Tooling for Metal Casting and Metal Joining Processes

PRPC21 Manufacturing Tooling and Automated Inspection

Class Activity

1. What is casting?
2. Types molds
3. Enumerate the types of tools and equipment used in foundry
4. What is pattern? Describe the pattern allowances

Foundry Shops

Foundry shops are used for carrying out different operations such as **sand preparation, pouring, molding, and casting**.

- **Flasks,**
- **Power-operated equipment,**
- **Metal melting equipment, and fettling and**
- **Finishing equipment.**

Power operated equipment

Furnace

Flasks

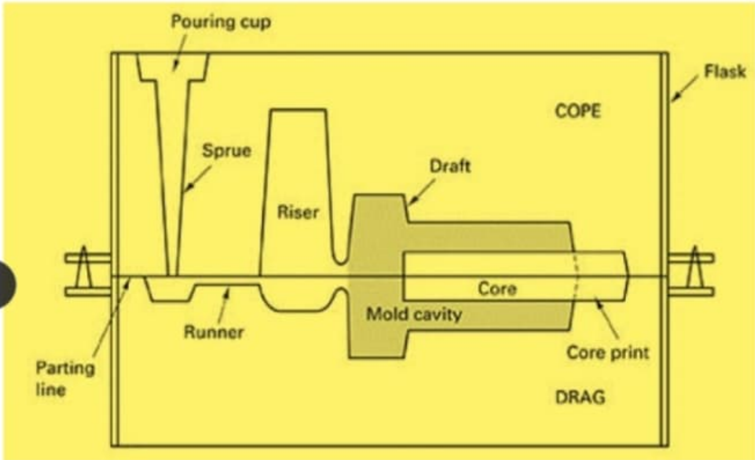
Fettling

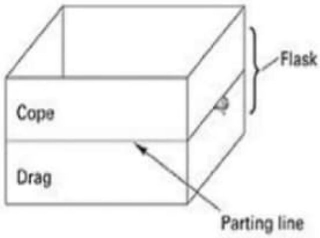
Metal Casting

- A process of pouring molten metal into a hollow cavity & a llowing it to cool and solidify into a desired shape.
- The solidified part is known as casting.
- Carried out in a foundry.
- Important casting products: Propellers, Engine blocks, Flywheel, Pistons, Turbine blades, and Machine tool beds

Casted parts

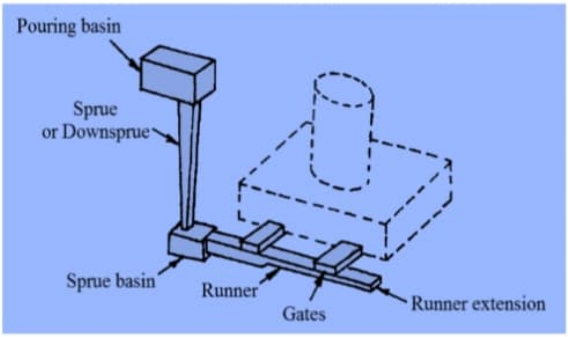
Cross Section and Isometric View of Mould





Elements of Gating Systems

- The term gating system refers to **all passageways** through which the **molten metal passes** to enter the **mould cavity**.
- The gating system is composed of
  - ✓Pouring basin
  - ✓Sprue
  - ✓Runner
  - ✓Gates
  - ✓Risers



Tools and Equipment for Molding

Eighteen commonly employed hand tools used for preparing the mould

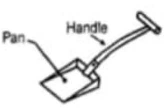


Fig. 4.1. (a) Shovel.

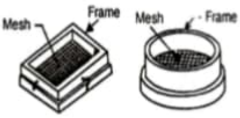


Fig. 4.1. (b) Riddles.

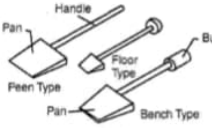


Fig. 4.1. (c) Rammers.

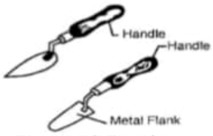


Fig. 4.1. (d) Trowel.


Fig. 4.1. (e) Strike off bar

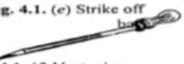


Fig. 4.1. (f) Vent wire.


Fig. 4.1. (g) Lifter.


Fig. 4.1. (h) Slick.


Fig. 4.1. (i) Swab.

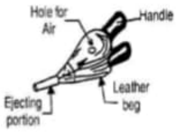


Fig. 4.1. (j) Hand bellow.


Fig. 4.1. (k) Gate cutter.


Fig. 4.1. (l) Sprue cutter.


Fig. 4.1. (m) Draw screw.


Fig. 4.1. (n) Mallet.


Fig. 4.1. (o) Gaggers.

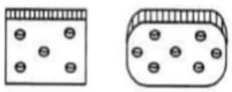


Fig. 4.1. (p) Rapping plate.


Fig. 4.1. (q) Clamps.

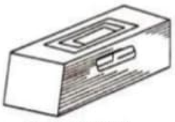


Fig. 4.1. (r) Sprit level.

Tools and Equipment for Molding

Shovel:
A shovel is used for mixing the sand with other ingredients. It is also used for handling the sand from one place to another in the foundary shop. It consists of a square metal pan fitted with a wooden handle Fig. 4.1 (a).

Riddle:
A riddle is used for cleaning the moulding sand. It removes the unwanted material like metal scrap, iron and other metal parts, pebbles etc., Fig. 4.1. (b).

Rammers:
A rammer is a wood or metal tool used for ramming or packing the sand in the moulding box. It has two parts peen and butt. Rammers are available in different designs and constructions. The popular and widely used rammers are peen-rammer, bench-rammer, and floor-rammer etc., Fig. 4.1 (c).

Trowels:
A trowel is used for finishing and repairing a mould. It consists of a metal-flat with different shapes and wooden handle. It is also used for smoothen the mould surfaces, shaping the square corners, finishing the parting surfaces. It is available in different shapes like rectangular, triangular, square, round etc., Fig. 4.1 (d).

Tools and Equipment for Molding

Strike-Off Bar:

A strike-off bar is used for striking off the excess sand from the mould to provide a smooth surface. It is a straight bar of wood or steel and usually have rectangular cross-section Fig. 4.1 (e).

Vent Wire:

A vent wire is used to form vents or holes in the rammed sand to provide easy escape of gases or steam formed during pouring of molten metal. It is a circular or rectangular long needle tool, pointed edge at one end and handle at the other end Fig. 4.1 (f).

Lifter:

A lifter is used for picking up the unwanted dust and damaged parts of the mould. It is a L- shaped steel tool with long holding shank and a small toe. It is available in thin sections of various width and lengths, according to the shape of the mould Fig. 4.1 (g).

Tools and Equipment for Molding

Slick:
A slick is used for repair and finishing the mould surface after the removal of pattern. It is a double ended tool having a spoon on one end and a flat on the other end Fig. 4.1. (h)

Swab:
A swab is used for moistening the sand around the edge before the pattern is withdrawn. It consists of soft hair brush to hold water at one end, and a rubber buld at the other end Fig. 4.1. (j).

Bellow:
A bellow is used to blow loose particles of sand from the cavity and surface of the mould. Sometimes, a compress jet of air is used for this purpose Fig. 4.1. (j).

Gate Cutter:
A gate cutter is used for cutting the gate in the mould which acts as a passage for the hot metal. It is U-shaped piece of thin sheet metal Fig. 4.1 (k).

Sprue Cutter:
A sprue cutter is used for creating a run-through or sprue for the molten metal in the cope. It has tapered cylindrical shape and made from wood Fig. 4.1 (l).

Tools and Equipment for Molding

Draw Screw:
A draw screw is used for drawn out the pattern embedded in the moulding sand. It is a pointed steel rod, with a loop at one end. Wooden mallet is used for striking the draw screw, also called draw spike. Fig. 4.1 (m).
Mallet:
A mallet is used to loosen the pattern in the mould so that it can be removed easily. It is used together with draw spike Fig. 4.1 (n).
Gagger:
A gagger is used for reinforcing the moulding sand in the cope part of the moulding box. These are the iron rods or thick wires bent at one or both the ends. The bottom end of the gagger must be kept 5 to 8 mm away from the embedded pattern Fig. 4.1 (o).

Rapping Plate:
A rapping plate is used for lift the large and heavy pattern from the mould. It is a steel plate and firmly fixed to the top of the pattern by means of bolts and screw. Rapping plates are available in many shapes Fig. 4.1 (p).

Clamps:
The clamps are used for holding the top and bottom parts of the mould so that the cope should not rise when the molten metal is poured into the mould cavity Fig. 4.1 (q).

Sprit Level:
A sprit level is used to keep sand bed, moulding box and table in horizontal position. It consists of an air bubble inside a curved glass tube Fig. 4.1 (r).

Pattern

- Replica of the desired product
- Different dimensions than the actual part to be manufactured
- Used to form the **mould cavity** (-ve replica of pattern)
- Mathematically pattern design treated as a series of transformations starting from the product shape to finally obtain the shape corresponding to mold cavity

$$[\text{Pattern}] = [\text{Part}]\,[T_{hole}]\,[T_{shrinkage}]\,[T_{machining}]\,[T_{distortion}]\,[T_{draft}]\,[T_{fillet}]$$

Centrifugal pump housing and its pattern

Wooden pattern for a cast-iron gear with curved spokes (Wiki)

Pattern Allowances

- Shrinkage or contraction allowance
- Draft or taper allowance
- Machining or finish allowance
- Distortion or camber allowance
- Rapping allowance
- Fillet

Shrinkage Allowance

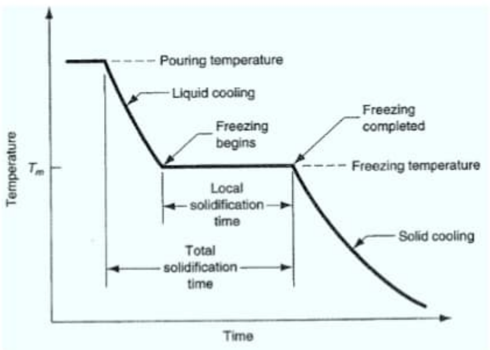
Shrinkage is defined as reduce the dimension of casting during solidification or during cooling.

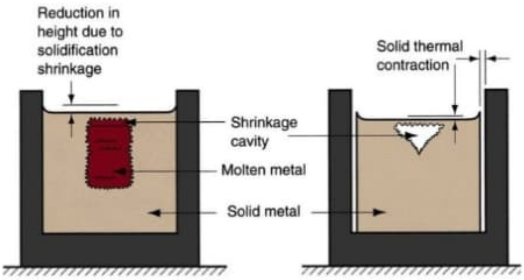
1. Liquid Shrinkage
2. Solidification Shrinkage
3. Solid Shrinkage

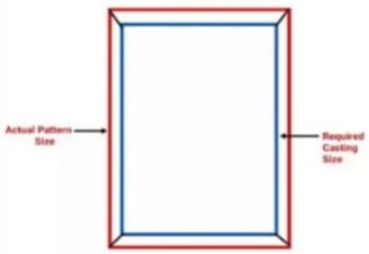
The liquid shrinkage and solidification shrinkage are compensated by suitable **riser** but **solid shrinkage** does not compensated by it so the pattern is made slightly larger to compensate shrinkage. This is known as shrinkage allowance.

Shrinkage Allowance

- **Shrinkage Allowance:**







- Liquid Shrinkage-Riser
- Solidification Shrinkage
- Solid Shrinkage-Provided on the pattern

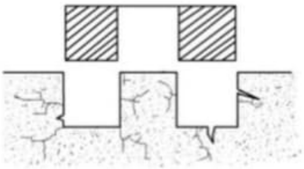
Shrinkage Allowance

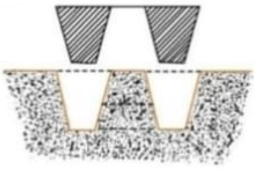
- Provided to compensate for shrinkage of material
- Pattern is made slightly bigger
- Amount of allowance depends upon type of material, its composition, pouring temperature etc
- Shrinkage allowance Differs from material to material.
- Positive type of allowance

Volumetric Solidification Contraction or Expansion for Various Cast Metals

Contraction (%)		Expansion (%)	
Aluminum	7.1	Bismuth	3.3
Zinc	6.5	Silicon	2.9
Al-4.5% Cu	6.3	Gray iron	2.5
Gold	5.5		
White iron	4-5.5		
Copper	4.9		
Brass (70-30)	4.5		
Magnesium	4.2		
90% Cu-10% Al	4		
Carbon steels	2.5-4		
Al-12% Si	3.8		
Lead	3.2		

Draft or Taper Allowance


Distorted Casting


Taper Casting

- When the pattern is removed from mould, the **parallel surface to the direction** at which pattern is withdrawn, damaged slightly and convert into slightly tapered surfaces.
- To compensate these changes, these parallel surfaces on patterns are made slightly **tapered (1-3 degree)**.
- This allow easy removal of pattern from mold and does not affect the actual dimension of casting. These are known as draft allowance.

Draft or Taper Allowance

Table 7.2 Suggested draft values for patterns

Pattern material	*Height of the given surface, mm*	*Draft angle of surfaces, degrees*	
		External surface	*Internal surface*
Wood	upto 20	3.00	3.00
	21 to 50	1.50	2.50
	51 to 100	1.00	1.50
	101 to 200	0.75	1.00
	201 to 300	0.50	1.00
	301 to 800	0.50	0.75
	801 to 2000	0.35	0.50
	over 2000	—	0.25
Metal and plastic	20	1.50	3.00
	21 to 50	1.00	2.00
	51 to 100	0.75	1.00
	101 to 200	0.50	0.75
	201 to 300	0.50	0.75
	301 to 800	0.35	0.50

Machining Allowance

- Provided to **compensate for machining** on casting
- Pattern is made **slightly bigger is size**
- Amount of **allowance depends upon size and shape of casting**, type of **material, machining process to be used, degree of accuracy and surface finish required** etc

Machining Allowance

<u>Machining Allowances of Various Metals:</u>

Table 2.3

Material	*Dimensions (in mm)*	*Machining allowance (in mm)*
Cast Iron	Up to 300 300 to 600	2.5 4.0
Aluminium	Up to 300 300 to 600	1.5 3.0
Cast Steel	Up to 300 300 to 600	3.0 4.5

Distortion Allowance

(a) Required shape of casting

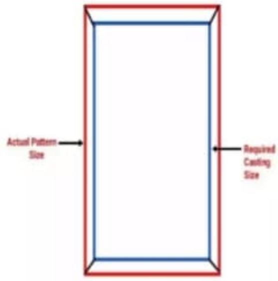
(b) Casting produced when no distortion allowance is provided

(c) Pattern with distortion allowance

- When casting of very thin surfaces like V Shape, U shape etc it will distort or damage during pattern removal or during casting.
- To avoid this problem, a chamber is provided on pattern to compensate distortion during pattern removal.
- Distortions are caused by internal stresses which are generated on account of unequal cooling of different sections of casting
- This change in casting dimension is known as distortion allowance.

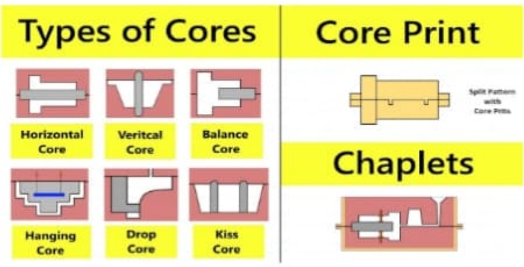
Shaking Allowance

- Before the withdrawal from the sand mould, the pattern is rapped all around the vertical faces to enlarge the mould cavity slightly, which facilitate its removal.
- When pattern is rapped, mould cavity is enlarged.
- To account for this increase, pattern size is reduced.
- This allowance is important in large-sized castings and precision castings.
- Amount of rapping allowance depends upon:
  1. Extent of rapping
  2. Degree of compaction of sand
  3. Size of mould
  4. Sand type



Elimination of Holes

All holes that are produced by cores are removed from the product model. The pattern must also produce the pockets for seating the cores, and hence the core support geometry must be added to its shape. For this purpose, the cored features must be identified, followed by the design of their support in mould (core print). Then the volume corresponding to the entire core (including its print) is to be added to the part geometry to obtain the pattern shape.



Pattern Materials

Wood

Plastic

Wax

Metal

Polystyrene

Plaster of Paris

Characteristics of a Pattern Materials

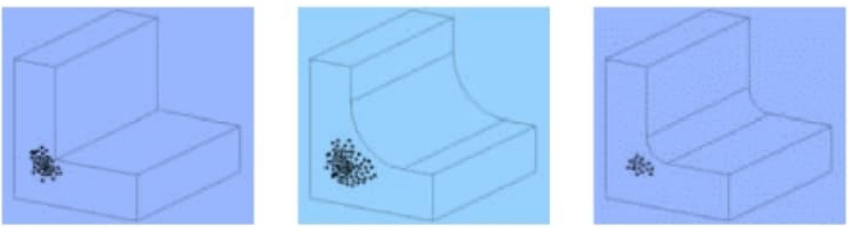
- Easily shaped, machined and joined
- Strong, hard and durable
- Resistant to wear and corrosion
- Resistant to chemical action
- Dimensionally stable
- Easily available and economical
- Light in weight

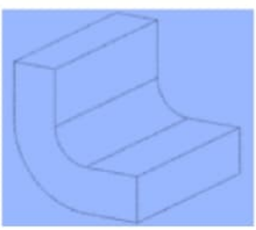
Pattern Plate Model with All the Allowances

- The allowances are added to the part model to obtain the full pattern model.
- It can them split into across the parting surfaces and converted into cope and drag pattern plates.
- For permanent moulds, the pattern model can be subtracted from a die block to obtain the die with the casting cavity

Pattern plate model for a compressor casing

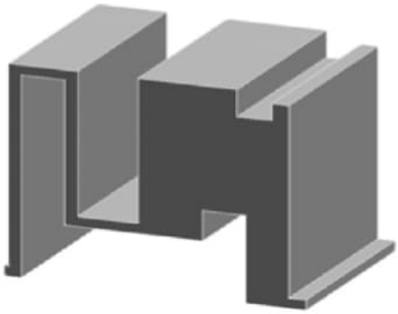
Correct The Radius At A Corner For Minimising The Shrinkage Porosity

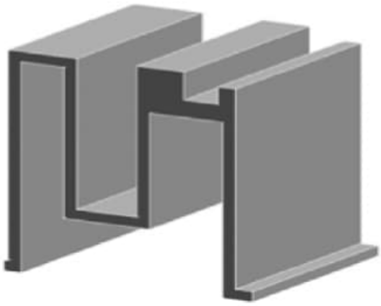




- Isolated hot spots occur in regions of high modulus surrounded by regions of lower modulus
- High modulus due to higher volume or lower heat transfer area
- When only the internal corner is filleted and the opposite external corner is sharp, this may lead to local hot spot and shrinkage porosity defect
- In general, fillet radius of 0.3-0.6 times the wall thickness is recommended

Redesign the Following Model By Considering Shrinkage Allowance

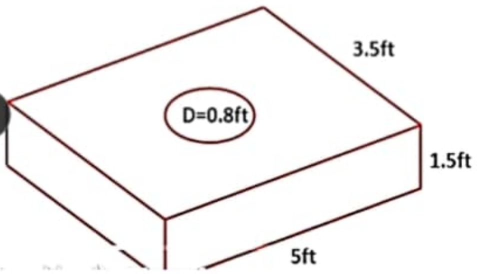




Thick sections are prone to shrinkage defects and must be avoided

Pattern Design Calculations

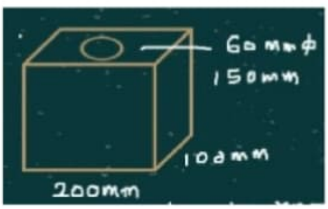
Calculate the pattern dimensions to cast the following object. Top surface, bottom surface and hole inner have to be machine (machine allowance per side is 0.1 in)

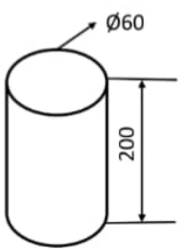


Material	Dimension/ft	Shrinkage Allowance in/ft
Cast iron	Up to 2ft	0.125
	2ft-4ft	0.105
	Over 4ft	0.083

Pattern Design Calculations

Determine the dimension of the pattern for casting shown in Figure. Shrinkage allowance is 20 mm/mt, machining allowance On all surface and bore is 1 mm and 0.75 and 1 degree draft allowance for external and internal dimension respectively.





What is Welding

➤ **Welding** is a "**joining process that produces coalescence materials by heating them to suitable temperatures, with or without the application of pressure and with or without the use of filler material**"

➤ Welding process is accomplished by

- Heat alone and no pressure applied
- Heat and pressure together
- Pressure alone and no heat is applied

➤ In some welding operations, filler material is used that aids in the joining process

➤ **Coalescence:** The uniting or fusing of metals upon heating

Selection of Welding Process

A wide range of welding processes are available to choose. Whatever process is selected for developing weld joint, it must be able to perform the intended function for designed life. Welding processes with their field of applications are given below:

➤ Resistance welding: **Automobile**

➤ Thermite welding: **Rail joints in railways**

➤ Tungsten inert gas welding: **Aerospace and nuclear reactors**

➤ Submerged arc welding: **Heavy engineering, shipbuilding**

➤ Gas metal arc welding: **Joining of metals** (stainless steel, aluminium and magnesium) sensitive to atmospheric gases

Tooling For Physical Joining Processes

Joining processes generally fall into two classes:

Physical and Mechanical

Welded Components

- **In the physical joining process**, parts are made to join along their contacting surfaces by applying heat or, pressure, or both. A filler material is often added, with the edges losing their identity in a homogeneous mass.

Woods Glued/Nailed

- **Mechanical joining ordinarily** does not involve changes in the composition of the work piece material. The edges of the pieces being joined remain distinct.

  Example: Two pieces of wood nailed together, Riveting, glued.

Classification of Welding Processes

Welding

1. Gas Welding

1. Air Acetylene Welding
2. Oxyacetylene Welding
3. Oxy hydrogen Welding
4. Pressure gas Welding

2. Arc Welding

1. Carbon Arc Welding
2. Shielded Metal Arc Welding
3. Flux Cored Arc Welding
4. Submerged Arc Welding
5. TIG (or GTAW) Welding
6. MIG (or GMAW) Welding
7. Plasma Arc Welding
8. Electro slag Welding
9. Electro gas Welding
10. Stud Arc Welding.

3. Resistance Welding

1. Spot Welding
2. Seam Welding
3. Projection Welding
4. Resistance Butt Welding
5. Flash Butt Welding
6. Percussion Welding
7. High Frequency Resistance Welding.

4. Solid State Welding

1. Cold Welding
2. Diffusion Welding
3. Explosive Welding
4. Forge Welding
5. Friction Welding
6. Hot Pressure Welding
7. Roll Welding
8. Ultrasonic Welding.

In general, various welding and allied processes are classified as follows:

5. Thermo-Chemical Welding Processes

1. Thermit Welding
2. Atomic Hydrogen Welding.

6. Radiant Energy Welding Processes

1. Electron Beam Welding
2. Laser Beam Welding.

7. Brazing, Soldering and Adhesive bonding

Welding Fixtures

- The purpose of a welding fixture is to hold the parts to be welded in the proper relationship before, during, and after welding.
- Typically, distortion is a by-product of the welding process due to the amount of heat input into the parts.
- Figure reflects the degree of heat input associated with a given welding process.

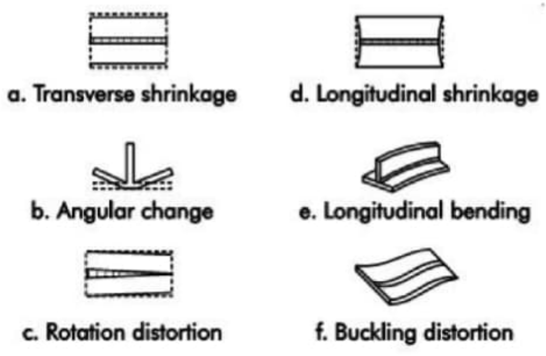
Select low-heat input process

Heat Input	Process
High	Gas tungsten-arc welding
↓	Shielded metal-arc welding
	Gas metal-arc welding
	Flux-cored arc welding
	Submerged-arc welding
Low	Laser

Degree of heat input (Joules/inch of linear weld) based on process.

Distortion

- The tool designer may have to be familiar with gas, arc, and resistance-welding processes.
- Each process will require individual variations to the general design factors involved.
- For instance, heat dissipation is not critical in some welding processes. Expansion is fine if the outer ends of the work piece are not restricted.



Typical types of distortion occurring during welding.

Distortion potential by material type

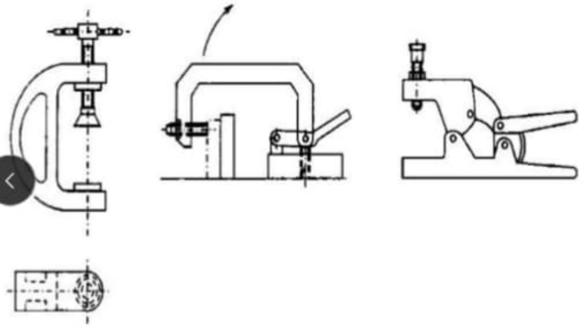
Lowest	Low-carbon steel
↓	High-strength steel
	Nickel-based alloys
	Nickel-copper alloys
	Copper alloys
	Stainless steel
Highest	Aluminum

Distortion potential based on material type

Fixture Design Objectives

- To hold the part in the most convenient position for welding,
- to provide proper heat control of the weld zone,
- to provide suitable clamping to reduce distortion,
- to provide channels and outlets for welding atmosphere,
- to provide clearance for filler metal,
- to provide for ease of operation and maximum
- accessibility to the point of weld.

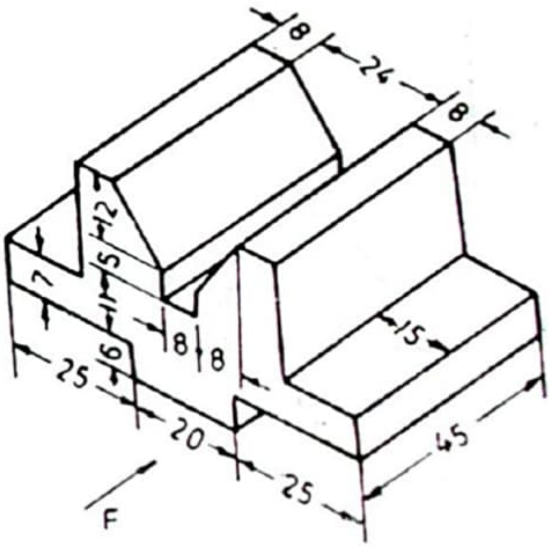
Welding Clamps



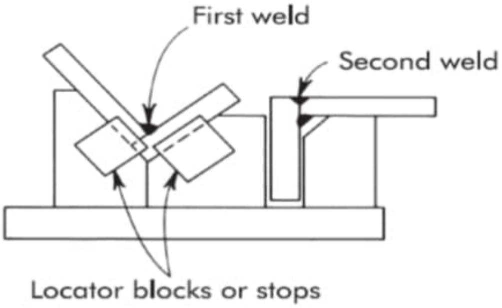
Figures: Various types of clamps used in welding fixtures

- Expansion of the heated workpiece and resulting distortion should not affect proper location, clamping, loading and unloading
- Welding spatter should not be allowed to fall on the threaded parts of the clamping elements
- Spatter grooves must be provided below the line of welding to prevent the workpiece from getting welded to the base plate by the welding spatter.
- Care should be taken to check that the joined workpiece does not get locked in the welding fixture after welding

Draw the Front and Side View of the V-Block



Gas Welding Fixtures

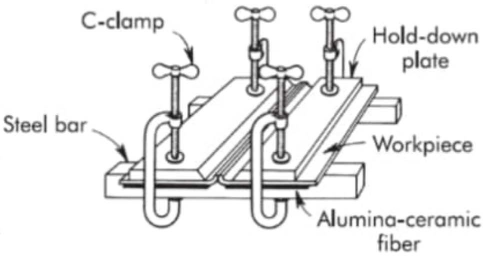


Simple welding fixture using gravity to help locate parts

- One of the simplest fixtures for gas welding is the gravity-type fixture shown in *Figure*.
- This design eliminates excess fixture material from the weld area to minimize heat loss, while providing sufficient support and locating points.
- The design also permits making welds in a horizontal position.

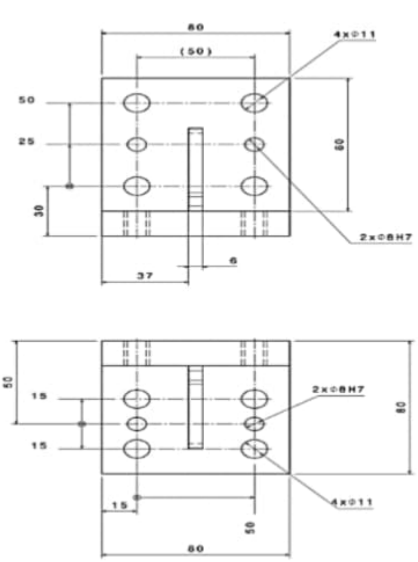
Gas Welding Fixtures

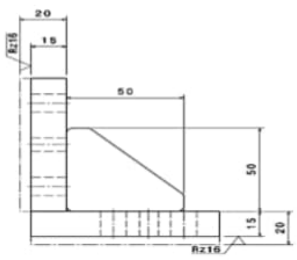
- Figure shows another simple form of gas welding fixture, which holds two flat sheets for joining
- C-clamps hold the workpieces to steel support bars
- Alignment is performed visually or with a straight edge
- A heat barrier of alumina-ceramic fiber is placed between the workpieces and steel bars
- Hold-down plates are used to keep workpieces flat and prevent distortion
- If the parts to be welded have curved surfaces, the supporting bars and hold-down plates may be machined to match the part

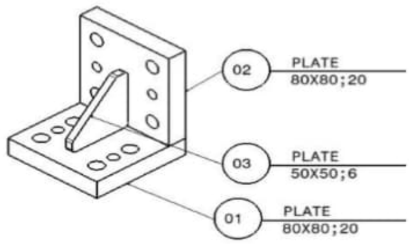


Workpieces with simple fixturing for gas-welding operations.

Draw the Isometric View of Welding Fixture







Selection of Gas Welding Fixtures & Materials

- The selection of material for gas welding fixtures is governed by these factors:

(1) part print tolerances;
(2) material heat resistance;
(3) heat transfer qualities, and
(4) the fixture rigidity required to assure
(5) workpiece alignment accuracy.

- The fixture material should not be affected in the weld zone and should prevent rapid heat dissipation from the weld area.
- Some of the fixture materials commonly used are
- cast iron,
- carbon steel, and
- stainless steel.

Arc Welding Fixtures

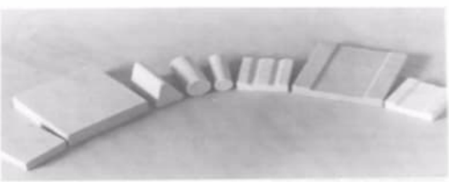
- Arc welding concentrates more heat at the weld line than gas welding.
- The fixtures for this process must provide support, alignment, and restraint on the parts,and also must permit heat dissipation.
- Some of the more important design considerations for arc welding fixtures are as follows:

(1) the fixture must exert enough force to prevent the parts from moving out of alignment during the welding process, and this force must be applied at the proper point by a clamp supported by a backing bar;
(2) backing bars should be parallel to the weld lines;
(3) backing bars should promote heat dissipation from the weld line; and
(4) backing bars should support the molten weld, govern the weld contour, and protect the root of the weld from the atmosphere

Arc Welding Fixtures

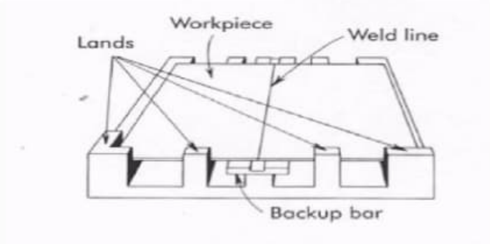
- Backing bars are usually made from solid metal or ceramics.
- A simple backup could be a rectangular bar with a small groove directly under the weld.
- This would allow complete penetration without pickup material by the molten metal. In use, the backup would be clamped against the part to make the weld root as airtight as possible.

- Typical backing bars



Arc Welding Fixtures

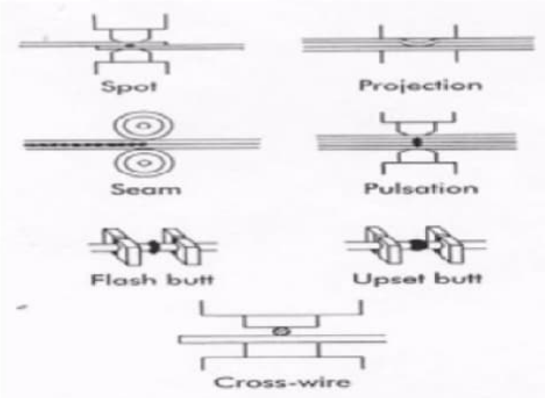
- **BACK UP BAR**
- The size of the backup bar is dependent upon the metal thickness and the material to be welded.
- A thin weldment requires larger backup to promote heat transfer from the weld.
- A material with greater heat-conducting ability requires less backup than that required for a comparable thickness of a poor conductor



- Backup bars may be made of
- copper
- stainless steel (used for tungsten inert gas)
- titanium ceramic, or
- a combination of several metals (sandwich construction)

Resistance Welding Fixtures

- Spot welding
- Projection welding
- Seam welding
- Pulsation welding
- Flash butt welding
- Upset butt welding



Resistance Welding Fixtures

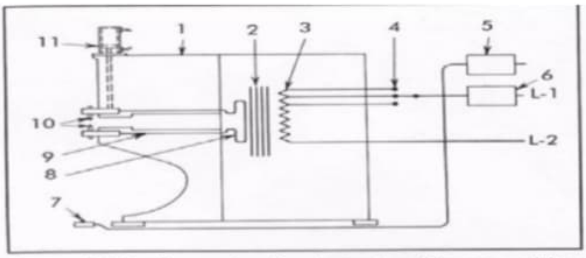


Figure 10-9. Elements of a typical resistance welder: (1) housing; (2) low-voltage, high-current transformer; (3) primary coils; (4) tap switch; (5) welding timer; (6) power interrupter; (7) foot switch; (8) secondary loop; (9) bands from electrodes to secondary; (10) electrodes; (11) cylinder that exerts pressure on work.

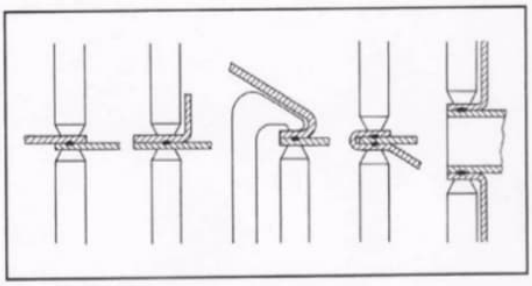


Figure 10-11. Typical spot-welded joints.

Resistance Welding Fixtures

- There are two general types of fixtures for resistance welding.
- The first type is a fixture for welding in a standard machine having a single electrode.
- The second type is a fixture and machine designed as a single unit, usually to attain a high-production rate.

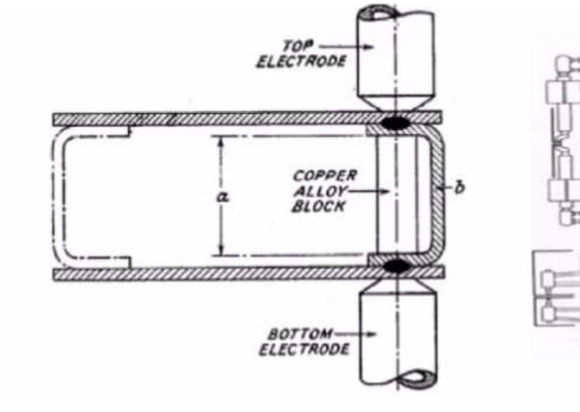
Design Considerations

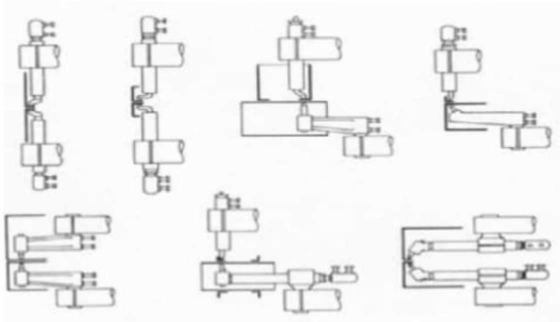
- Certain design considerations apply to fixtures for resistance welding:
- (1) keep all magnetic materials, particularly ferrous materials, out of the throat of the welding machine;
- (2) insulate all gage pins, clamps, locators, index pins, etc.;
- (3) protect all moving slides, bearings, index pins, adjustable screws, and any accurate locating devices from flash;
- (4) give consideration to the ease of operation and
- protection of the operator;
- (5) provide sufficient water cooling to prevent overheating;
- (6) bear in mind that stationary parts of the fixture and work are affected by the magnetic field of the machine. Work holder parts and clamp handles of nonmagnetic material will not be heated, distorted, or otherwise affected by the magnetic field

Basics Resistance Welding Fixtures

- 1. The fixture loop or throat is the gap surrounded by the upper and lower arms or knees containing the electrodes and the base of the machine that houses the transformer.
- This gap or loop is an intense magnetic field within which any magnetic material will be affected. In some cases, materials have actually been known to melt .
- Power lost by unintentional heating of fixture material will decrease the welding current and lower the welding efficiency.
- This power loss may sometimes be used to advantage; e.g., if the current is burning the parts to be welded, the addition of a magnetic material in the throat will increase the impedance, lower the maximum current, and halt the burning of parts.
- 2. The throat of the machine should be as small as possible for the particular job.
- 3. Welding electrodes should be easily and quickly replaceable. Water for cooling should be circulated as close to the tips as possible.
- Provide adjustment for electrode wear. If the electrodes tend to stick, knockout pins or strippers may be specified.
- Current-carrying members should run as close to the electrodes as possible, have a minimum number of connections or joints, and be of adequate cross-sectional area.
- 4. Provide adjustment for electrode wear.
- 5. Check welding pressure application.
- 6. Have knockout pins or strippers if there is a tendency of the electrode to stick to the electrode face. These may be leveraged or air operated.

Resistance Welding Fixtures





Resistance Welding Fixtures

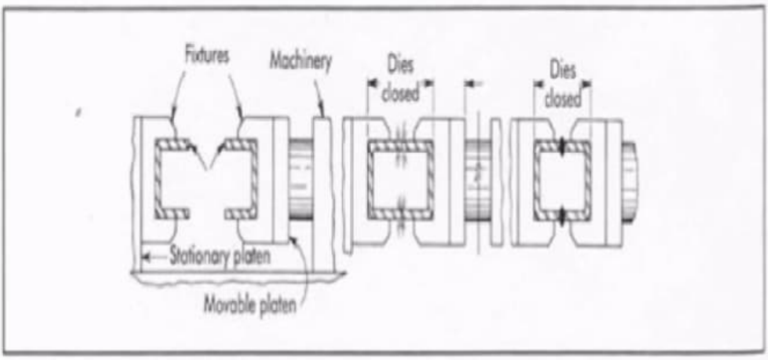


Figure 10-14. Flash-butt welding.

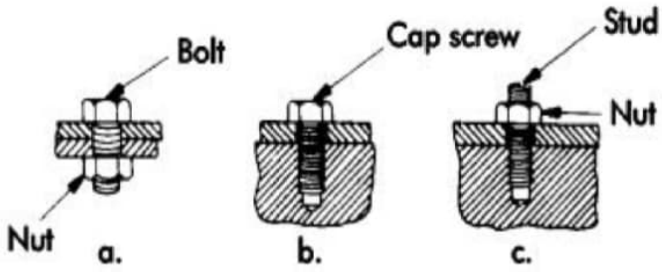
Tooling for Mechanical Joining Processes

Many workpieces can be held for mechanical joining without tooling. A worker often can manually align two workpieces and insert a fastener. This method has several limitations, however. The workpiece must be small or light enough to be positioned manually, and the forces incurred in the joining process must be relatively small. The complexity of an assembly joined in this manner is limited by the number of components a worker can conveniently handle. Thus an elementary workholder often can be used to advantage in even the most simple joining operation.

A universal-type vise can be of great value in mechanical joining. A primary workpiece can be held in any position while other workpieces are fastened to it. Several workpieces may be held in alignment between the jaws while the worker applies a fastener. Clamping pressure can be used to counteract the joining forces, such as torque applied to a threaded fastener.

Threaded Fasteners

Threaded fasteners are also used extensively for assemblies subjected to harsh environmental conditions, such as high temperatures and corrosion.



Typical assemblies using threaded fasteners: (a) bolt and nut; (b) cap screw; (c) stud.

Soldering and Brazing

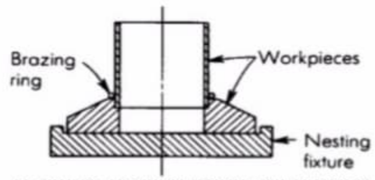
- Soldering and brazing differ from welding in several respects.
- The metal introduced to the workpiece for the joining operation is nonferrous, usually lead, tin, copper, silver, or their alloys.
- The workpiece or base metal is not heated to the melting point during the operation.
- The added metal is melted and usually enters the joint by capillary action.
- Lead-tin soldering is called soft soldering and is conducted below 800°F (427°C).
- Silver soldering is called hard soldering and requires temperatures from 1100° - 1600°F (593° - 871°C).
- Copper brazing requires temperatures from 1900° - 2100°F (1038°- 1149°C).
- The success of these processes depends on chemical cleanliness, temperature control, and the clearance between the surfaces to be joined.
- Cleanliness is usually obtained by introducing a flux which cleans, dissolves, and floats off any dirt or oxides.

Soldering and Brazing

- The flux also covers and protects the area by shielding it from oxidation during the process. It may to some extent reduce the surface tension of the molten metal to promote free flow.
- The worst contamination is usually due to oxidation during the process. Many joining operations are conducted in a controlled atmosphere with a blanket of gas to shield the operation.
- Temperature control, although influenced somewhat by fixture design, is dependent primarily on the heat application method.
- Many soldering and brazing operations are conducted without special tooling.
- As with mechanical joining methods, many work holding devices can be used to conveniently present the faces or areas to be joined.
- An electrical connecting plug can be conveniently held in a vise while a number of wires are soldered to its terminals.
- In many high-production assembly operations, parts are manually mated with a preformed brazing ring between them. They are then placed directly on the endless belt of a tunnel-type furnace, or on a gasheater ring fixture.

Soldering and Brazing

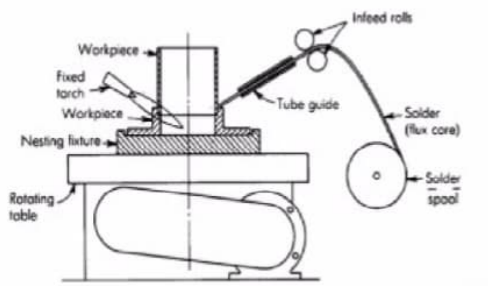
- If the shape of the workpiece is such that it will not support itself in an upright or convenient position, a simple nesting fixture may be required.



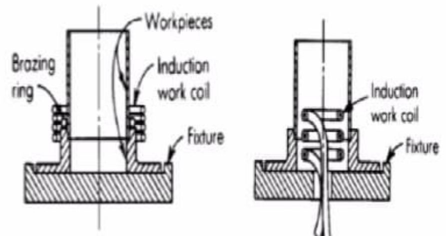
A simple nesting fixture for brazing

- The fixture can be mounted on a table while an operator applies heat with a hand torch. The same fixture could be mounted on a powered rotating base in the flame path of a fixed torch, while a feed mechanism would introduce wire solder at a predetermined rate .
- The same fixture could be attached in quantity to the belt of a tunnel furnace. A number of the fixtures could be attached to a rack for processing in a batch furnace.

Soldering and Brazing



Soldering machine using simple nesting fixture



Brazing fixture with external and internal induction coils

Work holding Principles of NC

- 1. To perform various operations in one work setup.
- 2. Automated transportation from one machine station to
- another, easy locating on machine, automated loading and unloading, automated clamping and unclamping.
- 3. Quick changeover time from job to job

Tooling for CNC Machines

- Design features of CNC Tooling
- (a) To give High accuracy.
- (b) For variety of operations.
- (c) Interchangeability to produce same accuracy.
- (d) Flexibility.
- (e) Rigidity of tooling to withstand cutting forces.
- (f) Rigidity to transmit the power at higher speeds.
- (g) Quick changing of tools to keep the down time minimum

Types of Work holders

- *Types of Workholders*
- 1. Temporary workholders - nonrepetitive jobs standard fixturing devices - vises, clamps.
- 2. Modular workholders - reusability, cost reduction constructed from a group of standardized fixturing devices It can be reassembled within a day or a few hours.
- 3. Permanent workholders - repetitive jobs custom-made holders

Cutting Tools for CNC

- The cutting tools can be classified on the basis of setting up of tool, tool construction and cutting tool material :
- **On the Basis of Setting up of Cutting Tool**
- (a) Preset tools.
- (b) Qualified tools.
- (c) Semi qualified tools.

- **On the Basis of Cutting Tool Construction**
- (a) Solid tools.
- (b) Brazed tools.
- (c) Inserted bit tools.

- **On the Basis of Cutting Tool Material**
- (a) High speed steel (HSS).
- (b) High carbon tool steel (HCS).
- (c) Cast alloy.
- (d) Cemented carbide.
- (e) Ceramics.
- (f) Boron Nitride.
- (g) Diamond.