COLLEGE OF TECHNOLOGY & ENGINEERING, UDAIPUR

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- Moulding tools & Equipments
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WELDING

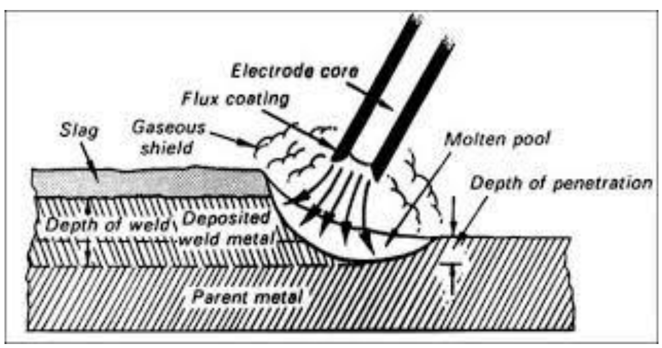
Introduction:

Welding is a process of joining similar metals by application of heat with or without application of pressure and addition of filler material. The result is a continuity of homogenous material, of the composition and characteristics of two parts which are being joined together.

Types of Welding:

1. Plastic welding or Pressure welding
2. Fusion welding or Non-Pressure welding

Arc Welding:



It is the most extensively employed method of joining metal parts. Here, the source of heat is an electric arc.

The arc column is generated between an anode, which is the positive pole of dc (direct current) power supply, and the cathode, the negative pole. When these two conductors of an electric circuit are brought together and separated for a small distance (2-4 mm) such that the current continuous to flow through a path of ionized particles called *plasma*.

The heat of the arc rises the temperature of the parent metal which is melted forming a pool of molten metal. The electrode metal is also melted and is transferred into the metal. The deposited metal serves to fill and bond the joint.

Two-Third of the heat is generated near the positive pole while the remaining one-third heat is developed near negative pole. As a result, an electrode, i.e. connected to the positive pole will burn 50% faster than when it is connected to the negative pole.

The blast of the arc forces the molten metal out of the pool thus forming a small depression in a parent metal known as arc crater.

The distance through the center of the arc from the tip of the electrode to the bottom of the arc crater is termed as arc length.

- **Arc Welding Equipments:**

1). A.C. or D.C. Machine

2). Electrode

3). Electrode holder

4). Cables, cable connectors

5). Cable lug

6). Chipping hammer

7). Earthing clamps

8). Wire brush

9). Helmet

10). Safety goggles

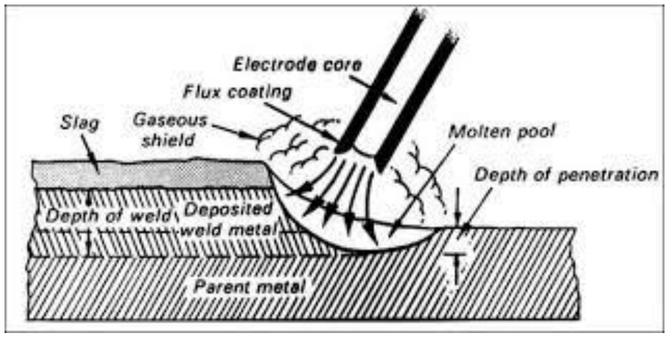
11). Hand gloves

12). Aprons, sleeves, etc.

Gas Welding:

Gas welding is done by burning a combustible gas with air or oxygen in a concentrated flame of high temperature. As with other welding methods, the purpose of the flame is to heat and melt the parent metal and filler rod of a joint. It can weld most common materials. Equipment is inexpensive, versatile and serves adequately in many job and general repair shops.

<u>Oxyacetylene Gas Welding</u>:



It is done by melting the edges or surface to be joined by the gas flame and allowing the molten metal to flow together. When material is thicker than 15 mm then additional metal called "Filler Metal" is added to the weld in the form of welding rod. The composition of filler rod is nearly the same as that of the part being welded.

Various gas combinations can be used for producing a hot flame. The common mixture of gases are Oxygen & Acetylene, Oxygen & Hydrogen, Oxygen & other fuel gases, Air & Acetylene.

<u>Welding Equipments</u>:

Welding Torch: Tool for mixing oxygen & acetylene in correct proportion and burning the mixture at the end of the tip.

Welding Tip: It is that portion of the welding apparatus through which the gases pass just prior to their ignition and burning.

Pressure regulator: The function of a pressure regulator is to reduce the cylinder pressure to the required working pressure and also to produce the steady flow of gases.

Hose & Hose fitting: The Hose for welding torch should be strong, durable and light.

Goggle, Gloves & Spark lighter: Goggles with coloured lenses are provided to protect the eyes from harmful heat, ultraviolet and infrared rays.

Gas cylinder: Oxygen gas in cylinders are usually charged with about 40 liters of oxygen at a pressure of about 154 kgf/cm^2 (or 15400 kN/m^2).

Types of Welding Joints:

Butt Joint: Used to join the ends/edges of two surfaces located approximately in the same plane with each other. For thickness from 2 to 5 mm, the open square butt should be selected, but thickness upwards of 5 mm, the joints with edge preparation on one or both sides may be recommended.

Lap Joint: It is used to join two overlapping plates so that the edge of each plate is welded to the surface of the other. Common lap joints are single lap and double lap. The single-welded lap does not develop full strength, but it is preferred to the butt joint for some applications. The lap joint, however, may be employed for thickness under 3 mm.

T-Joint: It is used to weld two plates or sections whose surfaces are approximately at right angle to each other. Plates or surfaces should have good fit-up in order to ensure uniform penetration and fusion. This is suitable up to 3 mm and is widely employed in thin walled structures particularly.

Corner Joint: It is used to join the edges of two sheets or plates whose surfaces are at an angle of approximately 90º to each other. It is common in the construction of boxes, tanks, frames, and other similar items. Welding can be done on one or both sides, depending on the position and type of corner joint used. This is suitable for both light and heavy gauges.

Edge Joint: It consists of joining two parallel plates by means of a weld. The joint is often used in sheet metal work. The two edges can be easily and quickly melted down, eliminating the need for any filler metal. In heavy plates, where beveling the edges is done to get deeper penetration, some filler rod is needed.

Types of Welding Joints:

1). According to the position of welding:

a) <u>Downhand or Flatweld</u> deposited in any direction on a horizontal surface so that the flame is above the face of the weld.
b) <u>Vertical weld</u> deposited on a vertical surface in a vertical direction (upward or downward).
c) <u>Inclined weld</u> deposited up or down on an inclined surface.
d) <u>Horizontal weld</u> deposited on a vertical surface in a horizontal direction (from left to right or from right to left).
e) <u>Overhead</u> weld deposited on a horizontal surface on any direction so that face of the weld is above the flame.

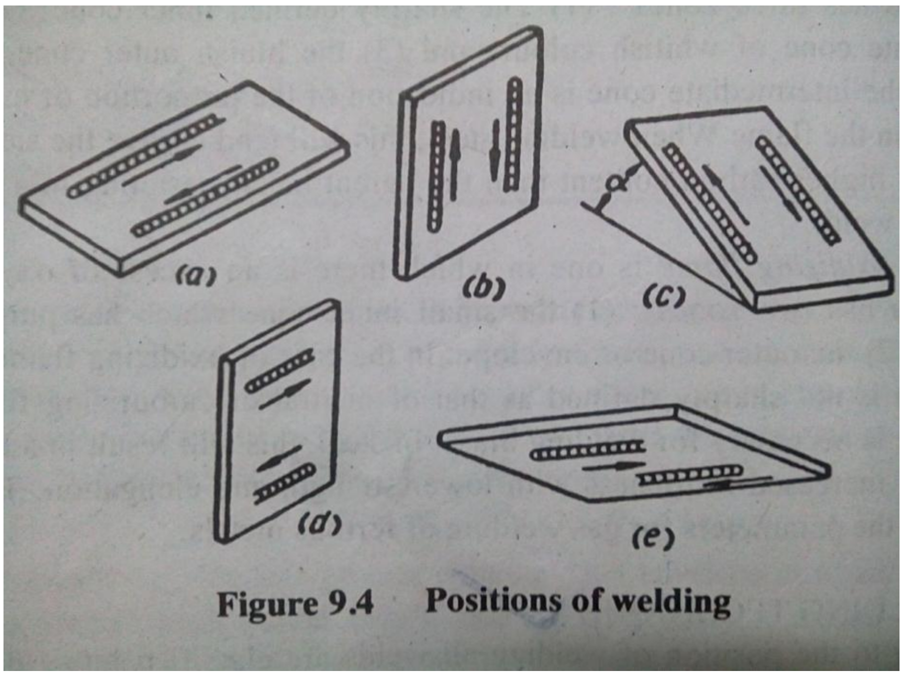
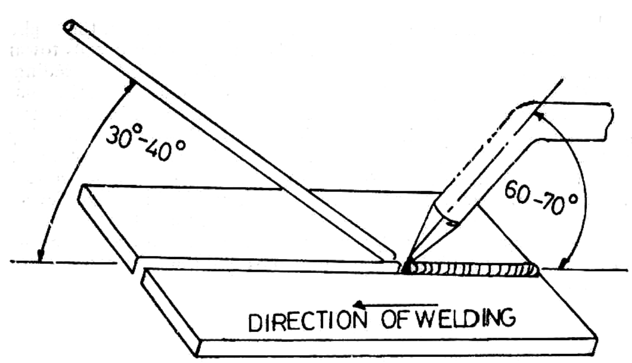


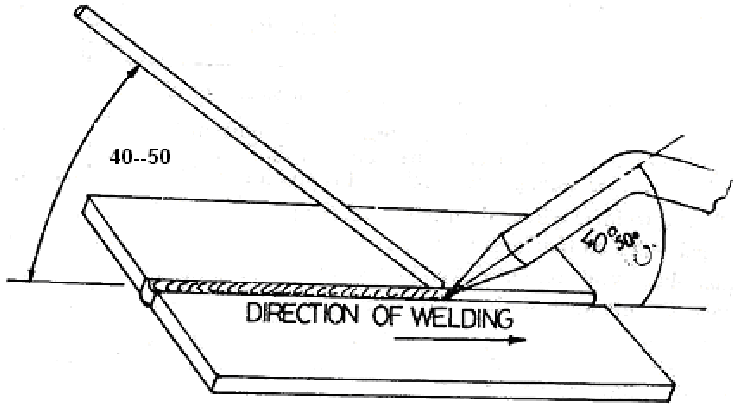
Figure 9.4 Positions of welding

2). According to the direction of travel and the tilt of the torch and welding rod:

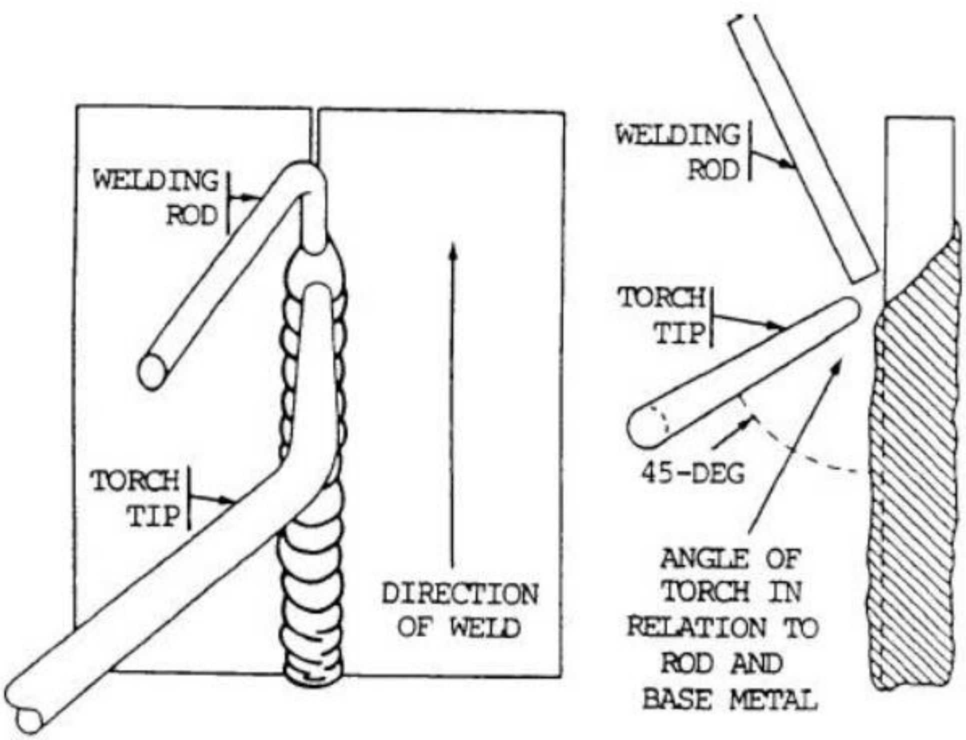
a) <u>Leftward or forward welding</u>: The weld is from right to left and blow pipe is held on right hand and welding rod in the left hand. The blow pipe should be given a small sideways movement and the rod should move straight. The head of the blowpipe is hold at an angle of 60º to 70º to the plane of the weld and the welding rod at 30º to 40º.



b) <u>Rightward or Backward welding</u>: The weld is made from left to right the rod follows the blowpipe, the blowpipe should make an angle of 40º-50º and the welding rod at 30º-40º.
The angle of blowpipe is 10º-20º greater in leftward welding.



3). Vertical Welding: In vertical welding, the operations start at the bottom of welding joint and use an oxidating movement to blow pipe which points slightly upward.



Types of Flame:

There are three types of Gas flame:

1). Neutral flame: Neutral Flame has two definite zones:

a) A Sharp brilliant cone extending at a short from the torch tip.
b) An outer cone or envelope with luminous and bluish colour.

The first one develops heat and the second one protects molten metal from oxidation.

2). carburizing flame**:** There is an excess of acetylene and this flame has three zones:

a) The sharply defined inner cone.
b) An intermediate cone of white colour.
c) The bluish outer cone.

The length of intermediate cone is an indicator of excess acetylene in the flame.

3). an oxidizing flame**:** This flame has two zones:

a) The small inner cone which has purple colour.
b) The outer cone or envelope.

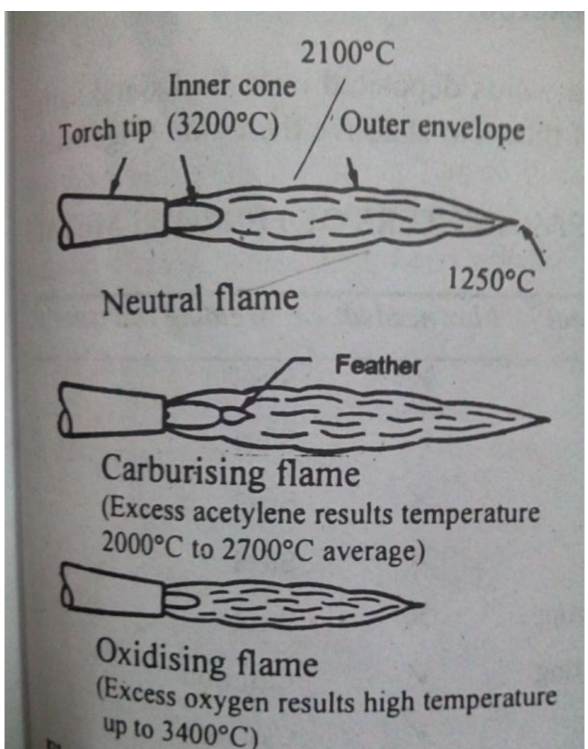


Figure 9.3 Oxy–acetylene gas flame

Soldering:

Soldering is a method of joining two or more pieces of metal by means of a fusible alloy or metal called “Solder”. Soldering is divided into two classifications, Soft Soldering and Hard Soldering.

1). Soft Soldering is used extensively in sheet metal work for joining parts that are not exposed to the action of high temperature and are not subjected to excessive loads and forces. It is also employed for joining wires and small parts.

The ‘Solder’ which is mostly composed of lead and tin has a melting range of 150ºC to 350ºC and a suitable flux is always used in soft soldering.

2). Hard Soldering employs solders which melts at higher temperature and are stronger than those used in soft soldering. Silver Soldering s a hard soldering method and silver alloy with tin is used as a solder. The temperature of various hard solders vary from about 600ºC to 900ºC.

Brazing:

It is essentially similar to Soldering but it gives a much stronger joint than Soldering.

The principle difference is the use of a harder filler material known as ‘spelter’.

Filler metal used in this process may be divided into two classes:

a) Copper based alloy
b) Silver based alloy

Brass (Copper + Zinc) and up to 20% tin are mostly used and silver alloy having a melting range of 600ºC to 850ºC are suitable for brazing.

JOB REPORT

(Welding)

- **<u>AIM</u>:** To prepare a butt joint.

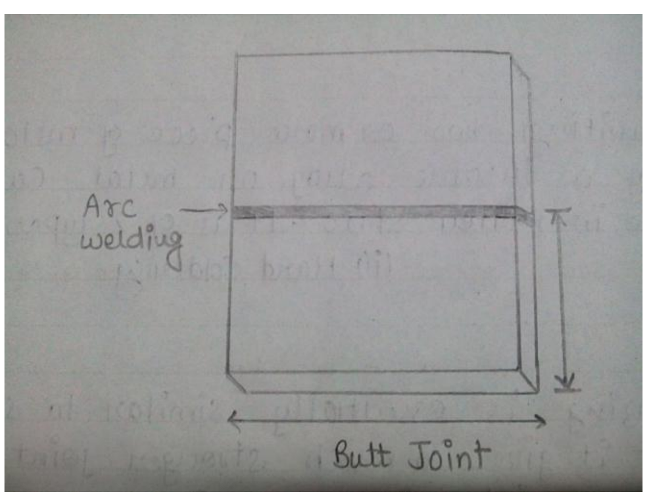
- **<u>MATERIAL USED</u>:** Mild Steel Plate

- **<u>Tools and Equipments</u>:**

  1) Arc welding machine
  2) Welding table
  3) Welding plate
  4) Electrode holder
  5) Electrode
  6) Hand screen
  7) Gloves
  8) Wire brakes
  9) Chipping Hammer
  10) Tongs

- **<u>Operations Performed</u>:** Arc welding was performed to prepare the required joint.

- **<u>Result</u>:** The butt joint of required dimensions was obtained.



MACHINE SHOP

Introduction:

The lathe is one of the oldest machine tools and came into existence from the early tree lathe, which was then a novel device for rotating and machining a piece of work held between two adjacent trees.

The main function of a lathe is to remove metal from a piece of work to give it the required shape and size. This is accomplished by holding the work securely and rigidly on the machine and then turning it against cutting tool which will remove metal from the work in the form of chips.

Lathe Machine & It's Classifications:

The types generally used are:

a) **Speed Lathe:** The Speed lathe, in construction and operation, is the simplest of all types of lathe. It consists of a bed, a headstock, a tailstock and a tool-post mounted on an adjustable slide. There is no feed box, lead screw or conventional type of carriage. The tool is mounted on the adjustable slide and is fed into work purely by hand control. As the tool is controlled by hand, the depth of cut and thickness of chip is very small. Light cuts and high speeds necessitate the use of this type of machine where cutting force is minimum such as in woodworking, spinning, centering, polishing, etc. The speed lathe has been so named because of the very high speed of the headstock spindle.

b) **The engine lathe or centre lathe:** This lathe is the most important member of the lathe family and is most widely used. The term "engine" is associated with lathe owing to the fact that early lathes were driven by steam engines.

c) **The bench lathe:** This is a small lathe usually mounted on a bench. It has practically all the parts of an engine lathe or speed lathe and it performs almost all the operations, its only difference being in size. This is used for small and precision work.

d) **The tool room lathe:** It has features similar to engine lathe and is much more accurately built and has a wide range of spindle speeds ranging from a very low to a quite high speed up to 2500 rpm. This is equipped, besides other things, with a chuck, taper turning attachment, draw in collet attachment, thread chasing dial, relieving attachment, steady and follower rest, pump for coolant, etc. This lathe is mainly used for precision work on tools, dies, gauges and in machining work where accuracy is needed. The machine is costlier than an engine lathe of the same size.

e) **The capstan and turret lathe:** These lathes are development of the engine lathe and are used for production work. The distinguishing feature of this type of lathe is that the tailstock of an engine lathe is replaced by a hexagonal turret on the face of which multiple tools may be fitted and fed into the work in proper sequence. The advantage is that several different types of operations can be done on a work-piece without re-setting of work of tools, and a number of identical parts can be produced in the minimum time.

f) **Automatic lathe:** These are high speed, heavy duty, mass production lathes with complete automatic control. Once the tools are set and machine is started it performs automatically all the operations to finish the job. The changing of tools, speeds and feeds are also done automatically.

Engine Lathe:

This lathe is the most important member of the lathe family and is most widely used. The term “engine” is associated with lathe owing to the fact that early lathes were driven by steam engines.

The headstock of an engine lathe is much more robust in construction and it contains additional mechanism for driving the lathe spindle at multiple speeds. Unlike the speed lathe, the engine lathe can feed the cutting tool both in cross and longitudinal direction with reference to the lathe axis with the help of a carriage, feed rod and lead screw.

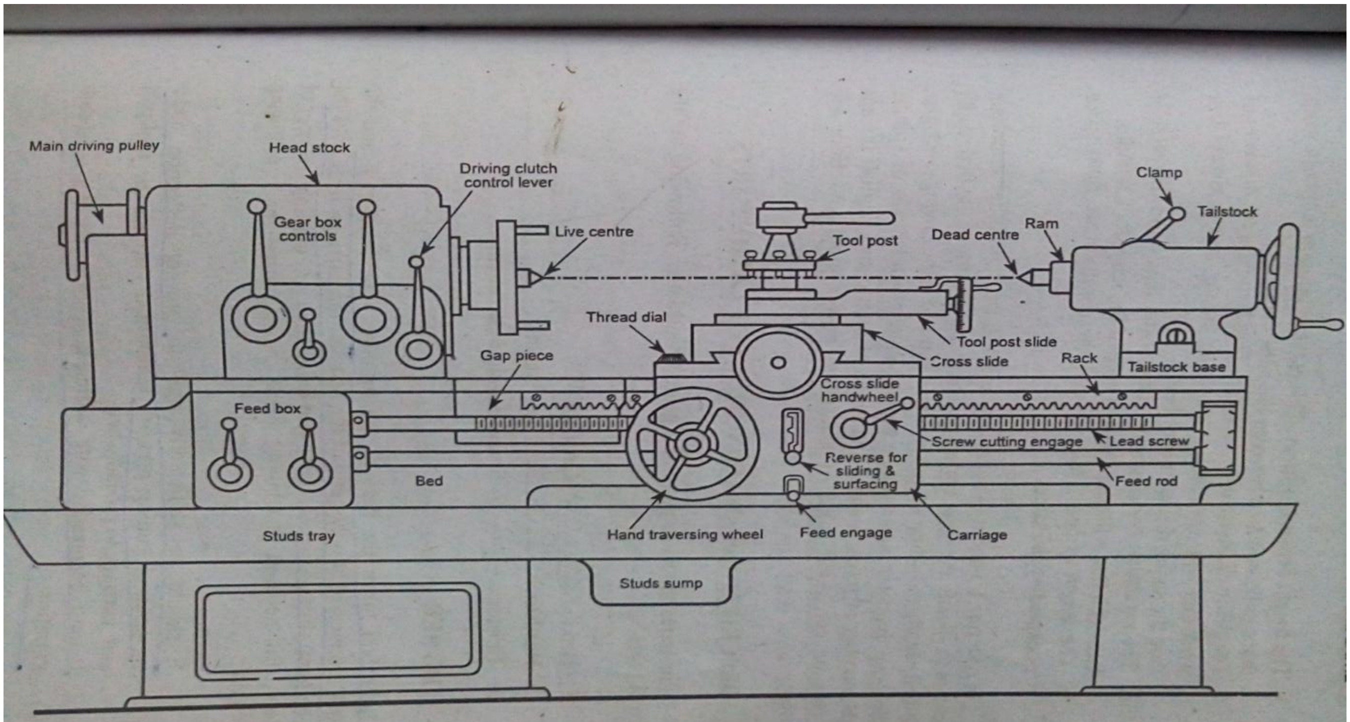


Figure 3.2 Lathe parts

Parts:

Following are the principle parts:

1) Bed
2) Headstock
3) Tailstock
4) Carriage
5) Feed mechanism
6) Screw cutting mechanism

1) The Bed:

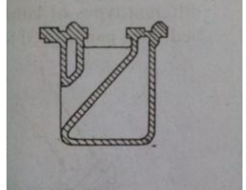


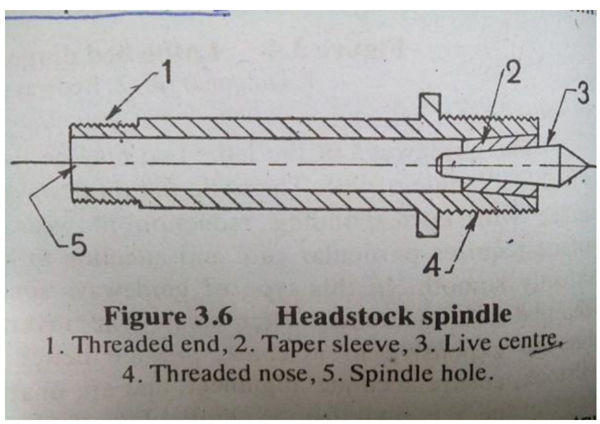
Figure 3.3 Box section lathe bed

The lathe bed forms the base of the machine. The headstock and tailstock are located at either end of the bed and the carriage rests over the lathe bed and slides on it. The lathe bed must satisfy the following conditions:

a) It should be sufficiently rigid tough to prevent deflection under tremendous cutting pressure transmitted through the tool-post and carriage to the lathe bed.
b) It must be massive with sufficient depth and width to absorb vibration.
c) It must resist the twisting stress, set up due to the resultant of two forces – the downward cutting force on the tool and the force tending to move the tool away from the work in horizontal direction.
d) The bed should be seasoned naturally to avoid distortion or warp that may develop when it is cooled after the bed is cast.

The bed material should have high compressive strength, should be wear resistant and absorb vibration. Cast iron alloyed with nickel and chromium forms a good material suitable for lathe bed.

2) The Headstock:



The headstock is secured permanently on the inner ways at the left hand end of the lathe bed, and it provides mechanical means of rotating the work at multiple speeds.

The spindle of the headstock is made of carbon or nickel chrome steel. This is usually of large diameter to resist bending and it should be perfectly aligned with the lathe axis and accurately machined for producing true work surface. A taper sleeve fits into the taper hole, and a live centre which supports the work and revolves with the work fits into the sleeve that acts as a bush.

The spindle revolves on two large bearings housed on the headstock casting. The clearance between the spindle and the bearing should be minimum to prevent vibration. Provision is made for expansion of the spindle when it gets heated under high speed metal machining.

3) The Tailstock:

THE LATHE 99

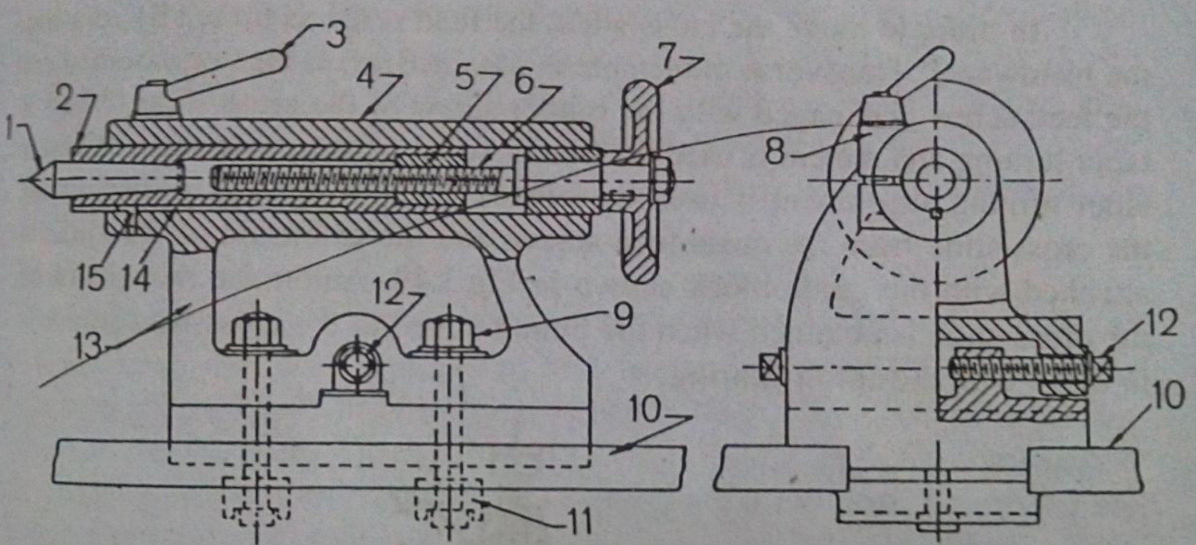


Figure 3.9 Tailstock

1. Dead centre, 2. Spindle, 3. Spindle clamp, 4. Barrel, 5. Bush, 6. Square threaded screw, 7. Hand wheel, 8. Split lug, 9, Tailstock clamping bolt, 10. Lathe bedways, 11. Clamping plate, 12. Setover screw, 13. Body, 14. Keyway, 15. Key.

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

The upper casting of the body can be moved towards or away from the operator by means of the adjusting screws to offset the tailstock for taper turning and to realign the tailstock centre for straight turning. The screw thread is left handed, so that clockwise rotation of the hand wheel causes the spindle to advance, while anti-clockwise rotation causes the spindle to be drawn inward and ultimately the end of the screw strikes the back of the dead centre or any tool that is fitted into the hole. The spindle has a key way in the underside which mates with a small key fitted on the barrel to prevent rotation.

4) Carriage:

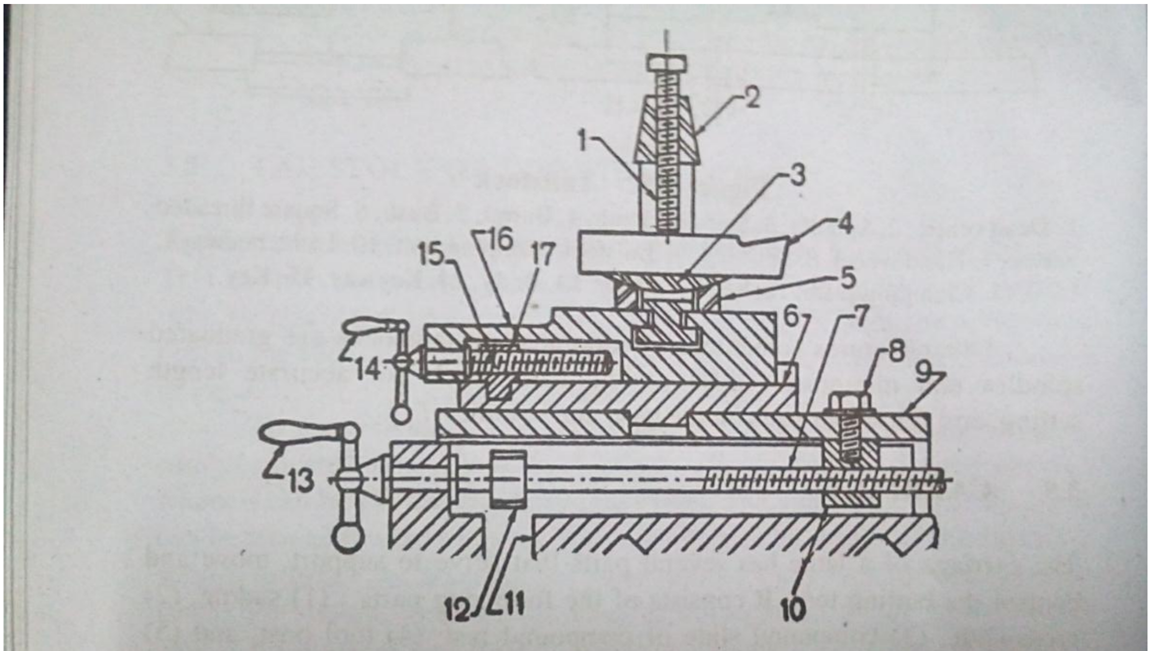


Figure 3.10 Carriage

1. Toolpost screw, 2. Tool post, 3. Rocker, 4. Tool, 5. Concave ring, 6. Compound rest swivel base, 7. Crossfeed screw, 8. Binder screw, 9. Cross slide, 10. Cross-slide nut, 11. saddle, 12. Pinion on Crossfeed screw for automatic feed, 13. Cross slide hand wheel, 14. Compound slide hand wheel, Compound slide feed screw, 16. Compound rest, 17. Compound slide nut.

The carriage of a lathe has several parts that support, move and control the cutting tool. It consists of the following parts: (1) saddle, (2) cross-slide, (3) compound slide or compound rest, (4) tool post, and (5) apron.

Saddle: The saddle is an H-shaped casting that fits over the bed and slides along the ways. It carries the cross slide ad tool post.

The cross-slide: It comprises a casting, machined on the underside for attachment to the saddle and carries locations on the upper face of the tool post or compound rest. The cross-piece of the saddle is mechanized with a dovetail way, at right angles to the centre of the lathe, which serves to guide the cross-slide itself.

The compound rest: It is mounted on the top of cross-slide and has a circular base graduated in degrees. It is used for obtaining angular cuts and short tapers as well as convenient positioning of the tool to the work.

The tool post: This is located on the top of the compound rest to hold the tool and to enable it to be adjusted to a convenient working position. The rigidity of the tool holder and effective method of securing are the essential factors in designing a tool post. The common types of tool post are:

1) Single screw tool post
2) Four bolt tool post
3) Open side tool post
4) Four way tool post

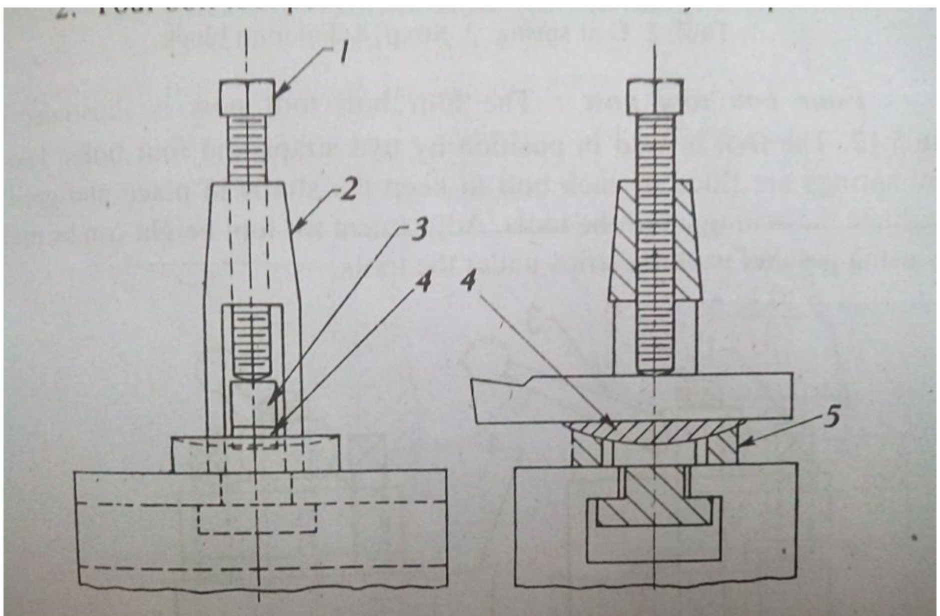


Figure 3.11 Single screw toolpost
1. Toolpost screw, 2. Toolpost body, 3. Tool, 4. Convex rocker, 5. Concave ring.

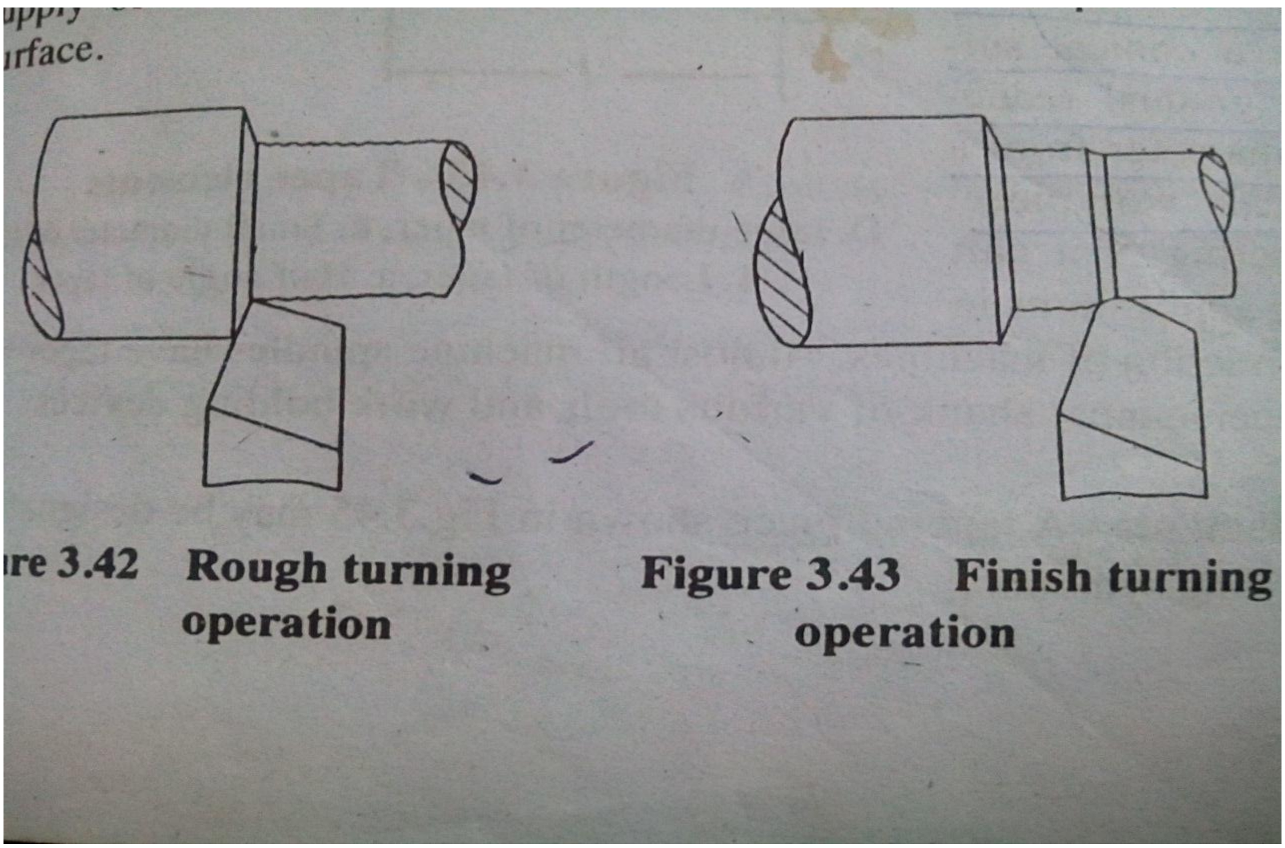
Lathe Operations:

1) **Turning:** It is done to remove excess material from the work-piece to produce a cone shaped or cylindrical surface. The various types of turning made in lathe work for various purposes are described below:

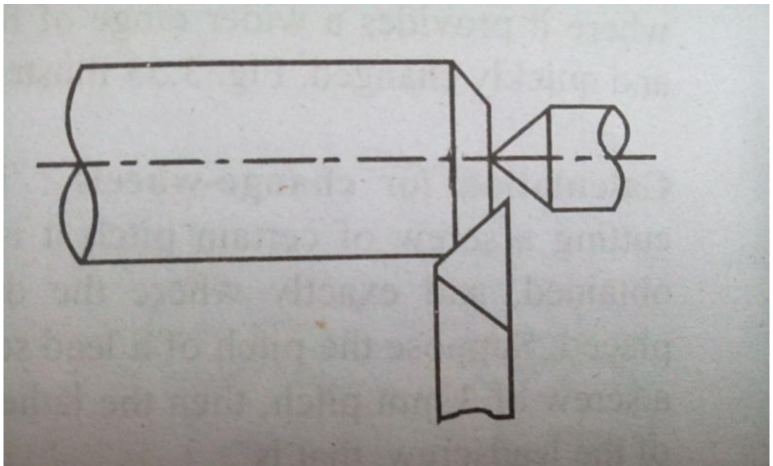
Straight Turning: Work is turned straight when it is made to rotate about the lathe axis and the tool is fed parallel to the lathe axis. A cylindrical surface is thus produced.

Rough Turning: It is the process of removal of excess material from the work-piece in a minimum time by applying high rate of feed and heavy depth of cut.

Finish Turning: It required high cutting speed, small feed and a very small depth of cut to generate a smooth surface.

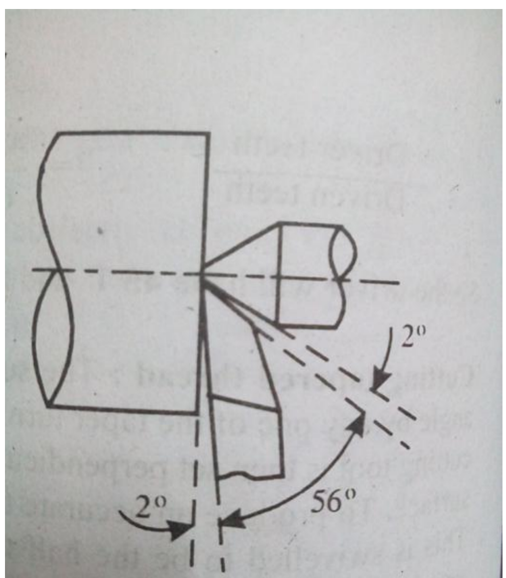


2) ***Chamfering:*** It is the operation of beveling the extreme end of a work-piece. This is done to remove burrs, to protect the end of work-piece from getting damaged and to have a better look. The operation may be performed after knurling, rough turning, boring, drilling or thread cutting. Chamfering is an essential operation after thread cutting so that the nut may pass freely on the threaded work-piece.



igure 3.52 Chamfering operation

3) ***Facing:*** It is the operation of machining at the ends of a work-piece to produce a flat surface square with axis. This is also used to cut the work-piece to the required length. The operation involves feeding the tool perpendicular to the axis of rotation of work-piece. A properly ground facing tool is mounted in a tool holder in the tool post. A regular turning tool may also be used for facing a large work-piece. The cutting edge should be set at the same height at the centre of the work-piece.



igure 3.60 Facing operation

4) ***Knurling:*** It is the process of embossing a diamond shaped pattern on the surface of a work-piece. The purpose of knurling is to provide an effective gripping surface. In some press fit work, knurling is done to

increase the diameter of a shaft. The operation is performed by a special tool which consists of one set of hardened steel rollers in a holder with the teeth cut on their surface in a definite pattern.

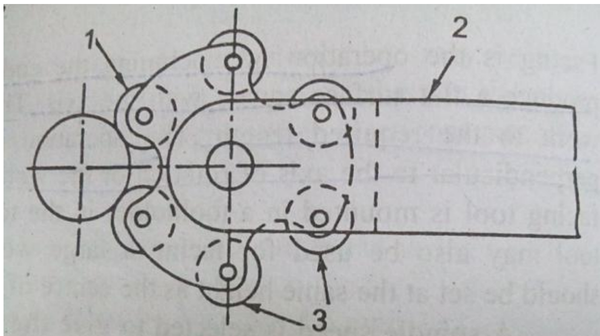


Figure 3.61 Revolving knurl holder
1. First set of Knurl, 2. Knurl holder, 3. Second set of knurl.

5) *Drilling:* It is an operation of producing a cylindrical hole in a work-piece by the rotating cutting edge of a cutter known as the drill. Drilling in a lathe is performed by any one of the following methods:

a) The work-piece is revolved in a chuck or a faceplate and the drill is held in the tailstock drill holder or in a drill chuck. Feeding is effected by the movement of the tailstock spindle. This method is adopted for drilling regular shaped workplaces.
b) The drill is held and driven by a drill chuck attached to the headstock spindle, and the work is held against a pad or crotch supported by the tailstock spindle. Feeding is effected by the movement of the tailstock spindle. Work-pieces of very irregular shape which cannot be accommodated on a chuck or faceplate are drilled by this method.

6) *Reaming:* It is an operation of finishing and sizing a hole which has been previously drilled or bored. The tool used is called the reamer, which has multiple cutting edges. The reamer is held on the tailstock spindle, either direct or through a drill chuck and is held stationary while the work is revolved at a very slow speed. The feed varies from 0.5 to 2 mm per revolution.

7) Boring: It is an operation of enlarging and truing a hole produced by drilling, punching, casting or forging. Boring cannot originate a hole. It is similar to external turning operation and can be performed in a lathe by the following two methods:

a) The work is revolved in a chuck or a face plate and the tool which is fitted to the tool post is fed into the work. This method is adapted for boring small sized works. One piece forged tool is used for boring small hole, whereas a boring bar with a tool bit attached to it is suitable for machining a large hole. The depth of cut is given by the cross-slide screw and the feed is effected by the longitudinal travel of the carriage.
b) The work is clamped on the carriage and a boring bar holding the tool is supported between the centres and made to revolve. Longitudinal movement of the carriage provides feeding movement and the depth of cut is given by adjusting the position of the tool 'insert'.

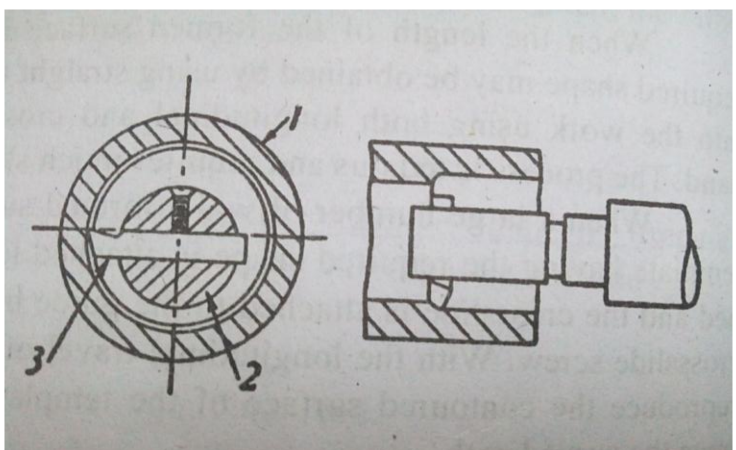


Figure 3.65 Boring operation
1. Work, 2. Boring bar, 3. Boring tool.

Difference between Engine, Capstan & Turret Lathe:

- The head stock of a turret lathe is similar to that of engine lathe in construction but it has wider range of speeds.

- Engine lathe requires motor of 3 horsepower to drive its spindle and other parts whereas capstan and turret lathe require high power as 15 horsepower for high rate of production.
- The tailstock of an engine lathe is replaced by a turret in turret lathe and it resembles a big six-sided nut which can carry six tools for rotating jobs, on the other hand, engine lathe holds one tool of limited size.
- Turret lathe is used in production machines while engine lathe is used for various types of odd jobs within limits.
- In a turret lathe, combination cuts can be taken while in centre lathe this type of arrangement is quite uncommon.
- The labour cost require to operate capstan and turret lathe is less than that of engine lathe.
- Capstan and turret lathe are usually not fitted with lead screws for cutting threads similar to an engine lathe.
- Turret movement can be controlled automatically, engine lathe movement is controlled manually.
- In capstan and turret lathe, the number of revolutions is more as compared to engine lathe.
- Capstan and turret lathe are suitable for mass production while engine lathe is not suitable for mass production.
- Capstan and turret lathe is centered automatically while in engine lathe, tool is centered manually after changing the tool.

JOB REPORT

(Machine Shop)

- **AIM:** To prepare job of given dimensions on engine lathe.

- **MATERIAL USED:** Mild Steel Bar

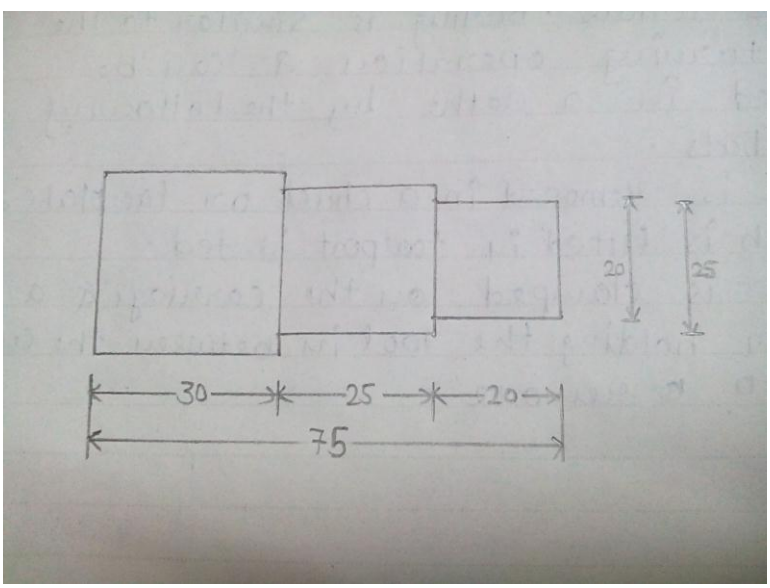
- **Tools:**

  1) Scale
  2) Caliper

- **Operations Performed:**

  1) The work-piece was held securely in 3-Jam Chuck
  2) The tool was set at required angles
  3) The motor was started
  4) The tool was fed to the job slowly
  5) Turning and facing operations were performed
  6) Job was taken out

- **Result:** The job of required shape and size was produced.



PATTERN MAKING

Introduction:

Pattern is the principal tool during the casting process. It may be defined as a model of anything, so constructed that it may be used for forming an impression called *mould* in damp stand or other suitable material. When this mould is filled with molten metal, and the metal is allowed to solidify, it forms a reproduction of the pattern and is known as casting. This process of making a pattern is called *pattern making*.

Pattern Materials:

The selection of pattern materials depends primarily on the following factors:

a) Service requirements, for example, quantity, quality and intricacy of casting.
b) Type of production of castings and type of moulding process.
c) Possibility of design changes.
d) Number of castings to be produced, i.e. possibility of repeat orders.

To be good of its kind, pattern material should be:

1. Easily worked, shaped and joined;
2. Light in weight;
3. Strong, hard and durable, so that it may be resistant to wear and abrasion, to corrosion, and to chemical action;
4. Dimensionally stable in all situation;
5. Easily available at low cost;
6. Repairable and reused;
7. Able to take good surface finish.

The wide variety of pattern materials which meet these characteristics are wood and wood products; metals and alloys; plasters; plastics and rubbers; and waxes.

Wood: Wood is the most common material for pattern as it satisfies many of the aforesaid requirements. It is easy to work and readily available. Wood can be cut and fabricated into numerous forms by glueing, bending and curving; it is easily sanded to smooth surface, and may be preserved with shellac, which is the most commonly used finishing material for wooden pattern. Wood has its disadvantages as a pattern material. It is readily affected by moisture: it changes its shape and size when the moisture dries out of it, and when it picks up moisture from the damp moulding sand. Owing to these reasons, wooden patterns do not last long and they are generally used when a small number of castings are to be produced.

Metal: Metal is used when a large number of castings are desired from a pattern or when conditions are too severe for wooden pattern. Metal patterns do not change their shape when subjected to moist conditions. Another advantage of a metal pattern is freedom from warping in storage. Metal patterns are very useful in machine moulding because of their accuracy, durability and strength.

Plastics: Plastics are now finding their place as a modern pattern material because they do not absorb moisture, are strong and dimensionally stable, resistant to wear, have a very smooth and glossy surface, and are light in weight. Because of its glossy surface it can be withdrawn from the mould very easily without injuring the mould and no dry or liquid parting compound is necessary.

Rubbers: Certain types of rubbers, such as silicon rubber, are favoured for forming a very intricate type of die for investment casting. When the two parts, originally in liquid form, are mixed together, poured over a master pattern or into a die, and cured, a solid shape, i.e. a pattern, is produced.

Plasters: Gypsum cement known as Plaster of Paris is also used for making patterns and core boxes. It has a high compressive strength, and it can be readily worked with wood tools. When talc and cement are mixed with water, it forms a plastic mass capable of being cast into a mould.

Waxes: Wax patterns are excellent for investment casting process. The materials generally used are blends of several types of waxes, and other additives which act as polymerizing agents, stabilizers, etc. The properties desired in a good wax pattern include low ash content (up to 0.05 %), resistant to the primary coat material used for investment, high tensile strength and hardness, and substantial weld strength.

Patternmaking Tools:

The patternmaker is basically a wood worker. The tools employed in making patterns, therefore do not differ from those used by a wood worker, except the special tools that the particular needs of the trade have developed.

In addition to those used by a wood worker or carpenter, there is one tool in the equipment, *the contraction rule*, which is a measuring tool typical of patternmaker's trade. All castings contract in cooling from the molten state, and patterns have to be made correspondingly larger than the required casting in order to compensate for the loss in size due to this contraction.

Different metals and alloys have different contractions. The allowance for shrinkage, therefore, varies with different metals and also according to the particular casting conditions, and it increases in proportion to the size of the pattern.

A separate scale is available for each allowance, and it enables the dimensions to be set out directly during the laying out of patterns. The rule usually used is the one that has two scales on each side, the total number of scales being four for four commonly cast metals namely steel, cast iron, brass and aluminium. To compensate for shrinkage, the graduations are oversized by a proportionate amount, example, on 1 mm or 1 percent scale, each 100 cm is longer by 1 cm.

Types of Patterns:

***Single-piece or solid pattern*:** A pattern that is made without joints, partings, or any loose pieces in its construction is called a single-piece or solid pattern. These patterns are cheaper. When using these patterns, the Moulder has to cut his own runners and feeding gates and risers. Single-piece patterns are generally used for large castings of simple shapes.

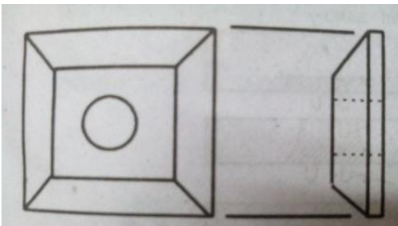


Figure 11.1 Solid pattern

Split Pattern**:** Many patterns cannot be made in a single piece because of the difficulties encountered in moulding them. To eliminate this difficulty, and for castings of intricate design or unusual shape, split patterns are employed to form the mould. These patterns are usually made in two parts, so that one part will produce the lower half of the mould, and the other, the upper half.

Spindles, cylinders, steam valve bodies, water stop cocks and taps, bearings, small pulleys and wheels are few examples of castings that require use of split patterns.

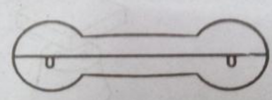


Figure 11.2 Two-piece split pattern

Match Plate Pattern**:** When split patterns are mounted with one half on one Side of a plate and other half directly opposite on the other side of the plate, the pattern is called a match plate pattern. Aluminium is commonly used for metal match plates. Match plate patterns are used for producing small castings in large quantities in moulding machines which give accurate and rapid production. They are expensive to construct, but the initial cost is justified when quantity production is desired.

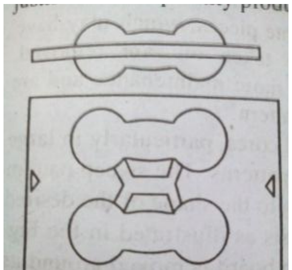


Figure 11.4 Match plate pattern

***Gated Pattern*:** To produce good casting, it is necessary to ensure that full supply of molten metal flows into every part of the mould. Provision for easy passage of flowing metal into the mould is called gating which cannot be made by hand operations for volume high production particularly because of the time involved. Gated patterns may be made of wood or metal and are used for mass production of small castings.

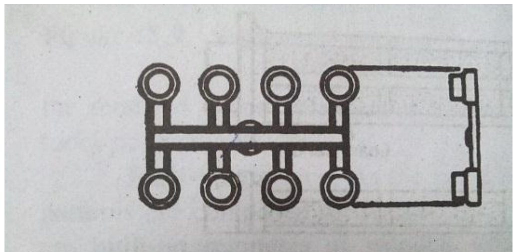


Figure 11.5 Gated pattern

***Sweep Pattern*:** Symmetrical moulds and cores, particularly in large sizes, are sometimes shaped by means of sweep patterns. The sweep pattern consists of a board having a shape corresponding to the shape of the desired casting and arranged to rotate about a central axis. Sweep patterns are employed for moulding part having circular sections. The principal advantage of this pattern is that it eliminates expensive pattern construction.

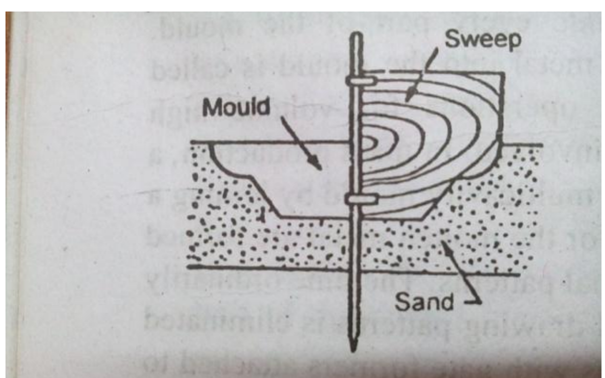


Figure 11.7 Sweep pattern

***Skeleton Pattern*:** Patterns for very large castings would require a tremendous amount of timber for a full pattern. In such cases, a skeleton pattern may be employed to give the general contour and size of the desired casting. This is a ribbed construction with a large number of square or rectangular openings between the ribs which form a skeleton outline of the pattern to be made.

Soil and water pipes, pipe bends, valve bodies, and boxes are few examples of castings which are made by making skeleton patterns.

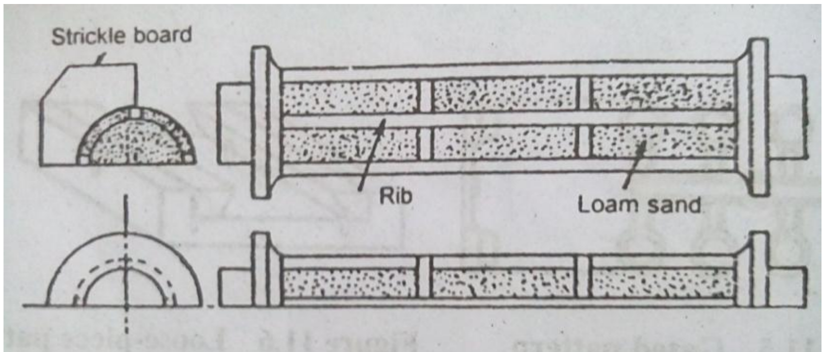


Figure 11.8 Skeleton pattern

Segmental Pattern**:** Segmental patterns or part patterns are generally applied to circular work such as rings, wheel rims, gears, etc. They are sections of a pattern so arranged as to form a complete mould by being moved to form each section of the mould.

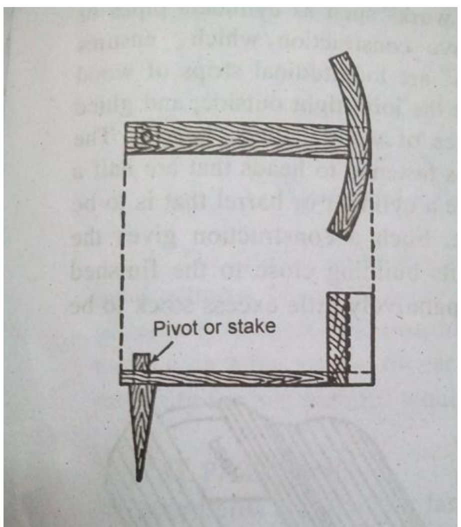


Figure 11.9 Segmental pattern

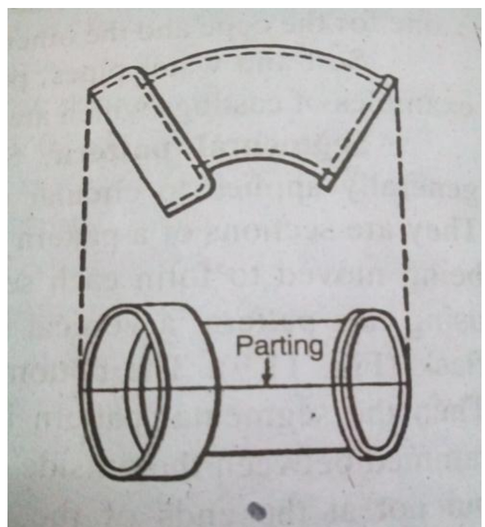


Figure 11.10 Shell pattern

Shell Pattern**:** The shell pattern is used largely for drainage fittings and pipe Work. The pattern is usually made of metal, mounted on a plate and parted along the central line, the two sections being accurately doweled together. These short bends are usually moulded and cast in pairs. The shell pattern is a hollow construction like a shell and the outside shape is used as a pattern to make the mould, while the inside is used as a core-box for making cores.

Pattern Making Allowances:

Patterns are not made the exact same size as the desired casting for several reasons. Such a pattern would produce castings which are undersize. Allowances must therefore be allowed for shrinkage, draft, finish, distortion, and rapping.

Shrinkage allowance**:** As metal solidifies and cools, it shrinks and contracts in size. To compensate for this, a pattern is made larger than the finishing casting by means of a shrinkage or contraction allowance. In laying measurements for the pattern, the patternmaker allows for this by using shrink or contraction rule which is slightly longer than the ordinary rule of the same length.

Draft allowance: When a pattern is drawn from a mould, there is always some possibility of injuring the edges of the mould. This danger is greatly decreased if the vertical surfaces of a pattern are tapered inward slightly. This slight taper inward on the vertical surfaces of a pattern is known as the draft.

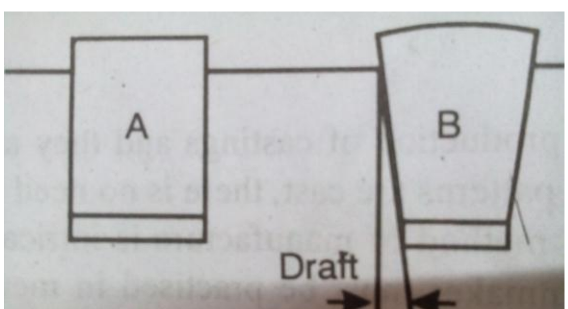


Figure 11.13 Draft allowance

Machining allowance: Rough surfaces of castings that have to be machined are made to dimensions somewhat over those indicated on the finished working drawings. The extra amount of metal provided on the surfaces to be machined is called machine finish allowance and the edges of these surfaces are indicated by a finish mark V, or F.

Distortion or camber allowance: Some castings, because of their size, shape and type of metal, tend to warp or distort during the cooling period.

This is a result of uneven shrinkage and is due to uneven metal thickness or to one surface being more exposed than another, causing it to cool more rapidly. The shape of the pattern is thus bent in the opposite direction to overcome this distortion. This feature is called distortion or camber allowance.

Rapping allowance**:** When a pattern is rapped in the mould before it is withdrawn, the cavity in the mould is slightly increased. In every cases where castings must be uniform and true to pattern, rapping or shake allowance is provided for by making the pattern slightly smaller than the actual size to compensate for the rapping of the mould.

Colour Coding for Patterns and Core-Boxes:

All surfaces of a wooden pattern are coated with shellac to keep out moisture and important parts of a pattern and core-box are coloured for identification of their different parts. A widely accepted colour code for general use is given below:

1) Surfaces to be left unfinished are to be painted black.
2) Surfaces to be machined are to be painted red.
3) Seats for loose-pieces are to be marked by red stripes on a yellow background.
4) Core prints are to be printed yellow.
5) Stop-offs are to be marked by diagonal black stripes on yellow base.

JOB REPORT

(Pattern Making)

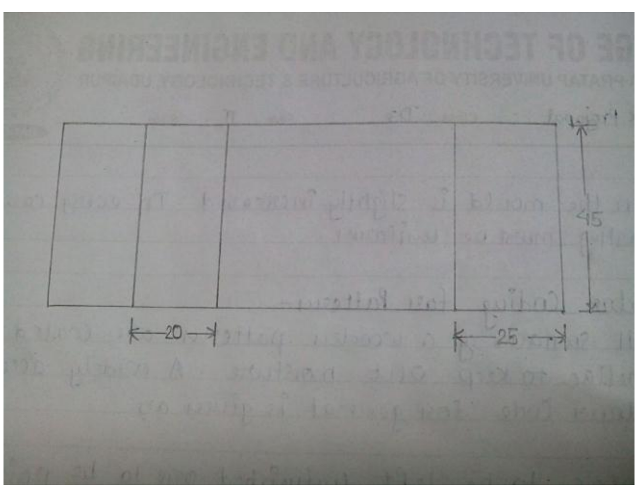
- **AIM:** To prepare pattern of required shape and size.
- **MATERIAL USED:** Teak Wood Block
- **Tools & Equipments:**

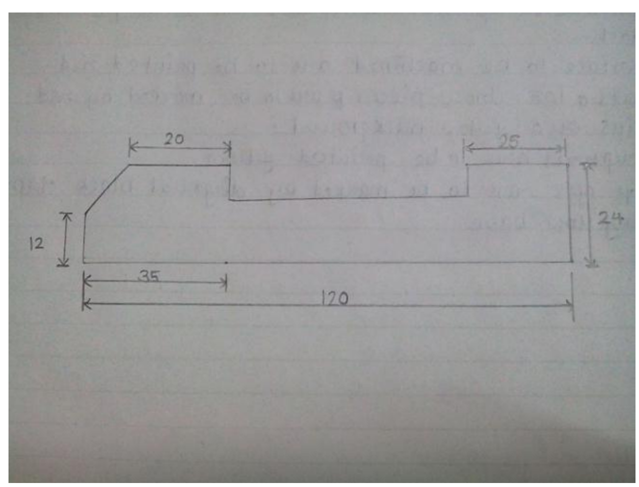
1) Half round file
2) Hand saw
3) Chisel

- **Operations Performed:**

1) Sawing
2) Measuring
3) Filing
4) Chiseling

- **Result:** The required pattern was obtained.





FOUNDRY SHOP

Introduction:

Foundry engineering deals with the process of making casting in moulds prepared by patterns. Foundry or casting is a process of forming metallic products by melting the metal, pouring it into a cavity known as the mould, and allowing it to solidify. When it is removed from the mould it will be of the same shape as the mould. Almost any article may be cast with proper technique and design, and there is practically no limit as to the size and shape of the castings that may be made.

Moulding Tools & Equipments:

Hand Tools:

Shovel: A Shovel is used for mixing and tempering moulding sand and for moving the sand from the pile to the flask.

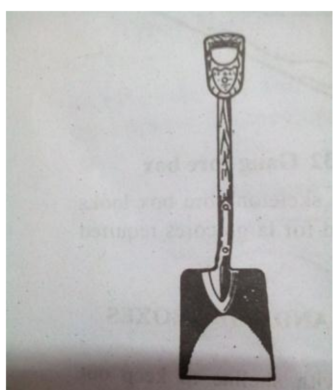
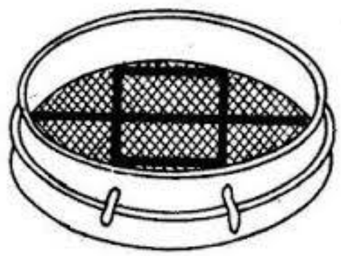
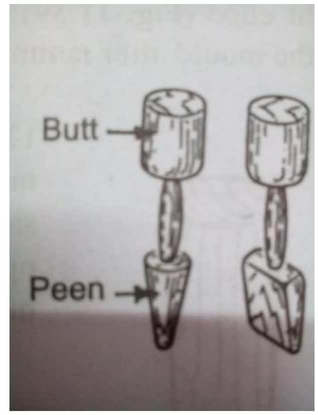


Figure 11.33 Shovel

Riddle: A riddle, sometimes called a screen, consists of a circular or square wooden frame fitted with a standard wire mesh at the bottom. It is used for removing foreign materials such as nails, shot metal, splinters of wood, etc. from moulding sand. Both hand and power riddles are available, the latter being used where large volumes of sand are to be riddled.



Riddle



Rammer: A hand rammer is a wooden tool used for packing or ramming the sand into the mould. One end, called the peen, is wedge shaped, and the opposite end, called the butt, has a flat surface. Floor rammers are similar in construction but have long handles. Pneumatic rammers are used in large moulds saving considerable labour and time.

Trowel: A trowel consists of a metal blade fitted with a wooden handle. Trowels are employed in order to smooth or sleek over the surfaces of moulds. A moulder also uses them in repairing the damaged portions of a mould. The usual trowel is rectangular in shape and has either a round or square end.

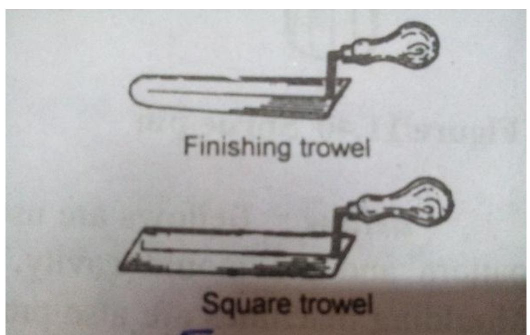


Figure 11.36 Trowel

Lifter: Lifters are made of thin sections of steel of various widths and lengths with one end bent at right angles. They are used to clean and finish the bottom and sides of deep, narrow openings in moulds.

Figure 10.38 Lifter

Swab: A simple swab is a small brush having long hemp fibres a bulb swab has a rubber bulb to hold the water and a soft hair brush at the open end. Swabs are used for moistening the sand around a pattern or for applying paint.

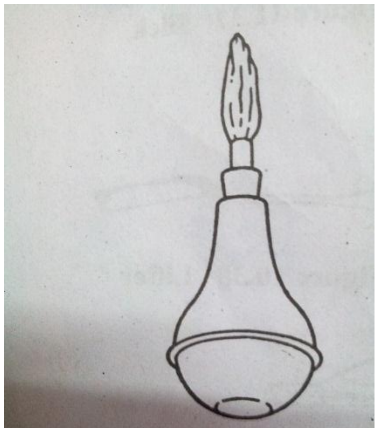


Figure 11.42 Swab

Gate cutter: It is a small piece of tin plate shaped. This serves as a tool for cutting gates and runners in the mould.

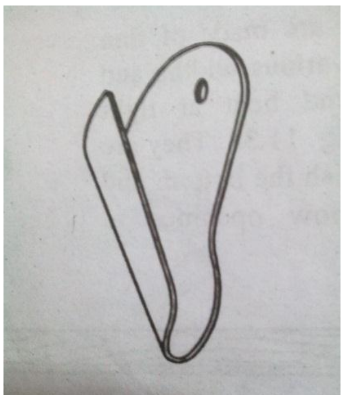


Figure 11.43 Gate cutter

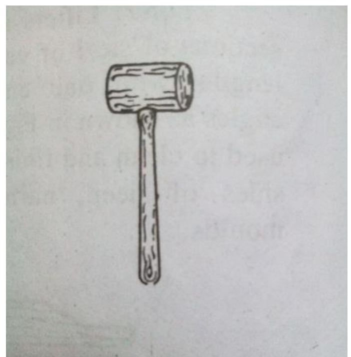


Figure 11.44 Mallet

Mallet: A raw hide mallet is used to loosen the pattern in the mould so that it can be withdrawn without damage to the mould.

Vent rod: A vent rod or wire, is used to make a series of small holes to permit gases to escape while the molten metal is being poured.

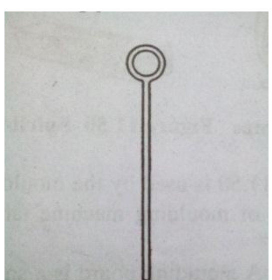


Figure 11.45 Vent rod

Draw spike or screw: The draw spike is a pointed steel rod, with a loop at one end: It is used to rap and draw patterns from the sand. The draw spike is threaded on the end to engage metal patterns.

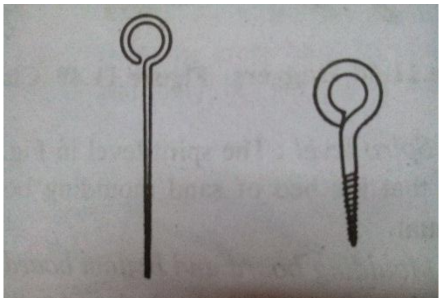


Figure 11.46 Draw spike

Spirit Level: The spirit level is used by the Moulder to ensure that his bed of sand moulding box or moulding machine table is horizontal.

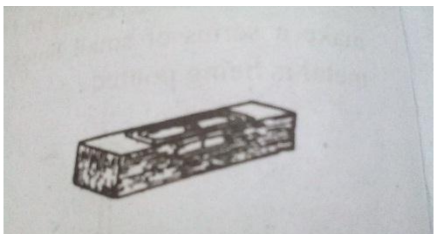


Figure 11.50 Spirit level

<u>Types of Moulding Sand</u>:

Green Sand: It is a mixture of silica sand with 18 to 30% clay, having a total water of from 6 to 8%. The clay and water furnish the bond for green sand. It is fine, soft, light and porous. Being damp, when squeezed in hand, it retains the shape, the impression given to it under pressure. Moulds prepared in this sand are known as green sand moulds.

Dry Sand: Green sand that has been dried or baked after the mould is made is called dry sand. They are suitable for larger castings. Moulds prepared in this sand are known as dry sand moulds.

Loam Sand: Loam sand is high in a clay, as much as 50% or so, and dries hard. This is particularly employed for loam moulding usually for large castings.

Facing Sand: Facing sand forms the face of the mould. It is used directly next to the surface of the pattern and it comes into contact with the molten metal when the mould is poured. Consequently, it is subjected to the severest conditions and must possess, therefore, high strength and refractoriness. It is made of silica sand and clay, without the addition of used sand. Different forms of carbon are used to prevent the metal from burning into the sand.

Backing Sand: Backing sand or floor sand is used to back up the facing sand and to fill the whole volume of the flask. Old, repeatedly used moulding sand is mainly employed for this purpose. It is sometimes called the *black sand* because of the fact that old, repeatedly used moulding sand is black in colour due to the addition of coal dust and burning on coming in contact with molten metal.

System Sand: In mechanical foundries where machine moulding is employed a so-called system sand is used to fill the whole task. In mechanical sand preparation and handling units, no facing sand is used. The used-sand is cleaned and reactivated by the addition of water binders and special additives. This is known as system sand. Since the whole mould is made of this system sand, the strength, permeability and refractoriness of the sand must be higher than those of backing sand.

Parting Sand: Parting sand is used to keep the green sand from sticking to the pattern and also to allow the sand on the parting surface of the cope and drag to separate without clinging. This is clean clay-free silica sand which serves the same purpose as parting dust.

Core Sand: Sand used for making cores is called core sand, sometimes called oil sand. This is silica sand mixed with core oil which is composed of linseed oil, resin, light mineral oil and other binding materials. Pitch or flours and water may be used in large cores for the sake of economy.

Properties of Moulding Sand:

Porosity: Molten metal always contain a certain amount of dissolved gases, which are evolved when the metal freezes, also, the molten metal, coming in contact with the moist sand, generates steam or water vapour. If these gases and water vapour evolved by the moulding sand do not find opportunity to escape completely through the mould they will form gas holes and pores in casting. The sand must be sufficiently porous to allow the gases or moisture present or generated within the moulds to be removed freely when the moulds are poured. This property of sand is called *porosity* or *permeability*.

Flow ability: Flow ability of moulding sand refers to its ability to behave like a fluid so that when rammed, it will flow to all portions of a mould and pack all-round the pattern and take up the required shape. High flow ability is required of a moulding sand to get compacted to a uniform density and to obtain good impression of the pattern in the mould. Good flow ability is very essential where energy for compaction during ramming is transmitted through the sand mass as in machine moulding. Flow ability increases as clay and water content increase.

Collapsibility: After the molten metal in the mould gets solidified, the sand mould must be collapsible so that free contraction of the metal occurs, and this would naturally avoid the tearing or cracking of the contracting metal.

Adhesiveness: The sand particles must be capable of adhering to another body, i.e. they should cling to the sides of the moulding boxes. It is due to this property that the sand mass can be successfully held in a moulding box and it does not fall out of the box when it is removed.

Cohesiveness or strength: This is the ability of sand particles to stick together. Insufficient strength may lead to collapse in the mould or its partial destruction during conveying, turning over or closing. The mould may also be damaged during pouring by washing off the walls and core by the molten metal. The strength of moulding sand must be sufficient to prevent the mould to be formed to the desired shape and to retain this shape even after the hot metal is poured in the mould.

Refractoriness: The sand must be capable of withstanding the high temperature of the molten metal without fusing. Moulding sands with a poor refractories may burn on to the casting. Refractoriness is measured by the sinter point of the sand rather than its melting point.

Process of Mould Making:

Green Sand Mould: Green sand moulds are prepared with natural moulding sands or with mixtures of silica sand, bonding clay, and water. These materials are thoroughly mixed in proportions which will give the desired properties for the class of work being done.

To make the green sand mould, the sand must be properly tempered before it can be used. If the sand is too dry, additional water is added if too wet, dry sand is added until it has the proper temper. To check the sand for proper temper, a handful is grasped in the first. The pressure is released, and the sand is broken in two sections. The sections of sand should retain their shape and the edges of the break should be sharp and firm.

Core and Core Making:

Cores are separate shapes of sand that are generally required to form the hollow interior of the casting or a hole through the casting. Sometimes cores are also used to shape those parts of the casting that are not otherwise practical or physically obtainable by the mould produced directly from the pattern. The core is left in the mould in casting and is removed after the casting.

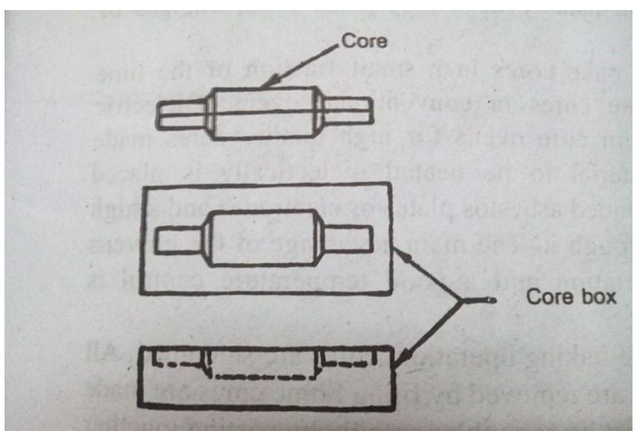


Figure 11.76 Core box and core

Core Making: It consists of the following operations: (1) core sand preparation, (2) core moulding, (3) baking and (4) core finishing.

Core sand preparation: The first consideration in making a core is to mix and prepare the sand properly. The mixture must be homogeneous so that the core will be of uniform strength throughout.

The core sands are generally mixed in (1) roller mills, and (2) core mixtures. In case of roller mills, the action of the millers and ploughs gives a uniform and homogeneous mixing. Roller mills are suitable for core sands containing cereal binders whereas the core sand mixer is suitable for all types of core binders.

Core moulding: Cores are then made manually or with machines. Normally a core box is required for the preparation of cores. Green sand cores are made by ramming the sand mixtures into boxes, the interiors of which have desired shapes and dimensions.

Core baking: After the cores are prepared and placed on metal plate or core carriers, they are baked to remove the moisture and to develop the strength of the binder in core ovens at temperature from 150ºC to 400ºC, depending on the type of the binder used, the size of the cores, and the length of baking time.

Core finishing: After the baking operation, cores are smoothed. All rough places and unwanted fins are removed by filing. Some cores are made in two or more pieces which must be assembled usually by pasting together with dextrin or other water soluble binders.

The last operation in the making of a core is to apply a fine refractory coating or core wash to the surface. This is sometimes called *core-dressing.* This coating prevents the metal from penetrating into the core and provides a smoother surface to the casting. Some materials used for core washes include finely ground graphite, silica, mica, zircon, flour, and a rubber base chemical spray. Coatings may be applied to the core surfaces by brushing, dipping, or spraying.

Casting Defects:

1) ***Shifts:*** This is an external defect in a casting caused due to core misplacement or mismatching of top and bottom parts of the casting usually at a parting line. Mis-alignment of flasks is another likely cause of shift. The defect can be prevented by ensuring proper alignment of the pattern or die part, moulding boxes, correct

mounting of patterns on pattern plates, and checking of flasks, locating pins, etc. before use.

2) ***Swell:*** A swell is an enlargement of the mould cavity by metal pressure, resulting in localized or overall enlargement of the casting. This is caused by improper or defective ramming of the mould. To avoid swells, the sand should be rammed properly and evenly.

3) ***Drop:*** A drop occurs when the upper surface of the mould cracks, and pieces of sand fall into the molten metal. This is caused by low strength and soft ramming of the sand, insufficient fluxing of molten metal and insufficient reinforcement of sand projections in the cope.

4) ***Dirt:*** In some cases, particles of dirt and sand are embedded in the casting surface. This is caused by crushing of the mould due to improper handling, sand wash and presence of slag particles in the molten metal. Dirt may be prevented from entering the mould cavity by proper fluxing and the use of dirt traps.

5) ***Metal penetration and rough surface:*** This defect appears as an uneven and rough external surface of the casting. The metal penetration between the sand grains occurs due to low strength, large grain size, high permeability and soft ramming of sand.

6) ***Shrinkage cavity:*** Shrinkage cavity is a void or depression in the casting caused mainly by uncontrolled and haphazard solidification of the metal. This may also be produced the poured temperature is too high. The defect can be eliminated by applying the principle of directional solidification in mould design and by judicious use of chills, paddling, etc.

7) ***Poured short:*** When the metal cavity is not completely filled at one pouring, the defect is called poured short. Sufficient metal in the ladle at correct temperature will eliminate this defect.

JOB REPORT

(Foundry Shop)

- **AIM:** To prepare metal from a given pattern.

- **MATERIAL USED:** Foundry sand (Green sand)

- **Tools & Equipments:**

  1) Rammer
  2) Lifter
  3) Strike off bar
  4) Gate cutter
  5) Sprue pin

- **Procedure:**

  1) Place pattern in moulding box at a distance of at least one inch from edge of box and sprinkle soap powder.
  2) Fill the mould box with sand.
  3) Level the surface.
  4) Rotate the box by 180º to make gates using spruce pins.
  5) Remove pattern using spike.
  6) Tilt the box 45º and make cut both the sides.
  7) Place the mould box or sand box.

- **Result:** A mould cavity was prepared in sand.