PRITAM....
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MANUFACTURING PROCESSES

1. INTRODUCTION: Everyday we use hundreds of items like furniture, clothing, telephones, cars, planes, railways, TVs, VCRs, and so on. These products are manufactured in factories, using some manufacturing processes.

Manufacturing means "conversion of raw material into the final product."

We can say manufacturing is a basic subject which is related to basic needs of people as well as living standard of the people of a country.

2. CLASSIFICATION OF MANUFACTURING PROCESSES

The manufacturing processes can be classified into two categories

1. primary manufacturing processes
(a) casting processes
(b) Forming processes
2. Secondry manufacturing processes
(a) Fabrication processes.
(b) Material Removal processes.

primary manufacturing processes

- casting processes
  - Single use mould
    1. Sand casting
    2. Shell mould casting
    3. Investment casting
  - Multiple use mould
    1. Die casting
    2. Centrifugal casting
- Forming processes
  - Hot working processes
    1. Forming
    2. Rolling
    3. Extrusion
    4. Hot drawing
  - Cold working processes
    1. Wire drawing
    2. Deep drawing
    3. Roll forming
    4. Sheet metal operations.

Classification of primary manufacturing processes.

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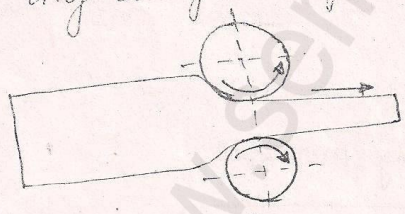
CASTING PROCESSES

These are only processes where liquid metal is used. In casting processes a solid material (usually a metal) is first melted and then poured in to a cavity or mould which resembles closely the shape of final object to be made. The molten metal is allowed to solidify and removed from cavity after solidification. Solidified object is called casting. In casting processes simple or complex shape can be made in single step.

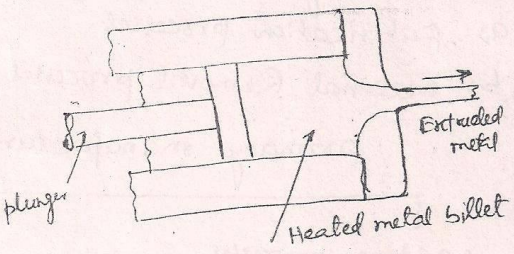
Casting processes are ~~unifo~~ universally used for manufacturing a wide variety of products. Extremely large, heavy metal objects can be made with casting process. casting of even 200 ton can be made

FORMING PROCESSES (MECHANICAL WORKING PROCESSES)

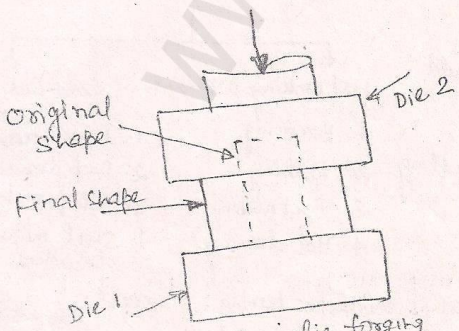
Forming processes or mechanical working processes are primary manufacturing processes. In these processes metals are deformed to get desired shape and size. The necessary deformation can be achieved by application of large amount of mechanical force only or by heating the metal.



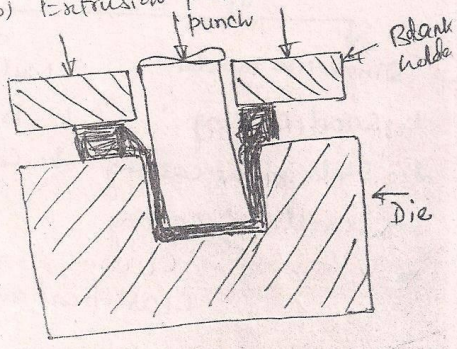
(a) Rolling ~~mill~~



(b) Extrusion process



(c) open die forging



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Secondary Manufacturing Process....!!

JOINING OR FABRICATION PROCESSES

These are secondary manufacturing processes where the starting raw materials are processed by any of primary manufacturing process (say casting or forging)

Secondry Manufacturing processes

- Joining process
  - Welding
    - 1. Arc welding
    - 2. Resistance welding
    - 3. Gas welding
    - 4. Forging welding
    - 5. Thermit welding
  - Brazing Soldering
  - Adhesive Joining
  - Mechanical Joining
    - (1) permanent fasteners
    - (2) Temporary fasteners
- Material removal process
  - Conventional ~~Mechanical~~ machining processes
    - 1. Turning
    - 2. Milling
    - 3. Drilling
    - 4. Boring
    - 5. Grinding
  - Non-conventional Processes
    - 1. Electric Discharge machining
    - 2. Ultrasonic machining
    - 3. Chemical machining
    - 4. Laser beam machining
    - 5. Abrasive jet machining

In welding processes joint is obtained by applying heat or pressure or by applying both, heat and pressure. Welding process is usually used to ~~joind~~ join similar metals.

Soldering and brazing are used to join dissimilar metals by means of a filler material.

permanent joining is achieved by means of rivetting, welding, Soldering or brazing. Rivetting find its application in joining sheet metal components (like boilers, aircraft and ship bodies)

Temporary joining may be achieved by means of nut and bolts, screws etc.

Adhesive joining is used to join metals to non-metals (examples are brake-shoe lining).

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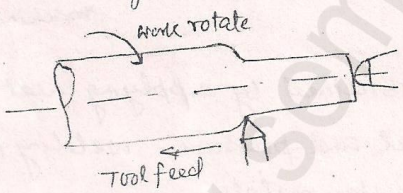
MATERIAL REMOVAL PROCESSES OR METAL CUTTING PROCESSES OR MACHINING PROCESSES

These are secondry manufacturing process where the desired shape, size and surface finish of materials are obtained by the removal of excess material in form of small chips. The material removed by a harder material (which is known as tool) through direct mechanical contact.

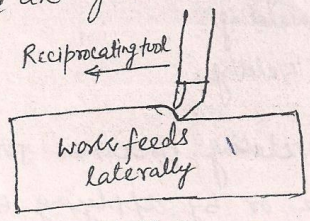
Various processes in this category are: Turning, drilling, shaping, milling, grinding, lapping etc.

Some example of machined components are: Gear teeth, Nuts, bolts, Crank shaft etc

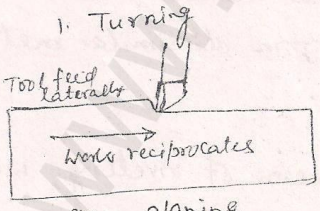
Metal cutting processes are expensive processes because lot of waste material is generated in these processes. waste materials are removed from workpiece as chips. But these processes produce good dimensional accuracy and good surface finish.



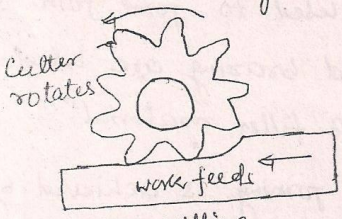
I. Turning



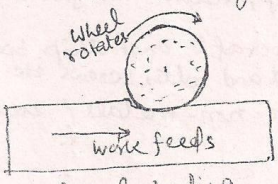
II. Shaping



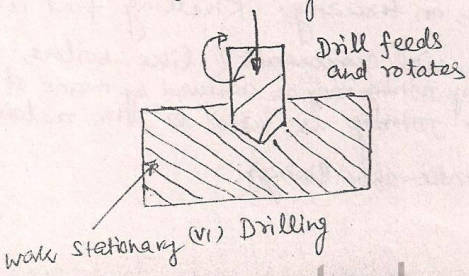
(III) planing



(IV) Milling



(V) Grinding



(VI) Drilling

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METAL CASTING PROCESS (FOUNDRY)

METAL CASTING PROCESS: consists of making patterns and moulds, preparing and melting the metal, pouring liquid metal into moulds and then allowing it to solidify. When solidified, the metal takes the shape of ~~cavity~~ pattern. It is then taken out from mould either by breaking the mould or taking the mould apart. The solidified object is called casting. The process is also known as foundry processes.

APPLICATION OF METAL CASTING PROCESSES:

Cylinder bed block, liners, machine tool beds, pistons, piston rings, wheels, turbine blades, water supply pipes, bell, agricultural parts, aircraft engines blades etc.

MATERIALS FOR CASTING PROCESSES: Cast iron, steel, aluminium, brass, bronze, magnesium, certain zinc alloys and nickel based super alloys etc.

2) CASTING TERMS: (a) Moulding flask: The box like frame without top and bottom base into which sand is rammed is called "flask". It holds the sand mould intact. It is made up of wood for temporary applications and metal for long term use. The flasks made of two or more parts.

Drag: Lower or bottom moulding flask is known as drag.

Cope: Upper moulding flask is called as cope.

Cheek: It is an intermediate moulding flask in three piece moulding.

b) parting line or parting surface: It is the surface or line that separates the cope and drag halves of the mould. In split piece pattern it is also the dividing line between two halfs of the pattern

(c) Bottom Board: This is the board normally made of wood which is used at starting of mould making. The pattern and drag is first kept on the bottom board, sand is sprinkled and

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ramming is done in the drag.

(d) pattern: pattern is the duplicate of final casting to be made with some modifications. It is used for making the mould cavity.

(d) core: core is placed in moulding cavity to make recess (hole) through the castings. core is made up of core sand.

(e) Core prints: core prints are provided to locate and support the core within the mould them in proper position while filing the mould.

(f) Chaplets: Chaplets are the metallic support kept inside the mould cavity to support the core. These should be of same composition as that of pouring metal. They melt and fuse with molten metal during solidification and become integral part of finished casting. The use of chaplets should be minimise because they usually cause casting defects.

(g). Chills: chills are metallic objects of high heat capacity and are placed in mould to provide the uniform rate of cooling or to achieve desired rate of cooling.

(h) Elements of Gating System:

Imp.

pouring cup or pouring Basin: It is the portion of gating system into which initially metal is poured from laddle. It is a small funnel shaped cavity at the top of the mould.

Sprue: from the pouring basin molten metals travels down a vertical portion of gating system. It is termed as sprue. In many cases it controls the flow of metal into mould.

~~Gates~~:
Runner: It is generally located in horizontal plane (parting plane) which connects the sprue to gates.

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Gates : This is the opening through which molten metal enters the mould cavity. Gate may be also defined as the actual entry point through which molten metal enters the mould cavity.

Riser : Almost all the metals shrink during solidification. Riser is reservoir of molten metal provided in the casting to compensate for the liquid shrinkage. To perform this ~~mat~~ function molten in the riser must solidify after the casting solidification.

BASIC STEPS ~~IN CASTING~~ PROCESS :

1. pattern making
2. core making
3. Mould making (Moulding)
4. Melting and pouring
5. solidification and mould breaking
6. cleaning and finishing

1. pattern making : The casting process starts with construction of pattern. pattern are required to make moulds. The mould is made by packing the moulding sand around it. When the pattern is withdrawn its impression provides the mould cavity which is ultimately filled with molten metal to make casting.

2. Core making : Cores are made of core sand. Basically core is a sand shape that is kept inside the mould cavity to produce holes or hollow cavities in the castings.

3. Mould making : Mould making consists of all operation necessary to prepare mould for receiving molten metal (for two piece mould) involves following operations

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I. placing drag half of pattern and lower moulding f[illegible] drag in position.

II. pouring of sand and ramming up the drag

III. place cope (upper moulding flask) is placed over the drag.

IV. locating sprue pin, riser pin and pattern

V. Removing sprue pin, riser pin and pattern

VI. Making of runner and gate

VII. Setting the core in mould

VIII. closing the mould

4. Melting and pouring: After the moulding, melting is major factor which controls the quality of casting. Melting simply means preparation of molten metal. There are number of methods available for melting such as pit furnace, open hearth furnace, cupola furnace.

Pouring means transferring the molten metal from furnace to the mould. Some type of pouring device or laddle is required for pouring. proper pouring technique must be used so that adquate amount of molten metal at desired temperature with minimum contamination should be supplied to mould. Thus producing a high quality casting which is free from defects.

5. solidification and Mould Breaking: After pouring the metal into the model, the casting is allowed to solidify and cooled in the model itself. The sand mould is to be broken to exact the casting. The breaking of sand mould is to be done only when the casting is sufficiently cooled since the metal at high temperature has very little strength. Removing the casting from mould is not very difficult in sand casting as the mould is destroyed after each casting but with multiple use mould, however removal of complex shaped casting may present a major design problem.

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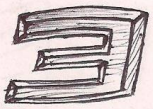
Cleaning and finishing: After the castings are removed from the mould various cleaning and finishing operations are required to remove of sand, scale and excess metal from the casting surface. Sand blasting is normally used. Tumbling is also used for cleaning ~~and~~ the casting surface.

PATTERN ALLOWANCES : pattern allowances means the dimensions of the pattern are slightly different from the final dimensions of the casting.

(a) Shrinkage Allowance : All metals shrink while cooling except bismuth. To compensate for shrinkage the pattern is slightly larger in every dimension.

* The rate of shrinkage (or contraction) with temperature is different for different materials. For example, Steel contracts to a higher degree as compared to aluminium



Shrinkage allowances for various metals

Material	Shrinkage Allowance (mm/mm)
Steel	0.0250 to 0.0380
Aluminium	0.0130
Brass	0.0155
Copper	0.01 to 0.0160
Lead	0.0260
Zinc	0.01 to 0.0150

It may be noted that there are two types of shrinkages in casting — liquid shrinkage and solid shrinkage.

* Liquid shrinkage means reduction in volume when the metal changes from liquid state to solid state. To account for this shrinkage riser are provided.

* Solid shrinkage is the reduction of volume caused when solid metal loses its temperature (from high temperature to room temperature). In solid state the shrinkage allowance are provided to take care of this reduction. Fig. 1 shows the dimensions of all casting to be made and corresponding dimensions of pattern.

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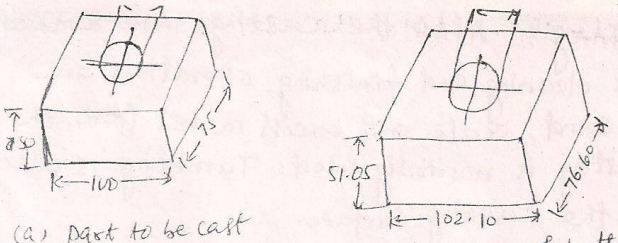
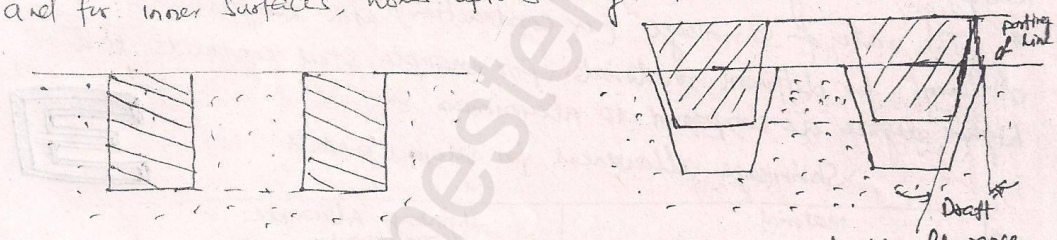


(a) Part to be cast

(b) Dimensions of pattern when steel part is cast.

Fig. 1 Shrinkage Allowance

(b) <u>Draft Allowance</u> : While withdrawing the pattern from sand mould the vertical faces of the pattern may damage the mould cavity. To reduce the chances of this happening vertical faces of pattern are always tapered from parting line. This is called draft. Draft allowance for external surfaces normally about 1° and for inner surfaces, holes upto 3° may be provided.

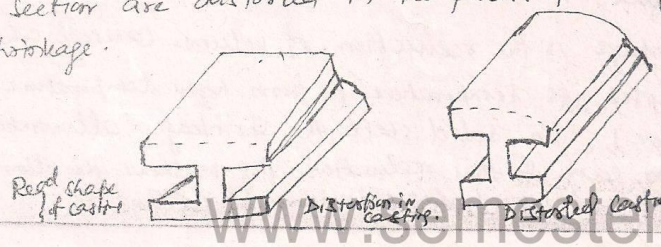


(a) pattern, where draft allowance is not provided, it may damage mould cavity while removing the pattern.

(b) pattern with draft allowance reduce the chances of damage of mould cavity.

(c) <u>Finish or Machining Allowance</u>: The finish and dimensional accuracy obtained in sand casting are generally poor when dimensional accurate part is to be produced, it is achieved by subsequent machining operation. The amount of extra metal depends ~~upon~~ on the dimensions, casting materials and surface finish required.

(d) <u>Distortion Allowance</u>: Certain objects such as long flat plate, U-shaped casting, V-section or complicated casting which have thin and long section are distorted in the process of cooling because of metal shrinkage.



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(e) Shake allowance: In all the allowances mentioned above the dimensions of pattern are larger than the cast component. But shake allowance is negative allowance. Before the pattern is withdrawn from sand mould, it is rapped to enlarge mould cavity which make the removal of pattern easy. In average size casting this increase in size can be ignored but in large size casting shake allowance is considered by making the pattern slightly smaller.

PATTERN MATERIAL: The pattern material is determined primarily by number of castings to be made. It is also influenced by size and shape of the casting, desired dimensional accuracy, and the moulding process. The usual pattern materials are wood, metal and plastics.

(a) wood pattern: The most common material for making pattern and sand castings

Advts: (1) Easily available in large quantities.
(2) low weight (3) can be easily machined
(4) Relatively cheap (5) Easy to obtain good surface finish.

Disadvt: 1. It absorbs moisture and result distortion and dimensional change occurs.
2. They are abraded by sand action 3. They possess poor wear resistance
4. They are weak as compared to metal pattern.

Applications: used when number of casting to be produced small and pattern size is large because for very large pattern wood is only practical pattern material.

(b) Metal pattern: Metal pattern are cast from wood pattern. Aluminium and white metal are commonly used pattern metal. Cast iron, brass and many other metals may also be used.

Advt: 1. Smooth surface finish
2. Good dimensional accuracy
3. Greater resistance to abrasion
4. possess life much longer than wooden pattern.
5. Light in weight and have good machiability.

Application: used ~~where~~ when a large number of castings have to be produced from same pattern.

Disadvt: 1). Expensive as compared to wooden pattern.
2. Are not easily repaired
3. Heavier than wood pattern
4. Cannot be machine so easily as wooden pattern.

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(C) plastics: plastics are also used as pattern material. Epoxy resin's are one of the best plastics used for making pattern.

Advantages: (1) low weight
2) Easier formability (easy to make)
3) Smooth surface
4) Durable
5) can be easily cleaned
6) moisure resistant
7) can be easily withdrawn
8) low solid shrinkage.

Limitations: 1. plastic patterns are week, thus this section may need metal reinforcements.
2. plastic pattern may not respond well when subjected to condition of severe shock as in machine moulding.

Applications: used for making small, intricate patterns and core boxes.

Expanded polystrene and wax is the common material used for moulding processes with disposable (or single use) patterns.

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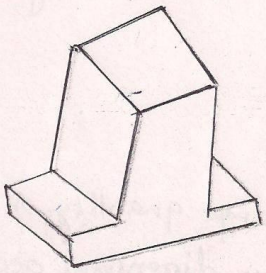
PATTERN TYPES

(a) Solid or Single piece pattern: Solid pattern, is made in one piece and carries no joint, partition or loose pieces.

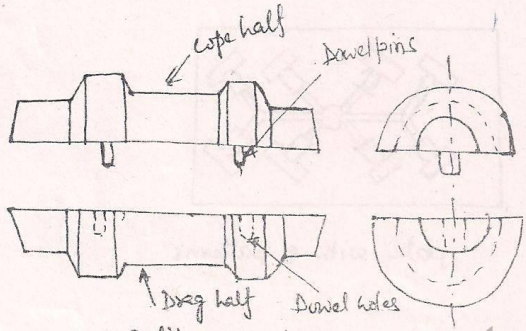
These are used when the shape of casting is simple and does not create problems while withdrawing the pattern from mould. These are used when number of casting required is rather small. The pattern is expected to be entirely in drag. Depending upon the shape, it can be moulded in one or two boxes.



(a) Solid pattern

b) ~~Split~~ Two piece OR split piece pattern.

Many pattern cannot be made in single piece because they cannot be removed from mould. To eliminate this problem some pattern are made in two parts. Lower half or pattern rests in drag (lower moulding flask) while upper half of pattern is in cope (upper moulding flask). The two ~~half~~ halves of pattern should be aligned properly by making use of dowel pins which are fitted to the (upper half) cope half of pattern. These dowel pin match with the precisely made hole in lower half (Drag half) of the pattern



Split pin pattern.

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(c) Cope and Drag pattern: These type of patterns are generally used for moulding medium and large castings. These are similar to split pattern. Such a pattern is made in two parts which are separately moulded in different moulding boxes. After completion of the moulds, the two boxes are assembled to form the complete cavity, of which one part contained by the drag and other in cope. It is nothing but a two-piece or split pattern of which both the pieces moulded separately instead of being moulded in assembled position.

(d) Match plate pattern: When large quantity of small casting is to be produced with higher dimensional accuracy then match plate pattern are used. It is the extension of cope and drag patterns.

In this case cope and drag ~~half of~~ halves of the split pattern along with gate and risers are permanently attached to opposite sides of single match plate which is made of wood or metal. one side is moulded in the drag and after turning over, the cope side is moulded. The upper and lower moulding boxes are now separated and match plate pattern is removed. Fig. shows the match plate with pattern. The 8 components can be cast at once in the match plate pattern

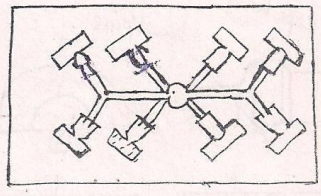

plate with 8 patterns

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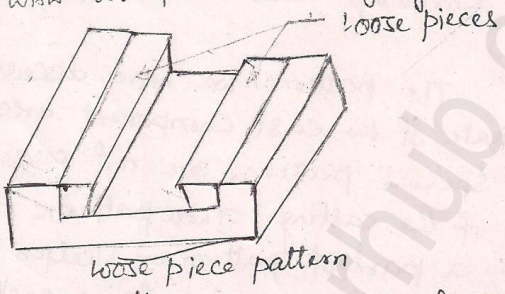
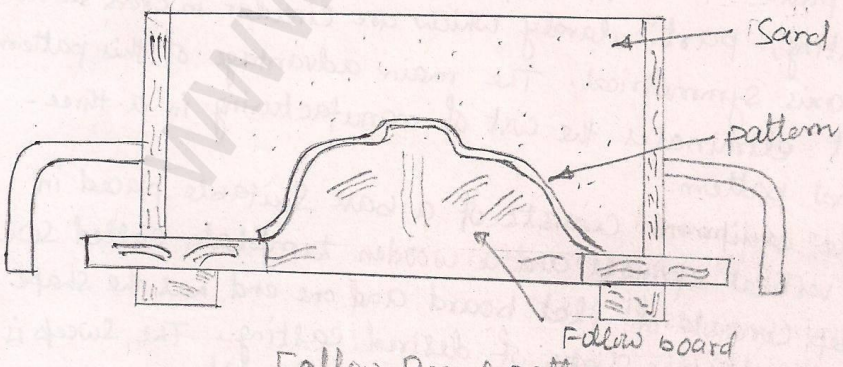
(e) Loose piece pattern: When the shape of pattern is such that one piece or split pattern could not be removed from moulding sand, loose piece pattern may be used. After moulding is over first the main pattern is removed then loose pieces are removed through the cavity generated by removal of main pattern. Loose piece pattern are expensive and moulding with loose piece is a highly skilled job.



(f) Follow Board pattern: This types of pattern's are used where some portion of pattern are structurally weak and if not supported properly and likely to break under the force of ramming. Hence the bottom board is modified as follow board. Follow board is provided with projection or cavity corresponding to the shape of pattern. Actually follow board acts as a seat for patterns. During the preparation of core no follow board is required because the sand which is rammed in drag will support the weak portion of pattern.



Follow Board patten

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(g) Master pattern: A master pattern, usually made of wood, is used as an original for casting metal patterns. Several pattern may be cast from the master patterns and mounted on the pattern plate after they have been finished to the proper dimensions. Most metal pattern are cast in sand mould from a wooden master pattern provided with double shrinkage allowance.

Special pattern. The patterns we have discussed till now are the duplicate of the cast component except some modification. But special patterns are not exact three-dimensional duplicate of the casting. These patterns may be just a plane figure, a part of pattern or skelton of patterm. These are employed when only a few large castings are to be produced.

1. Sweep pattern: used for making axis symmetrical shapes such as wheels, rims, bell shapes.
2. Segmental ~~shape~~ pattern: used for producing large ring shaped castings
3. Skelton pattern: Used for casting turbine castings, water pipes, cylinders.

1. Sweep pattern: These pattern are used for producing large casting, particularaly which are circular in cross section and are axis symmetrical. The main advantage of this pattern is that it eliminates the cost of manufacturing in a three-dimensional pattern.

The equipment consists of a base suitable placed in sand, a vertical spindle and a wooden template called sweep. The sweep consists of flat board and one end has the shape corresponding to the shape of desired casting. The sweep is rotated about spindle to form the mould cavity

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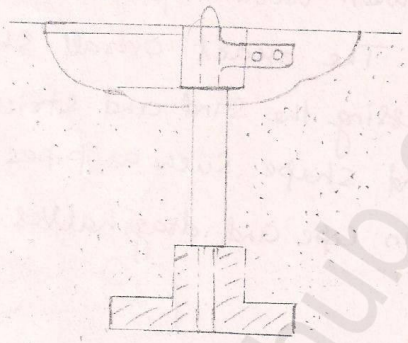
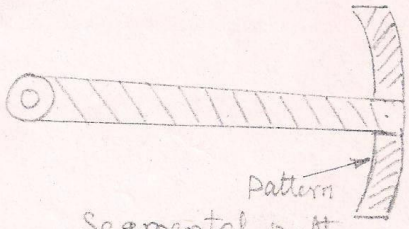
Sweep and spindle are then removed leaving the base in sand. The hole made by removal of spindle is filled by sand. Hence cavity is prepared. If shape desires then we may place core and chaplets in the cavity.



Sand Moulding using Sweep pattern

2 <u>Segmental pattern</u> : These pattern are used for producing large circular castings avoiding the use of solid pattern of exact size. Segmental pattern differs from Sweep pattern in the sense that sweep is given a continious revolving motion to generate desired shape, whereas segmental pattern is a portion of solid pattern itself and mould is prepared in part by it. In the use of this pattern a vertical central spindle is first firmly fixed near centre of drag and after preparing the part mould in one position the segment is moved to the next position. The process is continued until a complete circular mould cavity has been made.



Segmental pattern

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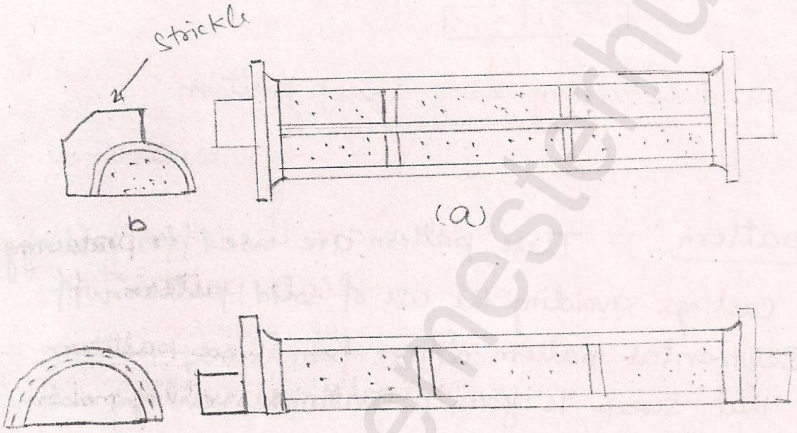
3) <u>Skelton pattern</u>: These patterns are ideal when preparation of a regular solid pattern would be too expensive. A skelton pattern is a wooden frame. The space between wooden frame is filled with moulding sand. The exact overall shape is obtained by firmly pressing the sand and strickling it. Skelton pattern for round shape such as pipes and cylinders are prepared in cope and drag halves.



A skelton pattern for a flanged pipe

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PATTERN MAKING.

(1) pattern Making Tools.

(1) plaining tools.

(a) Block plane
(b) Rabbet plane
(c) Router plane
(d) Circular plane
(e) plough plane
(f) Core box plane
(g) spoke shave
(h) Drawkinfe.

(2) Sawing tools

(a) coping saw
(b) Bow saw
(c) Mitre box.

(3) Marking and layout tools.

(a) contraction scale or shrinkage rule.
(b) Dividers
(c) Trammels.
(d) Calipers.

(4) Miscellaneous requirments.

(a) pinch dogs.
(b) Files
(c) Chisels

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(2) PATTERN MATERIALS.

1. Wood : wood for pattern making should be free from knots and other natural defects. It should be properly seasoned before use.

The common wood for pattern making:

1. Pine (ii) Deodar (iii) Teak (iv) Kail

(v) Shisham (vi) Mahogany.

2. Metals.

Advantages: (i) Obtain high and a closer dimensional accuracy as desired.

(ii) Longer life than wooden pattern.

Disadvantages: (i) costlier than wood.

(ii) For fine surface finish they need machining. This again adds to their cost.

(iii) tendency to get rusted.

The common metals used as pattern.

(a) cast iron.

(b) Brass

(c) Aluminium and its alloys.

(d) White metal : alloy of antimony, lead and copper has low melting point and can be easily cast into intricate shape.

3) plaster : plaster of paris or gypsum cement used as pattern material since it can be easily cast into intricate shapes

(4) plastics : plastics are used as pattern materials due to their following characteristics:

(i) Lightness in weight (ii) High strength

(iii) High resistance to wear (iv) Fine surface finish.

~~Mater~~ plastics used for pattern materials

(a) Thermo - setting resins.

(b) phenolic resin plastic

(c) foam plastic.

5) Wax : wax patterns are used in investment casting.

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MASTER PATTERNS.

Master pattern's are used for preparing the moulds for metal castings which are latter used as patterns for further moulding work. The master patterns are accurately finished wooden pattern which carry double shrinkage allowance. For example, an aluminium is to be made which is to be used further for making moulds for brass castings. The aluminium pattern should be larger than the desired brass casting by due to ~~so~~ shrinkage of casting during solidification. For making this aluminium pattern a wooden pattern is used which should be larger than aluminium pattern by amount equal to the aluminium shrinkage, added with proper machining allowance for finishing the aluminium pattern.

Size of master pattern = Size of final casting to be made + shrinkage allowance for the material of which the pattern is to be made + finishing allowance for the metal pattern.

PATTERN COLOURS.

i. Red – surface to be machined.
ii. Black – surfaces to be left unmachined.
iii) Yellow – core prints.
iv) Red strips on yellow base – seats for loose piece
v) No colour – parting surface.

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FOUNDRY TOOLS AND EQUIPMENT.

HAND TOOL'S

1) Shovel : It Consists of an iron pan fitted with wooden handle. It is used ~~for~~ in mixing and conditioning the foundry sand by hand transfering it to the flask (Fig.1)

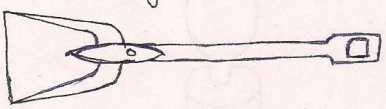

Fig 1. A shovel.

2) Hand Riddle :

It consists of a wooden frame fitted with a screen of a standard wire mesh at its bottom. It is used to remove foreign material from it.

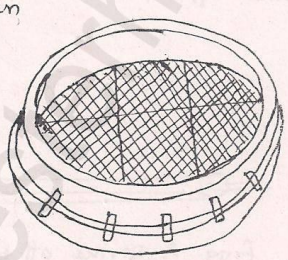

Fig 2. A Hand Riddle.

3) Rammers: Rammers are used for striking the sand mass in the moulding box to pack it uniformly arround the pattern

Types of ~~ram~~ rammers.

(a) peen rammer : ~~used~~ Shown in fig 3.1, used in packing the sand in packets and corners.

b) Hand rammer (fig 3.2) : It is smaller than peen rammer. one end carries a peen and other solid cylindrical shape called butt. It is mainly used in bench moulding.

(c) floor rammer (fig 3.3) : It consists of a long bar carrying a peen at one end and flat portion on the other. It is used for ramming sand in very large moulds.

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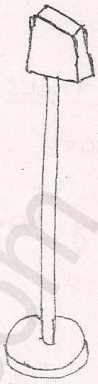
3.1 peen rammer.

3.2 Hand rammer.



3.3 Floor rammer.

4). Strike off bar (Fig4) : It is a flat bar, made of wood or iron, to strike off the excess sand from the top of box after ramming.

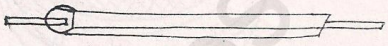
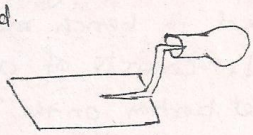


Fig4. A strike off bar.

5) Vent wire (Fig.5) : It is a thin steel rod or wire carrying a pointed edge at one end and a wooden handle at the other end. After ramming and striking off the excess sand it is use to make small holes, called vents, in the sand mould to allow the exit of gases and steam during casting.

Fig.5 vent wire.

6) Trowels : Trowels are used for finishing flat surfaces in a mould.



Trowels

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11) Smoothers and corner slicks : They are also finishing tools used for repairing and finishing flat and round surfaces etc.

12) Mallet : wooden mallet used in ~~carp~~ foundry shop. It is used for driving the draw spike into the pattern and then rapping it.

Mallet

13) Sprue pin : It is tapered rod of wood which is embeded in sand and latter withdrawn to produce a hole, called runner.

14) Sprue cutter : sprue cutter is used to produce the hole after ramming the mould. It is form of a tapered hollow tube which is inserted in the sand to produce the hole.

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(7) Slicks: used for repairing ~~the~~ and finishing the mould surfaces after the pattern has been withdrawn. The commonly used slicks are heart and leaf, squre and heart, spoon and bead and heart and spoon.

A heart and spoon slick

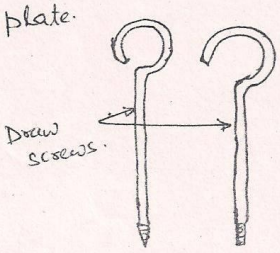
8) Lifters or cleaners: They are also finishing tools and are used for repairing and finishing the sand mould after withdrawl of pattern. They are also used for removing loose sand from mould cavity.

A simple lifter.

9) Draw spike: use to rap and draw patterns from the mould.

Draw spike

10) Draw screws and rapping plate. use ~~the~~ for withdrawing the pattern.



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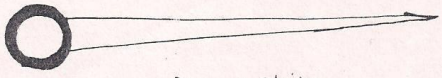
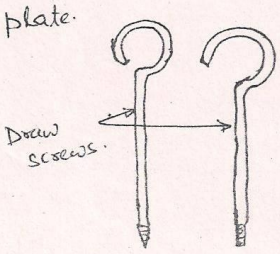


Draw spike

10) Draw screws and rapping plate. use ~~the~~ for withdrawing the pattern.



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Set(2)

WELDING (METAL JOINING PROCESS)

1. INTRODUCTION: Metal joining processes involves joining pieces either temporarily or permanently. Mechanism of bonding may be mechanical or atomic. Depending upon the mechanism of joining they may be classified as:

1. Mechanical joining processes
2. Atomic bonding processes

Joining processes

Mechanical joining | Atomic bonding

Classification of joining process.

1. Mechanical joining process: Mechanical joining process involves temporary as well as permanent joining process. Joints obtained by bolts and screws are temporary in nature. These are used where frequent dismantling is required. Rivets are the permanent fastening devices and joints can be separated only by destroying the rivet.

Classification of mechanical joining

Mechanical joining

Temporary joining	Permanent joining
Temporary fastener	permanent fastener
1. Nuts, bolts, screws	1. Rivetting.

Classification of Mechanical joining processes.

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II) Atomic Bonding processes

Joining processes involving atomic bonding are permanent in nature. Atomic bonding processes may be classified as

I. Adhesive bonding (II) Soldering, brazing and (III) welding

I. The adhesive bonding is commonly used to join plastics and is also applied to a variety of engineering materials. Metals and nonmetals can be best joined by adhesive bonding. The common applications are automobile break-shoe lining.

(II) In brazing and soldering processes base metals are not melted and joint is obtained by means of melting filler metal. Soldering and brazing processes are extensively used in uniting small assemblies and electrical parts.

Atomic bonding may be classified as;

ATOMIC BONDING PROCESS

- Soldering, Brazing
- Welding processes
  - Solid state welding
    1. Forge welding
    2. Friction welding
    3. Diffusion welding
    4. Explosive welding
    5. Ultrasonic welding
  - Fusion welding
    1. Metal arc welding
    2. Carbon arc welding
    3. Tungsten arc welding
    4. Resistance spot welding
    5. Resistance seam welding
    6. Resistance butt welding
    7. Gas welding
    8. Electroslag welding
    9. Laser Beam welding
    10. Electron Beam welding.
- Adhesive joining

Commonly used adhesives are thermosetting resins, thermoplastic resins, elastomers etc.

Classification of Atomic Bonding processes

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Another way for classification of joining processes are based on the composition of joint. In autogenous joining processes no filler material is used. In homogenious processes the filler material is same as the base material. In ~~hetrogenia~~ hetrogeneous processes the composition of filler material is different from parent material

Note: Two materials which are insoluble in each other like iron and silver can be joined using hetrogeneous processes. Filler material used are copper and tin which are soluble in both the parent metals, iron and silver.

ATOMIC BONDING PROCESS

- Autogeneous Joining processes (No filler material is used)
  1. Solid state welding
  2. Resistance welding
- Homogeneous Joining processes (Filler material is same as parent metal)
  1. Arc welding
  2. Gas welding
  3. Thermit welding
- Hetrogeneous Joining processes (Filler material is different from parent metals)
  1. Soldering.
  2. Brazing.

Classification of Atomic Joining processes.

2) WELDING PROCESSES

WELDING : Welding is a process of joining similar metals by application of heat with or without application of pressure and addition of filler material.

Welding is a metal joining processes in which fusion is obtained by application of heat and/or pressure. Combination of these two variables may be high temperature with no pressure, high pressure with no rise in temperature or both high temperature and pressure. Welding is an atomic bonding process and

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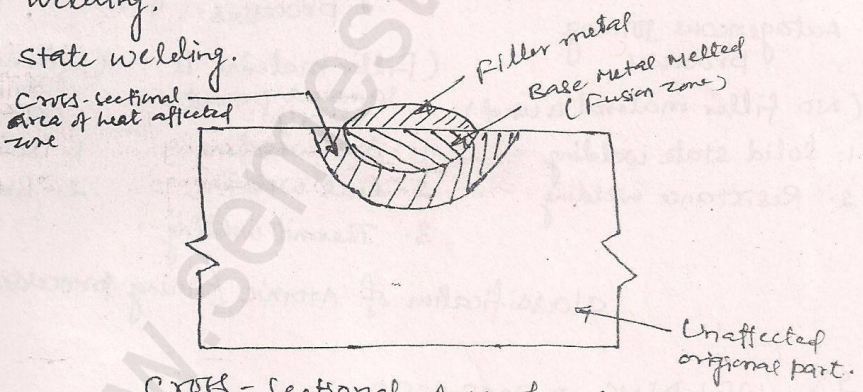
metallurgical bond is accomplished by the attracting forces between atoms. One beauty of welding processes in comparison to other processes is that by this process we can have strength of joint equal and sometime greater than parent metals. This makes welding one of the most extensively used manufacturing process.

b Use: Welding is extensively used in automobile industry, aircraft machine frames, structural work, tank repair work, ship welding etc. It is also useful method for repairing of broken castings and defective metal parts.

3. CLASSIFICATION OF WELDING PROCESSES

Welding may be classified as

1. Fusion welding.
2. Solid state welding.



Cross-sectional Area of a Bead on plate showing Fusion zone, Heat affected zone, and unaffected original part.

Fusion welding: In fusion welding process joint is completely melted to obtain the fusion and if necessary a molten filler material is also added. In fusion welded part there are three distinct zones (I) fusion zone (II) heat affected unmelted zone around the fusion zone (III) unaffected original part.

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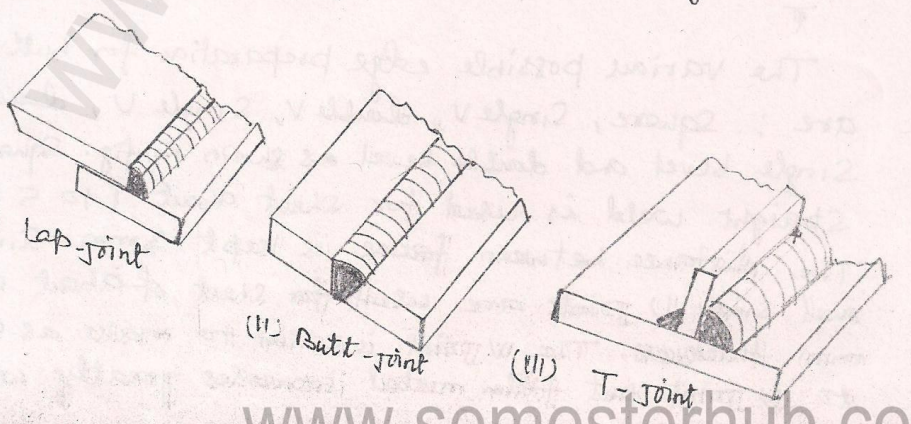
Solid state welding: These are the welding processes where the metal is brought to the plastic state without actual melting and joining is obtained by application of large forces. Solid state welding may also be carried out at room temperatures, but it does not allow recrystallisation and thus reduces the ductility. Solid state welding at elevated temperatures not only increase the ductility but also eliminates some welding defects.

Welding Heat Sources: The most common source of heat energy for different welding are following:

1. Gas flame (as in gas welding)
2. Electric resistance heating (electric resistance welding)
3. Exothermic reaction (thermits welding)
4. Electric arc (arc welding processes)
5. Energy ray (~~Lie~~ Laser welding and electron beam welding)
6. Frictional energy (friction welding)
7. Impact energy (Explosion welding)

4. <u>TYPES OF JOINTS</u>: Different types of joints used in welding processes are: lap, butt, edge, tee, fillet and corner joints. Lap and butt joints are normally used with arc welding, gas welding and resistance welding processes.



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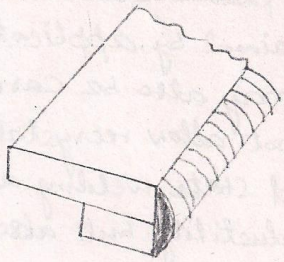
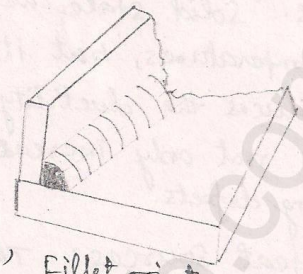


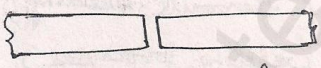
(IV) Edge joint



(V) Fillet joint

Different Types of welded joints

5. EDGE PREPARATION FOR BUTT JOINTS



Straight edge

The edge shown in above fig are straight. This type of edge preparation is used when thickness of two pieces to be jointed is small. As thickness increases it becomes necessary to prepare edge in such a way that heat produced would be able to penetrate the entire depth. If edge preparation is not ~~prepared~~ done then the joint will not be strong

The various possible edge preparation for butt joint are : Square, Single V, double V, Single U, double U, Single bevel and double bevel as shown in fig. Square or straight weld is used for sheet about 1 to 5 mm thick. The distance between faces is kept 3mm. Single V and single U joints are used for sheet of about 5 to 15 mm thickness. The V joint is easier to make as compared to U joint but filler metal increases greatly with increase

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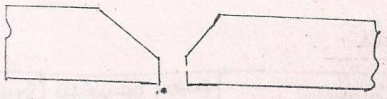
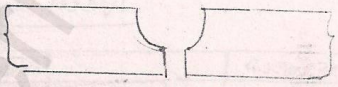
in thickness. That is why some times U joint is preferred but this joint is difficult to make. Double U (above 15 mm) joint is preferred for joining very thick material because of less requirment of filler material. The gap between plates should be kept an optimum value since penetration will be insufficient with small gap and with wide gap molten weld pools will fall through ~~the~~ and welding will be difficult to ~~control~~ control.

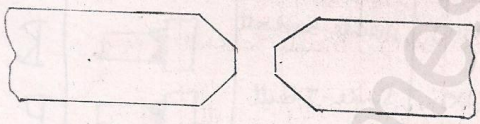
Straight



Single-V



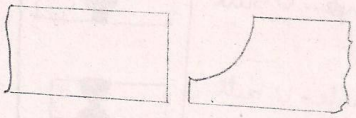
Single-U



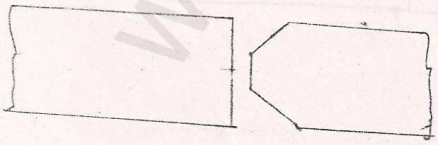
Double-V

Double-U

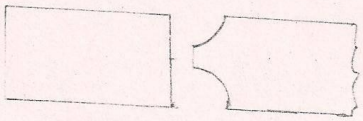
Single bevel



Single-J



Double bevel



Double-J

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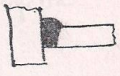
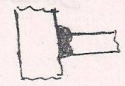
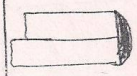
Cleaning of Joints: The edge (Interfaces) of metal must be very clean. If edges are not clean and oil, dirt, grease or paint residue are left, these would interfere with proper fusing of metal and thus weaken the joint. Surface oxides should also be removed because they tend to become entrapped in the solidifying metal.

To remove the oily substances from the surface organic solvents such as acetone and carbon tetrachloride may be used. But proper care may be taken to see that solvent is completely evaporated from the interfaces before any weleling is attempted. Otherwise highly poisonous gases such as phosgene may be formed.

To remove the oxides, flux are often employed.

Welel symbols.

	FORM OF WELD		SYMBOL			FORM OF WELD	SYMBOL
I	Fillet			VII	Single-bevel butt		
II	Square butt			(VIII)	Double-bevel butt		
III	Single V butt			(IX)	Single-J butt		
IV	Double V butt			(X)	Double-J butt		
V	Single-U butt			(XI)	Edge		
VI	Double-U butt			(X)	Spot		

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~~Pure substance~~

THE LATHE MACHINE

1. Function of The lathe

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 rigidly on machine and then turning it against a cutting tool which will remove ~~the~~ metal from the work in form of chips. To cut the material properly the tool should be harder than the material of the workpiece.

2. Types of Lathe

1. Speed lathe ~~or centre lathe~~
   (a) wood working
   (b) centering
   (c) polishing
   (d) spinning
2. Engine lathe or Centre Lathe
   (a) Belt drive
   (b) Individual motor drive
   (c) Gear head lathe
3. Bench lathe
4. Tool room lathe
5. Capstan and Turret lathe
6. special purpose lathe
   (a) wheel lathe
   (b) Gap bed lathe
   (c) T- lathe
   (d) Duplicating lathe
7. Automatic lathe

1. Speed lathe: The speed lathe, in construction and operation, is simplest of all types of lathe. It consist of a bed, a headstock, a tailstock and a tool-post mounted on an adjustable slide. There is no feed box, leadscrew and conventional type of carriage. speed range is 1200 to 3600 rpm. As a tool is controlled by hand, the depth of cut and thickness of chip is very very small. The headstock construction is very simple and only two or three spindle speeds are available. 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.

2. Engine lathe or centre lathe: It is also called centre lathe because the workpiece is clamped by centres in a lathe. It is called engine lathe because in earlier days lathe were driven by steam engine. Similar to speed lathe, the engine lathe has got all the ~~three~~ basic parts i.e bed, headstock and tailstock.

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But headstock contains additional mechanism for driving the lathe spindle at ~~different~~ multiple speeds. Unlike the ~~lathe~~ speed lathe, the engine lathe can feed the cutting tool both in cross and longitudinal direction with reference to lathe axis with a help of carriage, feedscrew and leadscrew.

The Bench lathe. This is small lathe usually mounted on a bench. It has practically all the parts of engine lathe or speed lathe and it perform almost all the operations. This is used for small and precision work.

The tool room lathe: A tool room lathe having features similar to an engine lathe is much more accurately built and has wide range of spindle speeds ranging from a very low to a quite high speed upto 2500 rpm. This is equiped, 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.

The capstan and turret lathe: These lathes are development of 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 feed into the work in proper sequence. The advantage is that several different types of operations can be done on a workpiece without re-setting of work or tools, and a number of identical parts can be produced in the minimum time.

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Special purpose lathes: As the name implies, they are used for special purposes and for jobs which cannot be accommodated or conveniently machined on a standard lathe. The wheel lathe is made for machining the journals and turning the railroad car and locomotive wheels. The gap bed lathe in which a section of the bed adjacent to the headstock is removable, is used to swing extra-large diameter pieces. The T-lathe, a new member of the lathe family, is intended for machining of rotors for jet engines. The axis of the lathe bed is at right angles to the axis of the headstock spindle in form of a T. The duplicating lathe is one for duplicating the shape of a flat or round template on to the workpiece. Mechanical, air and hydraulic devices are all used to co-ordinate the movements of the tool to reproduce accurately the shape of the template. The missile lathe, which has a very large swing for accomodating long missile component of very large diameter, is the most modern and latest in lathe design.

Automatic lathes: These are high speed, heavy duty, mass production lathes with complete automatic control. Once the tools are set and the machine starts it performs automatically all the operations to finish the job. The changing of tools, speeds, and feeds are also done automatically. After the job is complete, the machine will continue to repeat the cycles producing identical parts. An operator who has to look after five ~~and~~ or six automatic lathes at a time will simply look after the general maintenance of the machine and cutting tool, load up a bar stock and remove finished products from time to time.

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GAS WELDING

1. INTRODUCTION.

Gas welding, also called as oxy-fuel welding obtains the heat for welding by the combustion of a fuel gases. The process is fusion welding process where the joint is completely melted and no pressure is used. Filler metal may or may not be used. The fuel gas most widely used is acetylene (C_2H_2). When mixed with oxygen acetylene burns to produce temperature of the range of 3100°C. Hydrogen or some other gas may also be used but the temperatures obtained are lower than that of oxyacetylene flame. Oxy hydrogen welding may be used for welding low melting temperature metals and for welding thin pieces of metal.

2. Oxy-Acetylene Welding: This is the most common of all oxy-fuel gas welding process. As mentioned earlier in this case acetylene (C_2H_2), which is produced by chemical reaction between water and calcium carbide (CaC_2) mixes with pure oxygen to produce welding heat. The combustion of acetylene with pure oxygen takes place in two stages.

In the first stage acetylene and oxygen react to produce mono oxide and hydrogen and releasing intense heat which is present as smaller inner white cone close to welding torch tip as shown in fig.

$$C_2H_2 + O_2 \rightarrow 2CO + H_2 + 448 KJ/mol.$$

In second stage carbon mono-oxide and hydrogen in first stage further react with ~~atomic~~ atmospheric oxygen and gives rise to outer bluish flame.

$$4CO + 2H_2 + 3O_2 \rightarrow 4CO_2 + 2H_2O + 812 KJ/mol$$

Though higher amount of heat is produced in second stage but it is not concentrated and is distributed over a larger area. The temperature achieved is of the order of 1200-2000°C. This blue flame may be used

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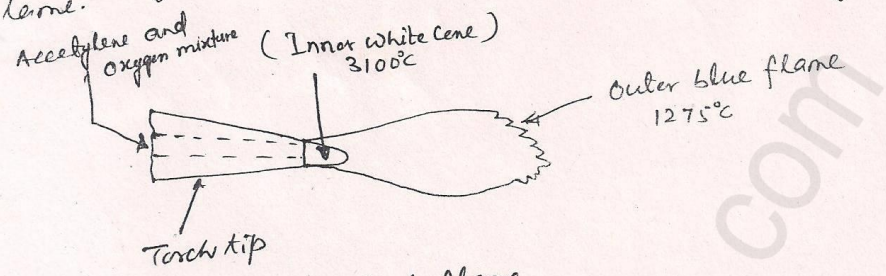
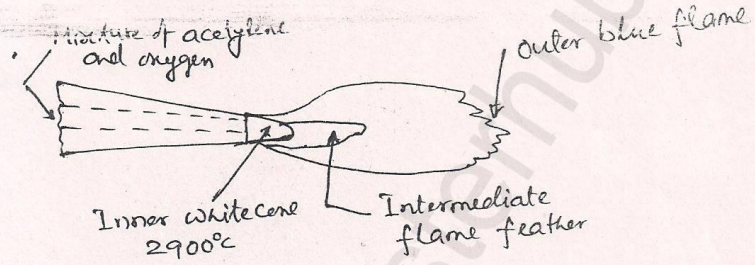
Some non-ferrous alloys such as copper base and zinc base alloys. Some alloys of iron such as cast-iron and manganese steel are also better welded by oxidising flame.



(a) Neutral flame



(b) Carburizing flame or reducing flame.

Reducing flame with intermediate flame feather. The length of feather indicates amount of access acetylene.

(c) Oxidising flame

In oxydising flame inner white cone is somewhat shorter which gives rise to high tip temperature.

WELDING FLAMES

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SOLDERING AND BRAZING

In previous articles we have discussed about the welding processes, where base metal is melted or brought to the plastic stage and then pressure may or may not be applied. Though welding gives higher joint strength, it is likely to cause metallurgical damages by way of ~~plasti~~ phase transformation. Two distinct advantages of soldering and brazing are:

I. Heating of parent metal is negligible to cause any change in their structure or proportions.

II. The process can joint two materials which are insoluble in each other.

Soldering and brazing processes ~~which~~ have wide commercial applications in joining small assemblies, electrical and electronic parts.

SOLDERING : Soldering is the process of joining similar or dissimiler metals by means of a filler material (especially lead-tin alloys), whose melting point is less than 450°c. As this temperature is lower than the melting temperature of base metal the strength of joint is largely determined by adhesive qualities of the filler metal. In soldering the gap between the metals to be soldered is filled by filler metal through capilary action.

Composition of some of the solders is listed below:

(a) Soft solder – lead 37% and tin 63%

(b) Medium solder – lead and tin each 50%

(c) Electrician solder – lead 58% and tin 42%

(d) Plumber solder – lead 70% and tin 30%

Soldering is divided into two classes

I(a) Soft soldering (II) Hard soldering

Soft soldering is extensively used in sheet metal works for joining parts, that are not exposed to the action of high temperature and excessive ~~heat~~ loads or forces.

Hard soldering is employed when a stronger joint is required than that obtained by soft solder. Silver alloyed with tin is used as hard solder, the melting point of which is 300°c to 450°c.

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Note : Soldered joints are weaker as compared to the brazed joint.

A good soldering process involve : (I) pre-cleaning (II) fluxing and (III) heating

Pre-cleaning : cleaning is done to provide chemically clean surface to obtain proper bond and may be done by acid pickling, solvent cleaning.

Fluxing : fluxing is done to remove the oxides from the joint surface and to prevent the filler metal from oxidizing. flux are in form of powder, paste or liquid.

Heating : The most common source of heating is the electrical resistance heating with soldering iron. Other method of soldering are induction soldering, furnace soldering, infrared soldering and ultrasonic soldering.

Heating : Heat sources used for brazing are electrical resistance heating, molten bath of brazing filler material, oxy-acetylene torch, induction heating, controlled atmosphere furnace etc.

BRAZING : Brazing is the method of joining similar or dissimilar metals with the help of molten filler material whose melting point is above 450°C and less than the melting point of the parents metals. The filler metal is copper alloy (copper zinc and copper silver alloys) and distributed between the surfaces of parent metals by ~~capali~~ capillary action. Joint strength is largely determined by the strength of filler metal used. Almost all the similar and dissimilar metals can be joined by brazing except Al and Mg, which are not easily joined by brazing. Like soldered joints brazed joints are also not suitable for high temperature service.

Brazing process ~~also~~ involves (I) pre-cleaning (II) fluxing (III) heating.

I. pre-cleaning : joint is properly pre-cleaned using proper solvents. Scales and oxides are removed by acid pickling. Cleaning is essential because the oil, dirt or greese prevent the flow of filler metal.

II. fluxing : fluxes are added to the brazed joint to remove any of oxides present and to prevent the formation of oxides in base metal and filler metal. The fluxes generally used are combination of borax, boric acid, ~~chlo~~ chlorides and fluorides. For ferrous metals fluxes used are mixture of borax and boric acid in powder form.

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6) WELDING FLUX

During the welding process when metal is heated or melted, atmospheric oxygen reacts with metal to form oxides and other gases. These oxides in fire with proper fusing and result in poor quality welds. Sometimes these welding oxides and gases make the welding process impossible, hence they are to be eliminated by use of flux. The flux is defined as "material used to prevent, dissolve or facilitate removal of oxides and undesirable surface substances".

The flux performs following actions during welding.

I. The flux acts as cleaner for weld metal. It reacts with oxides and other impurities present in weld pool and forms a slag. The slag has a lower density and floats on the top of weld pool. Slag can be removed after the solidification of weld bead by chipping hammer.

II. The slag protects the weld pool from atmospheric oxygen during the weld bead solidification.

III. The slag acts a insulator and helps ~~the pool~~ the metal to cool slowly and prevent the formation of brittle weld.

IV) Flux also improve the process efficiency by reducing spatter and burning losses.

In TIG (Tungsten inert gas arc welding) and MIG (Metal inert gas arc welding), welding process the purpose of flux is solved by means of inert gases whereas in SMAW the electrode ~~coat~~ coating serves the purpose flux.

Composition of fluxes: The type of flux used depend upon the welding operation and characteristics of base metal that is being welded. In SAW process flux may be physically classified as:

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1. Fused flux.
2. Agglomerate flux.

1. Fused Flux: This is most commonly used flux. The flux is manufacturing from minerals like Sand (SiO_2), Magnese ore ($MnSiO_3$), Chalk ($CaCO_3$), dolomite $CaMg(CO_3)_2$, and fluorspar etc. flux is prepared by fusing the ingredients together in furnace. This flux is free from moisture.

Table 1 Ingredients of fused flux

Name of Ingredient	Quantity
Silica	41 - 43.5%
Magnesium oxide	5.5 - 7.5%
Manganous oxide	34 - 38%
calsium flouride	4 - 5%
calsium oxide	5.5%
Alumina	4.5%
Sulpher	0.15%
phosphorus	0.12%

2. Agglomerated flux: These also are included ceramic fluxes and are prepared by mixing together the ingredients and bonding the grains with sodium silicate. These fluxes Certain ferro ~~mag~~ manganese, ferro silicon, ferro-titanium alloys.

Table 2 Ingredients of Agglomerate fluxes

Ingredient	Composition (by weight)
Marble	57.9
Rutile	15
fluorospar	20
ferromagnese	0.5
ferro silicon	0.8
ferro titanium	6.0
Sodium silicate (1.35 density)	20

Note: Drawback of ceramic flux is that it quickly ~~abs~~ absorbs moisture.

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7. WELDING POSITIONS AND TECHNIQUES

WELDING POSITIONS

Depending upon the position during welding, welding processes are classified as:

1. Flat or downhand welding: Flat weld is a weld in any direction on horizontal surface.
2. Horizontal welding: Horizontal weld is one running horizontally on a vertical surface.
3. Vertical welding: A vertical weld is that which runs vertically on a vertical surface.
4. Overhead welding: An overhead weld is one that is deposited above the operator's head.

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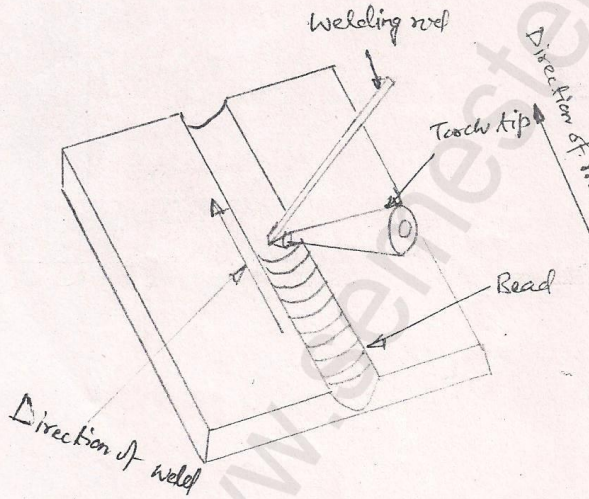
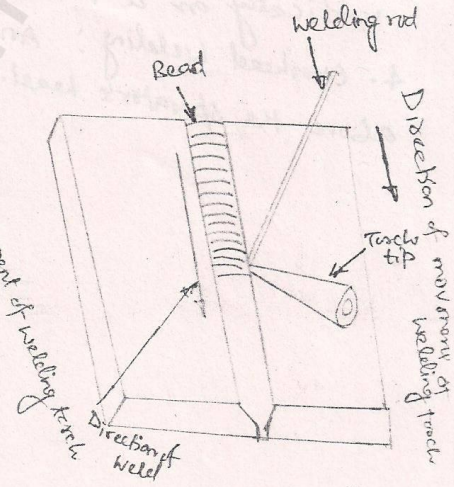
WELDING TECHNIQUES : welding techniques can be classified as forehand welding (Left ward welding) and backhand welding (rightward welding)

(a) Forward welding : In case of forehand welding the torch tip should be positioned above the metal plate at angle of 30° to 45° from the horizontal plane. The torch movement should be either oscillating or circular. In case of forward welding the torch is moved in the direction of the welding torch tip. This tends to preheat the metal.

(b) Backhand welding : In backhand welding the torch moves backhand and it allows to be joint to be continuously annealed and thus, relieving the welding stresses. It is generally used for thicker materials as it forms bigger weld bead.



(a) Forehand welding or leftward welding



(b) Backward welding or right ward welding

Welding Techniques

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ELECTRIC ARC WELDING

Arc welding is most versatile method of joining metal parts. Here the source of heat is an electric arc.

Arc welding is a fusion welding processes where fusion is obtained by heat produced by an electric arc. The arc may be obtained;

(a) Between workpiece and consumable electrode (acts as filler material also) as in shielded metal arc welding (SMAW), MIG welding etc.

(b) Between workpiece and non-consumable electrode as in tungsten inert gas arc welding. (TIG welding)

(c) Between two non-consumable electrodes as in carbon arc welding.

(d) or Between metal pieces which are to be welded together.

In arc welding process when consumable electrodes are used it also acts as filler material which is consumed continuously and deposited into the joint to make the weld. When non consumable electrodes are used seperate filler metal rods are used.

Principle of Arc welding

First of all, the contact is made between two conductors of electric circuit ie anode (which is positive pole of dc power supply) and the cathode (the negative pole). When these two conductors of electric circuit are brought together and separated for small distance (2 to 4 mm) such that the current continues to flow through a path of ionized particles (gaseous medium), called plasma and electric arc is formed.

Electron's librated from cathode move towards the anode and when they strike anode at high velocity large amount of heat is generated. positively charged ions moving from anode are impinging at cathode thus librating heat. Two third of heat is developed near the positive pole while the remaining one-third is developed near the negative pole.

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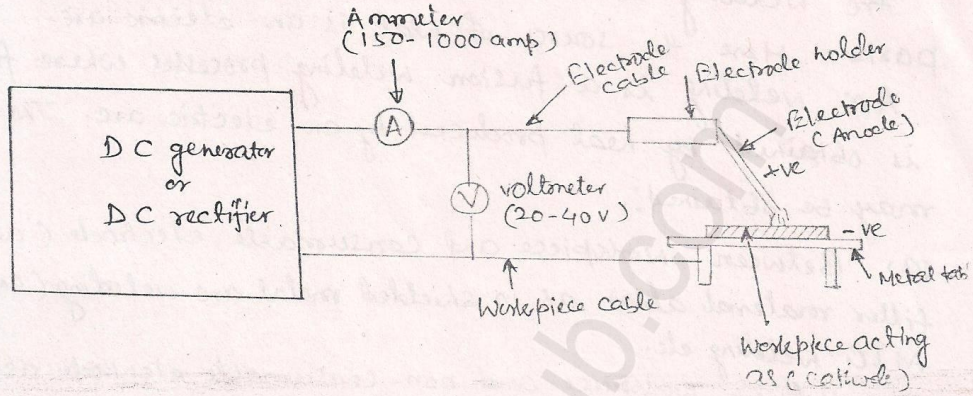
Thus electric energy is converted into intense heat in arc which attains the temperature around 5500°C.



Arc welding process

The potential difference between electrodes and air gap between electrodes are two significant parameters which are to be controlled efficiently. If the air gap becomes too large for voltage the arc may be extinguished. Larger air gap requires higher potential differences.

Above fig. shows basic circuit for arc welding. The sources of current may be AC or DC. The work piece kept on metallic table. One cable from power supply is connected to the electrode holder into which electrode is gripped. Other lead is connected to metallic table on which workpiece is kept. When the electrode is brought into contact with workpiece arc generates and welding takes place.

Arc Welding Equipment

The arc welding machines can be classified into two categories depending upon the source of electric power.

1. Alternating current machines
2. Direct current machines

Either alternating current or direct current can be used for electric arc welding.

Direct current arc welding is more expensive than AC arc welding, even then DC arc welding is preferred because of the control of heat input and easy arc maintenances.

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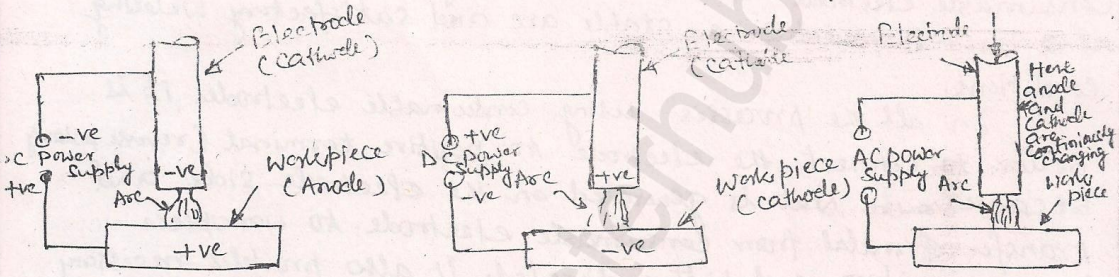
Polarity in Arc Welding

As discussed earlier in case of DC arc welding about 60-70% of heat is generated at anode and rest of heat is generated at Cathode. So if more heat is required on workpiece side, say for welding thick materials and materials having high thermal ~~conductivit~~ Conductivity. The workpiece may be made as anode (and electrode in the electrode holder of welding machine is working as cathode) liberating large heat near it. This arrangement is termed as straight polarity or direct current electrode negative (DCEN).

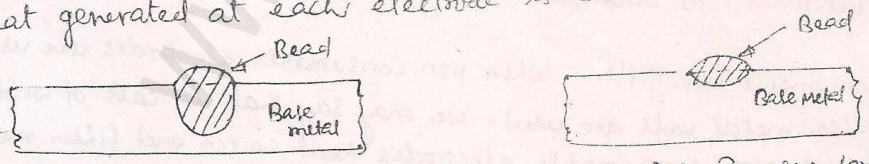


(a) Straight polarity (DCEN) (b) Reverse polarity (DCEP) (c) AC Arc welding

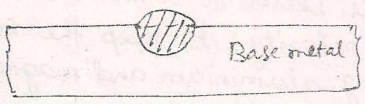
polarity in Arc welding

For thinner materials where less heat is required in the welding zone, the works piece may be made as cathode. This is termed as reverse polarity or direct current electrode positive (DCEP). DC arc welding is preferred for difficult tasks such as overhead welding as it maintains stable arc.

For AC arc welding there is no question of polarity because anode and cathode will interchange after every half cycle, so heat generated at each electrode is same.



(a) DC - Straight polarity (DCEN) (b) DC - Reverse polarity (DCEP)



(c) AC

The penetration obtained in straight polarity is large. In reverse polarity penetration is small. In AC arc welding penetration is somewhere in between above two types as shown in fig.

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Arc welding Electrodes

The electrodes used for providing heat are of two types.

1. Consumable electrodes
2. Non-consumable electrodes

Consumable Electrodes : Here electrode is consumed continuously and acts as filler material. The melting temperature of consumable electrode is below the temperature of arc. Since the electrode continuously melts the function of providing a filler metal and heat are both built into a single electrode. The consumable electrode must be continuously moved towards the workpiece to maintain a stable arc and satisfactory welding conditions.

In all the processes using consumable electrodes it is better to connect the electrode to positive terminal (reverse polarity) because more heat is generated on the electrode side and transfer of metal from consumable electrode to workpiece is more uniform and better directed. It also provides necessary cleaning action on metals with oxide layer such as aluminium.

Consumable electrodes are made of various materials depending upon the purpose and chemical composition of metals to be weld. They may be made of steel, cast iron, aluminium, copper, brass or bronze. When consumable electrode is used welding process is called metal arc welding.

The consumable electrode may be either bare or coated type. The coated electrodes most commonly known as stick electrodes are used in manual arc welding process. The stick electrodes are normally available in diameters 3, 2, 4, 5, 6 and 9 mm and the length.

Non-Consumable Electrode : When non consumable electrodes are used, separate filler metal rods are used. We may say that in case of welding processes using non-consumable electrodes heat source and filler metal deposition can be separately controlled. For all processes using non-consumable electrodes it is better to connect the electrode to the negative terminal (straight polarity) to keep the heat losses minimum. However, in case of welding aluminium and magnesium it is preferable to use AC power supply.

Non-consumable electrodes are usually made of tungsten, graphite or carbon. When non-consumable electrodes are used processes

electrode) or carbon arc welding (carbon is used as electrode).

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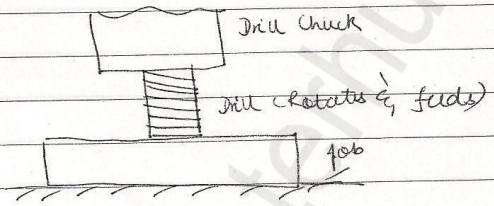
MILLING OPERATIONS:

(a) Slots & steps

(b) Gear Teeth.

DRILLING MACHINE

Producing / Generating a Round Hole in a work Machine.



PARTS

(a) Base

(b) Column

(c) Table

(d) Head

(e) Spindle & Drill head Assembly.

(f) Spindle drive Mechanism.

OPERATIONS

(a) Drilling

(b) Boring

(c) Counter Boring

(d) Counter sinking

(e) Tapping

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DRILL NOMENCLATURE

3 Principal Parts:

1. Point
2. Shank
3. Body

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STANDARDS OF MEASUREMENT:

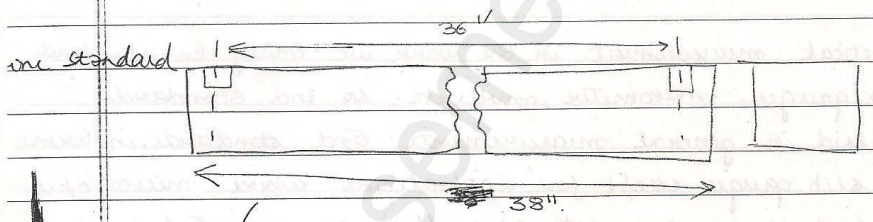
Metrology: science of measurement. Length & Angle mainly by production Engineers.

STANDARDS:

- → English
- → Metric.

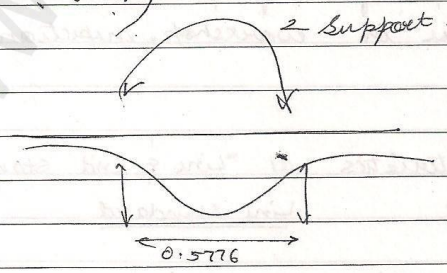
Various standards used for length measurement

- Line standard
- Wavelength standard
- End standard.



→ 1 Yard (62F)

2 Support System



Dist b/w supports $= \frac{L}{\sqrt{n^2-1}}$

L → Total length.

n → no. of supports

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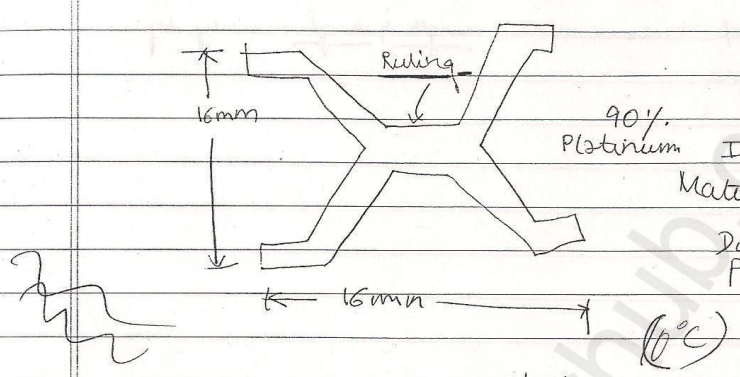
Metre :



Graduations on upper ~~Axis~~ surface of which coincide with neutral axis of the section.

1 yard = 0.9144 m

For all practical measurement in the work we imply End standards i.e the slip gauges, micrometer, anvils etc. so End standards actually used in general measurements. End standards in form of bars & slip gauges except for applications where microscopes can be used scales are not generally convenient for measurement of Engineering products whereas slip gauges are in everyday use in workshop, inspection department, tool rooms.

Relative characteristics of Line & End standard :

SNO.	Aspect	Line standard	End standard
1	Manufacturing & Cost of Equipment	simple & low	complex & high.
2.	Accuracy & Measurement	limited to 0 ± 0.2mm (For high accuracy scale have to be used in conjunction with microscope)	Very Accurate for tolerances upto ±0.001mm

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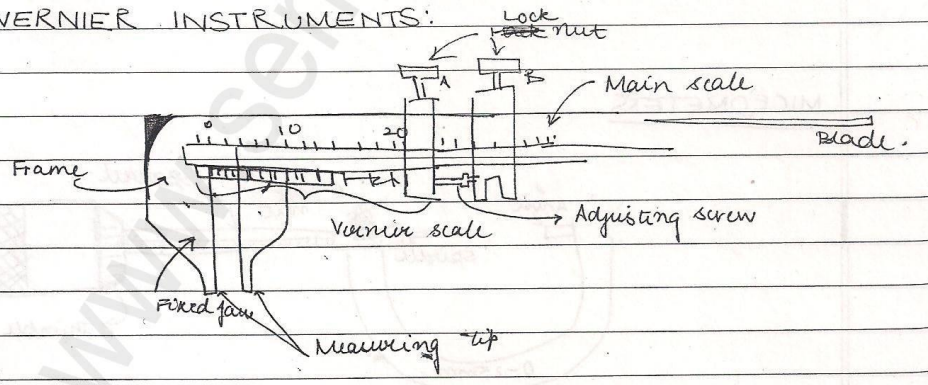
3. Time & Measurement	Quick & Easy	Time Consuming
4. ~~to~~ Effect of Use	scale marking not subjected to wear but end of scale is worn. Thus diff. to assume zero of a scale as datum.	Measuring pressure To make sure of that end piece can be hardened protective type.
5. Others Error	Parallax Error	Error may be introduced ~~in~~ due to improper averaging of slip gauge. Some error due to laboratory temp.

VERNIER INSTRUMENTS:



Vernier Callipers.

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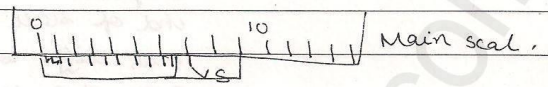
READING IN VERNIER CALLIPERS:



Main Scale divisions -

Vernier scale divisions.

Least Count =

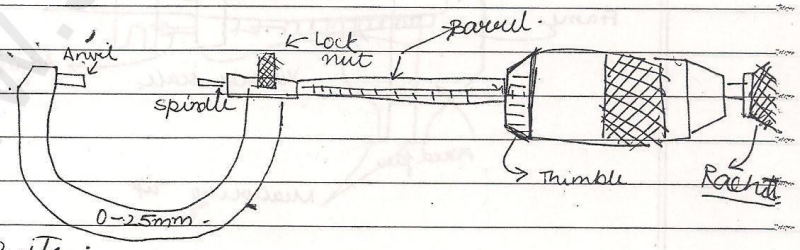
Types of Vernier Callipers:

has blade for depth measurement ← A type — has jaw on both sides for external & internal measurement.

B type - has jaw on one side for " & " .

C type — has jaw on both sides for making measurements and for marking operations.

MICROMETERS



Different Parts.

0-25mm Micrometer

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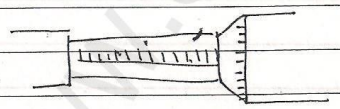
0-25mm Micrometer consists of the following parts: It requires the use of screw threads. The screw is attached to a spindle & is ~~are~~ turned by aid of thimble or ratchet. The ~~barrel~~ barrel which is attached to a frame acts as a nut to move screw ~~thre~~ threads which are accurately Made.

$$LC = \frac{\text{smallest MSD}}{\text{Turns to move one MSD}}$$

Each revolution of the thimble advances the screw. On the barrel a datum line is graduated with two sets of division marks. The set below the datum line reads in mm and the set above the line reads in half millimeters.

The thimble is divided into 50 equal divisions so that each small division on the thimble represents 1/50 of 0.5mm. Hence the Least Count is 0.01 mm or 0.001cm.

TAKING READING :



5.5 7 × 0.01

~~5.57~~ 5.64 5.57mm

Before taking the reading Anvil & thimble must be brought together carefully and calibration must be checked. In b/w micrometer each of the screw thread is 0.5mm so that 1 revolution of the screw moves by 0.5mm. Main scale of the barrel

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0-25mm Micrometer consists of the following parts: It requires the use of screw threads. The screw is attached to a spindle & is ~~use~~ turned by aid of thimble or ratchet. The ~~barrel~~ barrel which is attached to a frame acts as a nut to move screw ~~thro~~ threads which are accurately Made.

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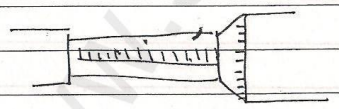

5.5 7 x 0.01

5.64 5.57 mm

Before taking the reading Anvil & thimble must be brought together carefully and calibration must be checked. In b/w micrometers each of the screw thread is 0.5mm so that 1 revolution of the screw moves by 0.5mm. Main scale of the barrel

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Vernier Height Gauge

Assignment

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COMPARATORS

A comparator is not a measuring device but is a comparing device. In general the comparator compare the workpiece wrt a standard masterpiece. Comparators find their application in all times of production work. It reduces the time of inspection and requires very less skill and it requires just a comparision of the values of the dimensions of the values of the product produced. They are classified into many catigories based on the type of principle applied for obtaining the Readings.

1. Mechanical Comparator
2. Mechanical optical Comparator
3. electric electronic Comparator
4. Pneumatic Comparator
5. Fluid Displacement Comparator.
6. Projection Comparator
7. Multi check Comparator.
8. Automic Gauging Comparator.

Irrespective of all the types of comparators it should follow some comparators. All Comparators have following essential parts:

- Fixed surface from which all measurements are taken
- A very sensitive indicator which shows the movements of a sliding piece.

CHARACTERISTICS:

1. It should have robust design & construction for max accuracy even at the worst possible conditions.
2. They should sustain all possible temperatures possible across the world.
3. A scale with linear & straight line characteristics should be implied. 4. The indicators should be constant when it retains its position back to 0.

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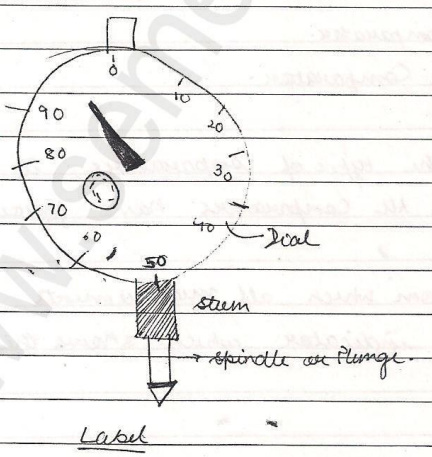
5. The Measuring pressure should be constant & should be low.

USES:

- They find use in mass production where components are to be checked at a faster rate
- They are used as Laboratory standards and are used for making the working of inspection gauges correlated & set
- They are used as special attachment to the production machines such that errors are reduced and work is not wasted.
- They are used in assembly section where more than 3 parts are to be assembled.

MECHANICAL COMPARATOR:

- Dial Gauge or Dial Indicator



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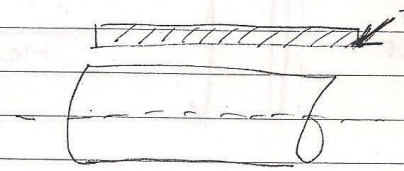
LIMIT GAUGES

It is not possible any part exactly to given size. Therefore part within a certain limit called tolerance.



If limit fixed both sides Bilatral.

If one side then Unilatral.

Limit Gauges are of two types:

"GO" & "NOT GO" type.

The "GO" side of limit Gauge should enter the hole or just pass over the shaft without any pass under the wt. of the Gauge. The "NOT GO" side of the Gauge must not enter or pass the basic/normal size of the GO side is high limit dimension of the shaft or low limit dimension of the hole. The basic side of the Not GO side is the low limit dimension of the shaft or high limit dimension of the ~~shaft~~ hole.

GO LIMIT: It refers to upper limit of the shaft and lower limit of the hole this corresponds to a max material condition.

NOT GO LIMIT: It refers to lower limit of the shaft & upper limit of the hole this corresponds to min material

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classmate

Date

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~~24~~

$3\cancel{2}(4x+3)$

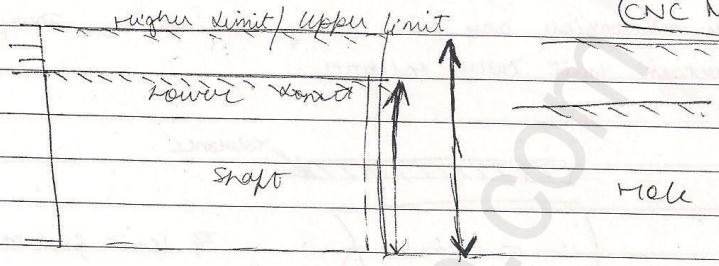
$12x+9$ 12

24 24

36

80

CNC Machining



INTRODUCTION TO MODERN MANUFACTURING:

study & Till

Traditional & New

↓

Classification

Advantages & disadvantages

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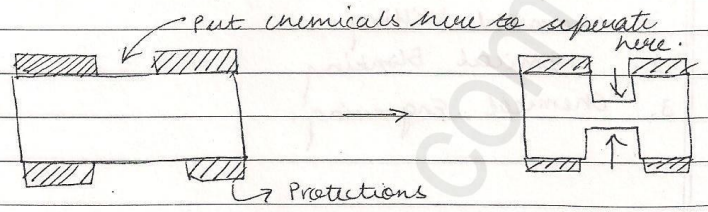
CHM (Chemical Machining)



- Selective or overall removal of material
- To Give desired shape
- Through selective or overall removal of material by controlled chemical attack by acids or alkalis (called etchant solution).
- Metal gradually transformed into metallic salt by chemical reaction and is ultimately removed in this form
- Area from where material not to be removed are protected by resistance materials known maskant or resist.
- Nearly all the materials from metals to ceramics can be machined.

- The component to be machined is cleaned in trichlorethylene vapour or in a mild alkaline solution at 80° to 90°C. following by washing in water.
- One of the widely used methods is to coat the component allover by spraying and dipping. This removes dust and oil.
- Cleaning ensures a good coating or application of maskants which is applied to protect the components which are not machined.
- Finally metal is removed by etching.
- Can be suitably applied for milling, engraving etc.

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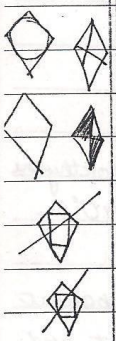
Chemical Machining Process may be classified as:

1. Chemical Milling
2. Chemical Blanking
3. Chemical Engraving.

Chemical Machining for special purposes can be done using reactive gases eg. Cl_2 on machining.
↳ storm on the material.

Chemical Milling:
sometimes called Chemmilling or contour maching or etching is used mainly to produce shapes by selective or overall removal of metal parts from the relatively large surface area. The main purpose is to achieve the shallow and complex profiles. The reduction is made by removing unwanted material from the surface ....



The components are thoroughly cleaned and degreased in trichloroethylene vapour or some alternative cleaner. The component is then coated with a cut and clean maskant by brushing, dipping or spraying upto 0.2mm. This can be suitably done with a neoprene base or some alternative plastic solution impervious to ~~acts~~ action of etching agent permitting etching depth upto 10mm.

A Template is used to portray the desired machine shape. The parts are then dipped into a tank of chemicals which will dissolve the metal. After etching the required depth and washing to remove all traces of agent.

surfaces are anodised / treating with Protecting agent.

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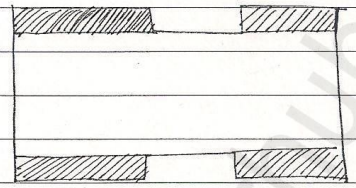
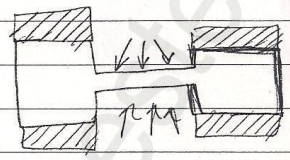
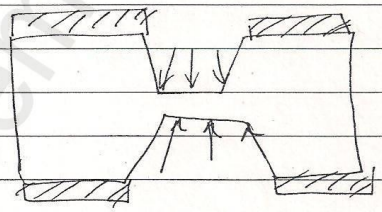
2. Chemical Blanking

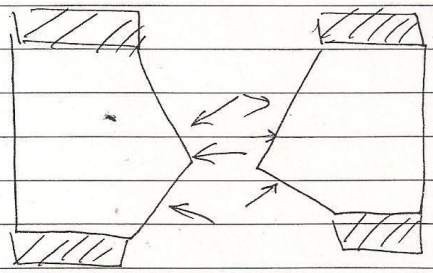
chemblanking, Photoforming, Photofabrication, Photoetching.

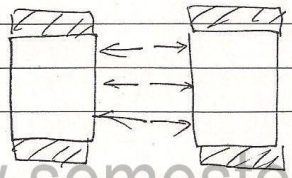
Metal is totally removed from certain areas. Not recommended than materials thicker than 2mm











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