, face or drive plates or lay work or tools on the ways of the lathe
- × Don't offer excuses when you scrap a job. Accept your responsibility and try to do better the next time.

AIM OF THE EXPERIMENT:-

To do boring operation on a work piece using lathe.

APPARATUS REQUIRED:-

SL NO	NAME OF THE APPARATUS	SPECIFICATION	QUANTITY
01	Drill bit	Ø16 mm	1
02	Drill chuck	1-12 mm	1
03	Socket/Sleeve	1-2″	1
04	Lathe	4′	1
05	Boring tool	4″	1

RAW MATERIAL REQUIRED:-

MS ROD of diameter 50mm and length 100mm.

PROCEDURE:-

At first the workpiece is fitted properly on the lathe chuck by the help of a surface gauge & chuck key.

Then facing and plain turning is done on the workpiece.

The center of the workpiece is located by the help of tail stock.

Now we run the lathe machine by making power switch on

Now a drill bit is to be fitted with the tail stock and to be locked and then the drill will penetrated in to the rotating workpiece and sufficient feed is given until the required drilling is done.

After drilling, the drill bit is removed and a boring tool is fitted into the toolpost.

Then the boring operation is done by the boring tool which is generally used to enlarge the drilled hole.

CONCLUSION:-

Finally we did the boring operation on the given round bar.

AIM OF THE EXPERIMENT:-

To make a drill on a round bar using lathe.

APPARATUS REQUIRED:-

SL NO	NAME OF THE APPARATUS	SPECIFICATION	QUANTITY
01	Drill bit	Ø16 mm	1
02	Drill chuck	1-12 mm	1
03	Socket/sleeve	1-2 "	1
04	Lathe	4'	1

RAW MATERIAL REQUIRED:-

MS ROD of diameter 50mm and length 100mm.

PROCEDURE:-

At first the round bar is fitted on the lathe chuck properly by the help of a surface gauge & chuck key.

Then facing operation is done on the job and after that plain turning is done.

Locate the centre of the work piece by using tailstock.

Now the dead centre is removed from the tailstock and a socket with sleeve and a drill bit fitted into it.

Now we run the lathe machine by making power switch on.

After this the drill bit is required to move forward by the tail stock hand wheel which will penetrate into the rotated job and drilled the required sized hole.

CONCLUSION:-

Finally we made a drill (Ø16 mm) on the given round bar.

RIGHT HAND SCREW THREAD CUTTING AND KNURLING OPERATION

Aim:

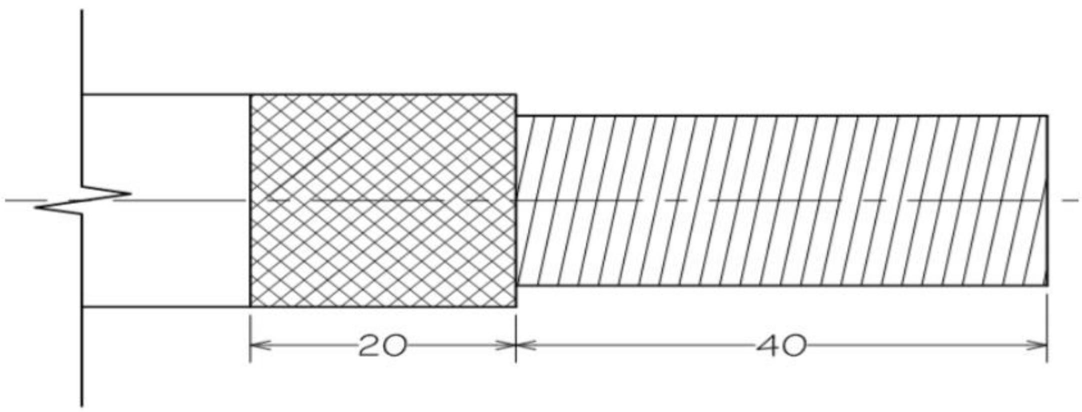
To obtain a Right Hand Screw threaded work piece of given dimensions.

Apparatus:

1. Lathe with standard accessories.
2. Work piece

Material:

Mild Steel round rod of diameter 20 mm



Procedure:

The given work piece is fixed tightly in the 3 jaw chuck. Facing and turning operations are done to make the diameter equal to the major diameter of the screw thread. According to the given Pitch, the necessary gearing ratio is calculated. The feed selection lever that unlocks the half-nut lever for use, is set on the carriage apron for cutting metric threads, the included angle of the cutting edge should be ground exactly 60O , the thread cutting tool is fixed in the tool post so that the tip of the tool coincides with the axis of the work piece the lathe spindle speed is reduced by on half, on forth of the speed required for turning by back gear mechanism or quick change levers. The half nut lever engaged at the end of the cut, the spirit nut lever disengages the carriage and the tool is withdrawn to its position sufficient depth is given for each cut using the cross slide the process is repeated till the required dimensions are obtained.

Precautions:

1. For cutting right threads the change gears should be so arranged that the direction of the lead screw is in same direction as that of the rotation of spindle.

2. The work piece should be fixed tight in the jaw.

3. The power supply switched off before measuring diameters.

Result:

Right Hand thread with required pitch is produced on the given work piece.

STEP TURNING OPERATION

Aim:

To perform a step turning operation on the given cylindrical work piece

Apparatus:

1. Lathe with standard accessories.
2. Work piece

Principle:

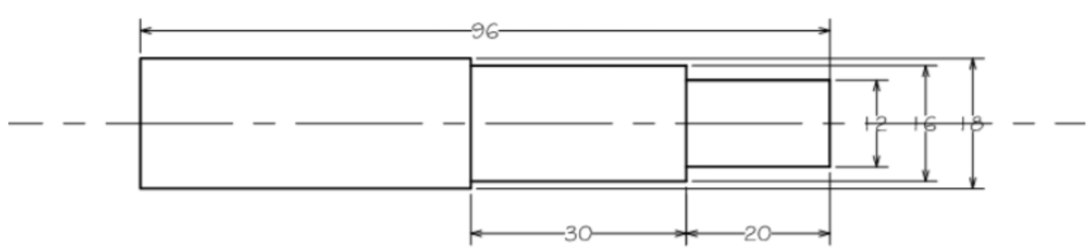
Turning is a lathe operation in which an external cylindrical surface is produced by generating.

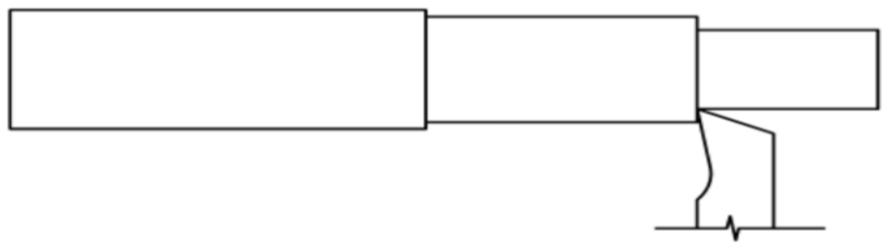
The cutting Tool is first adjusted for the desired depth of cut, using the cross slide. Then as the work piece rotates, the cutting tool is advanced relatively slowly I a direction parallel to the rotational axis of the spindle. The motion is known as the feed. These combined motions cause the work piece by adjusting the feed so that the helical path of the tool tips overlaps and generates a cylindrical surface on the work piece. A spindle rpm which gives a desired cutting speed at the circumference of the cylindrical surfaces should be reflected.

This may be calculated using the following formula:

$$\text{Spindle speed, rpm} = \frac{\pi \times d^2}{4}$$

Feed is measured as advance of the cutting tool per revolution of the work piece.





Tools:

Steel rule, outside callipers, tool holder with key, chuck key, HSS cutting Tool bit.

Material:

Mild Steel round rod of diameter 20 mm

Procedure:

Initially the given work piece is fitted the chuck using a chuck key. The high speed tool bit is positioned in the tool cutting is kept at an angle to the axis of the given work piece. During this Process positioned in the tool holder, the speed of the lathe is high.

After this operation, the diameter of the work piece is to be reduced according to the given dimensions by turning process. While doing the work piece one end of the work piece is reduced to the required diameter and after this, chamfering. Process if performed by burning the tool but at 45O inclination and by bringing the tool in contact with the edge of the job, this process removes all sharp edges of the component.

Precautions:

1. The chuck key must be removed immediately after the use.
2. The power supply switched off before measuring diameter.
3. Before performing facing they must be in same line.

Result:

The required steps are made on the work piece for the given dimensions.

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